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**PLANT
PROTECTION**

1. Plant Pathology

(i) Pearl millet

228. KUMAR, R., M. S. PANWAR AND A. S. RATHI 2001. **ROLE OF COLLATERAL HOST IN DEVELOPMENT OF PEARL MILLET ERGOT.** *Forage Res.*, **27 (1) : pp. 47-48.** Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004, India

Maximum ergot disease intensity of 65 per cent was observed in *Pennisetum glaucum* followed by 58 per cent in *Panicum antidotale* and 10 per cent in *Setaria verticillata* when the earheads were inoculated with the conidial suspension of *Claviceps fusiformis* derived from the naturally infected pearl millet earheads. Similarly, maximum disease intensity of 68 per cent was found in *P. antidotale* followed by 65 per cent in *P. glaucum* and 15 per cent in *S. verticillata* when inoculated with conidial suspension obtained from naturally infected *P. antidotale* earheads. However, the trend was not the same when inoculation was done from the conidial suspension of *C. fusiformis* obtained from *S. verticillata*. The maximum disease intensity of 65 per cent was observed in *P. glaucum* followed by 58 per cent in *P. antidotale* and 10 per cent in *S. verticillata*. These weeds, therefore, seem to serve as potential source for the development of ergot in pearl millet.

229. KUMAR, J., A. S. RATHI AND M. S. PANWAR 2002. **BIOCHEMICAL CHANGES IN PEARL MILLET LEAVES DUE TO RUST INFECTION.** *Forage Res.*, **28 (2) : pp. 67-69.** Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004, India

Biochemical parameters governing resistance/susceptibility were evaluated in pearl millet genotypes and changes brought about in these after infection of rust disease were studied. The concentrations of total phenols and ortho-dihydric phenols were higher in leaves of resistant genotypes, whereas total sugars, reducing sugars and total free amino acids were higher in leaves of susceptible genotypes. After rust infection, the concentrations of total phenols and ortho-dihydric phenols increased in all the genotypes, whereas total sugars and reducing sugars increased in resistant and moderately resistant genotypes and decreased in susceptible ones. Concentration of total free amino acids was higher in leaves of susceptible genotypes as compared to resistant genotypes. The concentration of total free amino acids decreased in all the genotypes after rust infection.

230. KUMAR, R., M. S. PANWAR AND A. S. RATHI 2002. **BIOLOGICAL CONTROL OF PEARL MILLET ERGOT BY POLLEN MANAGEMENT.** *Forage Res.*, **28 (2) : pp. 83-84.** Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004, India

Without pollination and no inoculation, the ergot intensity remained very low, however, when the earheads were inoculated with *Claviceps fusiformis*. The disease intensity increased to 58.50 per cent. Only pollination reduced the ergot intensity (3.72%). Pollination followed by inoculation next day caused 8.00 per cent disease intensity. While inoculation followed by pollination resulted in 49.00 per cent disease intensity. Pollination and inoculation at the same time resulted in 15.30 per cent disease intensity. However, when the earheads were bagged (without pollination) and also uninoculated the ergot intensity remained very low.

231. KUMAR, ANIL, RAM NIWAS, ATTAR SINGH AND ANIL KUMAR 2004. **INFLUENCE OF WEATHER PARAMETERS ON SMUT PROGRESSION IN PEARL MILLET VAR. HB-3.** *Forage Res.*, **30 (1) : pp. 13-16.** Department of Agrimeteorology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Agrometeorological indices : growing degree day, heliothermal unit and vapour pressure deficit were computed using the daily meteorological data. These agrometeorological indices and daily weather parameters were correlated with disease intensity, which was transformed using different models of disease progression such as Logistic, Gompertz, Monomolecular and Von Bertalanffy-Richards model. The weather parameters : Maximum, minimum and

mean temperature, wind speed and evening saturation vapour pressure and saturation deficit were negatively and significantly correlated, while morning and mean relative humidity, evaporation rate and growing degree days were positively correlated, with disease intensity. Among these models, disease intensity transformed by Logistic model showed highest correlation with weather parameters followed by Gompertz, Monomolecular and Richards model. The weather parameters such as evaporation, rainfall, mean saturated vapour pressure and mean saturated deficit explained the variability in disease progression upto 77 per cent.

232. JHANSI, K. 2004. **VAIETAL SUSCEPTIBILITY OF PEARL MILLET GERMPLOSM AGAINST SHOOT FLY, *ATHERIGONA APPROXIMATE* MALLOCH.** *Forage Res.*, **30 (3) : pp. 165-168.** AICRP on Forage Crops, Livestock Research Institute, Rajendernagar, Hyderabad-500030 (A. P.), India

The present studies on vaietal susceptibility of pearl millet germplasm against shoot fly was carried out at LRI, Rajendranagar (A.P.). The genotypes APFB-6, APFB-15-98, DRSB-11, DRSB-12, Raj Bajra-2, TNFB 9901, TNFB9902, TNFB 9903 and PCB-164 were found to be resistance.

233. DEYOL, A., ANIL KUMAR, A. S. RATHI AND M. S. PANWAR 2005. **EFFECT OF CROP SEQUENCING ON OOSPORIC LOAD OF *SCLEROSPORA GRAMINICOLA* AND DOWNY MILDEW INCIDENCE IN PEARL MILLET.** *Forage Res.*, **31 (1) : pp. 43-44.** Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Downy mildew caused by *Sclerospora graminicola* (Sacc.) Schroet is one of the most important and wide spread diseases of pearl millet and occurring annually through the oospores which survive for several years in soil. Oospore germination and the factors affecting remain the least understood aspects of downy mildew of pearl millet. The present investigations were undertaken to see the effect of different crops viz., onion, garlic, fenugreek and coriander grown as preceding crops to pearl millet on oosporic load and the downy mildew incidence. Onion crop grown in plot resulted in the maximum reduction of oospores from top as well as upto 15 cm deep soil. Garlic, fenugreek and coriander also reduced the oosporic load from top as well as upto 15 cm depth, when compared with fallow treatment. There was significant increase in the per cent seed germination and reduction in downy mildew incidence when pearl millet crop was grown after onion and garlic. A maximum reduction of downy mildew incidence upto 68.36 per cent at 30 days, 43.70 per cent at 60 days after sowing and 67.78 per cent in green ear incidence was recorded, when pearl millet crop was grown after onion crop. Fenugreek and coriander also reduced the oosporic load, when compared with the fallow treatment and proved effective in checking downy mildew upto 30 days of sowing.

234. SINGH, H. AND J. K. DANG 2005. **SEASONAL AND DIURNAL VARIATIONS IN *SCLEROSPORA GRAMINICOLA* OVER A PEARL MILLET FIELD.** *Forage Res.*, **31 (3) : pp. 203-204.** Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Seasonal and diurnal fluctuation of sporangia of *Sclerospora graminicola* was studied over a bajra field during **kharif** 2003 using Burkard 7-day Recording Volumetric Spore Trap. Sporangia were trapped during all the hours of the day but maximum of 59 per cent sporangia were trapped between 2.00 a. m. and 6.00 a. m., whereas minimum of 4 per cent of the total catch between 10.00 a. m. and 2.00 p. m. Similarly, the sporangia were observed throughout the season but the peak occurred during 3rd week of September. After that the number started decreasing. The diurnal and seasonal pattern of sporangial population helps us to understand the development of downy mildew epidemics in the field.

235. DEYOL, A., ANIL KUMAR, A. S. RATHI AND M. S. PANWAR 2006. **EFFECT OF SEED TREATMENT WITH BACTERIAL ANTAGONISTS AND METALAXYL ON PHYSIOLOGICAL PARAMETERS AND DOWNY MILDEW INCIDENCE IN PEARL MILLET.** *Forage Res.*, **31 (4) : pp. 234-237.** Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Seed treatment with *Pseudomonas fluorescens* in combination with Apron 35 SD @ 3 g kg⁻¹ seed resulted in 30.5 per cent increase in seed germination, 52.94 per cent in root length, 23.34 per cent in dry matter and 90.30 per cent in vigour index as compared to the untreated control. Seed treatment with bioagent *P. fluorescens* alone also significantly increased the seed germination (24.11%), root length (39.21%), dry matter (20.62%) and vigour index (67.16%) as compared to the untreated control. No significant difference in shoot length was recorded in all the treatments. Electrical conductivity fluctuated between the range 8.50-11.30 $\mu\text{mhos cm}^{-1} \text{ seed}^{-1}$ in all the treatments. A lowest electrical conductivity of 8.5 $\mu\text{mhos cm}^{-1} \text{ seed}^{-1}$ was observed, when the seeds were treated with *P. fluorescens*+Apron 35 SD @ 3 g kg⁻¹ of seed as compared to the highest electrical conductivity of 15.85 $\mu\text{mhos cm}^{-1} \text{ seed}^{-1}$ in untreated control. Seed treatment with *P. fluorescens* in combination with Apron 35 SD @ 3 g kg⁻¹ also resulted in maximum seed germination (78.0%) which was at par with the recommended dose of Apron 35 SD @ 6 g kg⁻¹ seed as compared to 66.0 per cent germination in untreated control. Seed treatment with Apron 35 SD @ 6 g kg⁻¹ seed significantly reduced the disease upto 98.46 and 60.29 per cent at 30 and 60 days after sowing, respectively, as compared to the untreated control. When the dose was reduced to half i. e. @ 3 g kg⁻¹ of seed and supplemented with seed treatment with *P. fluorescens*, the reduction in downy mildew was 88.09 per cent as compared to untreated control. Reduction in green ear incidence was also maximum when the seed was treated with *P. fluorescens* alone and in combination with Apron 35 SD @ 3 g kg⁻¹ seed.

236. KUMAR, SURENDER, SUSHIL SHARMA, B. K. SHARMA AND NARESH KUMAR 2006. **PROTECTIVE AND CURATIVE EFFICACY OF ANTAGONISTS AGAINST *SCLEROSPORA GRAMINICOLA* CAUSING DOWNY MILDEW OF PEARL MILLET.** *Forage Res.*, **32 (1) : pp. 34-37.** CCSHAU Krishi Vigyan Kendra, Bhopani, Faridabad-121 101 (Haryana), India

Experiments were conducted under screen house and field conditions to study the protective and curative efficacy of culture metabolites to protect the healthy seedlings of pearl millet from the sporangial infection of *Sclerospora graminicola*. The results indicated that spray of different concentrations of culture filtrates of each antagonist, 24 h prior or later to sporangial inoculation, provided varying degree of protection to the seedlings. The maximum effect was displayed to *Trichoderma harzianum*, *T. viride* and *Aspergillus flavus*. Phytotoxic effect of undiluted concentration of culture filtrates was observed on young seedlings which were severely affected by downy mildew.

237. KUMAR, SURENDER, SUSHIL SHARMA, B. K. SHARMA AND NARESH KUMAR 2006. **EFFECT OF ANTAGONISTS AND THEIR METABOLITES ON INFECTIVITY OF OOSPORES OF *SCLEROSPORA GRAMINICOLA*.** *Forage Res.*, **32 (3) : pp. 176-177.** CCSHAU Krishi Vigyan Kendra, Bhopani, Faridabad-121 101 (Haryana), India

An experiment was conducted under sterilized conditions to know about the infectivity of oospores in the presence/absence of antagonistic mycoflora. The results revealed complete inhibition of oospore's infectivity in the presence of antagonist irrespective of the method of application. The seed germination, plant growth and seedling vigour were normal as compared to reduced growth and sick appearance of the pearl millet seedlings under the treatment where infective oospore material was added without any antagonist.

(ii) Sorghum

238. SAHARAN, M. S., SULTAN SINGH AND D. S. KATIYAR 2001. **CHANGES IN CHLOROPHYLL, STRUCTURAL CARBOHYDRATES AND CRUDE PROTEIN IN SORGHUM LEAVES INFECTED WITH GLOECERCOSPORA SORGHI.** *Forage Res.*, **27 (3) : pp. 155-158.** Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

The effect of zonate leaf spot (*Gloeocercospora sorghi*) infection on chlorophyll contents and forage quality components of sorghum variety, HC-171 was studied. Infected leaves exhibited significant decrease in chlorophyll contents (Chlorophyll a, chlorophyll b and total chlorophyll), NDF, hemicellulose and crude protein as compared to healthy leaves (0 disease grade). However, there was increase in ADF in infected leaves as compared to healthy leaves (0 disease grade). This increase in ADF and decrease in chlorophyll a, chlorophyll b, total chlorophyll, NDF and hemicellulose was in linear proportion with increase in disease severity as compared to control (0 grade).

239. RIZVI, GAZALA, S. N. SINGH AND S. T. AHMAD 2001. **SCREENING OF FORAGE SORGHUM FOR MULTIPLE RESISTANCE TO MAJOR FOLIAR DISEASES.** *Forage Res.*, **27 (3) : pp. 217-220.** Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

Five hundred and thirteen forage sorghum collections were screened under field conditions for resistance to anthracnose, zonate leaf spot and sooty stripe during **kharif** 1995 and 1996. In addition, 12 promising entries were also evaluated for their reactions to leaf blight besides the above three foliar diseases. A high degree of resistance was observed in lines of cross 2077A x IS 18677 followed by ICS 92A x IS 6284. The entries 2219A x SMI 13 x 14-1-1-1 and Hyb. 14136 and J. Sel. 15 were found resistant to the four diseases. The rough leaf spot was most severe than to other diseases.

240. YADAV, R., R. P. S. GREWAL AND A. S. RATHI 2003. **EVALUATION OF FORAGE SORGHUM GERMPLASM LINES AGAINST IMPORTANT FOLIAR DISEASES.** *Forage Res.*, **28 (4) : pp. 204-206.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004, India

One hundred and six germplasm accessions were screened to identify the sources of resistance against three major foliar diseases viz., grey leaf spot (*Cercospora sorghi*), zonate leaf spot (*Cercospora sorghi*), zonate leaf spot (*Gloeocercospora sorghi*) and sooty stripe (*Ramulispora sorghi*). Fifty-five genotypes were found resistant to grey leaf spot, 79 to zonate leaf spot and 81 registered resistance against sooty stripe. Thirty-one genotypes can further be utilized in resistance breeding programmes.

241. SINGH, H., P. P. GUPTA AND VIVEK GUPTA 2004. **EFFECT ON DEVELOPMENT OF GREY LEAF SPOT OF SORGHUM IN RELATION TO WEATHER VARIABLES AND SOWING DATES.** *Forage Res.*, **29 (4) : pp. 198-200.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Grey leaf spot of sorghum [*Sorghum bicolor* (L.) Moench] induced by *Cercospora sorghi* has attained serious dimensions in all the sorghum growing areas of Haryana causing heavy reduction in green fodder yield and the quality of fodder crop. Grey leaf spot in combination with other foliar diseases causes losses ranging from 5-50 per cent in grain and fodder yield. The level of infection increases during humid weather conditions. This study was conducted to see the effect of various weather parameters on the development of this disease sown on different dates. The effects of three sowing dates from second fortnight of April to first fortnight of June on grey leaf spot of sorghum were studied in relation to weather parameters during cropping seasons of 2000 and 2001 using two susceptible (SSG 59-3 and IS-10954) and two tolerant (HC-308 and FSH-92079) cultivars. The crop showed least incidence of grey leaf spot when it was planted on first fortnight of June in both the types of cultivars. The highest

disease intensity was recorded when crop was planted during mid May. However, fodder yield was significantly better on this date of sowing because disease severity did not affect the fodder yield much. Significant and positive correlation existed between disease severity and weather factor i. e. humidity. However, disease severity had a strong negative correlation with temperature. The rate of infection on the first two sowing dates was initially less and finally showed sharp increase.

242. JHANSI, K. 2006. **EVALUATION OF DUAL PURPOSE FORAGE SORGHUM GENOTYPES FOR RESISTANCE TO SHOOT FLY AND STEM BORER.** *Forage Res.*, **31 (4) : pp. 274-275.** AICRP on Forage Crops, Livestock Research Institute, Rajendernagar, Hyderabad-500030(A.P.).

It was observed that the genotypes Su 658, UTFS 44, PVK 809, Mass/7/03, SRF 252, 1032, Mass 1/03, SRF 254, CVS 15, UTFS 40, and SPV 1535 were moderately resistance to stem borer but moderately susceptible to shoot fly.

243. RATHI, A. S., R. YADAV AND S. K. PAHUJA 2007. **EVALUATION OF FORAGE SORGHUM GENOTYPES FOR RESISTANCE AGAINST MAJOR FOLIAR DISEASES.** *Forage Res.*, **33 (3) : pp. 174-176.** Forage Research Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Thirty-four forage sorghum genotypes were screened against grey leaf spot, zonate leaf spot and sooty stripe diseases under artificial inoculation conditions during **kharif** 2005 and 2006. Genotypes G 46, G 48, S 199, S 512, S 513, S 437-1, S 540 and S 541 showed multiple resistance against grey leaf spot, zonate leaf spot and sooty stripe diseases. However, six genotypes viz., IS 2385, IS 3237, G 41, G 137, G 171 and G 172 exhibited resistance only against two diseases. These sources having multiple resistance against foliar diseases can be utilized to incorporate disease resistance traits in otherwise high yielding genotypes or can be directly used as pollinators in hybrid breeding programmes.

244. GUPTA, P. P., HARBINDER SINGH AND RAJESH YADAV 2009. **EFFECT OF BOTANICALS AGAINST GREY LEAF SPOT DISEASE IN FORAGE SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH].** *Forage Res.*, **35 (2) : pp. 110-112.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

With the increase in awareness towards toxic hazards of fungicides, three botanicals viz., neem kernel powder (*Azadirachta indica*), tumba cake powder (*Citrullus colocynthis*) and mustard cake powder (*Brassica campestris*) were applied in three different doses (5, 10 and 15 g/metre row length) making nine treatments and their effect against grey leaf spot disease in sorghum was observed. Two separate checks viz., recommended spray of dithane M-45 (0.2%) and inoculated check were also maintained. Results showed that all the three botanicals at the three doses were found effective in reducing the disease incidence significantly over the untreated check but none of the botanicals was found superior over the treated check (Dithane M-45, 0.2% spray). Amongst all the three botanicals, neem kernel powder at all the doses proved its superiority over others. Neem kernel powder 15 g/metre row length gave minimum disease intensity and highest green fodder and grain yield. In terms of efficacy, neem kernel powder was closely followed by tumba cake powder.

(iii) Clusterbean

245. SAHARAN, M. S., G. S. SAHARAN AND SULTAN SINGH 2001. **EFFECT OF ALTERNARIA BLIGHT SEVERITY ON FODDER QUALITY OF CLUSTERBEAN.** *Forage Res.*, **27 (3) : pp. 221-224.** Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

To determine the effect of different levels of disease (*Alternaria cucumerina* var. *cyamopsidis*) on fodder quality of clusterbean variety, FS-277 to the structural carbohydrates (NDF, ADF, hemicellulose, cellulose, lignin,

silica and organic matter) and crude protein (CP) were analysed. The amount of NDF, ADF, hemicellulose, cellulose, lignin and silica contents was observed to be significantly higher with the increase in *Alternaria* blight (*Alternaria cucumerina* var. *cyamopsidis*) severity as compared to healthy leaves (0 grade). However, crude protein and organic matter decreased with increase in disease severity.

246. KUMAR, S., SUSHIL SHARMA, NARESH KUMAR AND P. P. GUPTA 2005. **IMPACT OF EDAPHIC FACTORS ON THE DEVELOPMENT OF DRY ROOT ROT OF CLUSTERBEAN.** *Forage Res.*, 31 (1) : pp. 48-50. CCSHAU Regional Research Station, Bawal-123 501, Rewari (Haryana), India

Results revealed that 48.6 per cent pre-emergence mortality (PEM) and 17.9 per cent post-emergence mortality (POEM) were recorded with inoculum density of 1 : 20. Four days old culture induced 47.1 per cent PEM and 13.5 per cent POEM. A temperature of 29±2°C could cause 60.7 and 17.1 per cent PEM and POEM, respectively. Soil moisture of 40 per cent was most favourable and resulted in 40.8 per cent PEM and 14.2 per cent POEM.

247. SHARMA, SUSHIL, D. V. PATHAK, S. KUMAR AND NARESH KUMAR 2005. **EFFICACY OF PLANT FORMULATIONS AND BIOAGENTS IN CONTROLLING ROOT ROT OF CLUSTERBEAN.** *Forage Res.*, 31 (2) : pp. 103-105. CCSHAU Regional Research Station, Bawal-123 501, Rewari (Haryana), India

Different plant extracts and bioagents were evaluated under *in vitro*, *in vivo* and field conditions against *Rhizoctonia bataticola* causing root rot of clusterbean. *Trichoderma harzianum* showed its supremacy in controlling root rot incidence both under laboratory and pot conditions. However, under field conditions neem (*Azadirachta indica*) extract was adjudged best among all the treatments as it recorded least root incidence (4.7%) and highest grain yield (6.63 q/ha), followed by marwa (*Mirabilis jalapa*) and bavistin.

248. YADAV, E., D. V. PATHAK, NARESH KUMAR AND P. K. SHARMA 2005. **EVALUATION OF TN-5 MUTANTS OF PSEUDOMONAS MALTOPHILA FOR ROOT ROT CONTROL IN CLUSTERBEAN.** *Forage Res.*, 31 (3) : pp. 215-217. Regional Research Station, Bawal-123 501, Rewari (Haryana), India

Two *Tn-5* mutants P-7 and P-48 alongwith the parent PM-4 of *Pseudomonas maltophila* were examined for root rot control in clusterbean under screen house and natural conditions. Four fungal pathogens, namely, *R. bataticola*, *R. solani*, *F. oxysporum* and *S. sclerotiorum* associated with root rot complex were tested against mutants. Maximum disease control was observed with P-7 both under pot culture and field conditions. When these mutants were coinoculated with *Rhizobium* sp. and PSB, per cent disease control was enhanced.

249. KUMAR, S., SUSHIL SHARMA, NARESH KUMAR AND P. P. GUPTA 2008. **MANAGEMENT OF DRY ROOT ROT OF CLUSTERBEAN CAUSED BY RHIZOCTONIA BATATICOLA.** *Forage Res.*, 34 (3) : pp. 160-164. CCSHAU Regional Research Station, Bawal-123 501, Rewari (Haryana), India

Seven fungicides were tested under laboratory, screen house and field conditions alongwith organic amendments and different sowing dates against dry root rot of clusterbean incited by *Rhizoctonia bataticola*. Bavistin, benlate and vitavax showed cent per cent inhibition of mycelial growth at 50 ppm. In pot experiment, seed treatment with bavistin resulted in 21.1 per cent pre-emergence mortality (PEM) and 4.4 per cent post-emergence mortality (POEM), while in check it was 51.1 and 12.8 per cent. Under field conditions, maximum disease control (59%) and seed yield (23.1 q/ha) were observed in combination treatment of bavistin (2 g/kg)+bavistin spray (0.15). Early sowing (29 June) resulted in reduced disease incidence and more seed yield (17.7 q/ha). Mustard residue incorporation+vermicompost supplementation+summer irrigation gave 65 per cent disease control and 23.4 q/ha seed yield.

(iv) Berseem

250. KUMAR, K., A. S. RATHI AND RAMAVTAR 2003. **COMPARATIVE PERFORMANCE OF EGYPTIAN CLOVER GENOTYPES FOR RESISTANCE TO STEM ROT.** *Forage Res.*, **28 (4) : pp. 241-242.** Forage Section, CCS HAU, Hisar.

The performance of 30 Egyptian clover genotypes for resistance to stem rot was tested at CCSHAU, Hisar. In the present study, none of tested genotypes was found completely free from stem disease; however, two genotypes viz. HFB 115 and HFB 100-1 showed resistance reaction (<5% disease incidence).

251. BHASKAR, R. B., N. HASAN, K. C. PANDEY AND N. P. MELKANIA 2003. **MANAGEMENT OF ROOT-ROT DISEASE COMPLEX OF BERSEEM (*TRIFOLIUM ALEXANDRINUM* L.).** *Forage Res.*, **29 (2) : pp. 84-87.** All India Coordinated Project For Research on Forage Crops, Indian Grassland, Fodder and Agroforestry Research Institute, Jhansi-284 003 (U. P.), India

A trial was conducted for three consecutive years i. e. 1999-2000, 2000-01 and 2001-02, with the objective to manage effectively the root-rot disease complex by economically feasible and safe measure. The treatments consisted of soil and seed treatments of carbofuran, carbendazim, **neem** seed powder and **neem** cake in different combinations. Lower incidence of disease and nematode (*Tylenchorhynchus vulgaris*) and maximum green fodder yield were recorded in soil treatment with carbofuran 3G @ 1g/m row+seed treatment with carbendazim @ 2 g/kg seed. Seed treatment with **neem** seed powder @ 50 g/kg provided highest cost : benefit ratio (1: 69.4) suggesting the environmentally and economically effective management practice for this disease complex.

252. GUPTA, P. P., RAKESH KUMAR, A. S. RATHI AND B. L. JALALI 2005. **EFFECT OF SINGLE AND MULTIPLE INOCULATION OF EGYPTIAN CLOVER WITH *RHIZOBIUM*, *AZOTOBACTER* AND *VA-MYCORRHIZA* ON GROWTH, NUTRITION AND TOLERANCE TO INFECTION BY *SCLEROTINIA TRIFOLIORUM*.** *Forage Res.*, **31 (1) : pp. 33-38.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Interaction of *Glomus fasciculatum*, *Rhizobium leguminosarum* f. sp. *trifolii* and *Azotobacter chroococum* with *Sclerotinia trifoliorum* was studied in P-deficient sterilized soil. Plants inoculated with *G. fasciculatum*, *Azotobacter* and *Rhizobium* increased the plant height and mycorrhizal colonization of both the genotypes of Egyptian clover. Plants inoculated with all the three organisms recorded highest root and shoot dry weight and NPK content. Interactions of all the three organisms revealed that inoculation with bioagents significantly decreased the stem rot incidence from 52.6 to 55.0 per cent in both the cultivars. It is concluded that addition of bioagents derives maximum benefit from triple inoculation for management of stem rot of Egyptian clover in nutrient deficient soil.

253. RATHI, A. S., R. AVTAR AND B. S. JHORAR 2007. **SOURCES OF MULTIPLE RESISTANCE AGAINST STEM ROT AND ROOT ROT DISEASES IN EXOTIC AND INDIGENOUS GENOTYPES OF EGYPTIAN CLOVER.** *Forage Res.*, **32 (4) : pp. 201-203.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Twelve exotic and 25 indigenous genotypes of Egyptian clover (*T. alexandrinuni* L.) with different origin were screened for resistance against stem rot and root rot diseases under permanent sick plot conditions during rabi 2004-05 and 2005-06. Highly susceptible variety Mescavi was repeated after every two test entries in the sick plot. Out of 12 exotic genotypes tested, two genotypes viz., EC 253482 and EC 253484 showed multiple moderate resistance (<10% disease incidence) against both stem rot and root rot diseases. Among 24 indigenous genotypes screened, HFB 119, HFB 165 and HFB 700 showed multiple resistance (<5% incidence) against both the diseases. Moreover, four genotypes viz., HFB 216, HFB 234, HFB 495 and HB 1 exhibited multiple moderate resistance (<10% incidence) against both the diseases. The breeding programmes for development of resistant.

254. RATHI, A. S., R. AVTAR AND B. S. JHORAR 2007. **PREVALENCE AND SEVERITY OF STEM ROT DISEASE OF BERSEEM IN HARYANA—A SURVEY REPORT.** *Forage Res.*, **32 (4)** pp. 260-261. Forage Section, CCS Haryana Agricultural University, Hisar

It was observed that stem rot disease was prevalent in all the berseem growing regions of the Haryana state and the incidence ranged from 0+60 per cent at farmers' field. A maximum of 20-60 per cent incidence was recorded in Rohtak district.

255. HASAN, N., R. B. BHASKAR AND K. C. PANDEY 2007. **MANAGEMENT OF BERSEEM ROT COMPLEX THROUGH SALICYLIC ACID AND NEEM SEED KERNEL POWDER.** *Forage Res.*, **33 (2)** : pp. 78-81. All India Co-ordinated Project for Research on Forage Crops, Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

A field experiment was conducted at Jhansi during winter (**rabi**) season to find out the efficacy of salicylic acid on rot disease complex of berseem (var. Mescavi) with six treatments viz., T₁=Seed soaking (0.02%), T₂=Spray (0.02%) after 1st and 2nd cut, T₃=T₁+T₂, T₄=Seed treatment with neem seed kernel powder (50 g/kg), T₅=T₄+T₂ and T₆=Untreated control. All the treatments reduced both the nematodes and disease incidence and increased total green forage yield to a varying extent. Maximum increase (32.4%) in total green fodder yield was observed in T₅ (seed treatment with neem seed kernel powder+spray of salicylic acid after 1st and 2nd cut) as compared to untreated control. However, T₃ (seed soaking with salicylic acid+spray of salicylic acid) was found to be most effective both in reducing the diseases and nematode incidence. It is, therefore, suggested that potential use of salicylic acid both as seed soaking and spray may be further explored in larger areas endemic to these diseases.

256. PANDE, P. P., A. S. RATHI AND R. AVATAR 2008. **EFFECT OF DATE OF SOWING ON INCIDENCE OF STEM ROT IN EGYPTIAN CLOVER.** *Forage Res.*, **33 (4)** : pp. 212-215. Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Early sowing of Egyptian clover (1st week of Oct.) resulted in the highest disease incidence (62.5%), lowest green fodder (278.7 q/ha) and minimum seed yield (0.96 q/ha). It was observed that percentage of infected tillers was significantly low (32.4) in late sowing (3rd week of Nov.) as compared to normal (3rd week of Oct.) and (1st week of Oct.) early sowing (46.2 and 62.5), respectively. Maximum disease incidence was recorded just before second cut as compared to first and third cut. During second cut, highest (50.3%) and lowest (20.4%) disease incidence was observed in early (1st week of Oct.) and late (3rd week of Nov.) sown crop, respectively.

257. PANDE, P. P., A. S. RATHI, R. AVTAR AND ANIL KUMAR 2008. **VIABILITY OF SCLEROTIA OF SCLEROTINIA TRIFOLIORUM ERIKSS. AT DIFFERENT DEPTH AND DURATION IN SOIL.** *Forage Res.*, **34 (1)** : pp. 44-48. Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Sclerotia of *Sclerotinia trifoliorum* Erikss. obtained from natural infected Egyptian clover plants were wrapped in synthetic net and buried at different depths and duration to test their viability and found that viability declined gradually in screen house and sharply in natural field conditions with the increase in soil depth and duration of burial. None of the sclerotia germinated when placed below 5 cm for six months in comparison to 82.5 per cent germination at 7.5 cm depth after one month of burial in soil under field condition.

258. PANDE, P. P., A. S. RATHI AND R. AVTAR 2008. **MANAGEMENT OF STEM ROT OF EGYPTIAN CLOVER USING BIO-AGENTS AND CHEMICALS.** *Forage Res.*, **34 (2)** : pp. 83-86. Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Soil application of *Trichoderma viride* (4 kg) mixed along with FYM (60 kg) per hectare before sowing significantly reduced the stem rot incidence of Egyptian clover by 46.3 per cent and increased the green fodder and

seed yield by 43.6 and 53.6 per cent, respectively, as compared to control. Seed treatment with carbendazim (2 g/kg) and salicylic acid solution (0.02%) both for seed soaking and spray significantly reduced the stem rot incidence and increased the green fodder and seed yield, respectively.

- 259.** PANDE, P. P., A.S. RATHI AND R. AVTAR. 2009. **EFFECT OF CROP SEQUENCING ON INCIDENCE OF STEM ROT IN EGYPTIAN CLOVER.** *Forage Res.*, **34 (4) : pp. 205-207.** Department of plant pathology, CCS Haryana Agricultural University, Hisar-125004(Haryana),India.

Field experiment was conducted at Hisar during kharif 2007 and rabi 2007-08 crop seasons to find out the effect of different crops grown in stem rot in kharif seasons on the incidence of stem rot in Egyptian clover during rabi season. Crop sequencing had significant effects in reducing the disease incidence as compared to fallow (control) in all the three cuts. Maximum incidence of stem rot (76.8 percent) and lowest green fodder (265.4 q/ha) and seed yield (1.20 q/ha) was recorded, when Egyptian clover was grown in the plots which were left fallow during kharif season. Growing maize in the preceding kharif season significantly reduced stem rot incidence by 46.7 per cent and increased green fodder and seed yields by 52.2 and 47.5 per cent, respectively, as compared to fallow treatment. Similarly, planting sorghum and pearl millet as preceding kharif crops also significantly reduced stem rot incidence and increased the yield parameters.

- 260.** RATHI, A. S., RAMNIWAS, RAMAVTAR AND S. K. PAHUJA 2010. **EFFECT OF WEATHER VARIABLES ON DEVELOPMENT OF STEM ROT DISEASE IN BERSEEM.** *Forage Res.*, **36 (3): pp. 137-141.** Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Development of stem rot disease in Egyptian clover or berseem (*Trifolium alexandrinum*) caused by *Sclerotinia trifoliorum* was assessed under sick plot conditions at Forage Research Area, CCSHAU, Hisar during **rabi** 2001-02 to 2006-07 and correlated with weather parameters. The disease started appearing from the last week of December to the first week of January, when the overall mean temperature during this period was 12.1°C (ranging between 5.0-19.1°C) and overall mean relative humidity was 77.3 per cent (ranging between 58.1-95.5%) with low overall mean sunshine hours. There was a steep increase in incremental disease incidence from last week of January to 3rd week of February, when the overall mean temperature during this period was 13.5°C (ranging between 6.1-21.0°C) and overall mean relative humidity was 75.9 per cent (ranging between 58.0-93.7%) with overall low mean sunshine hours. Among the weather parameters, mean temperature, evening relative humidity and sunshine hours showed significant association with disease incidence. Mean temperature and sunshine hours were negatively correlated with disease incidence, while evening relative humidity favoured the disease incidence. Regression models based on individual weather variable explained the maximum variability upto 47 per cent, however, the above said significant weather factors collectively explained variability upto a greater extent of 68 per cent in case of stem rot in berseem.

(v) Fenugreek

- 261.** AVTAR, R., D. S. JATASRA, VIVEK GUPTA AND U. N. JOSHI 2002. **ASSOCIATION OF BIOCHEMICAL PARAMETERS WITH POWDERY MILDEW SEVERITY IN FENUGREEK.** *Forage Res.*, **27 (4) : pp. 295-298.** Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Present study was conducted at CCS HAU, Hisar. It was observed that total phenols, orthodihydric phenols, total chlorophyll, chlorophyll 'a', chlorophyll 'b', carotenoids and catalase activity. A positive and significant relationship was also observed between catalase activity, total chlorophyll, chlorophyll 'a', chlorophyll 'b', carotenoids, total phenols and orthodihydric phenols.

- 262.** LAKRA, B. S. 2003. **EFFECT OF DATE OF SOWING AND CROP GEOMETRY ON DOWNY MILDEW INCIDENCE AND SEED YIELD OF FENUGREEK.** *Forage Res.*, **29 (2) : pp. 65-67.** Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was designed during 1999-2000 and 2000-01 to break the outbreak of downy mildew of fenugreek through date of crop culturing and crop geometry. Results revealed that disease severity and wider row spacing had confounding effect on seed yield. East-west sowing with wider row spacing exhibited less disease than north-south row sowing with dense crop geometry at every date of planting. Under favourable conditions, when temperature ranged from 10-12°C, RH>80% and availability of free water on leaf surface for >8 h, then multi-cyclic infection on leaves, increased exponentially. Late November sown crop exposed to period of high temperature and low humidity produced sparse vegetative foliage providing unfavourable microclimate for infection and disease development.

- 263.** SHARMA, S., P. P. GUPTA AND O. P. YADAV 2004. **IMPACT OF SOWING DATES AND ENVIRONMENTS ON POWDERY MILDEW OF FENUGREEK.** *Forage Res.*, **30 (1) : pp. 3-5.** CCS HAU Regional Research Station, Bawal-123 501, Rewari (Haryana), India

A field experiment was conducted at three locations (Bawal, Hisar and Mahendragarh) to verify the results on the effect of sowing dates on powdery mildew incidence and seed yield of fenugreek. The results revealed that crop sown on October 30 gave higher seed yield with lowest disease severity at all the locations. The pathogen was restricted to leaves in first two sowings (October 20 and 30), whereas in last sowing (November 30), all the plant parts including pods were affected.

- 264.** AVTAR, R., A. S. RATHI, S. K. PAHUJA AND D. S. JATASRA 2006. **ROLE OF CHLOROPHYLL IN DEFENCE AGAINST POWDERY MILDEW DISEASE IN FENUGREEK.** *Forage Res.*, **32 (1) : pp. 17-20.** Forage Research Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The contents of total chlorophyll, chlorophyll 'a', chlorophyll 'b' and carotenoids in leaves of powdery mildew resistant (NLM and HM 350) and susceptible (T 8 and HM 65) genotypes were determined at 40, 80 and 100 days after sowing (DAS) in inoculated (E_1) and natural (E_2) environments. The contents of all the pigments were observed to be higher in resistant hosts as compared to susceptible ones before the appearance of disease (40 DAS) in both E_1 and E_2 . After infection, no apparent differences were observed in their contents in healthy leaves of resistant and susceptible genotypes. However, the infection reduced the contents of these pigments in linear proportion to the severity of the disease. Contents of chlorophyll 'a' remained higher than chlorophyll 'b' at all the growth stages. Possible role of these pigments in imparting resistance against powdery mildew disease in fenugreek has been highlighted.

- 265.** LAKRA, B. S. 2006. **RECOVERY PHENOMENON TO DOWNY MILDEW IN FENUGREEK.** *Forage Res.*, **32 (1) : pp. 55-57.** Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

When leaves are subjected to dry and warm conditions for longer duration of time, under such conditions, conidia of *P.trigonell* either become air born or develop into oospores and infected leaves start acquiring chlorophyll content reffered here to as recovery mechanism.

266. AVTAR, R., A. S. RATHI, S. K. PAHUJA AND D. S. JATASRA 2006. **INHERITANCE OF PLANT HEIGHT IN FENUGREEK UNDER POWDERY MILDEW INOCULATION AND NATURAL ENVIRONMENTS.** *Forage Res.*, **32 (2) : pp. 116-117.** Forage Research Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Inheritance of plant height in fenugreek (*Trigonella foenum-graecum* L.) was studied using six generations (P_1 , P_2 , F_1 , F_2 , B_1 and B_2) of a cross between NLM (tall) and HM 350 (dwarf) in two different environments i.e. inoculated with conidia of powdery mildew disease (E_1) and natural conditions (E_2). Dominance effects were present at most of the loci for plant height. The variances of F_2 and backcross generations and genetic analysis indicated the preponderance of non-additive gene effects with presence of generally all types of epistatic effects. Among interactions, dominance x dominance type was important. Suitable methodology has been suggested for further improvement in this trait.

(vi) Other Crops

267. SAINI, M. L., PUNIT JAIN AND SUSHIL SHARMA 2006. **SCREENING OF MOTHBEAN [*VIGNA ACONITIFOLIA* (JACQ.) MARECHALL] AGAINST YELLOW MOSAIC VIRUS.** *Forage Res.*, **31 (4) : pp. 271-272.** Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Results of present investigation revealed that none of the 170 genotypes was found resistance to yellow mosaic virus. However, five genotypes, viz. IC 39616, IC 39617, MH 8, MH 50 and MH 82 were found moderately sensible against yellow mosaic virus.

268. ARORA, RYBY, U. N. JOSHI, P. P. GUPTA AND J. V. SINGH 2007. **EFFECT OF YELLOW MOSAIC VIRUS ON STRUCTURAL CARBOHYDRATES IN MOTHBEAN (*VIGNA ACONITIFOLIA*).** *Forage Res.*, **33 (1) : pp. 52-55.** Department of Biochemistry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Mothbean plant (resistant and susceptible) genotypes were inoculated with yellow mosaic virus (YMV) at 30 days after sowing (DAS), under controlled conditions in naturally lit net house. Leaf samples were collected at 37, 48 and 66 DAS and analysed for structural carbohydrates. Following inoculation, the structural carbohydrates viz., NDF and silica content showed no regular trend. However, significant increase was observed in the contents of ADF, cellulose and lignin in the leaves of inoculated plants as compared to the control plants. The contents of these constituents (i. e. ADF, cellulose and lignin) increased gradually during subsequent stages of plant growth attaining its maximum value at 66 DAS. These biochemical constituents may prove helpful in providing defence to the plant against the pathogen. In contrast, hemicellulose content declined in the inoculated plants of all the four genotypes over the uninoculated one at all stages of plant growth. Sharp decrease was noted at 66 DAS. This decrease in the contents of hemicellulose may be responsible for the irregular trend in the NDF content.

269. KATOCH, R. AND SALEJ SOOD 2008. **EFFECT OF ANTHRACNOSE DISEASE ON THE YIELD POTENTIAL OF RICE BEAN [*VIGNA UMBELLATA* (THUNB.) OHAWI AND OHASHI].** *Forage Res.*, **34 (3) : pp. 174-178.** Department of Plant Breeding & Genetics (FPGMC), CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062 (H. P.), India

In the study conducted on different rice bean genotypes revealed the occurrence of Anthracnose disease to variable extents, which affected different productivity traits and ultimately the yield of the crop. Infestation of the disease was observed during early vegetative phase when the environmental conditions were favourable for the disease. Local genotypes (Dhagwar and Baroi), IC-137190 (Sikkim), IC-140803 (Punjab) and IC-016801 (Manipur) were highly affected by the disease, whereas IC-137195 (UP), IC-019352 (Orissa), IC-140795 (Punjab) and IC-

140796 (Punjab) were least affected as reflected in their yield. When the conditions for the pathogen turned unfavourable as indicated by the weather data, few of the genotypes showed the tendency to recover from the disease. The disease also affected pod setting, as the genotypes with higher disease severity were having less number of pods and higher number of pods were collected in the least affected genotypes. The study thus revealed the occurrence and the importance of Anthracnose disease on the overall productivity of the crop.

- 270.** BHATTACHARYA, N. M., SUMONA MONDAL, SOMNATH BHATTACHARYA AND D. K. DE 2009. **GENETIC DIVERSITY STUDY USING MOLECULAR MARKERS AND IDENTIFICATION OF A GENE SOURCE IN RICE BEAN (*VIGNA UMBELLATA*) FOR TOLERANCE TO YELLOW MOSAIC VIRUS (YMV).** *Forage Res.*, **35 (2) : pp. 59-66.** Department of Genetics, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia (West Bengal), India

A study was undertaken to assess genetic diversity in 17 rice bean germplasm collected from different parts of the state of West Bengal and to characterize them at molecular level using simple sequence repeat (SSR), inter simple sequence repeat (ISSR) and random amplified polymorphic DNA (RAPD) markers. Attempt was also made to screen these germplasm for yellow mosaic virus (YMV) resistance that causes major loss to most pulses. Amplification of genomic DNA of the 17 germplasm using six primers for ISSR analysis and one primer for SSR analysis yielded 296 fragments that could be scored. Percentage of polymorphism ranged from 1.44 per cent (IS-8) to a maximum of 100 per cent (IS 65, SSR GO 26, IS 63 and IS 65). The average polymorphism was 63.31 per cent, while four primers showed more than 60 per cent polymorphism. A dendrogram has been generated based on UPGMA analysis which grouped 17 genotypes with Jaccard's similarity coefficient from 0.95-0.57. Of the 17 genotypes, KRB-8, KRB-9 and KRB-10 appeared to be distinctly diverse from other genotypes that clustered in four close-knit groups. Of these groups I, II and III each clustered around 0.74-0.77 similarity level, while group IV was seen to cluster at about 0.85 similarity level and formed a distinctly diverse group of genotypes. Screening of these selected rice bean genotypes for the tolerance to YMV using molecular markers had a great success in the present study. Resistant gene analog primer (YM1F/YM2R), generated and applied in blackgram (Basak *et al.*, 2005) enabled us to identify rice bean as gene source for tolerance to yellow mosaic virus (YMV).

- 271.** BANYAL, D. K. 2009. **INTEGRATED MANAGEMENT OF POWDERY MILDEW AND CLOVER ROT DISEASES OF WHITE CLOVER (*TRIFOLIUM REPENS L.*).** *Forage Res.*, **34 (4) : pp. 212-215.** Department of Plant Pathology, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062 (H. P.), India

White clover (*Trifolium repens L.*) is one of the most important perennial leguminous forage crops of Himachal Pradesh. This is affected by large number of diseases causing serious losses to the crop. Powdery mildew (*Erysiphe trifolii Grew*) and clover rot or crown and stem rot (*Sclerotinia trifoliorum Eriksson*) are the most destructive and widely prevalent diseases in the state. An experiment on seed crop with 10 treatments at two locations i.e. Palampur and Salooni was conducted for three years for the management of these diseases. Maximum powdery mildew control i.e. 92.2 per cent at Palampur and 88.7 per cent at Salooni was recorded by the same seed treatment followed by alternate spray of contaf (hexaconazole 5 EC) @ 0.05 per cent and karathane (dinocap 48 EC) @ 0.05 per cent. However, minimum rot incidence was observed when seeds were treated with thiram (thiram 75%DS) @ 2g/kg seed+bavistin (carbendazim 50% WP) @ 2g/kg seed and followed by spray of carbendazim @ 0.1%, which provided 82.3 and 75.4 per cent disease control at Palampur and Salooni, respectively. Seed treatment with thiram+carbendazim followed by alternate spray of contaf and karathane also gave maximum per yield increase i.e. 75.0 and 82.2 at Palampur and Salooni, respectively, over check. Hence, it is concluded that if clover rot/crown and stem rot is only the problem then seed treatment with thiram+carbendazim should be followed spray of carbendazim, otherwise for the management of both the diseases is effective.

272. PATEL, N. N., C. C. PATEL, M. R. PATEL, H. P. PARMAR AND H. R. KHER 2010. **MANAGEMENT OF ROOT-ROT OF COWPEA CAUSED BY *FUSARIUM SOLANI***. *Forage Res.*, **35 (4) : pp. 227-230**. Main Forage Research Station, Anand Agricultural University, Anand-388 110 (Gujarat), India

A field experiment was conducted at Main Forage Research Station, Anand Agricultural University, Anand during **kharif** 2003, 2004 and 2005 to study the efficacy of systemic fungicides, bio-agents, different cakes and FYM against root rot disease of cowpea [*Vigna unguiculata* (L.) Walp.] caused by *Fusarium solani*. Among different seed dressers tried, seed treatment with carbendazim @ 2.0 g/kg seed alone significantly reduced pre-emergence (8 DAS) rotting (16.64%) and post-emergence (60 DAS) rotting (27.02 %) with highest yield of green fodder (210 q/ha), dry fodder (37 q/ha) and crude protein (6.74 q/ha), respectively, as compared to control. *Trichoderma viride* @ 5.0 g/kg seed+FYM 4000 kg/ha as a furrow application was found second best in order to reduce post-emergence rotting (27.86%) and increased green fodder (197 q/ha) and dry fodder (37 q/ha), respectively, as compared to control.

2. Entomology

273. DHALI WAL, J. S. AND NIRMAL SINGH 2002. **EFFECT OF CHEMICAL CONTROL ON *RHOPALOSIPHUM PADI* (L.) AND ITS PREDATOR, *COCCINELLA SEPTEMPUNCTATA* L.** *Forage Res.*, **28 (1) : pp. 1-5**. Department of Plant Breeding, Punjab Agricultural University, Ludhiana-141 004, India

Investigations regarding chemical control of *Rhopalosiphum padi* (L.) were done under natural conditions at Forage Research Farm, Punjab Agricultural University, Ludhiana during 2000-01. Four insecticides viz., dimethoate (Rogor 30 EC), oxydemeton methyl (Metasystox 25 EC), endosulfan (Thiodan 35 EC) and malathion (Malathion 50 EC) each having three dosages were applied at the earing stage of crop. After 24 h of treatment, highest reduction (94.00%) was observed with endosulfan 350 g/ha and it also caused 100 per cent reduction after 48 and 72 h of treatment. Highest seed yield (18.30 q/ha) was obtained from the plots treated with endosulfan 350 g/ha. Malathion 250 g/ha caused least reduction in *Coccinella septempunctata* L. adult population after 24, 48 and 72 h of spraying, whereas endosulfan (175, 262.5 and 350 g/ha) caused less reduction in *C. septempunctata* L. grub population after 48 and 72h of treatment.

274. SHARMA, S. S. AND V. K. KALRA 2002. **ASSESSMENT OF SEED YIELD LOSSES BY *APHIS CRACCIVORA* KOCH. IN FENUGREEK.** *Forage Res.*, **28 (3) : pp. 183-184**. Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004, India

Present study on seed yield losses by *Aphis craccivora* Koch. in fenugreek, HM-57 was carried out at CCS HAU, Hisar. The highest avoidable yield losses, over control, were worked out to be 62.3 and 68.8 per cent, respectively. Both malathion 0.075% and 0.07%, considered comparatively safe against vegetale insect-pest, may be used to control this pest within afornight of the initiation of aphid incidence on fenugreek.

275. SHARMA, S. K. AND J. R. SINGH 2003. **POLLINATION EFFICIENCY OF *APIS* SPECIES ON EGYPTIAN CLOVER, *TRIFOLIUM ALEXANDRINUM* L.** *Forage Res.*, **28 (4) : pp. 218-219**. Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004, India

Pollination efficiency of *Apis florea* F., *A. dorsata* F. and *A. mellifera* L. was studied on *Trifolium alexandrinum* at Chaudhary Charan Singh Haryana Agricultural University Research Farm, Hisar during April 1997. Abundance of different honeybee species and loose pollen grains sticking on their body were taken as a criterion for determining the pollination index. Abundance of *A. dorsata* was maximum (6.55 bees/m²/5 min) followed by *A. mellifera* (4.4 bees) and *A. florea* (1.52 bees). *A. dorsata* and *A. mellifera*, however, carried equal number of pollen grains (av. 8125) on their body and *A. florea* entrapped lesser pollen grains (av. 4625). The pollination index of *A. dorsata* was found to be the highest (53219), while it was lowest (7030) in case of *A. florea*. Hence, it delineates that

A. dorsata was most efficient pollinator of Egyptian clover followed by *A. mellifera* and *A. florea* under agro-ecological condition of Hisar.

276. PATEL, C. C., J. R. PATEL, T. D. PATEL, S. A. PATEL, J. P. YADAVENDRA, M. R. PATEL AND P. R. VAISHNAV 2003. **ASSESSMENT OF LOSS IN YIELD OF LUCERNE SEED DUE TO DIFFERENT PESTS.** *Forage Res.*, **29 (3) : pp. 107-109.** Main Forage Research Station, Gujarat Agricultural University, Anand-388 110 (Gujarat), India

The field trials were carried out at Forage Research Project, Gujarat Agricultural University, Anand during **rabi** and summer seasons of 1997-98 to 1999-2000 to find out the losses caused by different insect-pests in lucerne seed production. The experiments were conducted in paired design with 15 replications. Sowing was done after 15 November by keeping spacing of 25 cm between two rows and seed rate of 5 kg/ha. Endosulfan 0.07% was sprayed at flowering time to control different pests. The sucking pest population was counted on 10 leaves and *Spodoptera* and *Helicoverpa* larvae were counted per sq. m area before and after spraying of insecticide. Number of honey bee visiting to flowers per sq. m area was also counted. The pooled results of three years revealed that significantly lower population of jassids, thrips, *Spodoptera* and *Helicoverpa* was observed in treated plots as compared to untreated plots after spraying. Non-significant effect of sprayed insecticide was observed on honey bee population which showed that there was no toxic effect of sprayed insecticide on honey bee. Significantly higher yield was recorded in insecticide sprayed plots as compared to unsprayed plots during all the years of experiment. It is revealed from the data that in lucerne seed production programme loss in yield upto 16.49 per cent can be avoided due to attack of different pests by application of endosulfan 0.07 per cent at flowering time.

277. PANDEY, K. C., R. B. BHASKAR, N. HASAN AND N. P. MELKANIA 2004. **STUDIES ON NON-AGRONOMIC PEST MANAGEMENT IN FORAGE COWPEA.** *Forage Res.*, **29 (4) : pp. 180-184.** All India Co-ordinated Project for Research on Forage Crops, Indian Grassland, Fodder and Agroforestry Research Institute, Jhansi-284 003 (U. P.), India

A trial was conducted for three consecutive years i. e. 1999, 2000 and 2001 with the objective to minimize losses due to non-agronomic pests viz., insect-pests, pathogens and nematodes in forage cowpea by economically-feasible and safe method. The treatments consisted of two chemical pesticides (carbofuran and carbendazim) and *neem* seed kernel extract (NSKE) alone as spray and in different combinations. The observations on diseases, insect-pests and nematodes indicated lower pest population and maximum green and dry fodder yield in soil treatment with carbofuran 3G @ 1 g/m row+seed treatment with carbendazim @ 2 g/kg seed+NSKE sprays @ 3% at 30 and 45 days crop. The average cost : benefit ratio in this treatment was 1 : 2.43. The cost : benefit ratio was highest (1 : 17.8) in seed treatment with carbendazim alone @ 2 g/kg seed.

278. SINGH, S. P., B. S. CHHILLAR AND HET RAM 2004. **RELATIVE EFFICACY OF BIO-INSECTICIDES AGAINST POD BORER, *HELICOVERPA ARMIGERA* (HUBNER) IN BERSEEM SEED CROP AND ESTIMATION OF YIELD LOSSES.** *Forage Res.*, **30 (1) : pp. 31-33.** Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Two field experiments were conducted for the control of *Helicoverpa armigera* on seed crop of berseem. Three bio-pesticides, namely, *Bacillus thuringiensis* (Bt.), HaNPV and Neem products along-with recommended i. e. endosulfan were tested. Two sprays of endosulfan proved to be the most effective in controlling the larval population and obtaining the maximum seed yield. It was followed by *B. thuringiensis* (Bt.) and HaNPV. Neem based insecticides gave poor performance against this pest. Endosulfan gave maximum reduction (93.8%) in larval population followed by Bt. (65.2%) and HaNPV (58.3%). The seed yield obtained with endosulfan (3.30 q/ha) was followed by *B. thuringiensis* (Bt.) (2.80 q/ha) and HaNPV (2.50 q/ha). Comparing the seed yield of berseem under protected (2.20 q/ha) and unprotected (0.70 q/ha) conditions, it was more than three times in protected conditions. Overall 214 per cent seed yield was increased over the control. The avoidable loss of 68.2 per cent in berseem seed yield has been worked out due to pod borer.

279. CHOPRA, D., M. S. HOODA, R. S. DHILLON AND KRISHAN KUMAR 2005. **STUDIES ON POLLINATORS OF *PROSOPIS JULIFLORA* AND FORAGING SPEED OF *APIS* SPECIES.** *Forage Res.*, **30 (4) : pp. 176-178.** Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Three *Apis* species, namely, *Apis dorsata*, *Apis mellifera* and *Apis florea* of family Apidae and order Hymenoptera were the most frequent flower visitors. The time spent by *A. dorsata* was maximum i. e. 115 sec/spike (both the years) followed by *A. mellifera* (75 to 77 sec/spike) and *A. florea* (57 to 58 sec/spike). The maximum mean abundance of all the three *Apis* species was observed at 1200-1300 h. The general mean values of abundance of *A. dorsata*, *A. mellifera* and *A. florea* during 2000 and 2001 were 0.61 and 0.81, 0.86 and 0.86 and 1.76 and 2.33, respectively. Four insect species of order viz. Hymenoptera, one of Lepidoptera and two each of Coleoptera and Diptera were the casual visitors at bloom.

280. VAISHNAV, P. R., J. S. PATEL, C. C. PATEL AND H. M. BHATT 2005. **INFLUENCE OF WEATHER PARAMETERS IN RELATION TO APHID AND LEAFHOPPER POPULATION IN FORAGE SORGHUM ECOSYSTEM.** *Forage Res.*, **30 (4) : pp. 233-235.** Department of Agricultural Statistics, GAU, Anand.

The correlation coefficients between weather parameters and the aphid and leafhopper population revealed that aphid and leafhopper population was significantly and positively associated with maximum temperature and sunshine hours in all years of study.

281. SINGH, S. P. AND J. V. SINGH 2005. **EVALUATION OF SOME CLUSTERBEAN GENOTYPES FOR RESISTANCE TO APHID, *APHIS CRACCIVORA* KOCH.** *Forage Res.*, **31 (1) : pp. 67-68.** CCSHAU, Hisar

Three genotypes, HGS 363, HGS 563 and RGC 1066 were almost free from aphid attack under field conditions as these were early maturing and escape aphid infestation.

282. CHAUHAN, R. AND H. R. ROHILLA 2005. **INSECTICIDES USE IN TUNE WITH BIOAGENTS. I. GUIDING PRINCIPLES.** *Forage Res.*, **31 (2) : pp. 91-96.** Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The insecticides are the integral components of Integrated Pest Management. Their selective use to suppress the insect-pests with negligible effect on the natural enemies is the need of the day. This can be possible only through screening of the insecticides against pests and natural enemies. Information on the effect of insecticides on the juvenile and adult stages of predators and parasitoids will help to determine the timings of the insecticidal application, avoiding the most vulnerable stages of useful biota. For insecticide selection, physiological properties of the insecticides, biological activity on/in target organism, toxicity to other non-target organisms and metabolic pathways in the environment and biota need to be taken into account. Farmers' resources, objectives, aptitude towards pest control, cost, returns, risk, uncertainty and convenience are some of the factors which govern decision to go for any pest control technology. The application in time and space, improvement in method of application, physiological intrinsic selectivity, etc. are the important parameters which affect the selection of insecticide to produce desirable response in the field. The differential sensitivities of natural enemy species to various insecticides and impact of bio-pesticides on natural enemies have been reviewed comprehensively in three chapters i. e. I, II and III in series.

283. DABHI, M. V. AND C. C. PATEL 2005. **SEASONAL ABUNDANCE AND LIFE TABLE OF GRAM POD BORER, *HELIOTHIS (HELICOVERPA) ARMIGERA* (HUBNER) ON LUCERNE SEED CROP.** *Forage Res.*, **31 (2) : pp. 115-117.** Main Forage Research Station, Anand Agricultural University, Anand-388 110 (Gujarat), India

Seasonal abundance and life table of *Heliothis (=Helicoverpa) armigera* (Hubner) on lucerne was studied during the year 2002-03 at Main Forage Research Station, Anand Agricultural University (the then Gujarat Agricultural University), Anand Campus, Anand, Gujarat, India. The pest was active from first week of January to the second week of May. There was population peak during fourth week of February (2.8 larvae/q. m area). The correlation study revealed that maximum temperature and relative humidity during the morning hours were negatively and positively correlated with the population buildup of *H. armigera*, respectively. A study on life table of *H. armigera* was carried out from daily fecundity and survival data of a pest, when larvae were reared on lucerne pod at a constant temperature of $26 \pm 1^\circ\text{C}$. The maximum duration of egg, larva and pupa was recorded 3, 17 and 15 days, respectively. The net reproductive rate (R_o) was 193.73 with a mean length of generation (T_c) 42.25 days. The intrinsic rate of natural increase in numbers (r_m) was 0.1281 females per female per day with a daily finite rate of increase (?) 1.137 females per female per day. The adults contributed 0.57 per cent of stable age distribution, whereas contribution of eggs, larvae and pupae was 41.33, 52.95 and 5.14 per cent, respectively. The expectations of further life of newly deposited eggs and adults were 16.32 and 5.16 days, respectively.

284. KUMAR, D., J. P. BHANOT AND S. P. SINGH 2006. **EXTENT OF DAMAGE AND AVOIDABLE GRAIN YIELD LOSSES DUE TO EARHEAD BUGS IN FORAGE SORGHUM.** *Forage Res.*, **31 (4) : pp. 250-255.** Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Four forage sorghum varieties viz., HC 136, HC 171, HC 260 and HC 308 were exposed to earhead bugs at heading stage for 7, 14, 21 and 28 days. The grain yield loss increased as the exposure period increased and it was observed to be 5.44, 12.76, 16.93 and 21.84 per cent, respectively, irrespective of the variety of the crop under study. Further, the avoidable losses due to the incidence of earhead bugs in sorghum varieties, HC 308, HC 171, HC 136 and HC 260 were worked out to be 27.11, 25.30, 31.10 and 5.09 per cent, respectively.

285. JHANSI, K. AND N. R. G. VARMA 2006. **INFLUENCE OF WEATHER FACTORS ON POPULATION DYNAMICS OF PEA APHID AND SPOTTED ALFALFA APHID ON LUCERNE.** *Forage Res.*, **32 (1) : pp. 20-25.** AICRP on Forage Crops, A. N. G. R. A. U. Livestock Research Institute, Rajendranagar, Hyderabad (A. P.), India

The influence of weather factors on population dynamics of pea aphid, *Acyrtosiphon pisum* Harris and spotted alfalfa aphid, *Therioaphis maculata* (Monell) on alfalfa (*Medicago sativa* L.) was studied for four years (2001-02 to 2004-05) at Farm of Livestock Research Institute of Acharya N. G. Ranga Agricultural University, Hyderabad. Correlations were worked out with mean aphid population per plant and weather parameters of current week, preceding one week and preceding two weeks. Stepwise regression analysis was made pooling four years' data. Multiple correlation of pea aphid populations with weather data exhibited significant negative correlations with afternoon relative humidity (current week, preceding one week and preceding two weeks) and positive correlation with sunshine hours (current week, preceding one week and preceding two weeks) and wind speed (preceding one week and preceding two weeks). Pooled analysis of spotted alfalfa aphid with weather parameters exhibited significant negative correlation with RH 11 (current week, preceding one week and preceding two weeks), minimum temperature (preceding one week and preceding two weeks), maximum temperature (preceding two weeks) and positive correlation with wind speed (preceding one week and preceding two weeks). Stepwise regression analysis of four years' data revealed that pea aphid and spotted alfalfa aphid could be predicted with the help of preceding two weeks data to an extent of only 29 and 32 per cent, respectively, and other factors need to be explored.

- 286.** CHAUHAN, R. AND H. R. ROHILLA 2006. **INSECTICIDES USED IN TUNE WITH BIOAGENTS. II. SENSITIVITY OF NATURAL ENEMIES TO INSECTICIDES.** *Forage Res.*, **32 (1) : pp. 26-30.** Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The resume on insecticides used in tune with bioagents. II. Sensitivity of natural enemies to insecticides gives a fairly good idea of the sensitivity of the natural enemies to the insecticides effective against a particular pest species.

- 287.** JAIN, K. L. 2006. **OPTIMIZING POLLINATING BEE DENSITY OVER ALFALFA FOR ENHANCING SEED PRODUCTION.** *Forage Res.*, **32 (1) : pp. 38-40.** Department of Zoology & Aquaculture, CCS Haryana Agricultural University, Hisar -125 004 (Haryana), India

Alfalfa, *Medicago sativa* L., commonly called lucerne, is extensively grown for fodder throughout the world including India. Seed production in alfalfa is, however, considered a major impediment in its cultivation over larger areas. In spite of the fact that the breeders culminated in developing many high seed yielding cultivars of alfalfa, seed yield cannot be stabilized without appropriate pollinators. Some improvements in alfalfa seed production are made by managing honeybees in some of the western countries including USA and Canada; however, these, in general, are known as poor pollinators of alfalfa. Large number of other types of bees such as *Bombus*, *Helictus*, *Megachile*, *Chalicodoma*, *Nomia*, etc. visits alfalfa flowers for pollination. Of the nearly 20000 species of bees having worldwide distribution, 268 species of such bees are reported from South East Asia and 89 species from North India. The megachilids being instinctively seasonal, gregarious and oligolectic are active at the right time to pollinate the alfalfa crop. Quantity and quality of alfalfa nectar produced yield significant impact on bee attraction to alfalfa flowers. The alfalfa flowers yield on an average 0.36 μ l of nectar with 128 μ g of sugars depending upon its age and the environmental conditions.

- 288.** SHARMA, M. AND K. L. JAIN 2006. **ALFALFA PHENOLOGY AND ITS COMPETITIVENESS WITH OTHER BEE PLANT HOSTS FOR POLLINATION.** *Forage Res.*, **32 (2) : pp. 79-80.** Department of Zoology & Aquaculture, CS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The potential of alfalfa leaf cutter bee, *Megachile rotundata* F, in USA and Canada and a few other wild bee species in some other countries as a efficient and effective pollination of alfalfa is well established. Economic failure of honey bees for alfalfa pollinators resulted in their widespread use and management for enhancing alfalfa seed yields. The ambient conditions needed for effective pollination interaction in between alfalfa flowers and the wild bees are the continuous availability of hot and dry days with minimum day temperature around 35°C. Such conditions favour optimum nectar yields and bee visits for pollen collection. The affinity of bee with alfalfa flower is ascertained by their efficiency in terms of time spent to collect pollen and the number of flowers visited per day. The tripping efficiency of Indian bees ranges in between 64-91%. *Parkinsonia acculeata*, being a rich nectar source both in terms of quality and quantity, is a major hindrance in bee attractability of alfalfa. It yields 0.41 μ l of nectar with 33.1% sugar as compared to 0.24 μ l (32.9% sugar) in alfalfa flowers at the peak time of the day. It strongly blooms along with alfalfa in April-May months.

- 289.** PANDEY, K. C., N. HASAN AND R. B. BHASKAR 2006. **NON-CHEMICAL MANAGEMENT OF PESTS IN SORGHUM-COWPEA INTERCROP.** *Forage Res.*, **32 (2) : pp. 85-88.** All India Co-ordinated Project for Research on Forage Crops, Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

A field experiment was conducted during 2003 and 2004 with the objectives to minimize yield losses due to insect-pests, pathogens and nematodes in sorghum-cowpea intercrop by non-chemical methods. The treatments consisted of two bio-control agents (*Trichoderma viride* and *Paecilomyces lilacinus*), two neem products (neem seed powder and neem seed kernel extract) and cow urine+dung extract and their different combinations. The results

indicated that minimum incidence of leafhopper (0.6/leaf) and defoliators (6.8%) was observed in plots sprayed with neem seed kernal extract @ 3% at 30 and 45 days crop either alone or in combination with *Trichoderma* or *Paecilomyces*. The root rot disease in cowpea was minimum (6.7%) in seed treatment with *T. viride* @ 5 g/kg and its combination with spray treatments i. e. spray of cattle urine+cow dung extract or neem seed extract @ 3% in 30 and 45 days crop. Different treatments reduced the parasitic nematode population to varying degree (46.4-73.1%). The seed treatment with *P. lilacinus* @ 5 g/kg either alone or in combination with sprays was found to be most effective in reducing the total plant parasitic nematode population (>70%). The maximum average total green forage yield of 291.4 q/ha (16.1% increase over control) was obtained in T₆ (ST with *T. viride* @ 5 g/kg+spray of cattle urine and cow dung extract in 30 and 45 days crop). It is, therefore, suggested that these alternative pest management methods should be further tested at farmers' field and popularized.

- 290.** BHASKAR, R. B., N. HASAN AND K. C. PANDEY 2007. **BIOINTENSIVE PEST MANAGEMENT IN BERSEEM WITH SPECIAL REFERENCE TO ROOT-ROT DISEASE COMPLEX.** *Forage Res.*, **33 (1)** : pp. 22-25. All India Co-ordinated Project for Research on Forage Crops, Indian Grassland and Fodder Research Institute, Jhansi (U. P.), India

A field experiment was conducted on Mescavi variety of berseem with six treatments viz., T₁=FYM (62.5 kg/ha)+*Trichoderma harzianum* (2.5 kg/ha), T₂= Seed treatment with neem seed powder (50 g/kg), T₃=Bio-priming of seed with *T. harzianum* @ 5 g/kg+neem cake 400 kg/ha, T₄=Seed soaking in salicylic acid 0.02 per cent+spray of SA @ 0.02 per cent after 1st and 2nd cut, T₅=Seed treatment with thiram @ 0.25 per cent+carbendazim 0.02 per cent and T₆=Untreated control. All the treatments reduced the disease incidence as well as total parasitic nematode population to varying degree. However, seed treatment with neem seed powder (T₂) was most effective in bringing down (68%) the phytophagous nematodes as compared to untreated control. *T. harzianum* in combination with either FYM (T₁) or neem cake (T₃) proved to be most effective in reducing both root and stem rot disease incidence. These treatments also recorded maximum total green fodder yield (57.95 and 57.87 t/ha respectively). The results of the present investigation were thus indicative for wider use of *Trichoderma*, neem, FYM and salicylic acid alongwith other methods of pest control in developing suitable IPM module.

- 291.** KUMAR, D., J. P. BHANOT AND S. P. SINGH 2007. **EXTENT OF DAMAGE AND AVOIDABLE GRAIN YIELD LOSSES DUE TO EARHEAD BUGS IN FORAGE SORGHUM.** *Forage Res.*, **33 (1)** : pp. 48-51. Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Four forage sorghum varieties HC 136, HC 171, HC 260 and HC 308 were selected and exposed separately at heading stage to earhead bugs for the period of 7, 14, 21 and 28 days, respectively. At the exposure period of 7, 14, 21 and 28 days, there was a corresponding grain yield loss of 5.44, 12.76, 16.93 and 21.84 per cent, respectively, indicating that as the period of exposure of sorghum panicles to earhead bugs increased, there was increase in grain yield loss. On the basis of two years' data, the avoidable losses to the tune of 27.11, 25.30, 31.10 and 5.09 per cent were worked out in forage sorghum varieties HC 308, HC 171, HC 136 and HC 260, respectively. Irrespective of sorghum variety, the mean grain yield loss due to earhead bugs worked out was about 22.15 per cent.

- 292.** KUMAR, D., J. P. BHANOT AND S. P. SINGH 2008. **SCREENING OF SORGHUM GENOTYPES AGAINST EARHEAD BUGS.** *Forage Res.*, **33 (4)** : pp. 250-252. Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Out of a total of 150 sorghum genotypes belonging to different maturity periods and plant types screened against earhead bugs, none was found completely free from the earhead bug damage except those genotypes which were having loose type of earheads. Mean number of earhead bugs/5 panicles ranged from 0.0 to 30.9 with an overall mean of 12.46 bugs/5 panicles. All these 150 sorghum entries were also categorized on the basis of grain damage rating (GDR) at maturity and were assigned grade from 1 to 8. Based on earhead bug infestation and GDR, 114 sorghum genotypes (having GDR<6) were sown during **kharif** 2002 to know their reaction against earhead bugs

infestation. The mean number of bugs/5 panicles varied from 0.0 to 18.1 and GDR ranged from 1 to 5 and overall mean for these genotypes was 8.00 earhead bugs/5 panicles. Pooled data for **kharif** 2001 and 2002 revealed that in different sorghum genotypes, the mean infestation ranged from 0.6 to 20.90 earhead bugs/5 panicles with overall mean infestation of 9.27 earhead bugs/5 panicles and GDR ranged from 1 to 6.

- 293. KUMAR, Y. AND SATISHA SALUNKE 2008. DIVERSITY AND FORAGING BEHAVIOUR OF INSECT VISITORS OF PIGEONPEA BLOSSOMS [CAJANUS CAJAN (L.) MILLSP.]. *Forage Res.*, 34 (1) : pp. 49-52.** Department of Entomology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

An experiment was conducted on two cultivars of pigeonpea [*Cajanus cajan* (L.) Millsp.] at CCS Haryana Agricultural University, Hisar to record the diversity of insect visitors on pigeonpea blossoms, their activity initiation, cessation and peak activity time. A total of 16 insect visitors belonging to two orders, Hymenoptera (14) and Lepidoptera (2) were recorded to visit pigeonpea flowers. Insect visitors of both the varieties i. e. Paras and Manak were recorded to be the same. Different insect visitors started activity at different day time. Likewise, cessation and peak activity time of different insect visitors were noticed to be different. Insect visitors activity on the blossoms started even before 600 h and were noticed to be till the observation recording time i. e. 1800 h. *Apis dorsata* visited maximum number of flowers per min (7.05), while *Xylocopa amethystina* visited minimum flowers (2.95). *Psichotoe duvauceli* spent maximum time (8.50 sec), while *Apis cerana* spent minimum time (4.75 sec) per flower.

- 294. TAMBE, A. B. 2008. INTEGRATED PEST MANAGEMENT IN LUCERNE FOR SEED PRODUCTION. *Forage Res.*, 34 (2) : pp. 109-111.** All India Coordinated Research Project, Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722, Ahmednagar (M. S.), India

An experiment was conducted during the three **rabi** seasons from 2002-03 to 2004-05 at Forage Crop Research Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (M. S.) with the objective to test IPM module against pests infesting lucerne seed production. Two blocks were taken as treatment viz., IPM block and control block. The IPM treatment consisted four components i. e. transplanting of marigold flowers 50 cm apart around and on the ridges of water channel one month after sowing, spraying of NSE 5 per cent for aphid, spraying of HaNPV at appearance of two larvae of *H. armigera*/sq. m and spraying of NSE 5 per cent for management of *H. armigera*. The pooled results indicated that significantly lower number of survival of aphid population/tiller was recorded at 3 (11.95 aphids/tiller) and 7 (14.38 aphids/tiller) days after treatment in IPM block than control block (33.16 and 37.82 aphids/tiller, respectively). Integrated pest management block showed lesser number of survival of larval population of *H. armigera* larvae/sq. m area at 3 (1.25) and 7 (0.57) days after treatment against control block. As regards green forage and seed yield, highest green forage yield (237.20 q/ha) and seed yield (4.73 q/ha) was observed in IPM block. Highest incremental cost : benefit ratio (1 : 5.87) was obtained from IPM block.

- 295. SHARMA, S. K. AND ARUN KUMAR 2008. SOAPNUT, TAUR AND KHAIR AS IMPORTANT BEE FORAGE FOR SUSTAINING APIS MELLIFERA LINNAEUS HONEYBEES IN SHIVALIK HILLS OF HIMACHAL PRADESH. *Forage Res.*, 34 (2) : pp. 119-121.** Bee Research Station, CSK Himachal Pradesh Krishi Vishvavidyalaya, Nagrota Bagwan-176 047 (Himachal Pradesh), India

The performance of *Apis mellifera* Linnaeus colonies on *Acacia catechu* Willd., *Bauhinia vahli* Wt. & Arn. and *Sapindus detergens* Roxb. in Shivalik hills of Himachal Pradesh has been recorded. These flora were found effective for sustaining the *A. mellifera* colonies during dearth periods, each flora may be availed for at least a month during May to July every year involving little investment. The thermo hygro relationship between colony nectar collections with respect to its sealing during *A. catechu* bloom for two seasons was recorded as 4.79 ± 0.36 and 7.48 ± 2.23 per cent, respectively.

- 296. KUMAR, SUSHIL 2011. MANAGEMENT OF ALFALFA WEEVIL (*HYPERA POSTICA* GYLLENHAL) IN COLDARID REGION OF LADAKH. *Forage Res.*, **36 (4)** : pp. 220-222. Regional Agricultural Research Station, SKUAST-K, Leh-Ladakh, J & K-194 101 (J & K), India**

A field study was conducted to evaluate the efficacy of different insecticides against alfalfa weevil larvae (*Hypera postica* Gyllenhal) at the Regional Agricultural Research Station, SKUAST-K, Stakna, Leh-Ladakh during 2009 and 2010. The mean number of alfalfa weevil larvae per 10 stems in each plot did not differ significantly and averaged between 1.2 to 2.4 larvae and 2.3 to 2.5 larvae per stem before the application of insecticides during 2009 and 2010, respectively. The mean number of alfalfa weevil larvae in the untreated control plots averaged from 15.0 to 26.6 larvae/10 stems during 2009 and 15.00 to 28.66 larvae per 10 stems during 2010 on all sampling dates which were significantly higher than the number of alfalfa weevil larvae in all the insecticide treated plots which averaged from 0.00 to 3.00 larvae /10 stems. All the insecticide treatments reduced the mean number of alfalfa weevil larvae per 10 stems significantly, however, no significant differences were observed among all the insecticide treatments. All the insecticides used at their minimum recommended concentrations reduced the mean number of alfalfa weevil larvae/10 stems quite significantly, and were observed to be at par with their next two higher concentration used in the experiment. Moreover, all the insecticides gave efficient control of alfalfa weevil larvae for approximately 25 days after treatment.

- 297. SIDHU, JASPREET KAUR AND RAMESH ARORA 2011. STUDIES ON POPULATION BUILD-UP OF GRAM CATERPILLAR, *HELICOVERPA ARMIGERA* (HUBNER) ON SELECTED GENOTYPES OF RABI FORAGE LEGUMES *Forage Res.*, **36 (4)** : pp. 223-228. Department of Entomology Punjab Agricultural University, Ludhiana-141 004 (Punjab), India**

The population build-up of *Helicoverpa armigera* (Hubner) was studied on different cultivars of Egyptian clover (*Trifolium alexandrinum* L.), Alfalfa (*Medicago sativa* L.) and Persian clover (*Trifolium resupinatum* L.) at the Forage Research Area, Punjab Agricultural University, Ludhiana during 2006-07. The number of eggs laid as well as per cent larval infestation by *H. armigera* varied with the genotypes as well as the dates of observation. Mean number of eggs laid was lowest on Persian clover genotype S 69 and Egyptian clover genotype BL 10 i. e. 0.20 eggs per fruiting body, while it was highest (0.38) on BL 1 followed by LLC 5 (0.34). The genotypes in order to mean per cent infestation were S 69<BL 10<LLC 5<BL 22< BL 180< BL 42< BL 1. The earliest infestation was observed on Persian clover genotype S 69, but the Egyptian clover genotype BL 1 harboured the highest infestation after initiation of flowering. The mean per cent infestation was highest (36.91) on May 7, 2007, followed by May 11, 2007 (36.16%).

3. Quality

- 298. NEGI, ANJU, P. BOORA AND P.P. GUPTA 2001. ASSESSMENT OF NUTRITIONAL QUALITY OF SOME HIGH YIELDING VARIETIES OF MOTH BEAN (*VIGNA ACONITIFOLIA* JACQ. MARCHAL). *Forage Res.*, **27 (1)** : pp. 69-71. Department of Plant Pathology, CCS Haryana Agricultural University, Hisar**

An experiment was conducted at CCS HAU, Hisar to assess the nutritional quality of high yielding varieties of mothbean against the local variety. The nutrient quality of high yielding varieties viz. Jwala, RMO 225 and RMO 257 was better against the local variety.

- 299.** ARORA, R. N., G. P. LODHI AND J. V. SINGH 2001. **GENETIC ANALYSIS FOR PROTEIN AND GUM CONTENT IN UNIRRADIATED AND IRRADIATED DIALLEL POPULATIONS OF GUAR [CYAMOPSIS TETRAGONOLOBA (L.) TAUB.].** *Forage Res.*, **27 (2) : pp. 97-104.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Statistical and genetical analyses of Gardner and Eberhart (1966) were employed to study the heterosis and combining ability for protein and gum content in the F_1 , F_1M_1 , F_2 and F_2M_2 generations of a diallel cross of six guar genotypes. Parent HG 79-1-5 showed good general combining ability for both protein and gum content in all the four generations, while for other parents it varied from generation to generation. The partitioning of heterosis revealed the presence of desirable average heterosis (h) only for protein content in F_1 generation. HG 79-1-5 was the only parent which exhibited significant desirable parental heterosis for both the traits in all the generations. The crosses HG 75 x CP 68, HG 314 x HG 79-1-5 and PLG 85 x HG 79-1-5 expressed significant desirable specific heterosis for both protein and gum content in most of the generations. The influence of irradiation on gene effects and heterosis was observed for both these traits in guar.

- 300.** KHABIRUDDIN, M., S.N. GUPTA AND C.S. TYAGI 2002. **NUTRITIONAL COMPOSITION OF SOME IMPROVED GENOTYPES OF RICEBEAN (VIGNA UMBELLATA).** *Forage Res.*, **28 (2) : pp. 104-105.** Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Nutritional composition of 15 improved genotypes of ricebean (*Vigna umbellata*) was evaluated CCSHAU, Hisar. It is evident that ricebean is rich in protein, methionine and starch content. The genotype RBL-35 appears to be superior being highest in protein content. Methionine content is also very high and phenol content is comparatively toxic principles, if any, present in ricebean.

- 301.** KUMAR, S., U. N. JOSHI AND Y. P. LUTHRA 2004. **EFFECT OF CR (VI) LEVELS ON PLANT GROWTH AND PHOTOSYNTHETIC PIGMENTS IN FORAGE SORGHUM.** *Forage Res.*, **29 (4) : pp. 176-179.** Department of Biochemistry, CCS Haryana Agricultural University, Hisar-125 004, India

A pot experiment was conducted on forage sorghum (*Sorghum bicolor* L.). Sorghum plants (cv S 308) were raised in earthen pots filled with loamy sand soil treated with 0.0, 0.5, 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 ppm Cr (VI) ($\mu\text{g g}^{-1}$ soil) in the form of $\text{K}_2\text{Cr}_2\text{O}_7$. All the morpho-physiological parameters under study viz., fresh and dry weight of leaves, shoot and root, plant height and number of leaves were found to decrease significantly with increasing Cr (VI) levels at all growth stages. Shoot, in general, had higher fresh weight, whereas leaves accumulated more dry matter at all growth stages except at 90 DAS where shoot had higher dry matter than leaves. Total chlorophyll, chlorophyll 'a' and chlorophyll 'b' content in leaves also decreased with increasing applied Cr (VI) concentration. Chlorophyll 'a' was found to be more sensitive to Cr toxicity than chlorophyll 'b'.

- 302.** KHABIRUDDIN, M., J. S. HOODA AND C. S. TYAGI 2004. **VARIATION OF PROTEIN CONTENT AND FAVISM-INDUCING FACTOR (VICINE, CONVICINE) AT VEGETATIVE AND MATURITY STAGES IN FABABEAN (VICIA FABA L.).** *Forage Res.*, **30 (2) : pp. 78-82.** Medicinal, Aromatic and Under-Utilized Plants Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Twelve genotypes of fababean (*Vicia faba* L.) alongwith Vikrant (released variety) were evaluated for seed yield and related characters, nutritional characters as well as their favism-inducing factor vicine-convicine at vegetative and maturity stages. Fababean is a good source of protein of adequate nutritional quality. Among the edible leguminous bean crops, it is next to soybean in terms of protein content and has the highest yield of protein per hectare. In our experiment, seed yield was in the range of 33.56-45.27 q/ha and the seed weight was 28.3-33.9 g/100 seeds. It contained protein 12.1-15.7 per cent in blank green pods, 23.3-24.5 per cent in immature seeds and 22.3-26.2 per cent in mature seeds on dry weight basis. Vicine-convicine varied from 0.61 to 0.94 per cent in blank green pods, 1.1

to 2.1 per cent in immature seeds and 0.74 to 1.7 per cent in mature seeds. Phosphorus content was also higher in immature seeds (0.48-0.73%) as compared to mature seeds and blank pods had 0.47-0.58 and 0.15-0.29 per cent, respectively. Trace element (Cu, Fe, Zn and Mn) concentrations in mature seeds were also determined. Fe (0.73-2.16 mg/g) and Zn (0.701-0.919 mg/g) were found in highest concentrations. The results indicated that vicine-convicine and phosphorus mainly present in seeds were highest in the immature stage and declined on maturity. The various quality and quantitative characters at vegetative and maturity stages suggested that the genotypes BSH-42 and HB-180 were best for both quality and yield characters.

303. SINGH, S., S. S. SAINI AND B. P. SINGH 2005. **QUALITY OF CHICKPEA (*CICER ARIETINUM* L.) STRAW AS INFLUENCED BY IRRIGATION, SULPHUR AND SEED INOCULATION LEVELS UNDER LATE SOWN CONDITIONS.** *Forage Res.*, **30** (4) : pp. 1192-195. Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted during **rabi** (winter) seasons of 2000-01 and 2001-02 at CCS Haryana Agricultural University, Hisar to study the response of irrigation, sulphur and organic sources on straw yield, economics, quality and nutrient uptake. The experiment was conducted in split plot design with three levels of irrigation and sulphur each in main plots and four levels of seed inoculation in sub-plots with three replications. Two irrigations at pre-flowering and pod-development stages increased the straw yield, crude protein yield and gross returns of chickpea straw over one irrigation at pre-flowering and no irrigation treatment in both the years. Nutrient uptake also increased with increasing number of irrigations. Straw yield increased significantly with increasing levels of sulphur upto 40 kg/ha in 2000-01 and upto 20 kg/ha only in 2001-02, while crude protein yield and gross returns of straw increased significantly upto 40 kg S/ha. Sulphur content of straw increased significantly upto 20 kg S/ha, while N, K and S uptake by straw increased significantly upto 40 kg S/ha. Seed inoculation with *Rhizobium*+PSB recorded significantly higher straw yield, gross returns and S content of straw over control and single inoculation either with *Rhizobium* or PSB. Maximum nutrient content and uptake was also obtained by seed inoculation with *Rhizobium*+PSB.

304. VERMA, A. K., G. L. SHARMA, P. SINGH, H. K. SUMERIYA AND R. C. DADHEECH 2005. **INTERCROPPING STUDIES IN SUMMER MAIZE AND SORGHUM FORAGE FOR INCREASED FORAGE QUALITY.** *Forage Res.*, **30** (4) : pp. 227-228. Department of Agronomy, MPUA&T, Udaipur-313001

A field experiment was conducted at CoA, Udaipur to study intercropping in summer maize and sorghum forage for increased forage quality. Higher crude protein, crude fat, crude fibre, mineral and TDN produced by sowing of maize rows and cowpea crossed with full seed rate of both the crops.

305. BISHNOI, N. R., A. L. MALI AND H. K. SUMERIYA 2005. **FODDER QUALITY OF DUAL PURPOSE SORGHUM GENOTYPES AS INFLUENCED BY VARYING PLANT POPULATION AND NITROGEN.** *Forage Res.*, **30** (4) : pp. 229-230. Department of Agronomy, MPUA&T, Udaipur-313001

A field experiment was conducted at COA, Udaipur to study fodder quality of dual purpose sorghum genotypes as influenced by varying plant population and nitrogen. Application of 120 kg N/ha brought significant increase in crude protein, crude fibre and mineral content.

306. SANGWAN, R. S., G. P. LODHI AND Y. P. LUTHRA 2005. **BIOCHEMICAL CHANGES IN COWPEA YELLOW MOSAIC INFECTED LEAVES.** *Forage Res.*, **31** (1) : pp. 5-7. Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The levels of total phenols, ortho-dihydroxy phenols, flavanols, total chlorophyll, chl. 'a', chl. 'b' and carotenoids were measured in cowpea yellow mosaic virus (CYMV) resistant, tolerant and susceptible genotypes at 40, 50 and 60 days after sowing (DAS). Resistant and tolerant genotypes had higher contents of phenolic compounds

in comparison to susceptible genotypes at different stages of growth. There was no much variation in photosynthetic pigments at a particular stage in leaves of resistant, tolerant and healthy leaves of susceptible genotypes.

- 307.** TULIKA AND KAUSHLYA GUPTA 2006. **INTERACTIVE EFFECT OF CADMIUM ON MORPHOLOGICAL AND BIOCHEMICAL PARAMETERS OF DEVELOPING OAT (*AVENA SATIVA* L.).** *Forage Res.*, **31 (4) : pp. 275-277.** Department of Biochemistry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

In a study on Interactive effect of cadmium on morphological and biochemical parameters of developing oat, it was observed that maximum green and dry fodder yield was recorded up to 5 ppm cadmium level. Further progressive increase in cadmium level decreased plant growth and yield.

- 308.** TULIKA AND KAUSHLYA GUPTA 2006. **EFFECT OF CHROMIUM (VI) ON GROWTH, YIELD AND BIOCHEMICAL CONSTITUENTS OF OAT (*AVENA SATIVA* L.).** *Forage Res.*, **32 (1) : pp. 7-11.** Department of Biochemistry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Toxic effects of varying doses of chromium (VI) were studied on various growth and biochemical parameters of oat during plant growth at 55 DAS, 100 DAS and maturity. Plant height increased to about 10 per cent at 0.5 ppm Cr (VI) applied at maturity and then decreased at higher doses showing maximum inhibition at 5 ppm Cr (VI). Data revealed maximum significant reduction at 5 ppm Cr (VI) for both number of leaves (61, 47 and 15%) and tillers (57, 40 and 14%) at the three stages of development, respectively. However, number of leaves and tillers showed values above control upto 0.5 ppm Cr (VI) applied. Upto 0.2 ppm Cr (VI) levels were found to be stimulatory for biomass accumulation but thereafter both FW and DW of plant showed significant impediment with increasing Cr (VI) levels. FW decreased by 38, 65 and 75 per cent at 1.0, 2.5 and 5.0 ppm Cr (VI) applied, respectively, at 55 DAS. Similar observations were recorded at 100 DAS and maturity. Chlorophyll content was also found to be sensitive to Cr (VI) toxicity. Total chlorophyll content in leaves reduced (30 and 11%) maximally at 5 ppm Cr (VI) applied at both stages of development. Chlorophyll 'b' was found to be more sensitive relative to chlorophyll 'a' when compared with control. EC of leaf leachates first increased and then decreased with increasing Cr (VI) levels but values were near to control at all the treatments. With increase in Cr (VI) dosages, pH of leaf leachates showed values above or near to control showing its effect on membrane permeability properties.

- 309.** MOJUMDAR, A. B. AND G. P. SHUKLA 2006. **ASSOCIATION ANALYSIS AMONGEST QUALITY TRAITS IN LUCERNE (*Medicago sativa* L.)** *Forage Res.*, **32 (2) : pp. 81-84.** Plant Animal Relationship Division, Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

Ten promising materials including seven composites, one promising germplasm line (IL 2K-133) and two standard varieties, namely RL 88 and Chetak (IL 244) of lucerne (*Medicago sativa* L.) were grown in randomized block design with four replications. The harvesting was carried out at 50 per cent flowering stage and the material was evaluated for quality attributes, namely, CP, OM, TA, NDF, ADF, cellulose, hemicellulose and lignin contents. Crude protein content of all the breeding materials was high ranging from 18.19 (IL 244) to 21.72 per cent (IGFRI 99-2). IGFRI 99-2 (21.72%), RL 88 (21.58%), Comp 95 (21.14%), IL 2K-133 (20.58%) and IGFRI 99-1 (20.15%) possessed relatively higher CP content as compared to others. Organic matter varied from 89.62 (IGFRI 99-2) to 91.59 per cent (IL 244), NDF varied from 37.83 (RL 88) to 47.69 per cent (Comp 2002-2), ADF varied from 27.05 (IGFRI 99-2) to 40.08 per cent (Comp 2002-2), cellulose varied from 19.57 (Comp 2002-1) to 30.23 per cent (Comp 2002-2) hemicellulose varied from 5.36 (IGFRI 99-2) to 8.95 per cent (Comp 2000-2), and TA ranged from 8.41 (IL 244) to 10.38 per cent (IGFRI 99-2). The result for analysis of variance for all the quality characters indicated that varietal mean sum of squares was highly significant. CP content had significant negative correlation with NDF ($r = -0.743$), while positive correlation with TA ($r = 0.980$). NDF and ADF contents were significantly and positively correlated between themselves, while NDF was significantly and positively correlated with lignin ($r = 0.782$). It was inferred that IGFRI 99-2, Comp-95, RL-88 and IL-2K-133 were of relatively better quality and may prove suitable to be included in forage-based ration for ruminants.

- 310.** SARKAR, ARUP 2006. **EFFECT OF STORAGE ON THE SEED QUALITY OF RICE BEAN AND COWPEA UNDER TERAI REGION OF WEST BENGAL** *Forage Res.*, **32 (2) : pp. 112-115**. Department of Genetics and Plant Breeding, Uttar Banga Krishi Vishwavidyalaya, P. O. Pundibari, District Cooch Behar-736 165, (West Bengal), India

The terai agriculture is agro-ecologically predominated by high humidity and rainfall, considered to be the main impediments for safe storage of seed materials. The problem of safe storage gets accentuated further because of the differential storability of seeds of diverse crop species. The terai region of West Bengal is endowed with such bottlenecks. Given the enormous cattle population and the dependence on grass-based fodder culture in this region, a study was undertaken during the period of February-March, 2005 to find out the effect of storage on the seed quality of two alternative fodder legumes viz., ricebean and cowpea, which have the potentiality of being included as a part of terai agriculture. In this study, the seeds of suitable genotypes of both the crop species were kept in two different storage conditions, selected as the low cost storage conditions. The seeds, kept in the desiccator and at room temperature as prevailed during the storage period for varying durations showed differential response in terms of germinability, vigour, water soluble leachates as well as conductivity. The maximum germination percentage recorded in rice bean was 94.67 (Cal 14) as compared to minimum of 81.67 being recorded in cowpea genotype EC 390264. The vigour index of seedling at 15 days after germination ranged from the maximum of 15.64 in rice bean genotype Cal 14 to the minimum of 6.05 in rice bean genotype Bidhan 1. While cowpea seeds of most of the studied genotypes showed variable response but they gave poor performance as far as their membrane permeability is concerned as revealed from water soluble sugars and seed conductance in seed leachate in all storage conditions. Thus, rice bean seeds were found to be superior in terms of overall storability. The objective of such findings was to assess their performance and thus to give a low cost seed storage option to the intended farmers of the region so that they can go for alternative forage cultivation.

- 311.** KRISHNA, V., B. C. CHANNAKESHA, K. P. R. PRASANNA AND K. P. VISWANATHA 2006. **EFFECT OF SPRAY OF GROWTH REGULATORS, MICRONUTRIENTS AND PHEROMONES ON SEED YIELD AND QUALITY PARAMETERS IN LUCERNE.** *Forage Res.*, **32 (3) : pp. 152-154**. Department of Seed Science and Technology, University of Agricultural Sciences, GKVK, Bangalore-560 065 (Karnataka), India

A field experiment was conducted to study the influence of foliar sprays of growth regulators, micronutrients and pheromones at bud formation stage, 50 per cent flowering stage and at both the stages on the seed yield and quality parameters of lucerne (*Medicago sativa* L.) variety T-9 at the Main Research Station, Hebbal, UAS, Bangalore under irrigated condition. Application of GA₃ (0.005%) and IAA (0.001%) at 50 per cent flowering showed its superiority in seed quality parameters. The highest seed yield (290.0 kg/ha) combined with high protein content (19.37%) was recorded in plants sprayed with boron (3 ppm) and molybdenum at both bud formation and 50 per cent flowering stage compared to control which registered seed yield of 145 kg/ha. Seed quality parameters showed significant response for the spray of growth regulators, micronutrients and pheromones. The seed vigour was better in different treatments as indicated by low electrical conductivity as compared to control.

- 312.** DEEN, M. K. 2006. **PROXIMATE COMPOSITION AND FATTY ACID PROFILE OF GRAIN AMARANTH GENOTYPES.** *Forage Res.*, **32 (3) : pp. 169-172**. MA & UUP Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The chemical composition of 13 genotypes of grain amaranth was determined. The average value of protein, lysine, starch, oil and carotene was 14.1 per, 5.18 g/16 g N, 58.9 per cent and 24.9 mg/kg oil, respectively. A strong positive correlation was observed between carotene and protein content. Oil composition was determined by GLC. Consistent with earlier studies, wide variations in the fatty acid composition were reported. All varieties showed significant levels (8.2-11.2%) of oil and a total unsaturated fatty acid occurrence of between 55.3-65.6 per cent. This study represents first reported chemical composition of grain amaranthus cultivated in India.

313. KUMAR, S., U. N. JOSHI, JAIVIR SINGH AND M. L. SAINI 2007. **GALACTOMANNANS IN DIFFERENT GENOTYPES OF GUAR.** *Forage Res.*, **32 (4) pp. 204-208.** Department of Biochemistry, CCS Haryana Agricultural University, Hisar

Among various commercially utilizable crops in India, clusterbean occupies a very important place. Our country is a major exporter of guar gum to 65 countries. Guar is a rich source of high quality galactomannans and protein. The seeds of many leguminous plants have mucilaginous endosperms and treatment of either the endosperm or the whole seed with water or dilute alkali leads to the extraction of polysaccharide material which can readily be purified to give a galactomannan in a yield of upto 38 per cent of the seed (Reid and Meier, 1970). So, in the present study, 220 guar germplasm lines were collected from different parts of the country and evaluated for gum content.

314. TULIKA AND KAUSHALYA GUPTA 2007. **COMBINED EFFECTS OF Cd AND Cr (VI) ON MORPHO-PHYSIOLOGICAL PARAMETERS IN OAT.** *Forage Res.*, **33 (1) : pp. 26-29.** Department of Biochemistry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Oat (*Avena sativa* L.) variety HJ-8 was raised in earthenware pots filled with 5 kg sand and treated with requisite amounts of Cd : Cr (5 : 0.1, 5 : 0.5, 5 : 1.0, 20 : 0.1, 20 : 0.5 and 20 : 1.0 ppm), respectively, in the form of CdCl₂ and K₂Cr₂O₇. The study revealed that morphological parameters showed stimulation at lower doses of combination applied i. e. 5 : 0.1, 5 : 0.5 and 5 : 1.0 ppm in comparison to control. An increase of 38 per cent was recorded in fresh and dry weights of plant at 55 DAS at 5 : 0.1 ppm. Total chlorophyll content also showed enhancement of 14 per cent at 100 DAS at 5 : 0.1 ppm, but chlorophyll 'b' was found to reduce more in comparison to chlorophyll 'a' content at all the treatments applied. Better growth at lower doses of combinations showed the antagonistic effect of each other. Higher doses like 20 : 0.1, 20 : 0.5 and 20 : 1.0 ppm were observed to have additive inhibitory effect on plant growth.

315. SIKANDARA AND P. BOORA 2007. **PHYSICO-CHEMICAL PARAMETERS, PROXIMATE COMPOSITION AND ANTINUTRIENTS IN SORGHUM, WHEAT AND CHICKPEA VARIETIES.** *Forage Res.*, **33 (1) : pp. 56-60.** Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The present study was carried out to analyze the physico-chemical characteristics, functional properties and nutrient composition of sorghum (HC-136 and CSV-9), wheat (WH-711) and chickpea (HC-96-99) varieties. Among various physico-chemical properties, chickpea had higher value for seed density, hydration capacity, swelling capacity and germination per cent as compared to wheat and sorghum. Wheat had higher water absorption, oil absorption, gelation capacity, gel consistency and flour solubility per cent as compared to sorghum and chickpea; however, emulsification capacity was found to be higher in chickpea. Significant differences were found in protein, fat and crude fiber content of sorghum varieties viz., HC-136 and CSV-9. Phytic acid content was highest in chickpea (809.33 mg/100 g). Trypsin inhibitor activity of chickpea was highest and of wheat was minimum.

316. CHAUDHARY, D. P., SUKHAIN, H. S. MUKER AND B. L. BHARDWAJ 2007. **ANALYSIS OF FORAGE QUALITY PARAMETERS IN LEAVES AND CULMS OF OATS.** *Forage Res.*, **33 (1) : pp. 65-66.** Department of Plant Breeding, Genetics and Biotechnology, PAU, Ludhiana-141004

It is concluded from the present study that varieties, general, having higher leaf : stem ratio are likely to have more crude content, minerals and *in vitro* dry matter digestibility.

317. JAIN, VEENA AND SUNITA JAIN 2007. **EFFECT OF FLOODING AND NITRATE ON ENZYMES OF NITRATE ASSIMILATION IN SORGHUM (*SORGHUM BICOLOR* L.) CULTIVARS.** *Forage Res.*, **33 (3) : pp. 157-160.** Department of Biochemistry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Flooding resulted in differential changes in the activities of enzymes of nitrate assimilation viz., nitrate reductase (NR) and nitrite reductase (NiR) in roots and leaves of two cultivars of sorghum differing in stress tolerance. NR activity was lower in both roots and leaves of resistant cultivar SSG-59-3 as compared to their corresponding controls under waterlogging conditions. However, in roots of sensitive cultivar, HC-308, NR activity was same upto 6 h of flooding and decreased thereafter. NiR activity also declined in the roots of sensitive cultivar during the course of flooding treatment but enhanced progressively in resistant cultivar. There was no effect of flooding on NiR activity in the leaves of HC-308 but a steady enhancement (31%) upto 48 h of waterlogging was observed in that of resistant cultivar, SSG-59-3. Further stress of 72 h resulted in diminished activity which was same as that in the control. Exogenous application of nitrate during flooding upto 72 h had no effect on NR activity. Our results indicated that nitrate metabolism might not be involved in oxidation of NAD (P) H to support respiratory activity under flooding conditions.

318. SIKANDARA AND P. BOORA 2007. **IN VITRO PROTEIN AND STARCH DIGESTIBILITY AND MINERAL PROFILE OF SORGHUM, WHEAT AND CHICKPEA CULTIVARS.** *Forage Res.*, **33 (3) : pp. 177-179.** Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar- 125 004 (Haryana), India

The present study was carried out to analyze the *in vitro* protein and starch digestibility and mineral content of sorghum (HC-136 and CSV-9), wheat (WH-711) and chickpea (HC-96-99) varieties. Total soluble sugars observed highest in chickpea (8.98 g/100 g), reducing sugars in sorghum, HC-136 (4.27 g/100 g) and starch content in wheat variety (68.13 g/100 g). Sorghum (CSV-9) had significantly higher *in vitro* protein digestibility. Wheat had higher *in vitro* starch digestibility as compared to sorghum and chickpea. Calcium, copper, iron and zinc contents were highest in chickpea (HC-96-99).

319. SUKHCHAIN, H. S. MUKER AND AJAIB SINGH 2007. **VARIATION FOR SUROSE YIELD, FORAGE YIELD AND RELATED TRAITS IN SWEET SORGHUM.** *Forage Res.*, **33 (3) : pp. 183-184.** Department of Plant Breeding, Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India.

The results from the present investigation suggest that selection for late flowering lines with tall and thick stalk and higher total soluble solids may assist to increase not only sucrose yield but also forage yield.

320. PATEL, D. M., P. P. PATEL, B. S. PATEL AND H. D. PATEL 2008. **FORAGE QUALITY OF CHICORY (*CHICORIUM INTYBUS* L.) AS INFLUENCED BY VARIOUS SOURCES AND LEVELS OF NITROGEN.** *Forage Res.*, **33 (4) : pp. 227-232.** Department of Agronomy, S. D. Agricultural University, Sardarkrushinagar-385 506 (Gujarat), India

A field experiment was conducted on loamy sand soils during **rabi** 2002-03 and 2003-04 to study the forage quality of chicory (*Chicorium intybus* L.) as influenced by sources and levels of nitrogen. Application of nitrogen from urea improved protein content of forage chicory significantly at first cut and protein yield at second cut only. On the contrary, sources of nitrogen were failed to exert effect on crude fibre, oxalate, silica and mineral matter (ash) content. However, 60 kg N/ha applied as basal drastically increased protein content and crude protein yield of forage chicory, whereas it significantly reduced crude fibre and oxalate content at first and second cut and in mean value of all five cuts over lower levels. Superb effect of top dress application of nitrogen @ 30 kg N/ha was observed looking to the proximate quality of fodder. It significantly increased protein content, protein yield, ash content and silica content. But crude fibre and oxalate content of fodder were drastically reduced over control and 15 kg N/ha. Calcium

is very much important element for milch animals and Ca content is also increased with successive increase in nitrogen levels applied after harvest of each cut as well as in mean of all five cuts in pooled analysis.

- 321.** CHAUDHARY, D. P., SARVJEET SINGH, B. L. BHARDWAJ, ACHLA SHARMA AND G. S. DHINDSA 2008. **BARLEY : NUTRITIONALLY SUPERIOR NON-LEGUME WINTER FORAGE.** *Forage Res.*, **34 (3) : pp. 179-181.** Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

Eight promising strains of barley (*Hordeum vulgare* L.) were evaluated for green fodder yield, grain yield, chemical composition and *in vitro* dry matter digestibility. The green fodder yield was highest in PL-172 (216 q/ha) followed by PL-762 (206 q/ha), BL-185 (191 q/ha) and PL-790 (183 q/ha), whereas the grain yield after cutting was highest in PL-762 (51 q/ha), followed by BL-183 (43 q/ha), PL-172 (39 q/ha), PL-790 (38 q/ha) and BL-184 (37 q/ha). In terms of quality characteristics, PL-781 showed maximum dry matter content (24.10%). Crude protein differed significantly among various genotypes from 10.56 to 13.40 per cent with PL-790 showing the highest value. Highest value of crude fiber was observed in PL-781. The *in vitro* dry matter digestibility was best observed in the genotype BL-790. Similarly, highest values of nitrogen free extract (NFE), neutral detergent fiber (NDF) and acid detergent fiber (ADF) were observed in the genotypes BL-183, PL-172 and PL-426, respectively. Genotype BL-183 showed the lowest value of acid detergent lignin (ADL). Therefore, in terms of fodder yield and nutritional quality, these genotypes could be rated in the elite category.

- 322.** SAXENA, A. K., S. SHARMA, M. SRIVASTAVA AND B.L. BHARDWAJ 2009. **QUALITY EVALUATION OF DUAL-PURPOSE GENOTYPES OF PEARL MILLET (*Pennisetum glaucum* L.).** *Forage Res.*, **34 (4) : pp.254-258.** Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India.

Twelve pearl millet genotypes were tested for grain quality viz., moisture content, protein minerals, total sugars, oil content, eight for leaves and stalks quality characteristics and five fodder types were evaluated for different fodder morphological yield characters viz., fodder (green/dry), 50 per cent flowering days, tillers/plant, plant height and days to maturity etc. PHB 2245 registered maximum green fodder yield (233 q/ha) followed by PHB 2252 (207 q/ha) with their corresponding figures for dry fodder yield 140 and 113 q/ha, respectively. The plant height of the PHB 2168 (216 cm) was maximum with maximum days to 50 per cent flowering (55 days), and grain yield (41 q/ha), while of PHB 2238 was minimum (172 cm). Number of tillers per plant was maximum for PHB 2238 (2.6) followed by PCB 164 (2.2). Amongst eight genotypes tested for green fodder quality of leaves, PHB 2168 registered maximum moisture content (81.57%) followed by PHB 2245 (80.87%). PCB 164 with highest total mineral content (4.22%), total chlorophyll content (2.05mg/g) was promising. The sugar content of ICMA 92333 was maximum (2.63%). The chlorophyll content (total, a and b) in green leaves was maximum in PCB 164 (0.95,1.02 and 2.05 mg/g), while reducing sugars were maximum for PIB 199 (1.01%). PCB 164 registered maximum total chlorophyll content (1.34mg/g), while reducing, non-reducing and total sugars were maximum for ICMA94555 (0.91,4.39 and 5.30% respectively). The total sugar content of all genotypes tested was maximum in leaves as compared to stalks, which imparts sweetness. Grain protein content varied from 10.47-13.28 per cent, with mean value of 11.74 per cent d.w. Genotype PIB 593 registered maximum protein (13.28%) followed by ICMA 94555 and PHB 2252 (12.88% each). ICMA92333 recorded maximum minerals (2.33%) and oil content (5.7%). Total sugar content of PHB 2168 was maximum (2.88%) followed by PHB 2238 (2.68%). From the point of view of green fodder quality, PHB 2245, PHB 2168, PHB 2252 and ICMA 92333 were promising, while PHB 2168, PHB 2278, PIB 593 and ICMA 92333 excelled with respect to grain quality characteristics. Therefore, PHB 2168 and ICMA 92333 were found promising with respect to green fodder quality and grain quality characteristics thereby can be used for dual purpose.

323. KUMAR, S., SEEMA SANGWAN, MANJU BALA AND U. N. JOSHI 2009. **GENETIC DIVERSITY ANALYSIS AMONG *BRASSICA NAPUS* VARIETIES OBTAINED VIA. SDS-PAGE.** *Forage Res.*, **35 (2) : pp. 113-116.** Department of Biochemistry, DRMR, Sewar, Bharatpur (Rajasthan), India

Seed storage proteins, separated by SDS-PAGE, were used as biochemical markers for evaluation of polymorphic level among eight varieties of gobhi sarson (*Brassica napus*). On the basis of banding pattern, zymograms were sketched. A total of 26 bands were observed with Rm values ranging from 0.19 to 0.98, out of which 11 bands were polymorphic. Similarity indices were calculated using the Jaccard's coefficient and input into cluster analysis. The similarity indices ranged from 0.65 to 1.0 indicating high variability at protein level among the varieties. Some varietal specific bands were also obtained. Dendrogram was constructed using NTSYS-pc which revealed genetic relationship among different varieties.

324. KUMAR, S., SEEMA SANGWAN, MANJU BALA AND U. N. JOSHI 2009. **SDS-PAGE PROFILE OF SEED PROTEINS OF KARAN RAI (*BRASSICA CARINATA*) AND TARAMIRA (*ERUCA SATIVA*).** *Forage Res.*, **35 (2) : pp. 117-120.** Department of Biochemistry, DRMR, Sewar, Bharatpur (Rajasthan), India

Profile of seed storage proteins of Karan rai (five) and taramira (three) varieties obtained by using SDS-PAGE was used as biochemical marker to study genetic diversity. Electrophoretic comparative study generated a total of 27 bands having Rm value ranging from 0.1 to 0.92, out of which 15 bands were polymorphic. Jaccard's coefficient of similarity was used to evaluate relatedness among analyzed varieties. The similarity indices ranged from 0.52 to 1.0 indicating variability at protein level among the varieties. Some varietal and species specific bands were also obtained. Dendrogram was constructed using NTSYS-pc which revealed genetic relationship among different varieties. Seed protein profile analysis clearly distinguished the Karan rai from taramira varieties.

325. KADLAG, A. D., V. S. PATIL AND I. R. BAGWAN 2010. **QUALITY OF FODDER SORGHUM.** *Forage Res.*, **36 (2) : pp. 74-77.** Department of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722, Ahmednagar (Maharashtra), India

A field experiment was conducted during **kharif** 2002 and 2003 at Post Graduate Institute, MPKV, Rahuri in randomized block design (factorial) with three replications on Inceptisol. The treatments consisted of two fodder sorghum cultivars Ruchira (V_1) and M-35-1 (V_2) and three levels each of phosphorus (P_0-0 , P_1-40 and P_2-80 kg/ha) and sulphur (S_0-0 , S_1-40 and S_2-80 kg/ha, respectively). Ruchira fodder sorghum cultivar produced higher green forage and dry fodder yield (516.7 and 150.2 q/ha, respectively) than M-35-1 (509.3 and 147.6 q/ha, respectively). The higher levels of phosphorus @ 80 kg/ha recorded significantly higher green fodder yield during the year of experimentation and pooled mean (509.0, 550.3 and 529.6 q/ha, respectively) and dry fodder yield (152.3, 154.3 and 153.5 q/ha, respectively). Sulphur application @ 40 kg/ha recorded higher green fodder yield over 80 kg/ha and without sulphur. The crude protein and neutral detergent fibre content of fodder sorghum were influenced by the fodder sorghum cultivars and levels of phosphorus. The fodder sorghum cultivars, levels of phosphorus and sulphur significantly influenced the reducing and non-reducing sugars of sorghum fodder.

326. AMANDEEP, U. S. TIWANA AND D. P. CHAUDHARY 2010. **FORAGE QUALITY OF SORGHUM AS INFLUENCED BY IRRIGATION, NITROGEN LEVELS AND HARVESTING STAGE.** *Forage Res.*, **36 (2) : pp. 111-114.** Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

The field experiment was carried out at Forage Research Farm, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana during kharif 2008 to study the effect of scheduling of last irrigation, levels of nitrogen and harvesting stage on the quality of forage sorghum. The application of last irrigation at 7 days before harvest recorded significantly higher dry matter, crude protein, crude fat, mineral matter and NFE production over last irrigation at 14 and 21 days before harvest. Moreover, quality of sorghum was significantly improved with the

application of nitrogen upto 125 per cent of the recommended dose. The contents of quality parameters were significantly higher at 50 DAS, whereas significantly higher production of crude protein, crude fat, mineral matter and NFE were obtained with the harvesting of crop at 100 DAS.

327. BULDAK, L. R., SINGH, P. SUMERIYA AND H. K. GOLADA, S. L. 2010. **EFFECT OF NITROGEN LEVELS ON YIELD, HCN CONTENT AND QUALITY OF MULTICUT FORAGE SORGHUM [SORGHUM BICOLOR (L.) MOENCH] GENOTYPES.** *Forage Res.*, **36 (2) : pp. 121-123.** Rajasthan College of Agriculture, Udaipur

In a field experiment conducted at Research farm of Rajasthan College of Agriculture, Udaipur, it was observed that SSG 59-3 recorded significantly higher plant height, dry matter accumulation per plant, green as well as dry fodder yields, nitrogen content and uptake, gross returns, net returns and B:C ration than other genotypes and CSH 20 MF recorded significantly minimum HCN content at various growth stages at both the cuts over rest of genotypes.

4. Animal Nutrition

328. SAMANTA, A. K., S. K. NAG, A. S. NEGI AND K. K. SINGH 2001. **EFFECT OF DIFFERENT LEVELS OF LIPID SUPPLEMENTATION ON *IN VITRO* RUMEN FERMENTATION OF *STYLOSANTHES HAMATA*.** *Forage Res.*, **27 (3) : pp. 159-162.** Plant-Animal Relationship Division, Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

An *in vitro* experiment was conducted to study the effect of different levels of lipid on rumen parameters, total gas production and fibre digestibility of *Stylosanthes hamata* straw. The stylo straw was supplemented with 0, 2, 4, 6, 8 and 10 per cent of lipid. The IVDMD, NDFD, ADFD, NH₃-N, TVFA and gas production were enhanced on increasing lipid content upto 6 per cent but afterwards at 8 per cent or more lipid incorporation resulted in lower values of nutrient digestibility as well as rumen metabolites. The maximum IVDMD, NDFD, ADFD, NH₃-N, TVFA and gas production were observed at 6 per cent of lipid inclusion under *in vitro* system. The results revealed that incorporation of lipids upto 6 per cent was beneficial for the optimum utilization of lignified material like stylo straw.

329. KUMAR, V., S. K. MAHANTA, G. N. LODHI, V. C. PACHAURI AND U. P. SINGH 2001. **INFLUENCE OF ACCESS TO WATER DURING SUMMER ON FEED INTAKE AND UTILIZATION OF NUTRIENTS IN GOATS FED ALL FORAGE RATIONS.** *Forage Res.*, **27 (3) : pp. 189-192.** Department of Animal Husbandry and Dairying, Brahmanand Post Graduate College, Rath-210 431 (U. P.), India

Fifteen adult goats, divided into three groups (G₁, G₂ and G₃) of five animals in each, were fed all forage rations of leucaena (*Leucaena leucocephala*) leaves and dry mixed grass with different watering regimes for 49 days during summer. Goats under G₁ and G₃ groups were offered fresh drinking water *ad libitum* once and thrice a day, respectively. While animals under G₂ were offered only 50% of the water consumed by G₁ group. Average daily feed intake was 445.0, 446.9 and 435.4 g in G₁, G₂ and G₃ group, respectively, and the differences were non-significant. Average digestibility of DM, OM, CP, NDF, ADF and cellulose was similar among the groups and values ranged from 46.4 to 48.1, 49.4 to 51.5, 47.1 to 49.6, 46.0 to 47.8, 34.8 to 41.7 and 50.2 to 53.7 per cent, respectively. All the goats were in positive nitrogen balance. Goats under G₁, G₂ and G₃ groups retained 1.80, 1.87 and 1.83 g nitrogen daily and remained unaffected by watering regimes. Thus, restriction (upto 50%) or over access to water in local goats had no influence on feed intake, nutrient digestibility and nitrogen balance.

- 330.** SINGH, S. P., S. K. MAHANTA, G. H. PAILAN, G. N. LODHI, V. C. PACHAURI AND U. P. SINGH 2002. **INFLUENCE OF NITROGENOUS FERTILIZER APPLICATION TIME ON FEEDING VALUE OF GRASS HAY IN SHEEP.** *Forage Res.*, **27 (4) : pp. 243-311.** Department of Animal Husbandry & Dairying, Brahmaanand Post Graduate College, Rath-210 431 (U. P.), India

A year old stand of three perennial grasses viz., setaria (*Setaria sphacelata*), guinea (*Pennisetum maximum*) and hybrid napier (*Pennisetum purpurium* x *P. typhoides*) was applied with fertilizer N (@ 50 kg N/ha as urea) in split doses, varying in times after each cut of herbage, to study the influence of time of fertilizer N application on feeding value of grass in sheep. The experimental applications were 100% of recommended N dose just after cut (T_1), 75% of N dose just after cut and remaining 25%, 20 days before next cut (T_2), and 50% of N dose just after cut and remaining 50%, 20 days before next cut (T_3). The available grasses in each cut were conserved as hay and mixed (setaria : guinea : hybrid napier, 1 : 1 : 1; DM basis) as per treatments. Twelve ewes (12.40 ± 0.25 kg), divided into three groups of four each, were offered particular treatment of grass hay *ad-lib* over a period of 30 d followed by metabolism trial of 6 d duration followed by collection of blood and rumen liquor samples. Daily DM intake was 326.7, 341.6 and 319.0 g in ewes fed grass hay of treatments T_1 , T_2 and T_3 , respectively, and the differences were non-significant. Average digestibility of DM, OM, CP, EE, NDF, ADF, hemicellulose and cellulose was comparable amongst the treatment groups. Ewes under T_1 , T_2 and T_3 groups were in negative N balance and lost 0.15, 0.20 and 0.22 g N/d, respectively. The concentration of blood glucose, plasma protein and urea-nitrogen and rumen fermentation pattern in ewes did not differ significantly among the treatments.

- 331.** JAVED A. MULLA AND B. GANGAIAH 2002. **CONSERVATION OF SUBABOOL LEAF FODDER THROUGH SILAGE MAKING** *Forage Res.*, **27 (4) : pp. 293-294.** University of Animal Sciences, Dharwar.

A laboratory study was conducted at Dharwad to evaluate the silage making potential of subabool foliage with guinea grass. The desired silage pH (4.25) was attained by mixing subabool and guinea grass in 25:75 proportion in presence of molasses as additive.

- 332.** ROHILLA, P. P. 2002. **EFFECT OF AVENA SATIVA FEEDING ON GROWTH AND NUTRIENT DIGESTIBILITY IN RABBITS.** *Forage Res.*, **27 (4) : pp. 307-308.** NEH-Region, Nagaland Center, Jharnpani

A study was conducted at rabbit demonstration unit of ICAR Research Complex for NEH-Region, Nagaland Center, Jharnpani. It was observed that oats fodder can safely be added upto the level of 30% in rabbit ration during the lean periods.

- 333.** YADAV, K. K., R. P. S. GREWAL AND P. S. YADAV 2002. **NUTRITIONAL EVALUATION OF FORAGE SORGHUM IN BUFFALO HEIFERS-I.** *Forage Res.*, **28 (1) : pp. 26-28.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004, India

Two forage sorghum varieties viz., S-437 and PC-121 were nutritionally evaluated against the check HC-6 in buffalo heifer. Twelve heifers, divided into three equal groups of four each, were offered particular variety of forage sorghum *ad lib* over a period of 21 days followed by a digestibility trial of seven days duration and collected the feed and faeces samples. PC-121 contained higher CP and lower NDF than both HC-6 and S-437. The dry matter intake (% body wt.) remained similar in all groups. The digestibility of DM, OM, CF and NFE differed significantly being maximum in S-437 followed by HC-6 and PC-121; however, digestibility of CP and EE was maximum in HC-6 while minimum in S-437. The TND (%) content was lower in PC-121 (50.64 ± 1.65) than HC-6 (54.29 ± 1.28) and S-437 (54.23 ± 2.05) varieties. However, new variety PC-121 and check HC-6 were better in DCP content than new variety S-437 which met 97 per cent of the maintenance requirement of the protein. It may be concluded that the varieties HC-6 and PC-121 were nutritionally superior to the S-437 variety.

- 334.** YADAV, K. K., B. S. TEWATIA AND R. P. S. GREWAL 2002. **NUTRITIONAL EVALUATION OF FORAGE SORGHUM IN BUFFALO HEIFERS-II.** *Forage Res.*, **28 (2) : pp. 85-87.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004, India

Forage sorghum hybrids viz., SSG-59-3, 855-F and GK-905 were started to feed after 55 days of sowing to buffalo heifers. Twelve heifers, divided into three equal groups of four each, were offered particular hybrids of forage sorghum *ad lib.* over a period of 21 days followed by a digestibility trial of seven days duration for nutritional evaluation. GK-905 contained higher CP, NDF, ADF and cellulose contents and lower DM, EE and NFE contents than both SSG-59-3 and 855-F hybrids. The dry matter intake as such and g/kg w^{0.75} was significantly lower in 855-F fed group than other two groups. Digestibility of DM, OM, CF and NFE exceeded in SSG-59-3, while digestibility of CP and EE exceeded in animals offered GK-905 hybrid. All experimental animals maintained their body weight. The TDN content in all the hybrids was almost similar but DCP content in GK-905 was significantly higher than SSG-59-3. It may be concluded that all the three hybrids were nutritionally similar.

- 335.** MAHANTA, S. K., U. P. SINGH AND V. C. PACHAURI 2002. **SCOPE OF FEEDING SUBABUL (*LEUCEANA LEUCOCEPHALA*) FORAGE IN LIVESTOCK- A REVIEW.** *Forage Res.*, **28 (3) : pp. 124-129.** IGFRI, Jhansi (UP), India.

Subabul sole diet exhibited adverse effect in different species of animals. therefore, effort were made by various workers to take different preventive measures for utilizing subabul forage in the diet of animals have been discussed thoroughly.

- 336.** CHAUDHARY, J. L., L. R. GUPTA AND R. P. JAT 2002. **FEED COST OF MILK PRODUCTION IN BUFFALOES AS INFLUENCED BY LEVEL OF GREEN BERSEEM IN THE DIET.** *Forage Res.*, **28 (3) : pp. 159-161.** Department of Livestock Production and Management, CCS Haryana Agricultural University, Hisar, 125 004, India

A study was undertaken on 15 lactating buffaloes to see the effect of three levels of green berseem (*Trifolium alexandrinum*) (T₁-40 kg, T₂-20 kg and T₃-5 kg) in the diet on feeding cost of animals and feed cost of milk production was Rs. 2.84, 2.84 and 2.98 in T₁, T₂ and T₃ groups, respectively, based on farm price, while corresponding figures were Rs. 3.90, 3.40 and 3.13, respectively, based on market price. This study showed that dairy farmers particularly urban site could reduce the feed cost of milk production by feeding less amount of berseem (5 or 20 kg). However, feeding of higher level of berseem (40 kg) will be economical to those who grow the green fodder.

- 337.** CHAUHAN, T. R. 2003. **FORAGE CONSERVATION AND ITS UTILIZATION BY RUMINANTS FOR ECONOMIC ANIMAL PRODUCTION.** *Forage Res.*, **29 (1) : pp. 18-25.** Central Institute for Research on Buffaloes, Sirsa Road, Hisar-125 001 (Haryana), India

Forages are cheaper source of nutrients than conventional concentrate feeds. The feeding cost of animal production is 75 per cent of the total cost and this can be reduced by 40 per cent by replacing costly concentrate mixture with highly digestible dried legume forage using non-legume or their silage as basal roughage provided the CF content of such pooled rations is kept below 25 per cent. Different combinations of concentrate and roughages have been tried for raising buffalo calves economically. A daily body weight gain of buffalo calves has been reported to vary 0.4 to 0.6 kg/day on different planes of nutrition of different feeding regimes including all forage diets. Under normal feeding of concentrate mixture along with good quality of hay and green fodder, a growth rate of 0.5 to 0.6 kg has been achieved in buffalo calves of large breeds like Nili Ravi, Murrah and Mehsana. The replacement value of dried Indian legume forages like cowpeas, berseem and lucerne was found to be 1.0-1.3 kg for each kg concentrate mixture in the growing and lactating buffaloes. The availability of quality forage throughout the year is the major concern of dairy farmers. There are two scarcity periods (May-June and November-December) in a year, particularly in northern India. Forages when produced in excess may be conserved as hay or silage, which should meet the

requirements of buffaloes during these scarcity periods. Non-legume forages grown in India containing sufficient available carbohydrates can be conserved as silage without the use of any additive. The nutritive value of these forages can be enhanced if urea N is added at (1 or 1.5% wet basis) before ensilage. Similarly, leguminous crops containing sufficient proteins can be conserved as hay. The *in vitro* organic matter digestibility of legume hays available in India ranges from 60 to 75 per cent, depending upon their stage of harvesting as against the *in vitro* OMD of 80 to 85 per cent of conventional concentrate mixtures available in India.

338. BHATIA, S. K. 2003. **CONCEPTS AND ADVANCES IN THE CHEMICAL AND BIOLOGICAL EVALUATION OF NUTRITIVE VALUE OF FORAGES.** *Forage Res.*, 29 (1) : pp. 36-43. Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004, India

Deficit in feed resources is one of the reasons of low productivity of our livestock, necessitates the development of high yielding and nutritionally rich fodders through extensive researches, which warrant elaborate nutritive evaluation (chemical and biological). Several chemical methods viz., Proximate, Van Soest, modified detergent, cell wall partitioning by Gaillard and Nijkamp, cellulolytic enzymic digestion, pepsin-cellulase, *in vitro* digestibility—single stage or two stage of Tilley and Terry, modified *in vitro* method of Van Soest besides *in sacco* technique, near infrared reflectance spectroscopy (NIR), biological methods explicitly standardized for precision and accuracy of feeding value of tropical feeds and regression equations have been documented. The use of Fibrometer—a simple physical method considered complementary to both chemical and biological evaluation, to determine the bulk value of tropical forages has also been devised. Theodorou methodology using pressure transducer and rumen gas pool size using Menke and co-worker model are some of the latest techniques besides NIR, reported in the literature. Nutritional quality, based on morphological characteristics, has also been predicted. Indiscriminate and indiscreet usage of analytical techniques developed with temperate forages (differ in chemical composition and digestibility from tropical ones) warranted the modification of methods for nutritive evaluation of tropical fodders. Some of the techniques are not only too time consuming but also elaborative for routine analysis. An overview inferred the effective economical analysis by adopting 10 g instead of usually followed 30 g sodium lauryl sulphate/l and CTAB 5 g/l in place of 20 g/l of solution for NDF and ADF estimation, respectively, and IVDMD through two stage Tilley and Terry for initial genetic materials screening. Crude protein could be estimated with 20% NaOH instead of 40 per cent NaOH. Such altered techniques will reduce the cost of analysis by 2/3, 3/4 and 1/2 of those in original methods for NDF, ADF and CP analysis. Varietal screening of forages through modified Van Soest method and cellulase enzyme method for scanning of non-legume forages for DM solubility have been recommended. IVDMD can be estimated based on DM solubility (0.5 g sample, 0.5 mm particle size). An accurate prediction of IVDMD can be achieved in order of preference by using an anhydro-uronic acid, CP, NDF, cellulose and lignin contents of oat and for berseem through analysis of NDF, cellulose, lignin, CP and anhydro-uronic acid contents. Existence of animal species differences in digestibility contradicts the generalization of digestibility data of one ruminant to other ruminant.

339. TEWATIA, B. S. AND V. S. PANWAR 2003. **NUTRITIVE EVALUATION OF BER LEAVES HAY V. S. BERSEEM HAY IN GOATS.** *Forage Res.*, 29 (3) : pp. 107-109. Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Nutritive value of ber leaves hay was evaluated against berseem hay in Beetal goats. Twelve female goats of five months of age were distributed into two groups of six animals in each group and were fed either ber leaves hay or berseem hay *ad lib.* for a period of 30 days. After which a metabolism trial of five days duration was also conducted. Ber leaves hay contained 10.8% crude protein, 4.6% crude fat, 21.1% crude fibre, 52.7% NFE and 4.1% calcium. Berseem hay contained higher crude protein (13.4%) and crude fibre (26.3), while lower calcium (2.8%) than ber leaves hay. Dry matter intake (g/d) was 536.2 g in animals fed ber leaves hay and was higher ($P < 0.05$) than those fed berseem hay (408.6). Digestibility of dry matter and crude fibre was higher ($P < 0.05$) in animals fed ber leaves hay. Nitrogen retention (g/d) was 1.16 and 2.10 in berseem hay and ber leaves hay fed groups and these differences were statistically significant ($P < 0.05$). Animals fed berseem hay and ber leaves hay gained 30.6 and 50.8 g/day, respectively. Nutritive value in terms of DCP and TDN was 7.52, 52.23% and 6.26, 56.23%, respectively for

berseem hay and ber leaves hay. Nutritive value index was higher for ber leaves hay (73.78) as compared to that of berseem hay (52.80). It is, therefore, inferred that ber leaves hay could provide better nutrition to small ruminants than berseem hay.

340. DULAR, R. K. AND D. C. SANGWAN 2004. **RELATIVE DEGRADATION AND *IN VITRO* METABOLISM OF SULPHUR SUPPLEMENTED SORGHUM STOVER BY ANAEROBIC FUNGI FROM CATTLE AND BUFFALO.** *Forage Res.*, **30 (1) : pp. 17-21.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Sulphur supplemented (0.1, 0.2, 0.3 and 0.4% on DM basis) sorghum stover was incubated under *in vitro* simulated rumen using anaerobic fungi from cattle and buffalo. *In vitro* dry matter digestion, rumen gas volume and metabolites were studied to relatively assess the degradative and metabolic activity of these fungi. Dry matter degradability, irrespective of fungi habitat, was highest ($P < 0.05$) at 0.3% level of sulphur (51.9 and 52.3%) for two respective ruminants in relation to those of control (44.9 and 46.7%). The pattern of rumen gas pool size substantiated the ruminal DM degradation. The overall average values of DM degradation were fairly close between cattle (50.0%) and buffalo (50.2%). Sulphur incorporated sorghum stover linearly increased ($P < 0.05$) rumen total and protein-N metabolites and decreased ($P < 0.05$) ammonia-N (29.5 vs. 38.4 mg% in cattle, 35.0 vs. 42.7 mg% in buffalo) as compared to control in both the ruminants. Rumen nitrogen fraction (total and protein), TVFA and cellulase activity were maximum ($P < 0.05$) due to 0.3% sulphur level in both the ruminant species. Of the graded levels of sulphur, 0.3% helped in maximizing *in vitro* dry matter digestion and nitrogen metabolites by anaerobic fungi. Rumen fungi from buffalo than cattle enhanced DM degradability and rumen protein-N constituent.

341. PATEL, J. R., D. D. DUBEY AND S. RAJAGOPAL 2004. **INFLUENCE OF CROP MIXTURE ON GREEN FODDER PRODUCTION OF LUCERNE.** *Forage Res.*, **30 (1) : pp. 39-40.** Department of Animal Nutrition, College of Veterinary Science, P. B. No. 6, Anjora-491 001, Durg (Chhattisgarh), India

A study was conducted to find out the suitable crops and their plant geometry under mixed cropping system with lucerne for higher green fodder production at College of Veterinary Science and A. H., Anjora (Durg) during winter seasons of 1999-2000 and 2000-01. Results revealed that sowing with a mixture of 1, 2 and 3 kg seed/ha of mustard and 25 kg seed/ha of lucerne being at par produced significantly higher total green fodder yield over sole lucerne during both the years. However, green fodder yield obtained with mixing of oat and methi in lucerne seed did not reach the expected level of significance.

342. YADAV, K. K., B. S. TEWATIA AND R. P. S. GREWAL 2005. **NUTRITIVE EVALUATION OF SINGLE CUT FORAGE SORGHUM IN MALE BUFFALOES.** *Forage Res.*, **30 (4) : pp. 224-226.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Two new varieties of forage sorghum viz., UPFS-38 and SRF-239 were nutritionally evaluated against a popular forage sorghum variety, HC-308. Twelve male buffaloes were divided into three equal groups of four each. Animals were offered a particular variety of forage sorghum *ad libitum* over a period of 21 days followed by a digestion trial of seven days. The CP content was higher in new cultivars UPFS-38 (6.41%) and SRF-239 (5.48%) than the HC-308, while OM (90.45%) and NFE (61.03%) contents were higher in HC-308 than the other two varieties. The dry matter and organic matter intakes were apparently higher in SRF-239, while higher CP and lower TDN intakes were observed in UPF-38. The digestibility of proximate constituents and fibre fractions were maximum in HC-308 followed by UPFS-38 and SRF-239 varieties. DM, OM and NFE digestibility in HC-308 were significantly higher ($P < 0.05$) than UPFS-38 fed groups. It may thus be concluded that HC-308 is superior to the new cultivars of forage sorghum, namely, UPFS-38 and SRF-239 in respect of higher TDN and digestibility of nutrients.

343. ROHILLA, P. P. AND S. S. RAO 2005. **FORAGE INDUCED NUTRITIONAL DISORDERS OF LIVESTOCK IN ARID FRINGES.** *Forage Res.*, **31 (1) : pp. 1-4.** Central Arid Zone Research Institute, Regional Research Station, Pali-Marwar-306 401 (Rajasthan), India

In ruminants, metabolism of toxins by rumen microbes is an important factor in altering sensitivity to plant toxins. Bloat can be minimized by manipulating at least 50 per cent grass in the pasture or by giving animals access to some anti-foaming agent (Poloxalene). Ammoniation of stacked hay with anhydrous ammonia reduces the dicoumarol levels. Avoiding the use of sulphur and high nitrogen in fertilizer reduces sulfoxide levels and toxicity. Ensiling of sorghum markedly reduces the cyanide risk. Provisions of mineral supplements high in calcium to grazing animals overcome the adverse effects of oxalates in grasses. Ergotism can be avoided by not allowing animals to graze mature grass containing seed heads or by clipping pastures to prevent grass development. In some cases e. g. cynogenic glycosides and the brassica anaemia factor, the toxicity is increased by rumen fermentation. Sometimes e. g. mimosine or oxalate toxicity, the compounds are detoxified by microbial metabolism; the toxic amino acid mimosine in *Leucaena* spp. becomes of particular interest in such cases.

344. KUMAR, ANIL, R. S. YADAV, ANUJ TYAGI, T. R. CHAUHAN AND N. S. YADAV 2005. **PRODUCTION PERFORMANCE OF LACTATING MURRAH BUFFALOES UNDER DIFFERENT NUTRITION AND FEEDING SYSTEMS.** *Forage Res.*, **31 (1) : pp. 12-15.** Department of Livestock Production and Management, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Twenty lactating buffaloes in their early lactation (7-8 litres milk) were divided into four groups (five animals in each group) viz., T₁ group buffaloes were fed ICAR recommended 100% feeding level individually and in T₂ the animals were fed at 120% ICAR feeding levels individually. The same treatments in T₃ and T₄ were repeated where animals were reared in a group feeding system. The feeds and fodders available were conventional concentrate mixture, green berseem ammoniated wheat straw (4% urea). The feed conversion efficiency improved significantly with the increase in plane of nutrition but there was no effect due to rearing system. Similarly, milk yield increased significantly at higher plane of nutrition but this effect was non-significant due to feeding systems. In the milk composition, there was an increasing trend in milk fat, protein, total solids and SNF at higher plane of nutrition in both the rearing systems. However, the effect of two rearing systems remained unaffected. The time spent by labour for cleaning the shed and feeding, washing and watering the buffaloes was not influenced significantly either by levels of feeding or rearing systems. Animals gained higher body weight at higher plane of nutrition. The cost per kg milk production was less in group receiving 120 per cent ICAR feeding levels and reared individually.

345. YADAV, K. K., D. V. DAHIYA AND K. K. YADAV 2005. **EFFECT OF REPLACEMENT OF FABA BEANS (*VICIA FABA L.*) ON THE GROWTH AND NUTRIENT UTILIZATION IN KIDS.** *Forage Res.*, **31 (1) : pp. 16-17.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A growth-cum-digestion trial was conducted for a period of 180 days on crossbred (Black Bengal x Beetal) and Beetal kids (2-4 months; 7.9-12.6 kg). The kids were divided randomly into three equal groups (3 cross and 3 beetal each) fed concentrate mixture where (T₁) control, (T₂) 25 per cent replacement of CP of T₁ by faba bean and (T₃) complete replacement of concentrate mixture by faba bean. The dry matter intake was apparently higher in T₂ than T₃, while body weight gain was higher (P<0.05) in T₃ than T₁. No. significant differences amongst treatments were observed with respect to digestibility coefficients of DM, CP, EE and NFE, blood glucose, serum protein and serum urea. But higher growth rate was observed by inclusion of faba bean in the ration. It was concluded that concentrate mixture could be replaced completely with faba bean in the ration of growing kids.

- 346.** YADAV, K. K., K. K. YADAV, Z. S. SIHAG AND R. S. BERWAL 2005. **STUDIES ON STORAGE FOR DIFFERENT PERIODS ON NUTRITIVE VALUE OF UREA TREATED PADDY STRAW.** *Forage Res.*, **31 (2) : pp. 123-125.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Paddy straw treated with 4 per cent urea and 40 per cent moisture level was stored airtight for one month (T_1), three months (T_2), six months (T_3) and 12 months (T_4). The treated paddy straw was fed to four crossbred bullocks for 21 days (15 days adaptation period+ six days collection period). Four digestibility trials were conducted. Simultaneously six polythene bags of one kg capacity each were filled with urea treated straw and were sealed to make them airtight. These bags were weighed after one month, three months, six months and one year to find out the DM loss during storage. The DM, OM and NFE contents were reduced significantly ($P<0.05$) after six months of anaerobic storage of treated paddy straw, whereas total ash contents increased significantly ($P<0.05$). However, CP, CF and EE remained unaffected. The digestibility of CP, CF, EE and NFE did not differ significantly among different treatments. However, the DM digestibility recorded a significant ($P<0.05$) increase at three months (60.18%) as compared to one month (55.27%), six months (54.23%) and one year (50.60%). Digestible crude protein value of treated paddy straw remained unchanged during storage, whereas TDN value decreased significantly after six months of storage.

- 347.** AJAIB SINGH 2005. **EVALUATION OF NEWLY DEVELOPED FORAGE BAJRA COMPOSITE AND ITS SILAGE.** *Forage Res.*, **31 (2) : pp. 136-137.** Department of Animal Nutrition, PAU, Ludhiana-141001

It was observed that bajra fodder varieties were quite comparable but the newly developed variety FBC-16 and superiority over PCB-141 in terms of green and dry fodder production.

- 348.** YADAV, K. K., R. S. BERWAL, K. K. YADAV AND Z. S. SIHAG 2005. **NUTRITIONAL VARIABILITY AND *IN SACCO* DIGESTIBILITY IN DIFFERENT CULTIVARS OF RICE STRAW.** *Forage Res.*, **31 (3) : pp. 209-211.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Nutritional quality of 11 varieties of paddy straw (commonly grown in Haryana), namely, Taravari Basmati, Haryana Basmati No. 1, Pusa Basmati, Basmati-370, HKR-126, IR-64, Jaya, Narendra, Govind, RR-106 and HKR-46 grown under uniform agronomic conditions was compared and was reconfirmed by repeating the experiment in second year with straw of seven rice varieties viz., Taravari Basmati, Haryana Basmati No. 1, PR-106, Govind, IR-64, HKR-126 and HKR-46. During the first year, the CP contents of straw ranged from 3.15 in Jaya to 6.77 in PR-106. HKR-46, Govind and Taravari Basmati contained 6.22, 5.68 and 5.68 per cent CP, respectively. Total ash content ranged from 11.35 per cent in Taravari Basmati to 17.60 per cent in IR-64 and in Jaya 17.55 per cent, whereas acid insoluble ash contents ranged from 5.9 per cent in Taravari Basmati to 13.55 per cent in Jaya. Crude fibre fraction was lowest (25.79%) in IR-64 and highest (36.51%) in HKR-46. NDF varied by 7.13 units, ADF varied by 11.33 units, hemi-cellulose varied by 8.70 units among straw of different paddy cultivars. Similarly, Ca contents ranged from 0.42 per cent in HKR-126 to 0.65 per cent in Taravari Basmati. During second year, CP varied by 0.60 units, CF varied by 6.12 units, insoluble ash varied by 2.18 units, NDF varied by 3.75 units and ADF ranged from 35.06 to 42.88 per cent. Similarly, ADL lignin bound protein, Ca, K and oxalate content were also significantly different in straw of different rice varieties. *In situ* dry matter disappearance was found to be highest in HKR-46 i. e. 46.90 per cent, whereas minimum of 42.60 per cent was in IR-64. It was concluded that the straw of different rice varieties differed significantly in its chemical composition and *in situ* dry matter disappearance. Though the CP content of some of the varieties was observed to be slightly lower in second year as compared to the first year, yet it was quite good and encouraging.

349. RAI, P., D. B. V. RAMANA AND U. P. SINGH 2006. **PERFORMANCE OF SMALL RUMINANTS UNDER STALL FEEDING AND GRAZING CONDITIONS IN SILVIPASTORAL SYSTEM.** *Forage Res.*, **31 (4) : pp. 255-258.** National Research Centre for Agroforestry, Jhansi-284 003 (U. P.), India

The experiment was conducted on nine years old silvipasture consisting of *Leucaena leucocephala* as tree, *Dichrostachys cinerea* as shrub and perennial grasses such as *Chrysopogon fulvus*, *Heteropogon contortus*, *Sehima nervosum*, *Pennisetum pedicellatum*, etc. to know the comparative growth performance of small ruminants (sheep and goats) on stall feeding and *in situ* grazing condition from October 1999 to April 2000 (200 days). Five lambs (1 male+4 female) and five kids (1 male+4 female) were introduced for grazing and five each female lambs and kids of similar age and weight were stall fed with similar type of vegetation as in case of grazing animals. Data recorded on live weight gain revealed that kids and lambs gained in their body weight of 52.5 and 25.5 g/head/day, respectively, under grazing condition. While in case of stall feeding the gain was 24.0 and 10.5 g/head/day, respectively, in the same period. Thus, under grazing condition, the growth rate of kids and lambs was 54.3 and 58.8 per cent higher, respectively, over stall feeding condition. Further the wool production of sheep under grazing condition was also higher (18%) than stall feeding. Thus, rearing of small ruminants under grazing condition is more beneficial than stall feeding condition.

350. AJAIB SNGH AND M. S. GILL 2006. **CONSERVATION OF SUGARCANE TOPS FOR SCARCITY PERIOD.** *Forage Res.*, **31 (4) : pp. 272-273.** Department of Animal Nutrition, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India.

The results indicated that the silage could serve as a good source of roughage particularly in sugarcane belt areas.

351. YADAV, K. K., S. K. PAHUJA AND K. K. YADAV 2006. **COMPARATIVE NUTRITIVE EVALUATION OF FORAGE SORGHUM HYBRIDS IN BUFFALO HEIFERS.** *Forage Res.*, **32 (1) : pp. 15-16.** Forage Research Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Twelve buffalo heifers were distributed into three equal groups of four each. The fodder of fresh chaffed forage sorghum hybrids viz., 855F (Check), SSG 1001 and FSH 92079 was fed to the animals of the respective groups. Feeding was continued for 28 days followed by a digestion trial of seven days. Crude protein content of hybrid 855F (7.35%) and FSH 92079 (7.35%) was similar. But NFE (58.69%) content was slightly higher, whereas CF (25.66%) and cellulose (30.54%) contents were lowest in 855F than the other two hybrids. Dry matter intake kg/100 kg body weight was lowest in animals fed FSH 92079 as compared to the animals fed 855F and SSG 1001 sorghum hybrids. Therefore, it contained significantly ($P < 0.05$) lower TDN in comparison to 855F and SSG 1001 hybrids. Hence, it was concluded that the hybrids 855F and SSG 1001 were nutritionally better than FSH 92079 forage sorghum hybrid.

352. PANWAR, V. S., B. S. TEWATIA AND RAM AVTAR 2006. **NUTRITIONAL EVALUATION OF NEWLY DEVELOPED BERSEEM (*TRIFOLIUM ALEXANDRINUM*) VARIETIES IN BUFFALO CALVES.** *Forage Res.*, **32 (1) : pp. 41-43.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Two improved varieties of berseem (HFB-600 and HFB-130) were nutritionally evaluated against the check variety Mascavi in 12 male buffalo calves divided into three groups. Variety HFB-600 contained higher crude protein (19.05%) and lower crude fibre as compared to HFB-130 and the check variety Mascavi. The effective degradation (%) of berseem dry matter was also higher for HFB-600 (67.6) than Mascavi (63.6) and HFB-130 (63.2). Feed intake (total and % of BW) did not vary significantly among the groups. Digestibility of dry matter, organic matter, crude fibre, cellulose and energy was significantly higher ($P < 0.05$) in animals fed HFB-600 as compared to those fed HFB-130 or Mascavi. Nitrogen retention (g/day) and nitrogen retention as per cent of intake were higher ($P < 0.05$) in

the animals fed HFB-600 fodder. The varieties differed ($P < 0.05$) with respect to DCP content and the value was highest in HFB-600 (11.10%); however, TDN content did not differ significantly among the groups. It may thus be concluded that newly developed variety HFB-600 was nutritionally better than the check variety Mascavi; however, no differences were recorded between Mascavi and HFB-130.

- 353.** JAGLAN, B. S., NAND KISHORE AND Z. S. SIHAG 2006. **EFFECT OF DIFFERENT LEVELS OF CROP RESIDUES ON THE FORMATION OF FEED BLOCKS.** *Forage Res.*, **32 (1) : pp. 46-50.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Wheat straw was replaced by paddy straw, mustard straw and sugarcane bagasse at 0, 10, 25, 50, 75 and 100% levels. In the straw, the molasses were kept at 15 per cent and the moisture at 15 to 17 per cent and feed blocks were made through a hydraulic press by applying a pressure of 350 kg/cm^2 for 5 min. Loose bulk density decreased ($P < 0.01$) from 71.98 kg/m^3 to 59.25 kg/m^3 with an increase in the level of paddy straw from 0 to 100 per cent, while the replacement of wheat straw by mustard straw and sugarcane bagasse increased it to 87.84 and 86.83 kg/m^3 , respectively. The compact bulk density increased ($P < 0.01$) with an increase in level of paddy straw, mustard straw and sugarcane bagasse. The bulk density was maximum (260.22 kg/m^3) when wheat straw was completely replaced by sugarcane bagasse. The increase in density was 2.78 times when wheat straw was converted into feed block, increase in the replacement level to 100 per cent of paddy straw, mustard straw and sugarcane bagasse in the feed block increased ($P < 0.01$) it to 4.17, 2.96 and 3.01 times, respectively. Whereas post-compression expansion increased ($P < 0.01$) with the increase in the level of paddy straw, while increase in the level of mustard straw and sugarcane bagasse decreased it. Feed blocks of paddy straw were least, while the blocks of sugarcane bagasse were most ($P < 0.01$) durable.

- 354.** KUMAR, A., R. S. YADAV, N. S. YADAV, T. R. CHAUHAN AND ANJU TYAGI 2006. **FEEDS AND FODDERS DIGESTIBILITY IN LACTATING MURRAH BUFFALOES AND THEIR GROWING CALVES UNDER TWO LEVELS OF FEEDING AND REARING SYSTEM.** *Forage Res.*, **32 (2) : pp. 69-73.** Department of Livestock Production and Management, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Lactating Murrach buffaloes (20) and their calves (16) were divided into four groups viz., T_1 and T_2 animals reared individually and were fed 100 and 120 per cent ICAR recommended level of nutrition, respectively. Similarly, T_3 and T_4 groups were fed 100 and 120 per cent ICAR recommended level of nutrition, respectively, but reared in group feeding system. Each treatment group of buffalo and calves had five and four animals, respectively. It was observed that the digestibility of DM, EE, CF, CP except NFE, was significantly ($P < 0.05$) influenced by the levels of feeding in the ration of buffaloes. Similarly, CF, CP and NFE barring DM and EE digestibility was significantly ($P < 0.05$) influenced by the levels of feeding in case of calves. Rearing system significantly ($P < 0.05$) influenced the digestibility in lactating buffaloes. The interaction between feeding levels and rearing systems on nutrient digestibility was found non-significant.

- 355.** JAGLAN, B. S., NAND KISHORE, Z. S. SIHAG, K. K. YADAV AND R. S. BERWAL 2006. **EFFECT OF DIFFERENT LEVELS OF UREA TREATED CROP RESIDUES ON DENSIFICATION CHARACTERISTICS OF FEED BLOCKS.** *Forage Res.*, **32 (2) : pp. 74-78.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The crop residues viz., wheat straw, paddy straw, mustard straw and sugarcane bagasse were treated with urea at 4 per cent level. Treated wheat straw was replaced by treated paddy straw, mustard straw and sugarcane bagasse at 0, 10, 25, 50, 75 and 100 per cent levels. To the treated crop residues molasses was added at 15 per cent level and moisture was kept between 15 to 17 per cent by adding calculated quantity of water. The material was thoroughly mixed and blocks were made by pressing the material to a pressure of 350 kg/cm^2 for 5 min in the electrically operated hydraulic press machine. OM and CP content was higher ($P < 0.05$) in sugarcane bagasse than

the contents in other crop residues, however, sugarcane bagasse contained very low ($P < 0.05$) level of ash. Among the crop residues, hemicellulose content was highest ($P < 0.05$) in wheat straw, while cellulose content was more ($P < 0.05$) in mustard straw and sugarcane bagasse. Loose bulk density decreased ($P < 0.01$) from 75.83 to 68.76 with the increase in the level of paddy straw from 0 to 100 per cent, while the replacement of wheat straw by mustard straw and sugarcane bagasse increased ($P < 0.01$) it to 87.60 and 93.60 kg/m³, respectively. The compact bulk density increased ($P < 0.01$) with the increase in level of paddy straw, mustard straw and sugarcane bagasse and the value (285.41 kg/m³) was maximum when wheat straw was completely replaced by sugarcane bagasse. Times increase in density amplified ($P < 0.01$) with the increase in replacement levels of treated wheat straw by other treated crop residues and the values were 2.84, 3.61, 2.95 and 3.05 times in feed blocks made of treated wheat straw, paddy straw, mustard straw and sugarcane bagasse, respectively. The post compression expansion of the blocks increased ($P < 0.01$) with the increase in the level of paddy straw, while the increase in the level of mustard straw and sugarcane bagasse in the feed block decreased ($P < 0.01$) it. Increase in the level of mustard straw and sugarcane bagasse made most ($P < 0.01$) durable, while that of paddy straw made least ($P < 0.01$) durable feed blocks.

- 356.** KUMAR, A., R. S. YADAV, N. S. YADAV, T. R. CHAUHAN AND ANUJ TYAGI 2006. **GROWTH PERFORMANCE OF MURRAH BUFFALO CALVES OF PRE-RUMINANT AGE UNDER DIFFERENT FEEDING REGIMES.** *Forage Res.*, **32 (2) : pp. 101-106.** Department of Livestock production and Management, CCS Haryana Agricultural University, Hisar 125004 (India)

Murrah buffalo calves of pre-ruminant age (20 days) 16 in number were divided into four groups viz., T₁ and T₂ animals reared individually and were fed 100 and 120 per cent ICAR recommended level of nutrition, respectively. The same feeding levels were repeated in T₃ and T₄ groups of calves, respectively, but reared in group feeding system. There were four animals in each treatment group. The feeds and fodders available were conventional concentrate mixture, green berseem, sorghum, mustard, sugarcane top and ammonia (4% urea) treated wheat straw. The feed conversion efficiency improved significantly with the increase in plane of nutrition. Average daily body weight gain and increase in body measurement were significantly higher in calves receiving higher as compared to those standard planes of nutrition. The difference for these parameters between rearing system were found non-significant. Time spent by labour for rations and farm operations was found non-significant in both feeding levels and rearing systems. The cost per kg gain was less in 120 per cent ICAR feeding standard in group feeding system. It was inferred from this study that calves should be maintained at 120 percent ICAR levels in group feeding system in order to maintain their proper growth during early age period.

- 357.** YADAV, K. K., K. R. YADAV, JAIVIR SINGH AND SAJJAN SIHAG 2006. **COMPARATIVE NUTRITIONAL EVALUATION OF CLUSTER BEAN [CYAMOPSIS TETRAGONOLOBA (L.) TAUB.] FODDERS IN MALE BUFFALO.** *Forage Res.*, **32 (2) : pp. 107-111.** IATTE, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Two diet combinations viz., chaffed guar fodder (HG 365) and wheat straw (T₁) and guar fodder (HG 75) and wheat straw (T₂) in 2 : 1 ratio on dry matter basis were fed to eight male buffalo calves for 20 days. The animals of 1.5 to 2.0 years of age were divided into T₄ (229 kg) and T₂ (233 kg), two equal groups on the basis of their body weight. After 20 days of experimental feeding, a digestion trial of five days duration was conducted. The mean organic matter (OM), crude protein (CP) and nitrogen free extract (NFE) contents in guar fodder variety (HG 365) were higher, while CF, NDF, ADF, cellulose and hemicellulose contents were higher in HG 75 variety. The DM intake was higher ($P < 0.05$) in animals fed HG 365 fodder variety as compared to the animals fed with the fodder of HG 75 variety. Average digestibility coefficients of DM, OM, EE, NFE, NDF and ADF were slightly higher in animals under T₁ treatment as compared to T₂ and thus resulted in higher TDN in comparison to HG 75 variety. Hence, it was concluded that fodder of HG 365 cultivar was superior to the fodder of HG 75 guar cultivar.

358. NARWAL, S. S., D. S. DAHIYA, R. PALANIRAJ, S. C. SATI, R. S. SHEORAN AND HARDEEP SINGH 2006. **ALLELOPATHIC INFLUENCE OF FORAGE TO TOXICITY ON ANIMALS.** *Forage Res.*, **32 (3) : pp. 133-143.** CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Toxicity is caused by the allelochemicals present in forage and decreases the productivity of animals. Therefore, this review has been prepared to acquaint the Indian forage scientists about the allelopathic influence of toxic forage spp. on animals.

359. SINGH, A., M. S. GILL AND DHARAM PAUL 2006. **SOME ANTIQUALITY COMPONENTS OF COMMONLY CULTIVATED FODDER CROPS-A REVIEW.** *Forage Res.*, **32 (3) : pp. 144-147.** Department of Animal Nutrition, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana (Punjab), India

The toxicity due to the consumption of various forages is very common among farm animals. In this review paper, the common anti-nutritional factors viz., nitrates, oxalates, HCN, tannins and selenium present in different fodder crops have been discussed with reference to their toxic levels, symptoms and preventive measures to be taken for their safe feeding to dairy animals.

360. YADAV, K. K., K. R. YADAV, JAIVIR SINGH, AND SAJJAN SIHAG 2006. **COMPARATIVE NUTRITIONAL EVALUATION OF CLUSTERBEAN [CYAMOPSIS TETRAGONLOBA (L.) TAUB.] FODDERS IN BUFFALO CAVES.** *Forage Res.*, **32 (3) : pp. 185-187.** IATTE, CCSHAU, Hisar-125004

Two diet combinations viz., chaffed guar fodder (HG 365) and wheat straw (T_1) and guar fodder (hg 75) and wheat straw (T_2) in 2 : 1 ratio on dry matter basis were fed to eight male buffalo calves for 20 days. The animals of 1.5 to 2.0 years of age were divided into T_1 (229 kg) and T_2 (233 kg), two equal groups on the basis of their body weight. After 20 days of experimental feeding, a digestion trial of days duration was conducted. The mean organic matter (OM), crude protein (CP) nitrogen free extract (NFE) contents in guar variety (HG 365) were higher, while CF, NDF, ADF, cellulose and hemicellulose contents were higher in HG 75 variety. The DM intake was higher in animals fed HG 365 fodder variety as compared to the animals fed with the fodder of HG 75 variety. Average digestibility coefficients of DM, OM, EE, NFE, NDF and ADF were slightly higher in animals under T_1 treatment as compared to T_2 and the resulted in higher TDN in comparison to HG 75 variety. Hence, it was concluded that fodder of HG 365 cultivar was superior to the fodder of HG75 guar cultivar.

361. SIHAG, Z. S., NAND KISHORE, R. S. BERWAL AND K. K. YADAV 2006. **EFFECT OF DIFFERENT CHEMICAL TREATMENTS AND MOISTURE LEVELS ON *IN SACCO* DEGRADABILITY OF COTTON STICKS.** *Forage Res.*, **32 (3) : pp. 190-192.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

An experiment was conducted to study the effect of different moisture levels on the effectiveness of urea and lime treatment of cotton sticks straw. The cotton sticks were grinded through 8 mm sieve size through a hammer mill. The straw was then treated with 4 per cent urea (T_2), 4 per cent lime (T_3), (4%; 1 : 1) urea+lime (T_7) at 30, 40, 50 and 60 per cent moisture levels for 42 days. Adult rumen fistulated male Murrah buffaloes fed high roughage diet were used for strained rumen liquor collection and *in sacco* evaluation of straw. The effect of urea treatment on DM, NDF, ADF and CP degradabilities was non-significant ($P < 0.05$). The DM, NDF and ADF digestibilities were significantly ($P < 0.05$) higher at 30 per cent moisture level. With the increased moisture level, the effectiveness of treatment decreased. Lime treatment of cotton sticks significantly ($P < 0.05$) improved the DM degradability.

- 362.** TEWATIA, B. S., V. S. PANWAR AND K. R. YADAV 2007. **NUTRIENTS UTILIZATION AND PRODUCTION PERFORMANCE OF BUFFALO AND GOATS FED MULBERRY (*MORUS ALBA* L.) LEAVES AND ITS SILAGE.** *Forage Res.*, **32 (4) : pp. 216-219.** Animal Nutrition, CCS Haryana Agricultural University, Hisar

Mulberry leaves or its silage were incorporated in the rations of buffalo calves and lactating goats to assess nutrients utilization and their production performance. First study was conducted on growing buffalo calves by replacing 25 per cent (T and 50 per cent (T of the concentrate mixture crude protein mixture of the control group (T by mulberry leaves. Second experiment was conducted on 15 lactating Beetal goats divided into three groups. Mulberry leaves silage replaced 25 per cent (T and 50 per cent (T of crude protein of the control group (T concentrate mixture. Results of the first study revealed that DM intake (total and % of BW) and digestibility of nutrients did not vary among different groups indicating that mulberry leaves were highly palatable and digestible. Body weight gain (g/day) of buffalo calves did not vary among groups indicating efficient utilization of leaves. Feeding of silage replacing concentrate mixture protein did not affect dry matter intake adversely, however, digestibility of EE and CF was decreased significantly ($P < 0.05$). Total milk yield decreased significantly ($P < 0.05$) without altering the composition in goats fed with mulberry silage replacing concentrate protein at 50 per cent level. Results of present studies clearly suggest that green mulberry leaves can successfully replace upto 50 per cent of the concentrate mixture protein in the rations of growing buffalo calves, however, mulberry leaves silage can be used to replace 25 per cent of the concentrate mixture protein in the rations of lactating goats.

- 363.** YADAV, K. K., R. YADAV AND S. S. SIHAG 2007. **NUTRITIVE EVALUATION OF TWO FORAGE SORGHUM GENOTYPES IN BUFFALO HEIFERS.** *Forage Res.*, **32 (4) : pp. 236-237.** IATTE, CCS Haryana Agricultural University, Hisar

Ten buffalo heifers were distributed into two equal groups of five each. Fodder of forage sorghum variety HC 171 and hybrid CSH 13R was fed ad libitum to the animals in the respective groups. After 28 days of feeding, a digestion trial of seven days duration was conducted. Samples of feed, residue and faeces were collected and analysed for proximate constituents and fibre fractions. Crude protein, organic matter and nitrogen free extract contents were higher in CSH 13R hybrid than HC 171 forage sorghum variety. Whereas CF, NDF and cellulose contents were higher in HC 171 variety. The DM, OM and TDN intakes on per cent live weight and g/kg Wa75 basis were also higher in HC 171 variety. Digestibility coefficients of DM and NFE were higher in the animals, fed HC 171 variety, while the digestibility coefficients of CP, BE, CF, NDF, ADF, cellulose and HC were higher in the animals fed with CSH 13R hybrid. Therefore, the TDN content in the animals fed with HC 171 variety and CSH 13R hybrids was almost similar. Hence, it may be concluded that the newly evolved forage sorghum CSH 13R hybrid was nutritionally similar to its check i. e. a popular forage sorghum HC 171 variety.

- 364.** YADAV, A. S., MAHENDER SINGH AND R. S. BERWAL 2007. **EFFECT OF MUSTARD CAKE BASED RATIONS ON NUTRIENT BALANCE IN BROILERS.** *Forage Res.*, **32 (4) pp. 240-242.** Animal Nutrition, CCS Haryana Agricultural University, Hisar

The study was taken up to assess the effect of replacing groundnut cake (GNC) with mustard cake (MC) on the performance of the broiler chickens. Four hundred commercial day old broiler chicks were randomly distributed in 10 treatment groups consisting of two replicates of 20 birds each. Maize, GNC based control diet (T was formulated to meet out the requirements of birds as per BIS (1992) for starting (0-4 weeks) and finishing (4-6 weeks) phases of growth. In diets T T and T GNC was replaced with mustard cake at 10, 20 and 30 per cent, respectively. Diets of T to T were formulated by adding different levels of mustard cake treated with different concentrations of CuSO The average body weight at 14th, 28th and 42nd day of age was not significantly affected by replacement of GNC with mustard cake as well as treatment of MC with two levels 3 and 4 g per kg of MC of CuSO Similar trends were observed in average body weight gain, average feed intake, FCR and perfc index. The replacement of GNC with untreated MC significantly reduced the dressing percentage. Increasing the level of treatment from 3 to 4 g CuSO did

not have any significant effect. Thus, 3 g per kg CuSO of MC was level of choice. Based on the results it can be concluded that GNC can be replaced upto 30 per cent by MC treated with 3 g CuSO per kg MC without affecting growth and feed efficiency.

- 365.** SIHAG, SAJJAN, V. S. PANWAR AND K. K. YADAV 2007. **NUTRIENTS UTILIZATION AND PRODUCTION PERFORMANCE OF GOATS FED SORGHUM GRAINS IN PLACE OF MAIZE.** *Forage Res.*, **33 (1) : pp. 30-33.** Forage Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Fifteen lactating beetal goats in their 1st lactation and having average body weight of 25.75 kg were divided into three groups of five each. The animals of control group (T_1) were fed gram straw, berseem fodder and concentrate mixture based on maize grain as energy source, while the concentrate mixtures of T_2 and T_3 groups had sorghum grain replacing 50 and 100 per cent maize of control group, respectively. Total dry matter intake did not vary among the groups. Digestibility of DM, CP, EE, NFE and cellulose did not vary significantly by replacing maize with sorghum grains in the concentrate mixture of lactating goats. DCP and TDN per cent values were similar in all the three groups and all the animals were in positive N balance. None of the parameters studied for milk production and milk composition and DMI per kg milk production showed any variation with this replacement. Trial results indicated that sorghum grain at the level of 100 per cent can be used as energy source in place of maize grain in lactating goat rations.

- 366.** YADAV, A. S., MAHENDER SINGH AND R. S. BERWAL 2007. **MUSTARD CAKE AS AN ALTERNATE PROTEIN SOURCE IN THE RATION OF BROILER CHICKENS.** *Forage Res.*, **33 (1) : pp. 34-36.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The study was taken up to assess the effect of replacing groundnut cake (GNC) with mustard cake (MC) on the performance of the broiler chickens. Four hundred commercial day- old broiler chicks were randomly distributed in 10 treatment groups consisting of two replicates of 20 birds each. Maize, GNC based control diet (T_1) was formulated to meet out the requirements of birds as per BIS (1992) for starting (0-4 weeks) and finishing (4-6 weeks) phases of growth. In diets T_2 , T_3 and T_4 , GNC was replaced with mustard cake at 10, 20 and 30 per cent, respectively. Diets of T_2 to T_{10} were formulated by adding different levels of mustard cake treated with different concentrations of CuSO₄. The average body weight at 14th, 28th and 42nd day of age was not significantly affected by replacement of GNC with mustard cake as well as treatment of MC with two levels 3 and 4 g/kg of MC of CuSO₄. Similar trends were observed in average body weight gain, average feed intake, FCR and performance index. The replacement of GNC with untreated MC significantly reduce the dressing percentage. Increasing the level of treatment from 3 to 4 g CuSO₄ did not have any significant effect. Thus, 3 g/kg CuSO₄ of MC was level of choice. Based on the results it can be concluded that GNC can be replaced upto 30 per cent by MC treated with 3 g CuSO₄ per kg MC without affecting growth and feed efficiency.

- 367.** BERWAL, R. S., O. P. LOHAN, ZILE S. SIHAG AND A. S. YADAV 2007. **EFFECT OF VARIOUS BINDERS ON THE COMPACTION BEHAVIOUR OF CEREAL STRAWS.** *Forage Res.*, **33 (2) : pp. 104-106.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Four binders each at three levels viz., barley flour (15, 20 and 25%), mustard cake (15, 20 and 25%), calcium oxide (3, 5 and 7%) and cement (3, 5 and 7%) were tested for their effect on compaction behaviour of wheat straw, bajra karbi and gram straw. The crop residues were mixed with 15 per cent molasses followed by various levels of binders. The mixtures were pressed using hydraulic press. The post-compression expansion (%) was lower for blocks having fine ground barley as binder (28.20±1.27). The post-compression expansion (%) decreased with the increasing levels of various binders. The expansion (%) was minimum in gram straw (26.23±0.98) and was maximum (33.48±0.92) in bajra karbi based blocks. The durability (%) of blocks was maximum in calcium oxide (71.15±1.59) followed by cement (69.41±1.49), barley flour (61.07±2.58) and was lowest in mustard cake

(54.29±2.20) blocks. The levels of binders did not affect the durability of feed blocks. The bajra karbi blocks were least durable followed by wheat straw and gram straw.

- 368.** YADAV, A. S., MAHENDER SINGH AND R. S. BERWAL 2007. **ECONOMICS OF REPLACING GROUNDNUT CAKE WITH MUSTARD CAKE IN BROILER RATIONS.** *Forage Res.*, **33 (2) : pp. 114-117.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The study was taken up to assess the economics of replacing groundnut cake (GNC) with mustard cake (MC) in broiler rations. Four hundred commercial day-old broiler chicks were randomly distributed in 10 treatment groups consisting of two replicates of 20 birds each. Maize, GNC based control diet (T₁) was formulated to meet out the requirements of birds as per BIS (1992) for starting (0-4 weeks) and finishing (4-6 weeks) phases of growth. In diets T₂, T₃ and T₄, GNC was replaced with mustard cake at 10, 20 and 30 per cent, respectively. Diets of T₂ to T₁₀ were formulated by adding different levels of mustard cake treated with different concentration of CuSO₄. The average body weight at 14th, 28th and 42nd day of age was not significantly affected by replacement of GNC with mustard cake as well as treatment of MC with two levels 3 and 4 gram of CuSO₄ per kg of MC. The replacement of GNC with untreated MC significantly reduced the dressing percentage, while treatment with 3 g CuSO₄ alleviated the effect of untreated MC on dressing percentage. Increasing the level of treatment from 3 to 4 g did not have any significant effect, thus indicating that 3 g/kg of MC was level of choice. Similar trend was also observed for eviscerated percentage. No significant effect of replacement of GNC with MC as well as treatment of MC with CuSO₄ was observed on weights of liver, heart, gizzard and giblets. Based on the results of the present experiment, it can be concluded that GNC can be replaced upto 30% by MC treated with 3 g CuSO₄/kg MC without affecting growth, feed efficiency and carcass traits in broiler production.

- 369.** SIHAG, Z. S., R. S. BERWAL AND NAND KISHOR 2007. **UPGRADATION OF NUTRITIONAL VALUE OF DHAINCHA STALKS (*SESBANIA ACULETA*) BY CHEMICAL TREATMENTS.** *Forage Res.*, **33 (2) : pp. 127-129.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India.

The results of the present study indicated that the treatments of straw either with urea or lime or combination of both improved the degradability of various components. The degradability of straw was maximum at 30 per cent moisture level and a level of 4 per cent urea-lime (1:1) was more effective and economic. Further, the dhaincha stalk straw cannot be used as a sole roughage source in animal feeding.

- 370.** SINGH, A., H. S. MUKER, M. S. GILL AND S. SINGH 2007. **EVALUATION OF OAT (*AVENA SATIVA*) FODDER IN BUFFALO CAVES.** *Forage Res.*, **33 (2) : pp. 130-131.** Department of Animal Nutrition, Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana

It was observed that new variety OL-1235 of oat in terms of voluntary dry matter intake, DCP and TDN was comparable to standard variety OL-9, yet the test variety had an edge over OL-9, because of 7.17 per cent higher DM yield and 4.12q/ha more TDN production.

- 371.** SIHAG, SAJJAN, RAM AVTAR AND D. S. DAHIYA 2007. **NUTRITIONAL EVALUATION OF NEWLY DEVELOPED BERSEEM (*TRIFOLIUM ALEXANDRINUM*) GENOTYPE IN CROSSBRED CALVES.** *Forage Res.*, **33 (3) : pp. 180-182.** Forage Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana) India

An improved genotype of berseem HFB-119 was nutritionally evaluated against the check varieties Mescavi and HB 1 in 12 female crossbred calves divided into three groups. Berseem genotype HFB-119 and variety HB 1 contained higher crude protein (21.55 and 21.17%) and lower CF, NDF, ADF, cellulose and lignin as compared to popular variety Mescavi. Feed intake (total, % body wt., per W^{0.75} kg) did not vary significantly among groups. Crude

protein digestibility and green fodder yield were also highest in HFB-119. Digestibility of OM, CF, NDF, ADF and cellulose were significantly higher in HFB-119 and HB 1 fed group as compared to Mescavi. Nutrients intake i. e. DCP and TDN were also significantly higher in new genotypes HFB-119 and HB 1. The varieties differed significantly with respect to DCP and TDN content and these were highest in genotype HFB-119 (15.55 and 62.04%, respectively) followed by HB 1 (15.11 and 60.09%, respectively) and by feeding new genotype or variety (HFB-119 and HB 1) they met out 20 per cent more crude protein over NRC (2001) feeding standards, however, TDN intake in all groups was lower than the recommended values. The experimental calves gained more body weight by feeding fodder of variety HB 1 and genotype HFB-119 as compared to Mescavi. Hence, it may be inferred that newly developed berseem cultivar HFB-119 and variety HB 1 are nutritionally better than the check variety Mescavi; however, no significant differences were recorded between HFB-119 and HB 1.

372. BERWAL, R. S., O. P. LOHAN, ZILE S. SIHAG AND A. S. YADAV 2008. **EFFECT OF DIETARY CRUDE FIBRE LEVELS AND ENZYME SUPPLEMENTATION ON THE COST OF BROILER PRODUCTION.** *Forage Res.*, **33 (4) : pp. 241-243.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Effect of dietary crude fibre levels and enzyme supplementation on economics of broiler production was studied. The total cost of feed intake for dietary treatments T₁, T₂, T₃ and T₄ was Rs. 28.74, 32.11, 31.67 and 30.85, respectively. The feed intake cost in treatments T₅, T₆, T₇ and T₈ was Rs. 29.42, 32.93, 32.38 and 30.55, respectively. Relative profit /bird in treatment T₂ (7% CF), T₃ (9% CF) and T₄ (11% CF) was Rs. 4.98, 3.82 and 3.79 in comparison to control diet T₁ (5% CF). In enzyme supplemented diets T₅, T₆, T₇ and T₈ the relative profit was Rs. 1.31, 4.40, 5.98 and 4.77 per bird in comparison to T₁ (5% CF), control group. The results showed higher profit with increased crude fibre levels. The enzyme supplementation further improved the profit.

373. KUMAR, D., RAM SINGH, A. S. GODARA AND SAJJAN SIHAG 2008. **ECONOMIC ANALYSIS OF FEEDING PRACTICES AND MILK YIELD OF CATTLE IN SEMI-ARID REGION OF HARYANA.** *Forage Res.*, **34 (1) : pp. 53-57.** Department of Agricultural Economics, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The efficient use of available feed resources would rest in exploiting the greater potential of livestock without increase in input costs. The present study was carried out to study milk yield, gap between existing and balanced feeding practices adopted by different categories of farmers in Hisar district of Haryana; and to work out feed-milk production relationship alongwith formulation of least cost feeding schedule for cattle. The average milk yield and consumption pattern of green fodder and concentrates exhibited increasing trend with the increase in size of the farms in all seasons. The higher consumption of dry fodder was recorded on small sized farms. There was a direct relationship between milk yield and consumption of green fodder and concentrates. The supply of dry matter, digestible crude protein and total digestible nutrients was in excess in all seasons due to excess supply of green fodder. Whereas availability of digestible crude protein was found deficient only on small farms. The green fodder had significant impact on milk yield on small sized farms in all seasons. The positive and significant regression coefficients for concentrates in all three seasons indicated that there existed sufficient scope to increase milk yield with increased availability. The regression coefficients of body weight, dry matter and total digestible protein were non-significant, while the regression coefficients of digestible crude protein had significant impact on milk yield for all categories of farms. The cost of complete ration formulated with available ingredients by applying least cost equation can be reduced by Rs. 0.17 and Rs.0.62 per kg in **kharif** and **rabi** seasons, respectively.

374. KHATTA, V. K., B. S. TEWATIA AND NARESH KUMAR 2008. **CHEMICAL COMPOSITION, *IN VITRO* DRY MATTER AND PROTEIN DIGESTIBILITY OF SOME TREE LEAVES OF ARID REGION OF HARYANA.** *Forage Res.*, **34 (2) : pp. 105-108.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Samples of 16 species of tree leaves commonly available in the arid region of Haryana were collected and analyzed for nutrient composition, anti-nutritional factors and *in vitro* dry matter digestibility and protein. Proximate nutrient analysis of the samples revealed that subabul (*Leucaena leucocephala*) had the highest crude protein (CP) content followed by maha neem (*Alianthus excelsa*), siris (*Albizia lebbek*), bakain (*Melia azadirach*), desi kikar (*Acacia nilotica*) and Israeli kikar (*Acacia tortilis*). The respective values in these species were 20.50, 19.08, 18.85, 16.34, 15.63 and 15.39 per cent. Leaves of rest of the species had CP content in the range of 10.50 to 14.98 per cent. Pahari kikar and anjan tree had highest crude fibre content (25.56 and 24.11%), while desi kikar and maha neem had lowest values for crude fibre (11.02 and 12.24%). The total tannin content was lowest (1.38%) in subabul and neem (*Azadirachta indica*) followed by maha neem (1.80%). Maximum tannin content (5.87%) was observed in *desi kikar*. Total gas production (ml/200 mg DM) was highest in kasood (28.6) and lowest in anjan tree (18.4). *In vitro* dry matter digestibility (IVDMD) was maximum for kasood (*Cassia siamea*) followed by Israeli kikar (*Acacia tortilis*) and subabul (*Leucaena leucocephala*). The values were 54.60, 53.60 and 52.80 per cent in that order. The lowest value (29.60%) was observed in anjan tree (*Hardwika binnata*). *In vitro* dry matter digestibility had significantly positive correlation ($r=+0.82^*$) with total gas production. *In vitro* protein degradability (IVPD) in subabul, kasood and Israeli kikar was in the order of 46.40, 45.20 and 44.80 per cent, whereas the lowest value (30.20%) was observed in pahari kikar (*Prosopis juliflora*). Results revealed that leaves of subabul, kasood and Israeli kikar had potential to be nutritious feeds for small ruminants.

375. LAL, HEERA, R. S. SHEOKAND AND NARENDER SINGH 2008. **EFFECT OF SOCIO-ECONOMIC FACTORS ON FEEDING PRACTICES OF LACTATING BUFFALOES IN MEWAT AREA OF HARYANA.** *Forage Res.*, **34 (3) : pp. 186-189.** CCSHAU Krishi Vigyan Kendra, Post Box No. 40, Kaithal-136 027 (Haryana), India

A field study was conducted to collect the information regarding feeding practices in lactating buffaloes by the different categories of the farmers (land holding, age, education, family size and caste) in different blocks i. e. Nuh, Firozpur Jhirka, Punhana, Tauru, Nagina and Hathin of Gurgaon/Faridabad districts of Haryana state. It was observed that the farmers in different blocks were offering seasonal green fodder, wheat straw or bajra karbi and concentrate mixture to their animals, however, none of the farmers was feeding mineral mixture and common salt. Statistical analysis revealed that farmers of Punhana and Firozpur Jhirka offered significantly ($P<0.05$) more green fodder as compared to Nuh, Tauru, Nagina and Hathin blocks but quantity of seasonal green fodder offered to the animals was not affected by land holding, age, family size and education of the respondent. It was also noticed that the area, land holding size and caste of the respondents showed significant ($P<0.05$) association with dry fodder and feeding practices of the farmer. As the land holding increased the amount of concentrate mixture increased significantly ($P<0.05$). It was also found that concentrate feeding was also affected by the area; and the farmers of general and backward castes were feeding more concentrate as compared to scheduled caste. The average quantity of green, dry fodder and concentrate mixtures offered to lactating buffaloes was 5.03, 6.42 and 2.98 kg per animal, respectively. The study revealed that farmers were lacking adoption of scientific and balanced feeding.

376. BERWAL, R. S., O. P. LOHAN AND ZILE S. SIHAG. 2009. **EFFECT OF METHOD OF MIXING CALCIUM OXIDE AT DIFFERENT LEVELS WITH AND WITHOUT PHOSPHORIC ACID ON COMPACTION BEHAVIOUR IN DIFFERENT STRAWS AND STOVERS.** *Forage Res.*, **34(4):pp.259-261.** Department of Animal Nutrition, CCSHAU, Hisar-125004 (Haryana), India

An experiment was conducted to study the compaction behaviour of crop residues. In the experiment roughage based feed blocks were prepared just after mixing the calcium oxide (3, 5 and 7%) first with molasses and

phosphoric acid (as catalyst) and then with straws, namely, wheat straw, bajra karbi and gram bhoosa (T_1) to utilize the heat generated during chemical reactions. It was compared with the procedure in which first calcium oxide was mixed with molasses and then with straws and kept overnight (T_2). Using 3 per cent CaO level, the post-compression expansion (%) was 32.56, 37.04, 26.20 in T_1 and 35.23, 33.14 and 31.60 in T_2 for wheat straw, bajra karbi and gram bhoosa based feed blocks, respectively. The corresponding value of durability (%) were 72.73, 67.08 and 75.06 in T_1 and 69.74, 68.26 and 81.84 in T_2 for wheat straw, bajra karbi and gram bhoosa based feed blocks, respectively. Post calcium-compression expansion and durability were not affected significantly by the levels of calcium oxide. However, the post-compression expansion was significantly low in gram bhoosa based feed blocks. Whereas durability of gram bhoosa based feed blocks was highest followed by wheat straw and bajra karbi based feed blocks.

- 377.** BERWAL, R. S., O. P. LOHAN, ZILE S. SIHAG AND SAJJAN SIHAG 2009. **EFFECT OF DIFFERENT LEVELS OF CATTLE DUNG AND POULTRY FARM ORGANIC WASTES ON COMPACTION BEHAVIOUR IN DIFFERENT ROUGHAGES.** *Forage Res.*, **35 (1): pp. 36-38.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

An experiment was conducted in a 3 x 3 x 3 factorial design using three farm wastes viz., poultry litter, fresh poultry excreta and fresh cattle dung; three roughages, namely, wheat straw, bajra karbi and gram straw and three levels (20, 30 and 40% w/w) of each waste. The different levels of wastes were mixed with molasses (15%) treated crop residues and blocks were prepared. Post-compression expansion was significantly ($P < 0.05$) higher in blocks having cattle dung (39.26) as a binder than poultry excreta (33.28) and poultry litter (34.70) blocks. Durability was lowest in poultry excreta (50.26) blocks. Durability was not significantly affected with the level of binders. Type of roughages significantly affected the post-compression expansion and durability of blocks. Gram bhoosa based feed blocks were having highest durability (77.16) followed by wheat straw (51.68) and the bajra karbi based feed blocks were least durable (43.72).

- 378.** BERWAL, R. S., O. P. LOHAN AND ZILE S. SIHAG 2010. **THE EFFECT OF FEED PARTICLE SIZE, ENZYME SUPPLEMENTATION AND PELLETING ON ENERGY METABOLISM AND ECONOMICS OF BROILER PRODUCTION.** *Forage Res.*, **35 (4) : pp. 201-205.** Department of Animal Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana) India

The effect of feed particle size, enzyme supplementation and pelleting on energy metabolism and economics of broiler production were studied. The nitrogen corrected metabolizable energy values (Kcal/kg) varying from 2735.61 (T_5) to 2899.72 (T_7). Enzyme supplementation had significant ($P < 0.05$) improvement in ME_n as compared to unsupplemented mash groups. There was 4.43, 5.27, 3.86 and 1.78 per cent improvement in ME_n in enzyme supplement diets T_6 , T_7 , T_8 and T_9 as compared to unsupplemented counterparts T_2 , T_3 , T_4 , and T_5 diets, respectively. There was no effect of particle size on ME_n in mash (T_2 , T_3 , T_4 and T_5), enzyme supplemented (T_6 , T_7 , T_8 and T_9) and pelleted (T_{10} , T_{11} , T_{12} and T_{13}) diets. Per cent improvement in ME_n due to pelleting of diets was 2.25, 4.00, 4.37 and 3.45 in T_{10} , T_{11} , T_{12} and T_{13} diets as compared to mash diets T_2 , T_3 , T_4 and T_5 , respectively. The per cent gross energy metabolizability in dietary treatments T_1 , T_2 , T_3 , T_4 and T_5 was 68.66, 67.05, 67.30, 66.68 and 66.27, respectively. There was a significant ($P < 0.05$) decrease in GE metabolizability in T_2 , T_3 , T_4 and T_5 than control T_1 . There was a significant ($P < 0.05$) improvement in GE metabolizability in enzyme supplementation diets (T_6 , T_7 , T_8 and T_9) than their corresponding unsupplemented groups i. e. T_2 , T_3 , T_4 and T_5 . There was no effect of particle size on GE metabolizability in mash (T_2 , T_3 , T_4 and T_5), enzyme supplemented (T_6 , T_7 , T_8 and T_9) and pelleted (T_{10} , T_{11} , T_{12} and T_{13}) diets. Pelleting of diet increased GE metabolizability significantly ($P < 0.05$) than their corresponding mash diets and statistically similar with enzyme supplemented counterparts except in T_{13} where significantly ($P < 0.05$) higher values were found than enzyme supplemented counterpart T_9 group. Relative profit (Rs./bird) in T_2 (669 ? GMD), T_3 (905 ? GMD), T_4 (1142 ? GMD) and T_5 (913 ? GMD) was 2.20, 4.70, 0.88 and 0.38 in comparison to control (T_1). In enzyme supplemented diets T_6 , T_7 , T_8 and T_9 , a relative profit of Rs. 2.69, 5.41, 3.65 and 2.35 was observed. Relative profit (Rs./bird) in pelleted treatments T_{10} , T_{11} , T_{12} and T_{13} was 3.01, 3.74, 0.80 and 1.13, respectively. The diets having particle showed higher profit and enzyme supplementation further size of 905 ? increased the profit.

379. SIHAG, SAJJAN AND S. K. PAHUJA 2010. **SORGHUM SILAGE—A POTENTIAL ENSURANCE AGAINST FODDER SCARCITY.** *Forage Res.*, **35 (4) : pp. 209-214.** Forage Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Fodder and feed for animals, in particular for milch cattle, is of great economic importance in India, the highest milk producing country in the world. Forage sorghum is important source of green fodder and for making silage as well. To sustain the large population of animals, a year round assured supply of good quality fodder, feed is required. Seasonal variation in production of fodder results in a large gap between demand and supply of green fodder during some crucial periods of the year, such as summer and winter. This deficit can be partially augmented through silage production during the peak period of green fodder production in the rainy season. In India, it is reported that number of constraints in silage production technology deter farmers, in particular small farmers, to adopt it. There is a need to popularize the technology of making good silage and use it as replacement of feed concentrate at village level in Haryana. Several studies revealed that heifers could be fed a silage based diet without grain supplement and if a cow is fed silage everyday for at least three months she will be in good condition and be fertile. The nutrient utilization and milk production efficiency will be better in milch cow fed ensiled sorghum as compared to stover.

380. BISHNOI, D. K., RAM SINGH, ANIL KUMAR AND DEEPAK SINGH 2010. **ECONOMIC ANALYSIS OF FEEDING PRACTICES AND MILK YIELD OF CATTLE IN WET ZONE OF HARYANA.** *Forage Res.*, **35 (4) : pp. 236-240.** CIMMYT-CSISA Haryana Hub, CSSRI, Karnal (Haryana), India

The present study was carried out to study milk yield, gap between existing and balanced feeding practices to work out feed-milk production relationship along with to calculate least cost feeding schedule adopted by the different categories of farmers in Karnal district of Haryana for cattle. The average milk yield and consumption pattern of green fodder and concentrates exhibited increasing trend with the increase in size of the farms in all seasons. The higher consumption of dry fodder was recorded on small sized farms. There was a direct relationship between milk yield and consumption of green fodder and concentrates. In rainy and winter season, the supply of dry matter, digestible crude protein and total digestible nutrients was found excess than required quantity for all categories of farms, whereas in summer season availability of digestible crude protein was found deficient only on small farms. The green fodder had significant impact on milk yield on small sized farms in all seasons. The positive and significant regression coefficients for concentrates in all three seasons indicated that there existed sufficient scope to increase milk yield with increased availability. The regression coefficients of body weight, dry matter and total digestible protein revealed non-significant impact, while the regression coefficients of digestible crude protein had significant impact on milk yield for all categories of farms. The cost of complete ration formulated with available ingredients by applying least cost equation was reduced by Rs. 0.06 and Rs. 0.50 per kg in **kharif** and **rabi** seasons, respectively.

381. TEWATIA, B. S., SAJJAN SIHAG, V. S. PANWAR AND S. DHANKAR 2010. **EFFECT OF FEEDING BROCCOLI VEGETABLE RESIDUE AND BERSEEM ON THE PERFORMANCE OF CROSSBRED CALVES.** *Forage Res.*, **36 (1) : pp. 34-36.** Department of Animal Nutrition, LLR University of Veterinary and Animal Sciences, Hisar-125 004 (Haryana), India

Comparative nutritive value of broccoli vegetable residue and berseem fodder was evaluated in 12 growing crossbred female calves divided into two groups of six animals each. Animals were offered chaffed broccoli fodder+ wheat straw (T_1) and berseem+ wheat straw (T_2). Broccoli vegetable residue contained 18.65 per cent crude protein and 10.16 per cent crude fibre, while the corresponding figures for berseem were 17.92 and 14.15 per cent. Total feed intake (kg/day) did not vary between the groups and the figures were 3.96 ± 0.07 and 3.82 ± 0.05 for animals fed broccoli residue and berseem fodder based rations, respectively. Feed intake (kg/100 kg BW and $g/W^{0.75}$ kg) also did not vary significantly between the groups indicating that broccoli residue was as palatable as berseem fodder. Digestibility of nutrients viz., dry matter, organic matter, crude protein and crude fibre was significantly ($P < 0.05$) higher in animals fed broccoli residue based ration than those fed berseem fodder based ration. Nutrients intake in terms of

DCP and TDN was 391.2 g and 2.54 kg in animals fed broccoli, while the corresponding figures for berseem fed group were 337.4 g and 2.26 kg. Body weight gain was higher ($P < 0.05$) in animals fed broccoli residue based ration (626.5 g/day) than those fed berseem based ration (514.2 g). Results of the present study indicate that broccoli vegetable residue can successfully sustain growth of crossbred calves without supplementing concentrate mixture.

- 382.** SIHAG, SAJJAN, B. S. TEWATIA AND RAM AVTAR 2010. **NUTRITIONAL EVALUATION OF NEWLY DEVELOPED BERSEEM (*TRIFOLIUM ALEXANDRINUM*) GENOTYPE IN BUFFALO CALVES.** *Forage Res.*, **36 (1) : pp. 42-44.** Department of Animal Nutrition, LLR University of Veterinary and Animal Sciences, Hisar-125 004 (Haryana), India

An improved genotype of berseem fodder, HFB-700 was nutritionally evaluated against the existing variety HB-1 in 10 female buffalo calves divided into two groups, G-I and G-II. The calves of group G-I and II were fed fodder from berseem HB-1 and HFB-700, respectively. Berseem genotype HFB-700 contained higher crude protein (22.75%) than HB-1 (21.35%) and higher calcium & phosphorus contents and lower CF, NDF and ADF contents as compared to HB-1 variety of berseem fodder. Feed intake (total, % body weight per $W^{0.75}$ kg) did not vary significantly among both the groups. Digestibility of dry matter, crude protein and NDF were significantly higher in HFB-700 fed group as compared to HB-1. Digestible crude protein intake was also significantly higher in new genotype HFB-700. The both fodders differed significantly with respect to DCP content and were high in genotype HFB-700, TDN per cent value improved but did not differ significantly. The green fodder and dry matter yields were 14.68 and 19.85 per cent higher in genotype HFB-700, respectively. On the basis of results, it may be inferred that newly developed berseem cultivar HFB-700 is nutritionally better than existing variety HB-1.

5. Pasture and Grassland and Management

- 383.** THAKURIA, K. 2001. **REJUVENATION OF OLD STANDS OF *SETARIA SPHACELATA* CV. KAZUNGULA.** *Forage Res.*, **27 (1) : pp. 67-68.** AAU, Jorahat

A field experiment on the rejuvenation of a three year old stand of setaria grass was conducted at the AAU, Jorahat. It was concluded that application of 75 kg N/ha either in the form of inorganic (urea) or organic (FYM) or both in equal halves did not influence the growth and forage yield of setaria grass. However, higher dry matter yield was recorded when N was applied in organic (FYM) form or in both inorganic and organic forms in equal halves, the increases being 12.3 and 11.7 % over the inorganic form, respectively.

- 384.** BASUMATARY, M. AND THAKURIA, K. 2001. **EFFECT OF PLANTING METHODS AND NITROGEN MANAGEMENT ON FODDER PRODUCTION OF PARA GRASS [*BRACHIARIA MUTICA* (FORSSK) STAPF].** *Forage Res.*, **27 (2) : pp. 143-146.** AAU, Jorahat

A field experiment was conducted at AAU, Jorahat to study the effect of planting methods and Nitrogen management on fodder production of para grass. It was concluded that broadcasting of stem and cross ploughing method was the best planting method of paragrass and application of 120 kg N/ha in three equal splits at planting and after first and second cuts could give the highest fodder yield and economic returns.

- 385.** PATEL, P. T., V. V. SONANI AND G. G. PATEL 2001. **RESPONSE OF GATTON PANIC GRASS (*PANICUM MAXIMUM* JACQ.) TO LEVELS OF NITROGEN AT VARYING PLANT DENSITIES UNDER RAIN FED CONDITION.** *Forage Res.*, **27 (3) : pp. 229-232.** G. A. U. Regional Research Station, Arnej-382 230 (Gujarat), India

Three years' field experiments were conducted on Gatton panic grass to investigate the response of different levels of nitrogen at varying plant geometry. Intra row spacing (30, 45 and 60 cm) significantly influenced green and dry forage yield in two out of three years. Narrow spacing of 30 and 45 cm remained at par but produced significantly

higher dry forage on pooled basis. Intra row spacings did not exert significant influence on forage (green and dry) yield. Increase in nitrogen level (25, 50 and 75 kg/ha) brought successive increase in green and dry forage yield and the highest yield was recorded with the highest level of 75 kg N/ha. Increase in plant height, number of tillers and leaf : stem ratio due to nitrogen application favoured forage yield of the Gatton panic. Closer spacing tended to increase crude protein content. Supply of N did not exert its effect on crude protein content.

- 386.** KUMAR, P. AND PURI, U. K. 2001. **EFFECT OF CUTTING AND NITROGEN MANAGEMENT ON FORAGE PRODUCTION OF *FESTUCA ARUNDINACEA* UNDER RAINFED CONDITIONS.** *Forage Res.*, **27 (3) : PP. 237-238.** HPKV Chamba Research Sub Station Salooni (H. P.), India

A field experiment was conducted at HPKV Chamba Research sub station Salooni (H.P.). The results indicated that three cuttings and 50 kg N /ha in a year were most suitable to obtain higher yields from *Festuca arundinacea* under rainfed conditions.

- 387.** THAKURIA, K. 2002. **EFFECT OF NITROGEN AND CUTTING MANAGEMENT ON *SETARIA SPHACELATA* CV. KAZUNGULA UNDER RAINFED CONDITION** *Forage Res.*, **27 (4) : pp. 303-306.** AAU, Jorhat

The experiment was conducted for two years at AAU, Jorhat on the established setaria grass. The application of 120 kg N/ha as ½ at 1st rain + ½ after 1st cut following two cut frequency is beneficial for higher production of forage and crude protein in setaria grass.

- 388.** MENDHE, S. M., R. P. SINGH AND S. S. MENDHE 2002. **EFFECT OF SOWING AND LEVELS OF PHOSPHORUS AND POTASH ON NUTRIENT CONCENTRATION IN *STYLOSANTHES HAMATA*.** *Forage Res.*, **28 (1) : pp. 38-41.** College of Agriculture, Nagpur (Maharashtra), India

Field experiment in split plot design, with four replications keeping plot size 2.0 x 2.0 m in net was conducted at Central Research Station, Indian Grassland and Fodder Research Institute, Jhansi during 1994-95 and 1995-96. Pooled results indicated that nitrogen content was significantly higher in 28 June (2.153%) over 13 August, however, at harvest stage all treatments were similar in N, P and K content. Phosphorus application did not influence N and K contents. But P content was significantly increased due to phosphorus, which was higher at 75 kg (0.162%) at 80 per cent flowering stage and at all levels from 25 to 75 kg (0.102-0.106%) at harvest. Graded levels of K₂O did not register significant influence on nitrogen and phosphorus content. However, K content increased with K₂O application and found higher at 180 kg (1.632%) at 80 per cent flowering and at all levels from 60 to 180 kg (0.771-0.793%) at harvest.

- 389.** BASAK, N. S., M. K. NANDA AND A. K. MUKHERJEE 2003. **PERFORMANCE OF *STYLOSANTHES* CULTIVARS IN THE NEW ALLUVIAL ZONE OF WEST BENGAL.** *Forage Res.*, **28 (4) : pp. 223-227.** Department of Agronomy, Bidhan Chandra Krishi Vishwavidyalaya, West Bengal, India

A field experiment was conducted during September 2000 to March 2001 at Gayespur Regional Research Station (Alluvial zone), under upland situation to evaluate the performance of *Stylosanthes* cultivars. A total of 20 cultivars were evaluated in the present study for their growth and yield performance which included plant height, interrupted aerial crop growth rate, green forage yield, dry matter yield, seed production potentiality in addition to crude protein content. There were noticeable differences among the cultivars tested. The cultivars *Stylosanthes scabra* RRR 94-96, *S. fitzroy* and *S. scabra seca* had better regeneration capacity. The cultivar *S. seabrana* 110370C was proved best with respect to overall yield performance, whereas *S. scabra* RRR 94-96 had high crude protein content. Seed production was higher from *S. seabrana* 2539 and *S. seabrana* 2523 as compared to others. All the cultivars under the present study increased the nitrogen status of soil thus proving its suitability to grow in marginal soil as a pasture crop.

390. SHEKHAWAT, S. S., D. K. GARG, P. PUNDIR, P. JOSHI, N. S. YADAVA AND RAJENDRA CHHIPA 2003. **EVALUATION OF *LASIURUS SINDICUS* HENR. COLLECTIONS FOR THEIR PERFORMANCE IN ZONE IC OF RAJASTHAN.** *Forage Res.*, **29 (2) : pp. 76-78.** AICRP on Forage Crops, R. A. U., Agricultural Research Station, Beechwal, Bikaner-334 006 (Rajasthan), India

Five hundred collections of *Lasiurus indicus* Henr. grass collected from zone Ic of Rajasthan were established at Agricultural Research Station, Beechwal, Bikaner of Rajasthan Agricultural University during **kharif** 2000. These were evaluated during **kharif** 2001 and **kharif** 2002. Some promising clones have been identified, which will be evaluated in replicated and coordinated trials for release of a suitable variety for the zone.

391. CHANDER, S. AND K. C. SHARMA 2003. **PERFORMANCE OF PASTURE GRASSES AND THEIR VARIETIES UNDER DIFFERENT CUTTING SCHEDULES IN HOT ARID REGION OF RAJASTHAN.** *Forage Res.*, **29 (2) : pp. 91-93.** Central Sheep and Wool Research Institute, Arid Region Campus, Bikaner-334 006 (Rajasthan), India

The field experiments were conducted for three consecutive years (2000-2002) to study the performance of two pasture grasses of desert i. e. Sewan (*Lasiurus indicus*) and Dhaman (*Cenchrus ciliaris*) having three varieties of each grass [Sewan (CAZRI mutant 30-5, CAZRI 317 and CAZRI 319), Cenchrus (CAZRI 75, CAZRI 358 and CAZRI 1106)] under different cutting schedules i. e. half yearly and annual cutting. The soil of experimental field was coarse sand, alkaline in reaction (pH 8.8), low in organic carbon (0.16%), low in available nitrogen (84.7 kg/ha), low in available phosphorus (9.5 kg P₂O₅/ha) and low in available potash (57.9 kg/ha). The data recorded on plant height, number of tillers per plant, tussock diameter and green as well as dry fodder yield for three consecutive years (2000, 2001 and 2002) revealed that Sewan grass produced significantly higher plant height, number of tillers per plant, tussock diameter and green as well as dry fodder yield as compared to cenchrus grass in all the three years of study. Among varieties, Sewan variety CAZRI mutant 30-5 produced significantly higher green as well as dry fodder yield owing to higher plant height, number of tillers/plant and tussock diameter. Among cenchrus varieties, CAZRI-75 produced the significantly higher plant height, number of tillers per plant, tussock diameter and green as well as dry fodder yield. Half yearly cutting schedule though recorded less plant height, number of tillers per plant and tussock diameter but produced significantly higher green and dry fodder yield over annual cutting schedule, owing to addition of yield of two cuttings. From these results it may be concluded that Sewan grass especially its variety CAZRI mutant 30-5 produced maximum green as well as dry fodder yield under half yearly cutting schedule in hot arid conditions of Rajasthan.

392. RAM, S. N., S. S. PARIHAR AND M. M. ROY 2004. **PERFORMANCE OF CARIBBEAN STYLO IN ASSOCIATION WITH DHAWALU GRASS UNDER DIFFERENT LEVELS OF POTASH.** *Forage Res.*, **29 (4) : pp. 173-175.** Grassland and Silvopasture Management Division, Indian Grassland, Fodder and Agroforestry Research Institute, Jhansi-284 003 (U. P.), India

A field experiment was conducted during 1995-2000 to find out the effect of potash on yield and forage quality of Caribbean stylo when intercropped with Dhawalu grass. Intercropping of Dhawalu grass with Caribbean stylo in 1 : 1 row ratio resulted in significantly higher total dry matter yield (6.73 t/ha) when compared to sole legume, sole grass and intercropping in 1 : 2 row ratio, while it was at par with 2 : 1 row ratio of intercropping. However, maximum dry matter yield (3.69 t/ha) of Caribbean stylo was recorded under the sole treatment followed by intercropping in 1 : 2, 1 : 1 and 2 : 1 row ratios. Total crude protein yield (516.77 kg/ha) also significantly increased in intercropping (1 : 1 row ratio) when compared to sole grass. In case of Caribbean stylo highest crude protein yield (471.54 kg/ha) was recorded under the sole treatment when compared to the intercropping treatments. Potash application @ 60 kg K₂O/ha exhibited significantly higher total dry matter (6.79 t/ha) and crude protein yield (585.40 kg/ha) when compared to the control and 30 kg K₂O/ha. Similarly, peak dry matter (2.02 t/ha) and crude protein yield (269.68 kg/ha) from the legume component was also obtained with application of 60 kg K₂O/ha than control and 30 kg K₂O/ha.

393. BHATTACHARYA, S., M. K. NANDA AND A. K. MUKHERJEE 2004. **EFFECT OF PHOSPHORUS AND CUTTING ON BIOMASS AND SEED PRODUCTION OF *STYLOSANTHES* CULTIVARS.** *Forage Res.*, **30 (2) : pp. 96-98.** Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, W.B.

A field experiment was conducted at Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, W.B. to study the Effect of phosphorus and cutting on biomass and seed production of *Stylosanthes* cultivars. Application of P has positive impact on number of branches and seed yield. Cutting decreased the number of branches and seed yield

394. PATEL, J. R. 2004. **RESPONSE OF DINANATH GRASS TO NITROGEN LEVELS.** *Forage Res.*, **30 (3) : pp. 170-171.** College of veterinary science, P. B. No. 6, Anjora.

A field experiment was conducted to study the response of dinanath grass to nitrogen levels wastested at College of veterinary science, P. B. No. 6, Anjora. Application of 75 kg N/ha gave significantly higher green and dry fodder yield as compared to other levels of nitrogen.

395. RAM, S. N., G. SURESH AND M. M. ROY 2005. **RESPONSE OF MIXED PASTURE TO ROW RATIOS, SPACING AND CUTTING SCHEDULES.** *Forage Res.*, **30 (4) : pp. 203-206.** Grassland and Silvopasture Management Division, Indian Grassland and Fodder Research Institute, Jhansi-284 003 (Uttar Pradesh), India

An experiment was conducted for five consecutive years (1997-98 to 2001-02) on sandy loam soil to study the effect of row ratios, spacing and cutting schedules on performance of mixed pasture. Intercropping of grasses and legumes in 1 : 1 row ratio at 50 cm distance gave significantly higher green forage and dry matter yield of grasses as compared to intercropping in 1 : 2 row ratio at both 50 and 75 cm distance. However, significantly higher green forage and dry matter yield of legumes was obtained when it was intercropped with grasses in 1 : 2 row ratio at 50 cm distance than 1 : 1 row ratio at 50 and 75 cm distance. Total crude protein yield was also significantly increased with intercropping of grasses and legumes in 1 : 1 row ratio at 50 cm distance compared to 1 : 2 row ratio at 75 cm distance. Cutting of grasses at 70 days interval recorded significantly higher total green forage, dry matter, crude protein yield and grass green forage yield equivalent than other cutting intervals.

396. DESALE, J. S., N. P. MELKANIA, V. B. AHER AND SUNIL KUMAR 2005. **EVALUATION OF AUSTRALIAN *STYLOSANTHES* SPECIES UNDER VARIED FERTILITY ENVIRONMENTS.** *Forage Res.*, **31 (1) : pp. 39-42.** All India Coordinated Project for Research on Forage Crops, Project Coordinating Unit, Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

The investigation was undertaken to evaluate the performance of different Australian *Stylosanthes* species under varied fertility environments i. e. *Rhizobium* inoculation with and without supplemented N and P₂O₅. Data indicated significant variation among *Stylosanthes* species for green fodder, dry matter and crude protein yield. Data collected for the three consecutive years (1999 to 2001) for five cuts recorded significantly higher green fodder, dry matter and crude protein yield for *S. seabrana*-115995, closely followed by *S. seabrana*-104710 'A'. Inoculation of *Stylosanthes* species with *Rhizobium* recorded significantly higher total (for five cuts) green fodder, dry matter and crude protein yield than 40 kg N/ha. However, it remained at par with 40 kg N+40 kg P₂O₅/ha+*Rhizobium*. The interaction effect of *Stylosanthes* species and fertility environments was evident for dry matter yield during 2000 and 2001 and total of three years (for five cuts), and for crude protein yield in the year 2000 and total of three years (for five cuts) only. *S. seabrana*-115995 inoculated with *Rhizobium* recorded significantly higher dry matter and crude protein yield than the other treatment combinations studied.

397. KATOCH, R., SALEJ SOOD, SMRITI PRIYA, J. C. BANDHARI AND K. K. DOGRA 2005. **REVIEW OF THE NUTRITIONAL STATUS OF NATURAL GRASSLAND/PASTURES AND SILVI-PASTORAL SYSTEM OF HIMACHAL PRADESH.** *Forage Res.*, 31 (3) : pp. 153-162. Fodder Production and Grassland Management Centre, Department of Plant Breeding and Genetics, CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur-176 062 (H. P.), India

Himachal Pradesh is primarily an agrarian state with crop farming and livestock rearing playing a significant role in the economy of the people. Due to marginal and sub-marginal nature of farm holdings, forage research base is multidimensional that includes pastures, grasslands, forests, wastelands, farm bunds, etc. Area under these resources is around 1.82 million hectare (53%) of the geographical area, which supports about 1.5 million animals. Grassland and permanent pastures are the major feed resources in the state, which have been highly mismanaged due to continuous and uncontrolled grazing leading to elimination of palatable grasses and dominance of weeds. Nutrient composition of a grass species is essential for maintenance, growth, production and reproduction of animals. Most forage plants are high in nutrients during early growth and loose nutrients markedly at maturity. Among the tropical and sub-tropical grasses in the mid hills of state *Setaria anceps* cv. Nandi has been proved to be superior in quality in comparison to other grasses. In the alpine pastures of Bara Banghal, the highest crude protein was recorded in the month of August and during subsequent months there was loss in the nutritive value of the pasture. A study conducted on the nutrient component of *Leucaena* sp. revealed that *L. leucocephala* and *L. diversifolia* had better nutritive quality in the months of July and May, respectively. For higher yield and better nutritive value, natural grassland of mid hill region could be cut 60 to 90 days after the initiation of vegetative growth, the latter stage resulting in poor nutritive value of the herbage. Although native grasslands of high hill zone are good in nutrients, they are poor in crude protein, which could be supplemented by introduction of superior grasses/legumes. An improved grass like *Setaria* and combination of grass+fodder tree (*Setaria+Robinia*) increased the quantity and quality of herbage where the native herbage was inferior in quality. Grading of different temperate grasses on the basis of nutritionally desirable (CP, cell contents, cellulose and hemi-cellulose) and incriminating factors (NDF, ADF, ADL and silica) has shown *Pennisetum orientale*, *Digitaria* spp. and *Chrysopogon pseudophragmites* best among 10 species whose introduction on extensive scale can provide nutritional adequacy for optimal livestock production.

398. MEENA, L. R., J. S. MANN AND ROOP CHAND 2008. **EFFECT OF INTERCROPPING ROW RATIO AND INTEGRATED NUTRIENT MANAGEMENT ON THE FORAGE PRODUCTIVITY AND ECONOMIC RETURN FROM DHAMAN GRASS (*CENCHRUS SETIGERUS* L.) AND COWPEA (*VIGNA UNGUICULATA* L.) UNDER SEMI-ARID CONDITIONS.** *Forage Res.*, 33 (4) : pp. 219-223. Grassland and Forage Agronomy Section, Central Sheep and Wool Research Institute, Avikanagar-304 501 (Rajasthan), India

A field experiment was conducted at Central Sheep and Wool Research Institute Avikanagar (Rajasthan) during **kharif** seasons of 2004 and 2005 to evaluate the effect of intercropping row ratio between *Cenchrus* and cowpea (1 : 1, 2 : 1 and 1 : 2) with six fertility combinations of nitrogen and phosphorus with conjunction of bacterial inoculation (control, bacterial inoculation, 40 kg N/ha, 60 kg P₂O₅/ha, 40 kg N/ha+60 kg P₂O₅/ha and 40 kg N/ha+60 kg P₂O₅/ha+bacterial inoculation) on forage yield and economic return from Dhaman grass (*Cenchrus setigerus* L.) and cowpea (*Vigna unguiculata* L.). The results of the experiment showed significant increase in green forage and dry matter production of *Cenchrus* and cowpea under varying row ratios. However, the highest green forage (134.48 q/ha) and dry matter yields (36.16 q/ha) were recorded with 1 : 2 row ratio followed by 1 : 1 row ratio i. e. green fodder (109.09 q/ha) and dry matter (33.45 q/ha) yields. The higher crude protein (13.66 %) content was estimated when *Cenchrus* and cowpea were grown in the proportion of 1 : 2 followed by 1 : 1 row ratio (10.44%). The maximum net return (Rs. 24764/ha) and benefit : cost ratio (2.55) were also obtained when *Cenchrus* and cowpea were planted in 1 : 2 proportion. The combined application of nitrogen and phosphorus @ 40 kg N+60 kg P₂O₅/ha alongwith bacterial strains of both the crops produced significantly higher green forage (126.67 q/ha) and dry matter (38.16 q/ha) yields than other treatment combinations (1 : 1 and 2 : 1). The higher crude protein (13.20%), net return (Rs. 22535/ha) and benefit : cost ratio (1.87) were recorded when combined application of nitrogen and phosphorus @ 40 kg N+60 kg P₂O₅/ha alongwith bacterial inoculations of *Azospirillum* and *Rhizobium* strains was used.

6. Agroforestry

399. KAUSHIK, N. 2001. **EFFECT OF SEED SIZE ON THE PERFORMANCE OF TOP FEED TREE SPECIES AT SEEDLING STAGE.** *Forage Res.*, 27 (1) : pp. 43-46. CCSHAU Regional Research Station, Bawal-123 501, Rewari (Haryana), India

The influence of seed size and weight on seed germination and development of *Colophospermum mopane* and *Hardwickia binnata* has been investigated. Heavy and large seeds of both the species performed better in terms of germination and seedling development at seedling stage. *C. mopane* performed better in terms of shoot length, root length and total dry biomass production.

400. PREMI, O. P. AND B. R. SOOD 2001. **QUALITY IMPROVEMENT OF NATURAL GRASSLAND THROUGH THE INTRODUCTION OF IMPROVED GRASS, LEGUME AND FODDER TREE COMPONENT.** *Forage Res.*, 27 (1) : pp. 49-54. Department of Agronomy, Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, India

An experiment in the natural grassland was carried out during 1993, 1994 and 1995 at Animal Nutrition Farm, College of Veterinary and Animal Sciences of Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The treatments included the introduction of siratro, setaria, setaria+siratro, setaria+siratro in between two hedgerows of Leucaena/Robinia in the natural grassland with two control plots (fertilized and unfertilized). On the basis of three years' data, the introduction of setaria in the natural grassland increased the productivity level of natural grassland by three times, but keeping in view both the production and quality, the introduction of setaria+siratro in between two hedgerows of Robinia recorded 13.39 per cent higher in vitro dry matter digestibility (IVDMD) over no introduction due to an increase in cell constituents and decrease in cell wall constituents. IVDMD exhibited significant positive correlation with all the cell wall constituents.

401. NANDAL, D. P. S. AND R. R. SINGH 2001. **COMPARATIVE PERFORMANCE OF GRAIN AND FODDER CROPS IN JAMUN (*SYZGIUM CUMINI*) BASED AGRO-HORTICULTURAL SYSTEM.** *Forage Res.*, 27 (1) : pp. 55-62. Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004, India

A field experiment was carried out at Forestry Research area of CCS Haryana Agricultural University, Hisar (Haryana) for two growing seasons (1993-95) on sandy loam soil to study the comparative performance of wheat, lentil and mungbean grain crops and sorghum, cowpea and oats fodder crops under different spacings of Jamun. Results indicated that fodder crops were more tolerant to shade than grain crops and the yield reduction in crops was higher during the rainy season than the winter season. Decrease in plant height and stem diameter of fodder crops under Jamun resulted in their decreased fodder yield. In grain crops, poor branching and pod setting in lentil and mungbean and reduced tillering, test weight and grains/earhead in wheat contributed towards their decreased grain yields. Sorghum during the rainy season and wheat during the winter season were found most remunerative crops for agroforestry. Cowpea-wheat cropping sequence gave the highest returns at all the spacings of Jamun. Growth, yield attributes, yield and net returns of crops improved with increasing tree spacing.

402. BANGARWA, K. S. AND R. C. VERMA 2001. **PRODUCTION POTENTIAL AND QUALITY OF FODDER TREES—A REVIEW.** *Forage Res.*, 27 (2) : pp. 73-78. Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The growing of fodder trees can meet out the gap between demand and supply of the fodder requirement of the bovine population of our country. Growing of fodder trees has several advantages like wider adaptability to harsh agroclimatic regions as well as low production cost. Fodder trees are grown mainly for their leaves to be used as fodder but several trees also produce nutritious fruits, pods and seeds. The fodder trees are rich in protein, lime,

phosphorus, etc. but the presence of certain alkaloids restricts their utility and the fodder of these species should be mixed with other fodder crops residues and grasses to avoid adverse effect on the health and productivity of livestock.

- 403.** KAUSHIK, N. AND R. P. S. DESWAL 2001. **GROWTH PERFORMANCE OF SOME FODDER TREE SPECIES IN ARID ECOSYSTEM.** *Forage Res.*, **27 (2) : pp. 87-90.** CCSHAU Regional Research Station, Bawal, Rewari-123 501 (Haryana), India

Seedlings of three important tree species were raised in nursery. These species were planted in the experimental area and survival rate, height and crown spread were measured. Maximum survival (100.0%) after two years was recorded in *Colophospermum mopane*. *Acacia bivenosa* performed excellently in terms of height and collar diameter from 6 to 24 months' age after planting in the field. Maximum crown spread (2.72 m²) was observed in *A. bivenosa* followed by *C. mopane* after the completion of third year. *A. bivenosa* showed its superiority in terms of growth over other species throughout the study period.

- 404.** BANGARWA, K. S. AND V. P. SINGH 2001. **PROVENANCE VARIATION FOR SEED AND POD CHARACTERS IN DALBERGIA SISSOO ROXB.** *Forage Res.*, **27 (3) : pp. 207-212.** Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004, India

Seed pods were collected from five randomly taken trees of *Dalbergia sissoo* Roxb. from 20 diverse sites (provenances) of Uttar Pradesh, Punjab, Haryana and Rajasthan in India. Data on pod and seed characters were recorded from each site. Significant variation was observed among provenances for seed and pod characters. Variation was higher for seed and pod weight in comparison to seeds per pod, seed length, seed breadth, pod length and pod breadth. Among 1-4 seeded pods, single seeded pods were 60 to 90 per cent. Pod length and breadth had no association with seeds per pod, seed length and 100-seed weight. Seed breadth had positive association with all the seed and pod parameters.

- 405.** JAT, B. L., MAHENDER SINGH AND HARPHOOL SINGH 2002. **FORAGE PRODUCTION IN SEMI-ARID REGIONS OF RAJASTHAN UNDER NUTANS (*DICHRUSTACHYS CINEREA*) BASED SILVIPASTORAL SYSTEM.** *Forage Res.*, **27 (4) : pp. 299-302.** Agricultural Research Station, Fatehpur-Shekhawati, Rajasthan.

A experiment was conducted at Agricultural Research Station, Fatehpur-Shekhawati (Sikar) Rajasthan to judge suitability of nutans based silvipastoral system in the zone and its effect on soil fertility. It was observed that all the treatments improved the soil fertility in term of organic carbon, available N and P.

- 406.** KAUSHIK, J. C., SANJAY ARYA AND P. P. GUPTA 2002. **MANAGEMENT OF DAMPING-OFF DISEASE IN FOREST NURSERIES BY SOIL SOLARIZATION AND BIOCONTROL AGENTS.** *Forage Res.*, **28 (1) : pp. 29-31.** Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004, India

Soil solarization with 25 µm transparent polythene sheets during May-July resulted in significant reduction in soil population of the damping-off fungi viz., *Fusarium oxysporum* f. sp. *dalbergiae*, *F. solani*, *Pythium aphanidermatum*, *Rhizoctonia solani* and *R. bataticola* compared to non-solarized soil. Solarization coupled with biocontrol agents—*T. viride*, *T. harzianum*, *T. longibarchiatum* and *Pseudomonas fluorescens* and sub-lethal doses of captan and carbendazim exhibited significantly higher seed germination and seedling survival of *Acacia nilotica*, *Albizia lebbek*, *Azadirachta indica* and *Dalbergia sissoo*.

407. JAMADAGNI, B. M., V. N. SHETYE AND B. V. INGALE 2002. **ESTABLISHMENT OF *STYLOSANTHES HAMATA* IN DIFFERENT ORCHARDS.** *Forage Res.*, **28 (2) : pp. 70-72.** Agricultural Research Station, Mulde, Tal. Kudal, Sindhudurg-416 520 (Maharashtra), India

An experiment was conducted to assess the ability of *Stylosanthes hamata* to get established in mango, cashew, Aonla and oil palm orchard. The yield and proportion of *S. hamata* was high during initial two years after sowing in different orchards. Thereafter it declined remarkably. In open field, the forage yields of *S. hamata* declined slowly, however, its proportion to total forage yield was least affected. The actual yield of *S. hamata* declined most rapidly when sown in Aonla orchard followed by oil palm, cashew, old mango orchard and high density mango. The crop of *S. hamata* could be established permanently in above mentioned horticultural orchards by sowing the seeds once or twice in early two years. However, a good yield of *S. hamata* can be obtained by sowing the seed every alternate year in any of the above said horticultural orchards.

408. SHANKAR, V. AND J. P. SINGH 2002. **FODDER TREES AND SHRUBS OF THE HIMALAYA : STATE-OF-ART AND PERSPECTIVES—A REVIEW.** *Forage Res.*, **28 (2) : pp. 88-93.** Indian Grassland and Fodder Research Institute, Jhansi-284 003, India

Fodder trees and shrubs are the key components of the Himalayan hill farming systems which combine crop and pasture production, horticulture, forestry and animal husbandry. A typical example of widely practised hill farming system is the agro-silvo-pastoral system which integrates woody perennials and annual crops with livestock rearing on pasture, fodder trees/shrubs and agrowaste (crop residues). This paper presents a critical review on the status of research and development of fodder trees/shrubs resources in the Himalayan region and it also provides a base line that would be helpful in developing a perspective plan of research and development of these resources.

409. PATIDAR, M., ANURAG SAXENA AND S. R. SIYAK 2003. **EFFECT OF NITROGEN FERTILIZATION ON FODDER COWPEA [*VIGNA UNGUICULATA* (L.) WALP.] GROWN IN ASSOCIATION WITH *KHEJRI* IN ARID ZONE.** *Forage Res.*, **28 (4) : pp. 201-203.** Division of Animal Sciences & Forage Production, Central Arid Zone Research Institute, Jodhpur (Rajasthan), India

A field experiment was conducted during two consecutive **kharif** seasons in the year 2000 and 2001 at CAZRI, Jodhpur to study the performance of cowpea in silvipastoral system. Cowpea was grown in cropping system with and without fertilizer application in association with *Khejri* (*Prosopis cineraria*) trees. Application of 40 kg N/ha increased plant height of cowpea and dry matter accumulation by 64% over no fertilizer application. Consumptive use and water use efficiency of cowpea also increased with fertilizer application. It was also found that plant height and dry matter yield of cowpea grown under canopy area of *Khejri* were improved and equivalent to that of application of 40 kg N/ha. Water use was lower under *Khejri* tree but water use efficiency of cowpea was increased under canopy of *Khejri* tree. Nitrogen concentration and uptake, and crude protein content of cowpea foliage were also improved with application of nitrogen fertilizer and under canopy of *Khejri* tree.

410. GILL, A. S. 2003. **INTRODUCTION OF *LEUCAENA LEUCOCEPHALA* IN MANGO BASED AGROFORESTRY SYSTEM.** *Forage Res.*, **28 (4) : pp. 238-240.** NRCAF, Jhansi

Study on introduction of *Leucaena leucocephala* in mango based agroforestry system was conducted at NRCAF, Jhansi. The results revealed that mango orchard interspaces can be successfully exploited by introducing fast growing multipurpose N fixing fodder trees.

411. SOLANKI, K. R. 2003. **FORAGE PRODUCTION THROUGH AGROFORESTRY.** *Forage Res.*, **29 (1) : pp. 1-9.** Indian Council of Agricultural Research, Krishi Bhavan, New Delhi

Existing gap between demand and supply of quality feed and forages requires to be narrowed down. R & D efforts made so far clearly proved that agroforestry played an important role in augmenting the supply of fodders

especially in degraded land which was estimated to be one third of total area reported. In order to raise production and productivity more area of degraded land was to be brought under agroforestry and also cost effective technology required to be developed. In India, although many systems with yield higher biomass in different situations are now available. However, research on system based animal production and role of each component has been poorly documented also.

412. DHILLON, R. S., M. S. HOODA, D. CHOPRA AND S. ARYA 2003. **STUDIES ON FLORAL BIOLOGY AND BREEDING BEHAVIOUR OF *PROSOPIS CINERARIA* (L.) DRUCE (KHEJRI)** *Forage Res.*, **29 (2) : pp. 71-75**. Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Defoliation started during the month of November and continued till end of January. The new leaves started appearing in February. The floral buds began to open from first week of April. The peak period of flowering was noticed from mid April to mid May. Flowering pattern was observed asynchronous and the flowers were small in size, yellow and creamy white in colour. Stigma receptivity was recorded between 8-11 a. m. Natural pod setting started in last week of April and it was ready to harvest in first week of June. Per cent pod set varied from 0.19 for selfing/bagging to 1.58 for natural open pollination during 1999 and 0.15 to 1.84 per cent during 2000. Apomixis was found to be totally absent.

413. UPPAL, R. AND V. K. SHARMA 2003. **NUTRITIONAL EVALUATION OF IMPORTANT FODDER TREES OF MID HILLS SUB HUMID ZONE OF HIMACHAL HIMALAYAS.** *Forage Res.*, **29 (2) : pp. 68-70**. Department of Agroforestry and Environment, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H. P.), India

Samples of 11 important fodder tree leaves cultivated by farmers in the hills of Himachal Pradesh were collected and analysed for macro- and micro-minerals. Per cent dry matter, crude protein (CP) and other contents of leaves ranged from 22 to 42, 11 to 22 and 5 to 15, respectively. The Ca, K and Mg contents were more than 1, 0.9 and 0.25 per cent, respectively, but majority of fodder tree leaves contained less than 0.06 per cent Na. However, P in most of the leaves was within the range of 0.16 to 0.40.

414. DHANDA, S. K., R. S. DHILLON AND S. ARYA 2003. **EFFECT OF SEED SIZE AND PRE-SOWING TREATMENTS ON EARLY GROWTH CHARACTERS OF SUBABUL (*LEUCAENA LEUCOCEPHALA*).** *Forage Res.*, **29 (3) : pp. 107-109**. Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The study was undertaken to find out the effect of seed size and pre-sowing treatments (hot or cold water) on seed germination, early seedling growth and biomass production in *Leucaena leucocephala* under controlled conditions. Hot water pre-sowing treatment was found much effective as compared to cold water treatment for higher germination per cent as well as for early seedling growth and biomass production. Seed size and weight had direct correlation with seed germination, seedling growth and biomass production.

415. UPPAL, R. AND V. K. SHARMA 2004. **NUTRITIONAL EVALUATION OF IMPORTANT FODDER TREES OF MID HILLS SUB HUMID ZONE OF HIMACHAL HIMALAYAS.** *Forage Res.*, **30 (2) : pp. 69-71**. Department of Agroforestry and Environment, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062 (H. P.), India

Samples of 11 important fodder tree leaves cultivated by farmers in the hills of Himachal Pradesh were collected and analysed for macro and micro minerals. Per cent dry matter, crude protein (CP) and other contents of leaves ranged from 22 to 42, 11 to 22 and 5 to 15, respectively. The Ca, K and Mg contents were more than 1, 0.9 and 0.25 per cent, respectively, but majority of fodder tree leaves contained less than 0.06 per cent Na. However, P in most of the leaves was within the range of 0.16 to 0.40 per cent.

416. JAT, B. L., MAHENDRASINGH AND HARPHOOL SINGH 2004. **PROSPECTS OF ANJAN (*HARDWICKIA BINATA*) AS FODDER AND FUEL TREE UNDER SEMI-ARID CONDITIONS OF NORTH-WEST INDIA.** *Forage Res.*, **30 (2) : pp. 86-88.** Agricultural Research Station, Fatehpur-Shekhawati-332 301, Sikar (Rajasthan), India

A field experiment was conducted at Agricultural Research Station, Fatehpur-Shekhawati (Sikar), Rajasthan to study the influence of tree density on growth and fodder production of *Hardwickia binata* (Anjan) during 2000-01 and 2001-02. The growth data revealed that closer row spacing of *H. binata* increased the height of tree at a faster pace as compared to wider row spacing. On the other hand, diameter at breast height (dbh) increased at a rapid rate in wider row spacing/lower density in contrast to higher densities. There was positive correlation between tree density and green fodder yield and total wood volume over bark (TWOB). The highest mean green fodder yield was recorded with 3.0 m row spacing (22.63 q/ha), while lowest was recorded with 8.0 m row spacing (13.07 q/ha). Available nitrogen, phosphorus and organic carbon were significantly higher in closer row spacing as compared to wider row spacing. While pH of the soil significantly decreased with the increasing plant density.

417. KUMAR, D., D. P. S. NANDAL AND KRISHAN KUMAR 2004. **COMPARATIVE PERFORMANCE OF SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH] VARIETIES UNDER DIFFERENT SPACINGS OF POPLAR (*POPULUS DELTOIDES* BARTR.).** *Forage Res.*, **30 (3) : pp. 128-130.** Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted at Forestry Research Farm, CCS Haryana Agricultural University, Hisar during the **kharif** seasons of 1998 and 1999 to assess the performance of sorghum varieties under various spacings of poplar. Five varieties of sorghum (Haramoti, PC 23, HC 136, HC 171 and JS 20) were grown under three spacings (control, 5 m x 4 m and 10 m x 2.5 m) of poplar. Among different varieties of sorghum, HC 171 during 1998 and PC 23 during 1999 under poplar and HC 136 in control during both the years produced highest green fodder yield. Sorghum varieties HC 171 and HC 136 also recorded higher protein content than other varieties. Low tannin content in HC 136 coupled with higher fodder yield and protein content made it a suitable variety for cultivation. The studies also revealed that closely spaced (5 m x 4 m) poplar had more harmful effect on fodder yield of sorghum varieties than wider tree spacing of 10 m x 2.5 m. However, fodder quality judged in terms of higher protein content and low tannin content was better under poplar than control.

418. PONIA, T. C., B. L. JAT AND G. D. SINGH 2005. **COMPARATIVE PERFORMANCE OF DIFFERENT SILVIPASTURE SYSTEMS ON FODDER PRODUCTION IN HOT ARID WATERSHED AREAS.** *Forage Res.*, **30 (4) : pp. 236-237.** Agriculture Research Station, Fatehpur-Shekhawati-332301(Raj.)

It is evident from the results that maximum gross monetary realization of Rs. 16692/ha was recorded from silvipasture system of *C. ciliaris* grass *D. nutans* (shrub).

419. JHORAR, B. S., R. S. DHILLON, R. P. MOR AND O. P. NEHRA 2005. **GROWTH PERFORMANCE AND BIOMASS PRODUCTION OF MULTIPURPOSE TREE SPECIES UNDER SILVI-PASTORAL SYSTEM IN ARID ECOSYSTEM.** *Forage Res.*, **31 (1) : pp. 26-29.** Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Sandy soils including sand dunes are common features of arid and semi-arid regions. About 10 per cent of the total geographical area of India is having this type of soils. Whereas in Haryana, about 19 per cent of the total geographical area is under such soils which are characterized by acute shortage of vegetation due to scarcity of water, resulting in the shortage of food, fodder and fuelwood. A field experiment at Regional Research Station, Balsamand of CCSHAU, Hisar was conducted with about 12 months old seedlings of *Azadirachta indica* and *Ailanthus excelsa* were transplanted at 6 m x 6 m with silvi-pastoral system. *Cenchrus ciliaris* grass was raised in this system. The planting of tree was done in October 1991, whereas *C. ciliaris* was planted in July 1992. In silvi-pastoral system

C. ciliaris was found to check the movement of shifting sand dune and gave green fodder yield of 60 q/ha/year. It was observed that this grass gets very quick establishment.

420. CHOPRA, D. AND M. S. HOODA 2005. **CHEMICAL COMPOSITION OF LEAVES AND HULLS OF *PROSOPIS JULIFLORA* (SW)DC COLLECTED FROM DIFFERENT LOCATIONS.** *Forage Res.*, **31 (1) : pp. 64-66.** Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The variation in chemical composition might be a reflection of genetic makeup of the tree or due to the properties of the soil.

421. GILL, A. S. AND AJIT 2005. **PERFORMANCE OF FODDER COWPEA IN INTER SPACING OF MANGO VARIETIES.** *Forage Res.*, **31 (2) : pp. 147-149.** NRC Agroforestry, Jhansi-284003

On pooled basis (four years) maximum green and dry forage yield of cowpea was recorded with mango variety Deshari.

422. GILL, A. S. AND S. K. GUPTA 2005. **PERFORMANCE OF MULTIPURPOSE TREE SPECIES FOR THEIR FORAGE YIELD UNDER RAINFED CONDITIONS.** *Forage Res.*, **31 (3) : pp. 200-202.** Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

Field studies were initiated at IGFRI, Jhansi during 1989-90 with planting four important multipurpose tree species (MPT's) in a randomized block design with three replications. Treatment combinations comprised four MPT's (Siris, Neem, Shisham and Babul) with and without crops. In all, there were 12 treatments. The trees were planted in a spacing of 6 m x 12 m under rainfed conditions. Growth parameters were recorded each year prior to pruning of trees during June. The trees were pruned to their 50 per cent height during June from the year 2000 onwards for their forage yield. All growth parameters were in favour of Babul except plant height, where Shisham gave the highest plant height over rest of the trees. For forage production (green fodder, dry matter and crude protein), Shisham was found superior to Babul. Performance of Siris and Neem was quite inferior to rest of the trees under rainfed conditions at Jhansi.

423. MARAGATHAM, N., G. VIJAYA KUMAR AND A. GOPALAN 2006. **AGRONOMIC EVALUATION OF FORAGE PRODUCTION AS INTERCROP IN COCONUT PLANTATION.** *Forage Res.*, **31 (4) : pp. 228-230.** Department of Forage Crops, Tamil Nadu Agricultural University, Coimbatore-641 003 (Tamil Nadu), India

The field experiment was undertaken at Tamil Nadu Agricultural University, Coimbatore in forage unit to find out the suitability of forage crops as intercrops in coconut plantation. The experiment consisted of five forage crops viz., Lucerne (Co 1), Cowpea (Co 5), Desmanthus, Guinea grass (Co 2) and Guinea grass (Co 2)+Desmanthus (3 : 1). This was compared with pure crop situation under unshaded condition. The result indicated that taking up guinea grass+Desmanthus (3 : 1 ratio) under shaded condition of coconut plantation recorded maximum green fodder yield of 832.5 q/ha/year followed by guinea grass. Similar trend was observed with respect to dry fodder production also. The grass equivalent and economic analysis also favoured growing of Guinea grass (Co 2)+Desmanthus (3 : 1) as inter crop. The higher BC ratio of 1.60 in coconut+Guinea grass (Co 2)+Desmanthus (3 : 1) among intercrop situations encourages the possibility of effective utilization of interspace in the coconut plantation.

424. LAKSHMI, S., ANJU GEORGE AND C. VIDYA 2006. **NUTRIENT CONSUMPTION OF GUINEA GRASS (*PANICUM MAXIMUM*) IN COCONUT BASED FODDER PRODUCTION SYSTEM.** *Forage Res.*, **31 (4) : pp. 241-243.** Department of Agronomy, College of Agriculture, Vellayani-695 522 (Kerala), India

A field experiment was conducted to study the nutrient consumption of guinea grass in coconut based fodder production system during 1998-2002. Four years' study revealed that the uptake of N, P₂O₅ and K₂O by guinea grass was highest when these nutrients were applied @ 200 : 100 : 150 kg NPK/ha. The application of magnesium and boron to guinea grass favoured the uptake of nitrogen by guinea grass from third year of planting onwards.

425. GILL, A. S. 2006. **PERFORMANCE OF FODDER COWPEA IN ASSOCIATION WITH TREES UNDER RAINFED SEMI-ARID SUB-TROPICS.** *Forage Res.*, **32 (3) : pp. 155-158.** Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

A field study was initiated with four known tree species, namely, neem (*Azadirachta indica*), siris (*Albizia lebbek*), sisham (*Dalbergia sissoo*) and babul (*Acacia nilotica*) under rainfed semi-arid sub-tropics, to see the performance of fodder cowpea as raised in their inter spaces as a succeeding crop for two consecutive years (2004 and 2005) at Indian Grassland and Fodder Research Institute, Jhansi (U. P.). The results revealed that, on an average, sisham gave the best growth characters except crown area (it was highest with siris). On plant yield basis, cowpea gave highest forage yield (green, dry and crude protein) in association with babul, whereas forage yield (green, dry and crude protein) per hectare was maximum from the inter spaces of sisham. Cowpea forage yield on per plant basis and yield per hectare were lowest from the inter spaces of siris trees.

426. KAUSHIK, N., J. C. KAUSHIK, SUSHIL KUMAR AND KRISHAN KUMAR 2006. **TREE/CROP INTERFACE FOR FODDER PRODUCTION UNDER RAINFED CONDITIONS** *Forage Res.*, **32 (3) : pp. 181-184.** CCSHAU Regional Research Station, Bawal-123 501, Rewari (Haryana), India

Fodder production studies from tree/crop interface system under rainfed conditions were initiated at CCSHAU Regional Research Station, Bawal during 2002-04. The fodder crops viz., pearl millet, Napier bajra hybrid (NBH), an interspecific cross between napier (*Pennisetum purpureum*, Schumacher) and pearl millet (*Pennisetum americanum* (Burm) S & H), cowpea, cowpea+pearl millet and NBH+cowpea were raised in five year old plantation of *Acacia bivenosa*, *Hardwickia binnata* and *Cholophospermum mopane*. The green and dry yield of all the fodder crops raised in the interspaces of tree did not show significant variation as compared to their sole cropping. The same trend was observed during whole period of the study (three years). However, the fodder crops raised under different tree species varied significantly in terms of fodder yield. NBH gave significantly higher yield than crops under all the tree species. Maximum fodder yield (384.5 q/ha) was found in NBH under *H. binnata*. Fuelwood obtained by pruning was maximum in *A. bivenosa* and minimum in *H. binnata*. Fodder yield received from different top feed tree species also varied significantly. Total biomass production was more in tree/crop interface as compared to sole cropping.

427. PAL, A., RAJNI CHAUHAN, S. K. CHAUHAN AND S. S. SIKHA 2008. **EVALUATION OF *LEUCAENA* SOURCES FOR BIOMASS PRODUCTIVITY AND FODDER QUALITY.** *Forage Res.*, **33 (4) : pp. 244-249.** Department of Forestry and Natural Resources, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

The sources of *Leucaena* comprising *Leucaena leucocephala*, *L. diversifolia* and a hybrid between *L. leucocephala* x *L. diversifolia* were evaluated during two seasons for biomass productivity and fodder quality. Results revealed that the productivity of K-8 was maximum, while the anti-quality parameters were low in source K 156 of *L. diversifolia*. Therefore, the *L. diversifolia* and its hybrid offer potential scope for their exploitation in the genetic improvement in *Leucaena* for fodder quality.

428. GILL, A. S. 2008. **PERFORMANCE OF TREES IN AGRO FORESTRY FOR FORAGE YIELD UNDER RAINFED SEMI-ARID SUB-TROPICS.** *Forage Res.*, **34 (1) : pp. 14-16.** Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

Studies were initiated with four tree species under agro forestry system in rainfed semi-arid sub-tropics at Indian Grassland and Fodder Research Institute, Jhansi (U. P.) to evaluate their foliage yield. The trees, namely, *Siris* (*Albizia lebbek*), *Neem* (*Azadirachta indica*), *Shisham* (*Dalbergia sissoo*) and *Babul* (*Acacia nilotica*) plant saplings were planted during **kharif** 1998 in 6 x 12 m spacing. The trees were planted under sole planting, with barley and chickpea crops. In all, there were 14 treatments including two treatments of sole planting of crops. On six years basis (on an average) *shisham* gave the best growth characters followed by *babul*, *siris* and *neem*. For foliage production (green and dry) the trend was identical as achieved with the growth characters. However, for crude protein yield, highest production was achieved with *babul* followed by *shisham*, *siris* and *neem*. In case of intercrops, best performance (on an average) for green and dry foliage was registered with sole planting of trees followed by chickpea and barley. But for quality forage, higher crude protein yield was recorded with trees in association with chickpea. Thus, planting *shisham/babul* with chickpea in the inter spaces gave the best performance for quality forage yield under rainfed semi-arid sub-tropics.

429. SHANTHI, M, BHUPAL RAJ, G, NAGALAKSHMI, D., CHIRANJEEVI, CH. SHASHIKALA, T. 2010. **SURVEY AND NUTRITIONAL EVALUATION OF IMPORTANT FORAGE TREES AND FORAGE VALUE PLANT SPECIES OF MAHABOBNAGAR DISTRICT OF ANDHRA PRADESH.** *Forage Res.*, **36 (1) : pp. 57-58.** AICRP on Forage Crops, Rajendernagar, Hyderabad (A.P.), India

In mahboobnagar district, it was observed that among the tree species *Acacia nilotica* was found to be most promising and popular tree in the entire district and farmers had good potential source of green fodder even in lean period of summer months.

430. SHEKARA, B. G., H. C. LOHITHASWA, G. B. SHIVAKUMAR AND R. PAVAN 2010. **PERFORMANCE OF FORAGE LEGUMES IN COCONUT GARDEN.** *Forage Res.*, **36 (2) : pp. 87-90.** Department of Forage Crops (AICRP), Zonal Agricultural Research Station, V. C. Farm, Mandya-571 401 (Karnataka), India

A field experiment was conducted at Zonal Agricultural Research Station, Visweswaraiiah Canal Farm, Mandya (Karnataka) started during **kharif** season of 2007 and continued for three consecutive years from 2007 to 2009 to assess the feasibility of forage legumes as intercrop in coconut plantation. The experiment consisted of six forage legumes viz., cowpea, horsegram, lucerne, *Stylosanthes hamata*, sirratro and centrocema and were laid out in split plot design with four replications. The three years' pooled data indicated that cultivation of cowpea-lucerne recorded significantly higher green fodder yield (650.8 q/ha), dry matter yield (149.2 q/ha) and crude protein yield (26.4 q/ha) followed by horsegram- lucerne (555.6, 133.4 and 24.1 q/ha, respectively). Slight reduction in soil pH (6.90) and electrical conductivity (0.54 dS/m) and improvement in organic carbon (0.48), available nitrogen (245.38 kg/ha), phosphorus (28.06 kg/ha) and potassium (209.17 kg/ha) were observed with forage legumes as intercrop in coconut garden.

431. AHLAWAT, K. S., D. P. S. NANDAL, M. K. SINGH, O. P. LATHWAL, ANIL DUHAN AND VINOD KUMAR 2010. **GROWTH AND YIELD OF FODDER SORGHUMS INFLUENCED BY DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS FERTILIZER IN EUCALYPTUS TERETICORNIS BASED AGRISILVICULTURE SYSTEM.** *Forage Res.*, **36 (2) : pp. 94-99.** CCSHAU Krishi Vigyan Kendra, Kurukshetra-136 118 (Haryana), India

A field experiment was conducted to study the response of various fertilizer levels on *Sorghum bicolor* in 5-6 year old *Eucalyptus tereticornis* based agrisilviculture system. Plant height of sole sorghum increased by 62, 37, 35 and 34 per cent with application of 0, 75, 100 and 125 per cent recommended dose of fertilizer, respectively, as

compared to agrisilviculture system. Green and dry fodder yield increased significantly upto recommended dose of fertilizer in both the systems and during both the years. Poor yield attributes of sorghum, resulted in 45 and 42 per cent reduction in green fodder and dry fodder yield, respectively, in sorghum under *E. tereticornis* as compared with sole sorghum.

432. GILL, A. S. 2009. **TREE PERFORMANCE FOR FORAGE YIELD UNDER RAINFED SEMI-ARID SUB-TROPICS.** *Forage Res.*, **34(4)** : pp.239-243. IGFRI, Jhansi-284003 (U.P.), India.

Studies were initiated with four tree species under agro forestry system in rainfed semi-arid sub-tropics at Indian Grassland and Fodder Research, Jhansi(U.P.) to evaluate their foliage yield. The tree, namely, Siris (*Albizia lebbek*), Neem (*Azadirachta indica*), Shisham (*Dalbergia sissoo*) and Babul (*Acacia nilotica*) plant saplings were planted during **kharif** 1998 in 6 x 12 m spacing. The trees were planted under sole planting, with barley and chickpea crops. In all three were 14 treatments including two treatments of sole planting of crops. On six years basis (on average) shisham gave the best growth characters followed by babul, siris and neem. For foliage production (green and dry) the trend was identical as achieved with the growth characters. However, for crude protein yield, highest production was achieved with babul followed by shishim, siris and neem. In case of intercrops, best performance (on an average) for green and dry foliage was registered with sole planting of trees followed by chickpea and barley. But for quality forage, higher crude protein yield was recorded with trees in association with chickpea. Thus, planting shisham/babul with chickpea in the inter spaces gave the best performance for quality forage yield under semi-arid sub-tropics.

433. KAUSHIK, J. C. AND PARMOD DABAS 2003. **INTERACTION BETWEEN VA MYCORRHIZAL FUNGI, PHOSPHORUS FERTILIZER AND WATER STRESS APPLICATION ON NODULATION IN ACACIA NILOTICA (L.) DEL. AND DALBERGIA SISSOO ROXB.** *Forage Res.*, **28 (4)** : pp. 220-222. Department of Forestry, CCS Haryana Agricultural University, Hisar-125 004, India

Application of VA mycorrhiza, P fertilizer and water stress conditions were studied to record their effect on nodulation and NPK in 120 days old seedlings of *Acacia nilotica* and *Dalbergia sissoo* under green house conditions. The design of the experiment was 2 x 2 x 2 factorial \pm VAM, \pm P fertilizer and \pm water stress. Application of *G. mosseae*, P fertilizer and water significantly increased nodule formation in both the tree species. Water stress conditions significantly reduced nodule number and size in *A. nilotica* but did not have significant difference in *D. sissoo*. Interaction between the Phosphorus x Water stress (P x W), Mycorrhizae x Phosphorus (M x P) and Mycorrhizae x Water stress (M x W) was significant in *A. nilotica*. Average nodule size was comparatively larger in *D. sissoo* than in *A. nilotica*. Individual application either of VAM or P fertilizer statistically increased nodulation in both the tree species, whereas water stress conditions significantly reduced nodulation in *A. nilotica*. VAM inoculation significantly improved phosphorus concentration in shoots of both the tree species, whereas water stress conditions reduced it.

7. Miscellaneous

434. CHANDAGI RAM, MANN ANITA AND PUNIA, R.C. 2001. **DISTINCTNESS, UNIFORMITY AND STABILITY (DUS) TESTING AND TECHNIQUES FOR TESTING GUIDELINES OF VARIETIES BY LABORATORY AND FIELD TECHNIQUES.** *Forage Res.*, **27 (3)** : pp. 239-242. Seed Technology Centre, Haryana Agricultural University, Hisar-125 004, India

Dostinctness, Uniformity and stability (DUS) testing and techniques for testing guidelines of varieties by laboratory and field techniques. Various laboratory and field techniques for DUS testing have been given in this communication.

435. DAHIYA, B. S. AND R. P. S. KHARB 2003. **FODDER SEED PRODUCTION-CONSTRAINTS AND STRATEGIES** *Forage Res.*, **29 (1) : pp. 10-17**. Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Inadequate availability of quality seed of improved varieties of fodder crops is the single most important constraint in increasing the production and productivity of these crops. As such they are shy seeders with low seed productivity. There are many genetical, physiological, environmental and organisational problems/constraints associated with low seed productivity. In addition, the appropriate crop management practices greatly help in enhancing the seed production potential. In this article, strategies are discussed for development of an effective and viable seed production programme from maintenance breeding to certified seed. Through systematic efforts at all levels, the forage seed production problem could be resolved to a reasonable level.

436. MELKANIA, N. P. 2003. **FORAGE RESEARCH IN INDIA : PROSPECTS AND RETROSPECTS.** *Forage Res.*, **29 (1) : pp. 26-27**. Indian Grassland, Fodder and Agroforestry Research Institute, Jhansi-284 003, India

Forages include a range of species belonging to Poaceae and Leguminosae prominently. Naturally, these occupy almost all the habitats in all the altitudinal and latitudinal environs as harsh as the cold and hot arid regions to as congenial as the humid tropics. Agriculturally, forages include both cultivable farm (e. g., sorghum, maize, cowpea, berseem, etc.) and non-farm (e. g., range grass and legume species) plant species palatable to and preferred by the domesticated livestock.

- SINGH, A. K. 2003. **ROLE OF NATIONAL DAIRY DEVELOPMENT BOARD IN FORAGE AND FODDER SEED PRODUCTION.** *Forage Res.*, **29 (1): pp. 49-54**. National Dairy Development Board, Anand, Gujarat.

The NDDDB developed integrated programme for augmenting green fodder resources. Salient features of the programme are summarized here.

437. NEGI, A. AND P. BOORA 2003. **INVESTIGATION ON EFFECT OF DOMESTIC PROCESSING AND COOKING METHODS ON THE MINERAL COMPOSITION OF SOME HIGH YIELDING VARIETIES OF MOTH BEAN (*VIGNA ACONITIFOLIA* JACQ. MARECHAL).** *Forage Res.*, **29 (2) : pp. 97-101**. Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Moth bean is one of the most drought tolerant pulse crops and is widely grown under rainfed conditions in semi-arid and arid zones of India. It is grown for food, feed and fodder in India. The present study was conducted to determine the mineral composition (Ca, Fe and Zn) of the four varieties, namely, Local, Jwala, RMO 225 and RMO 257 of moth bean and effect of different domestic processing and cooking on the mineral composition. Different processing treatments given were soaking, dehulling and germination. The total Ca, Fe and Zn contents in all four unprocessed varieties differed from 233.94 to 241.91, 6.32 to 7.78 and 4.05 to 4.82 mg/100 g, respectively. Soaking of moth bean for 12 h reduced the calcium content by 6 to 8 per cent and iron by 12 to 16 per cent. After dehulling, the soaked losses were higher i. e. calcium content declined by 23 to 26 per cent and iron from 30-32 per cent among all the four varieties of moth bean. After germination (60 h) calcium and iron content decreased by 1-2 per cent and 15-19 per cent, respectively. In unsoaked, soaked and soaked-dehulled pressure cooked seeds of all the varieties calcium content decreased by 3-5, 8-10 and 23-27 per cent, respectively, while iron content decreased by 2-4, 13-15 and 28-35 per cent, respectively. Similar trends were observed during microwave cooking. The zinc content increased non-significantly after different processing and cooking treatments. Thus, all the processing and cooking treatments decreased Ca and Fe content to varying degrees but maximum losses were caused by dehulling of seeds. So, it may be recommended that dehulling of legumes should be avoided as it causes considerable losses in minerals.

438. RAO, V. SATYANARAYANA 2004. **FORAGE AND FORAGE SEED PRODUCTION—PERSPECTIVES, RESOURCES AND STRATEGIES FOR THE TELENGANA REGION OF ANDHRA PRADESH.** *Forage Res.*, **29 (4) : pp. 163-169.** AICRP on Forage Crops, Livestock Research Institute, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad (A. P.), India

The bovine population of Andhra Pradesh, though remained almost constant during the last four decades 1961-99, has undergone significant structural changes. Male cattle population remained constant during the period indicating that agriculture is still dependent on animal power. Shift in cow population to buffalo population indicated the preference for buffalo milk. There was a phenomenal increase in ovine population between 1993-96. The area under cultivated fodder crops in the State, 2.04 lakh hectare was less than 1 per cent of the geographical area of the State. The grazing pressure of the State was 3.49 ACU/ha and the availability of grazing area in ha/ACU was 0.29. The shortage of fodder in Telengana region was 115.01 lakh tonnes. Seed production of forage crops in the State is yet to start. Breeder seed requirement of this region is approximately 2163 kg.

439. RATHI, A., ASHA KAWATRA AND SALIL SEHGAL 2004. **PIGMENTATION OF PEARL MILLET (*Pennisetum glaucum* L.) : A MEANS TO IMPROVE THE SENSORY ATTRIBUTES OF ITS PRODUCTS.** *Forage Res.*, **29 (4) : pp. 201-205.** Department of Foods & Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

This investigation was undertaken to study the effect of depigmentation on sensory attributes of pearl millet products. Pearl millet grains were depigmented by soaking in 0.2 N HCl for 18 h followed by washing, blanching (98°C for 30 sec) and sun drying. Five different food products i. e. biscuit, pasta, *chapatti*, *idli* and *dhokla* were developed from native/depigmented pearl millet. Biscuits and pasta prepared from refined flour, *chapatti* prepared from whole-wheat flour, *idli* prepared from semolina and *dhokla* prepared from chickpea flour were taken as control. Results of sensory attributes suggested that all the developed products were acceptable organoleptically. Depigmentation significantly improved the colour, appearance, aroma, texture and taste of pearl products. Colour attributes of biscuit, pasta, *chapatti* and *dhokla* prepared from depigmented pearl millet were rated similar to their respective control and fell in the category of "like very much". It implies that depigmentation can be successfully adopted in order to improve the acceptability of pearl millet products and thus expanding its utilization to large section of world population.

440. KHETARPAUL, N., RAJ BALA GREWAL, RAJNI GOYAL AND RENU GARG 2004. **INFLUENCE OF ENZYMATIC PRETREATMENT ON COOKING TIME AND SENSORY EVALUATION SCORES OF SOY DHAL.** *Forage Res.*, **29 (4) : pp. 219-221.** College of Home Science, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Influence of enzymatic pretreatment on cooking time and sensory evaluation scores of soy *dhal* was studied at Hisar. The overall effect of soaking in varying concentrations of amylase solution for 1, 2 and 4h was compared, no significant effect on sensory scores of cooked spiced dhal was observed.

441. VARSHA AND R. B. GREWAL 2004. **PHYSICAL, NUTRITIONAL AND SENSORY ATTRIBUTES OF BREAD SUPPLEMENTED WITH SOY FLOUR.** *Forage Res.*, **30 (1) : pp. 41-44.** Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Soybeans have been part of the human diet for well over 5,000 years, particularly in Asia. Their potential was not recognized until the 20th century but during the past several years, soy and its derivatives have received considerable attention from industry as well as researchers and health practitioners. One of the most promising uses of soybean is the fortification of cereal-based products, as the profile of essential amino acids in soy is complementary to that in most cereals. Addition of soy flour to baked products such as bread can improve the nutritional and physical properties. Hence, an attempt was made to supplement soy in bread formulation. The breads were prepared using wheat flour

alone and with soy flour. The breads were evaluated for their physical, nutritional properties and sensory characteristics using 9-point hedonic scale. Bread containing wheat soy flour in the ratio of 85 : 15 had significantly higher specific loaf volume and significantly higher protein, fibre, minerals and energy content. The breads were found to be 'satisfactory' in terms of general appearance, crust colour, crumb grain, texture, odour and taste, and overall acceptability. The results indicate that soy flour can be successfully incorporated in the whole wheat bread to improve the physical attributes and nutritive value of bread.

442. LOHAN, S. K. AND S. S. JAKHAR 2007. **STUDIES ON MACHINE CROP VARIABLES FOR THRESHING OF CLUSTERBEAN.** *Forage Res.*, **32 (4)** pp. 245-248. Department of seed science and Technology, CCS Haryana Agricultural University, Hisar

The study was conducted for damage-free seeds, maximum threshing efficiency, high germination and less electrical conductivity of clusterbean (*Cyamopsis tetragonoloba*). Three types of threshers having hammer mill (Hadamba thresher), spike tooth (Hadamba thresher) and raspbar (Axial flow thresher) threshing cylinders w.r.t. three levels of cylinder speed (400, 450 and 500 rpm) and concave clearance (5, 10 and 15 mm) were selected for the study. The crop was harvested at maturity and sun-dried upto moisture content of 10.5 per cent. The data were optimized for optimum combinations for minimum seed damage (<5%), maximum threshing efficiency (>95%) and maximum per cent germination (>70%). The minimum seed damage (2.8%) and maximum germination (73%) were found under the cylinder speed (500 rpm) and 96.0 per cent threshing efficiency with the use of raspbar threshing cylinder.

443. URMILA DEVI AND S. K. VARMA 2008. **UTILIZATION OF COMMUNICATION SOURCES FOR SEEKING INFORMATION REGARDING BERSEEM AND SORGHUM CULTIVATION IN HARYANA.** *Forage Res.*, **34 (2)** : pp. 112-115. Department of Home Science Extension Education, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

It was concluded that information source utilization for berseem cultivation as neighbours, family members and friends were most frequently used localite sources of information and all cosmopolite sources were used least frequently by the farm women. Radio and television were frequently mass media sources of information used by the farm women, whereas in case of sorghum cultivation, most frequently utilized localite sources of information were family members, neighbours and friends. All the cosmopolite sources of information were used least frequently and radio, television were frequently utilized as mass media sources of information. So, it can be concluded that women were not more aware of different sources of information. So, the need of the hour is to educate women about different cosmopolite and mass media sources of information and proper linkage should be established for promotion of transfer of knowledge. Motivational camps should be organized to create awareness among the rural women for different technological information sources.

444. KHAR, S. AND S. S. PAHUJA 2008. **EFFECT OF FLAIL TYPE FORAGE HARVESTER ON QUALITY OF MAIZE FODDER.** *Forage Res.*, **34 (2)** : pp. 127-129. Division of Agricultural Engineering, J&K, India

The maximum crude protein in a plant was concentrated in the leaves as compared to stem. The higher forward speed resulted in higher height of cut, which increased the crude protein level at higher forward seed. The higher flail speeds resulted in the lower height of cut which resulted in decrease of the crude protein level at higher flail speed.

445. TRIPTA AND S. MEHTA 2008. **GENDER ANALYSIS IN AGRICULTURAL ACTIVITIES.** *Forage Res.*, **34 (3) : pp. 193-196.** Department of Home Science Extension Education, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The study was conducted in two randomly selected villages of Hisar district, Haryana state. Fifty couples from each village were selected randomly. To find out the gender participation in agricultural activities, both husband and wife were interviewed. It was found that in agriculture related activities female participation was more in weeding, harvesting, storage of crop for domestic purpose than male. Regarding gender participation in animal husbandry activities large number of females participated in collection of animal dung, preparation of food, cleaning of animals and habitat. Equal participation was seen in fodder collection and milking (34.0% each). Whereas 18.0 per cent were engaged in taking care of sick animals. In case of males, their participation was less in all animal husbandry activities.

446. YADAV, M. AND S. MEHTA 2010. **STATUS AND PROBLEMS OF SC FAMILIES IN HISAR DISTRICT.** *Forage Res.*, **35 (4) : pp. 241-245.** CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A study was conducted in 2 randomly selected villages in Hisar district to study the status and problems of SC families. Based on the study it was concluded that 51.33 % respondents belonged to 18-35 years of age, were married (89.33%), illiterate (65.33%), had nuclear family system (64.67%) and were agricultural labourers (82.66%).

447. SINGH, M. K., MANISHA, R. K. ARYA AND B. S. YADAV 2010. **ALLELOPATHIC EFFECT OF JATROPHA CURCAS LEAF EXTRACTS ON GERMINATION AND SEEDLING GROWTH OF SUMMER CROPS IN SEMI-ARID REGION OF HARYANA.** *Forage Res.*, **36 (3) : pp. 171-175.** CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India /Department of Energy and Environmental Sciences, Chaudhary Devi Lal University, Sirsa-125 055 (Haryana), India

The results of bioassay study (carried out at CCS Haryana Agricultural University, Hisar) revealed that germination per cent, early seedling growth and vigour index of pearl millet (*Pennisetum typhoides*) cv. HHB-67, greengram (*Vigna radiata*) cv. MH-96-1, clusterbean (*Cyamopsis tetragonoloba*) cv. HG-563 and mothbean (*Phaseolus aconitifolius*) cv. RMO-40 were reduced significantly as the concentrations (5, 10, 15, 20 and 25 g/100 ml) of leaf extract of *Jatropha* were increased. In all the test crops, the inhibition of radical length was more severely affected by all concentrations of leaf extract as compared to plumule length. However, no germination was recorded in all the test crops at higher concentrations of leaf extract.

ABSTRACTS

- PLANT PROTECTION
- QUALITY
- ANIMAL NUTRITION



Volume 27 to 36

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The Indian Society of Forage Research

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The Society was founded in October 1974 with the following objectives :

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Ronney, W. L., and C. W. Smith, 2000 : In : *Sorghum : Origin, History, Technology and Production*, C. W. Smith, and R. A. Frederiksen (eds.). Wiley, New York. pp. 329-347.