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AGRONOMY
AND
SOIL SCIENCE

1. Cereal Forages

(i) Sorghum

1. BARIK, A. K. AND P. NAG 2001. **EFFECT OF BIOFERTILIZERS WITH NITROGEN LEVELS ON GRAIN YIELD OF SORGHUM FODDER.** *Forage Res.*, 27 (3) : pp. 199-202. Institute of Agriculture, Palli Siksha Bhavana, Visva-Bharati, Sriniketan-731 236 (West Bengal), India

A field experiment was conducted at Agricultural Research Farm of Palli Siksha Bhavana, Sriniketan, during **kharif** season of 1998 to evaluate the effect of biofertilizers with levels of nitrogen on grain yield of sorghum fodder. Seed inoculation with *Azotobacter* and *Azospirillum* gave significantly higher panicle length, grains/panicle and grain yield over no inoculation treatment. *Azospirillum* and *Azotobacter* increased the grain yield of sorghum by 8.73 and 11.91 per cent, respectively, compared with no inoculation. Yield attributes and grain yield were increased with increasing levels of nitrogen upto 90 kg/ha where grain yield of 1514 kg/ha was achieved. The interaction effect between inoculation and N levels was found significant with respect to panicle length, grains/panicle, test weight and grain yield of sorghum. *Azospirillum* in combination with 90 kg N/ha gave the highest gross return (Rs. 23,883/ha) and net return (Rs. 18,593) in sorghum grain production.

2. RANA, R. S., O. P. SINGH AND NAVEEN KUMAR 2001. **NITROGEN AND PHOSPHORUS FERTILITY MANAGEMENT IN RELATION TO YIELD AND QUALITY PARAMETERS OF DIFFERENT GENOTYPES OF SORGHUM.** *Forage Res.*, 27 (3) : pp. 203-206. Department of Agronomy, Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062 (H. P.), India

A study on nitrogen and phosphorus fertilization to new genotypes of sorghum under rainfed condition during 1992 and 1993 revealed that hybrid PJH-58 yielded highest grain yield to the tune of 36.8 and 37.54 q/ha during 1992 and 1993, respectively, with highest green forage yield, crude protein and dry matter digestibility percentage. Application of $N_{100}P_{50}$ kg/ha gave the highest grain yield and green forage yield (401.87 q/ha in 1992 and 407.74 q/ha in 1993) with highest dry matter digestibility percentage of 59.67 and 61.67 in 1992 and 1993, respectively. The crude protein was also higher in grain as well in stover at $N_{100}P_{50}$ compared to $N_{20}P_{10}$, $N_{40}P_{20}$ and $N_{60}P_{30}$ rates of nitrogen and phosphorus.

3. RATHOD, N. D., M. N. MEGHANI AND M. S. DUDHAT 2002. **RESPONSE OF FORAGE SORGHUM (SORGHUM BICOLOR) TO DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS.** *Forage Res.*, 28 (1) : pp. 16-18. G. A. U. Grassland Research Station, Dhari-365 640, District Amreli (Gujarat), India

An experiment was carried out during the **kharif** seasons of 1989-90 to 1996-97 to study the response of forage sorghum var. GJ-37 to different levels of nitrogen and phosphorus fertilizers on medium black soils at Dhari (Gujarat). Application of 80 kg N/ha was found to be the optimum dose to increase green as well as dry fodder yield, net return and net ICBR. In case of phosphorus application, 80 kg P_2O_5 /ha produced significantly highest dry fodder yield, however, 40 kg P_2O_5 /ha was found to be optimum dose in respect to net ICBR.

4. BHILARE, R. L., V. S. PATIL AND A. G. HIRAY 2002. **EFFECTS OF N LEVELS AND TIME OF N APPLICATION ON FORAGE YIELD OF SORGHUM.** *Forage Res.*, 28 (1) : pp. 32-34. Forage Crops Research Project Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722, India

A field experiment was conducted to assess the response of various nitrogen levels and its time of application on forage yield of sorghum during **kharif** seasons of 1999-2000 and 2000-2001. The two years' study revealed that with increasing levels of N from 30 to 120 kg/ha increased the green forage, dry matter and crude protein yields. The

application of 120 kg N/ha gave significantly higher green forage, dry matter and crude protein yields over 30, 60 and 90 kg N/ha during both the years. The statistically highest green forage, dry matter and crude protein yields were obtained with application of nitrogen in three splits i. e. 1/3 at basal+1/3 at 30 DAS+1/3 after first cut during the years under study.

5. SIDAR, R. S., G. S. TOMAR AND P. KHANNA 2002. **GROWTH PARAMETERS AND QUALITY OF SUMMER FORAGE SORGHUM INFLUENCED BY DIFFERENT AGRONOMIC PRACTICES.** *Forage Res.*, **28 (2) : pp. 80-82.** Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur-492 012 (Chhatisgarh), India

With a view to assess the effect of various agronomic factors on growth and quality of forage sorghum, field experiment was conducted during the summer season of 1998 at Instructional Farm, IGAU, Raipur. Treatments comprised 12 different combinations of cutting heights, chemical and interculture practices, irrigation schedules and top-dressing of nitrogen. The results revealed that the treatment T₁₁ (cut at 8±2 cm CH+Interculture+N₃₀+Irrigation at 10 DI) was found to be better as compared to other treatments.

6. KUMAR, S. AND B. L. SHARMA 2002. **EFFECT OF FYM, NITROGEN AND AZOSPIRILLUM INOCULATION ON YIELD AND QUALITY OF FODDER SORGHUM.** *Forage Res.*, **28 (3) : pp. 165-168.** Department of Agronomy, Agricultural Research Station, Durgapura, Jaipur-302 018 (Rajasthan), India

Field experiments were conducted during **kharif** seasons of 1990 and 1991 at Agricultural Research Station, Durgapura, Jaipur, Rajasthan study the effect of different levels of FYM (0, 10 and 20 t/ha), nitrogen (0, 40, 80 and 120 kg N/ha) and Azospirillum culture (with and without inoculation) on yield and quality of fodder sorghum. The increase in green and dry fodder yield due to Azospirillum inoculation varied from 7.8 to 11.3 per cent but its inoculation had no effect on crude protein and crude fibre. Green and dry fodder yield and the content of crude protein and crude fibre either increased significantly or tended to increase with an increase in the dose of FYM and nitrogen application. Inoculation had no beneficial effect at higher doses of nitrogen application.

7. CHARI APPAJI, P. K. BISWAS AND N. SEETHARAMA 2003. **FODDER AND STOVER CONCERNS—SOME ISSUES RELATED TO SORGHUM CULTIVATION IN INDIA.** *Forage Res.*, **29 (2) : pp. 55-64.** National Research Center for Sorghum (NRCS), Hyderabad-500 030 (A. P.), India

Efforts by the R & D agencies should be targeted towards the development of the cultivars, which have less HCN content. Zonal preference of the farmers should be taken care of and suitable technology be developed for sustainable growth of the sorghum fodder sector and also to meet the growing demands of the farmers for fodder. The technology developers should keep in mind the problems associated with the growth of sorghum fodder particularly in north India where the seed of the improved cultivars is not adequately available in time to the farmers. Thus, if proper efforts are made the fodder requirement of cattle through sorghum can be met for a healthy cattle and good quality of dairy and meat products.

8. LEVA, R. L., L. K. PATEL, K. D. MUNGRA AND A. G. PANSURIYA 2004. **EVALUATION OF PROMISING FORAGE SORGHUM GENOTYPES FOR RATOONING ABILITY UNDER VARYING FERTILITY LEVELS.** *Forage Res.*, **30 (1) : pp. 45-48.** G. A. U. Main Sorghum Research Station, Athwa Farm, Surat-395 007 (Gujarat), India

The field experiment was conducted during **kharif** seasons of 2000 to 2002 at GAU Main Sorghum Research Station, Surat, to study the ratooning ability of different forage genotypes and their requirement of fertilizer doses. The results indicated that the differences in green and dry fodder yield due to different genotypes and fertilizer doses were significant. The genotypes SRF 203 (GFS 6) gave significantly highest green and dry fodder yield with the application of 100 per cent RDF (80 : 40 NP kg/ha) in ratoon crop. The highest net ICBR was observed with the application of 25% RDF (20 : 10 NP kg/ha) to ratoon crop.

9. KUMAR, S., C. R. RAWAT, K. SINGH AND N. P. MELKANIA 2004. **EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH, HERBAGE PRODUCTIVITY AND ECONOMICS OF FORAGE SORGHUM [SORGHUM BICOLOR (L.) MOENCH].** *Forage Res.*, **30 (3) : pp. 140-144.** All India Coordinated Project for Research on Forage Crops, Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

A field experiment was conducted for three consecutive years during **kharif** seasons of 1997 to 1999 at Indian Grassland and Fodder Research Institute, Jhansi to study the effect of integrated nutrient supplementation through vermicompost, FYM and inorganic fertilizers on growth, herbage productivity and economics of forage sorghum. The results indicated that application of 50 per cent recommended dose of NPK (40 : 20 : 0) + vermicompost 5 t ha⁻¹ + FYM 5 t ha⁻¹ gave significantly higher green fodder, dry matter and crude protein yields of sorghum than the other treatments. However, these results for yield and quality were comparable with 100 per cent recommended dose of NPK (80 : 40 : 0). Growth attributes exhibited the similar trend to that of forage yield and quality. Gross return was higher with 50 per cent recommended dose of NPK + vermicompost 5 t ha⁻¹ + FYM 5 t ha⁻¹ but maximum net return was obtained with 100 per cent recommended dose of NPK. Maximum benefit : cost ratio (2.21) was recorded with 100 per cent recommended dose of NPK closely followed by 50 per cent recommended dose of NPK + FYM 5 t ha⁻¹ (2.14). The net return and benefit : cost ratio due to the vermicompost application was reduced due to higher cost of cultivation.

10. SINGH, P. AND H. K. SUMERIYA 2005. **RESPONSE OF FORAGE SORGHUM CULTIVARS TO DIFFERENT NITROGEN LEVELS UNDER UDAIPUR CONDITIONS IN RAJASTHAN.** *Forage Res.*, **31 (1) : pp. 51-54.** Department of Agronomy, Maharana Pratap University of Agriculture & Technology, Udaipur-313 001 (Rajasthan), India

The field experiments were undertaken at Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) to study the effect of various nitrogen levels on yield and economics of sorghum cultivars during **kharif** seasons of 2002 and 2003, respectively. The experiment consisting of five sorghum genotypes (UPFS-37, UPFS-38, SRF-239, SU-658 and HC 308) and four nitrogen levels (0, 40, 80 and 120 kg/ha) was conducted with three replications and laid out in split plot design taking cultivars as main plots and nitrogen levels as sub-plots. In experimental results, variety UPFS-37 registered significantly taller (328.46 cm) followed by UPFS-38 and HC-308 but variety HC-308 flowered about six days earlier over these varieties (63.58 days). Significantly maximum green (770.32 q/ha) and dry (253.43 q/ha) fodder yields were obtained with variety HC-308 followed by UPFS-38. Variety HC-308 also gained maximum gross (Rs. 69329/ha) and net (Rs. 64109/ha) returns. All the varieties significantly responded at 80 kg N/ha and produced (727.58 q/ha) green and (237.46 q/ha) dry fodder and (Rs.65483/ha) gross returns which were 9.94 and 4.50, 10.07 and 5.34, and 17.44 and 8.62 per cent higher over 40 kg and 120 kg N/ha.

11. VERMA, S.S., NAVNEET SINGH AND Y. P. JOSHI 2005. **EFFECT OF NITROGEN AND ZINC ON GROWTH, GRAIN AND STOVER YIELD AND HARVEST INDEX IN SORGHUM (CV. PANT CHARI-5) UNDER TARAI CONDITION IN NORTH INDIA.** *Forage Res.*, **31 (2) : pp. 75-77.** Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar-263 145 (Uttaranchal), India

A field experiment was conducted during **kharif** seasons of 2001 and 2002 at the Livestock Research Centre of G. B. Pant University of Agriculture & Technology, Pantnagar to study the response of sorghum (Pant Chari-5) to nitrogen and zinc. Application of 120 kg N/ha resulted in significantly higher grain yield (25.63 q/ha) than rest of the nitrogen levels. Application of 5 kg zinc had positive effect on grain yield (19.87 q/ha) and magnitude of increase in yield was 16.96 per cent higher over no zinc application. The economic optimum doses of nitrogen and zinc came out to be 95.50 and 7.32 kg/ha, respectively. Similarly, doses of nitrogen and zinc for maximum yield were 129.60 and 5.68 kg/ha, respectively.

12. AGRAWAL, S. B., V. K. SHUKLA, H. P. S. SISODIA, RAJNI TOMAR AND ARTI SHRIVASTAVA 2005. **EFFECT OF INOCULATION AND NITROGEN LEVELS ON GROWTH, YIELD AND QUALITY OF FODDER SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH] VARIETIES.** *Forage Res.*, 31 (2) : pp. 106-108. Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur-482 004 (M. P.), India

Field experiments were conducted during **kharif** seasons of 1998 and 1999 to select suitable sorghum genotypes for fodder and their nitrogen requirement alone and in combination with *Azospirillum* inoculation to reduce the cost of cultivation. Results revealed that cultivar J-195 showed superiority over rest of the varieties in terms of fodder tonnage. The incremental levels of nitrogen showed increasing trend with respect to growth as well as fodder yields. Amongst the various nitrogen levels, 150 kg N ha⁻¹ produced the maximum yield of 419.3, 127.2 and 8.27 q ha⁻¹ green fodder, dry matter and crude protein, respectively, which was significantly superior over rest of the levels. Seed inoculation with *Azospirillum* culture recorded 15.5, 16.0 and 7.7 per cent higher green fodder, dry matter and crude protein yield over uninoculated control. Moreover, the seed bacterization alongwith 100 kg N ha⁻¹ produced as good yield as recorded from 150 kg N ha⁻¹ alone.

13. AYUB, M., ABDUL GAFOOR, ASIF TANVEER AND MUHAMMAD ATHER NADEEM 2005. **STUDIES ON THE COMPARATIVE PERFORMANCE OF SORGHUM (*SORGHUM BICOLOR* L.) CULTIVARS UNDER FAISALABAD CONDITIONS.** *Forage Res.*, 31 (2) : pp. 109-111. Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Fodder yield and quality of different sorghum (*Sorghum bicolor* L.) cultivars viz., JS-263, JS-88, Hegari, F-9601, F-9603, F-9706, F-9806 and F-9809 were compared under field conditions. Significant differences were noted among the cultivars for yield, growth characteristics and quality parameters like crude protein, crude fibre, ether extractable fat and total ash contents. The cultivar F-9603 produced highest fodder yield but it had significantly higher crude and lower crude protein contents than the other cultivars. The increase in yield was mainly due to higher plant height, number of leaves per plant, stem diameter and plant density. The highest crude protein contents and minimum crude fibre contents were noted in cultivars Hegari and F-9603, respectively. Keeping in view both yield and quality, the cultivars F-9806 and F-9809 should be preferred for sowing over other cultivars under Faisalabad conditions.

14. CHOTIYA, A. AND P. SINGH 2005. **EFFECT OF GRADED LEVELS OF NITROGEN AND PHOSPHORUS ON SORGHUM FODDER PRODUCTION.** *Forage Res.*, 31 (3) : pp. 218-219. Department of Agronomy, MPUA&T, Udaipur-313001.

Increased level of nitrogen significantly increased plant height, dry matter accumulation, stem girth, leaves/plant, green and dry fodder yield. Green and dry fodder yield were significantly increased with 40 kg P₂O₅/ha over 20 kg P₂O₅/ha.

15. KUMAR, A. 2006. **EFFECT OF DATE AND METHOD OF SOWING ON THE GREEN FORAGE YIELD OF SORGHUM-SUDAN GRASS UNDER ALKALI WATER IRRIGATION.** *Forage Res.*, 31 (4) : pp. 247-250. Central Soil Salinity Research Institute, Karnal-132 001 (Haryana), India

A field experiment was conducted for two years during summer (**kharif**) of 1997 and 1998 to study the effect of methods and time of sowing on the green forage yield of sorghum-sudan grass [*Sorghum sudanense* (Piper) Stapf] under alkali water irrigation. Date (time) of sowing did not influence the green forage yield of sorghum-sudan grass significantly. Broadcasting the seed in proper moisture produced significantly greater yield compared with conventional row sowing. Irrigation immediately after sowing of crop whether under optimum moisture condition or dry sowing decreased the yield significantly. Since per day yield was greater when sorghum-sudan grass was sown in the month of June, therefore, it is recommended that sorghum-sudan grass should not be sown before the month

of June. Also, after the month of June rainfall starts which contributes maximum to its water requirement and owing to which less of alkali water is used reducing the harmful effect on soils and plants.

16. SHEORAN, R. S. AND D. S. RANA 2006. **RELATIVE EFFICIENCY OF AZOTOBACTER AND NITROGEN FERTILIZER IN FORAGE SORGHUM (*SORGHUM BICOLOR* L.) UNDER SEMI-ARID CONDITIONS.** *Forage Res.*, **32 (2) : pp. 65-68.** Forage Research Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The present investigations were carried out at Forage Research Section, CCS Haryana Agricultural University, Hisar, India for three consecutive years from 1998 to 2000 to evaluate the effect of *Azotobacter* inoculation with varying levels of nitrogen (0, 20, 40, 60, 80 and 100 kg/ha). The experiment was laid out in randomized block design with three replications. Three years' results indicated that significantly higher green as well as dry matter yield of sorghum was obtained with the inoculation of *Azotobacter* over uninoculated treatment. The green fodder and dry matter yields were increased to the tune of 7.3 and 9.3 per cent due to azotobacterization over uninoculated treatment on pooled mean basis. Increasing levels of nitrogen upto 60 kg/ha increased the forage yield of sorghum significantly over their lower doses. However, the maximum forage yield was obtained with 100 kg N/ha. Higher nitrogen use efficiency was recorded with *Azotobacter* inoculation than the uninoculated treatment. Nitrogen use efficiency was found to decrease with the increasing levels of nitrogen.

17. JOSHI, Y. P., RAMESH CHANDRA AND S. S. VERMA 2007. **RESPONSE OF MULTICUT FORAGE SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH] TO DIFFERENT CUTTING INTERVALS.** *Forage Res.*, **32 (4) : pp. 262-263.** Department of Agronomy, GBPUA&T, Pantnagar

It was also observed that hybrid FSH-92079 gave significantly higher net return and B : C ratio than other genotypes/varieties. Based on the results obtained it can be concluded that multicut sorghum hybrid FSH-92079 should be harvested at 55 days interval for higher tonnage and quality fodder.

18. GUPTA, K., D. S. RANA AND R. S. SHEORAN 2007. **RESPONSE OF FORAGE SORGHUM TO AZOSPIRILLUM UNDER ORGANIC AND INORGANIC FERTILIZERS.** *Forage Res.*, **33 (3) : pp. 168-170.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The present investigations were carried out to study the effect of *Azospirillum* inoculation with varying combination of organic and inorganic fertilizers (F_0 =control, F_1 =25% RDF+15 t/ha FYM, F_2 =50% RDF+10 t/ha FYM, F_3 =75% RDF+5 t/ha FYM, F_4 =100% RDF and F_5 =20 t/ha FYM) on ancillary characters, yield and quality of forage sorghum (var. HJ 513). The green fodder and dry matter yields were increased by 2.9 and 11.2 per cent, respectively, due to *Azospirillum* bacterization over uninoculated treatments on pooled mean basis. Similarly, protein and DDM yields increased by 14.9 and 1.9 per cent, respectively, due to inoculation over uninoculated. Maximum green fodder (431.6 q/ha) and dry matter (134.6 q/ha) yields were obtained with F_4 =100% RDF. Maximum protein (4.59 q/ha) and DDM (60.6 q/ha) yields were obtained with F_2 =50% RDF+10 t/ha FYM and F_4 =100% RDF, respectively.

19. THAKRAL, S. K. 2008. **RESPONSE OF FORAGE SORGHUM (*SORGHUM BICOLOR* L.) TO DIFFERENT SOURCES OF NUTRITION UNDER SEMI-ARID ECOSYSTEM.** *Forage Res.*, **34 (1) : pp. 39-40.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The present experiment was conducted at CCS Haryana Agricultural University, Hisar for four consecutive years i. e. from 2004 to 2007 during **kharif** season to study the response of organic and inorganic sources on herbage yield of forage sorghum in sorghum-wheat cropping system. Four treatment combinations comprised organic and inorganic fertilizers alone or their combinations were tested in a randomized block design with four replications. Applications of recommended dose of nitrogen through inorganic source resulted in highest green fodder yield of

sorghum followed by the treatment having the application of inorganic fertilizer based on soil test. Minimum herbage yield was obtained where recommended dose of nitrogen was applied through organic source.

20. GUPTA, K., D. S. RANA AND R. S. SHEORAN 2008. **RESPONSE OF NITROGEN AND PHOSPHORUS LEVELS ON FORAGE YIELD AND QUALITY OF SORGHUM [SORGHUM BICOLOR (L.) MOENCH].** *Forage Res.*, **34 (3) : pp. 156-159.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The present investigation was carried out at Forage Research Farm, CCS Haryana Agricultural University, Hisar, India for two consecutive years from 2005 to 2006. The treatments comprised four levels each of nitrogen i. e. 0, 40, 80 and 120 kg N/ha and phosphorus 0, 20, 40 and 60 kg P₂O₅/ha. The experiment was laid down in split plot design with three replications. The two years' results indicated that plant height and number of tillers/metre row length were increased on pooled mean basis significantly with the increasing level of nitrogen from 0-80 kg N/ha and phosphorus from 0 to 40 kg P₂O₅/ha. Maximum plant height (338.7 cm) and number of tillers/plant (19.1) were obtained with 120 kg N/ha. Significantly higher green as well as dry matter yield (391.25 and 121.8 q/ha) were recorded with 120 kg N/ha over other levels, treatments and on pooled mean basis. Higher green and dry matter yields were observed with nitrogen fertilization in comparison to that of phosphorus. Protein and DDM yields (q/ha) ranged from 3.36 to 5.89 and 40.86 to 60.42, respectively, under different N and P. Highest amount of Fe (298.4 ppm) and Mn (28.68 ppm) was observed in 40 and 120 kg N/ha treatments, respectively. Highest amount of Cu (13.38 ppm) and Zn (43.38 ppm) was observed in 20 kg P₂O₅/ha treatments. Variation in Na and K content was also observed.

21. KUMAR, A., D. S. RANA AND R. S. SHEORAN 2008. **EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON FORAGE YIELD AND QUALITY OF SORGHUM [SORGHUM BICOLOR (L.) MOENCH].** *Forage Res.*, **34 (3) : pp. 165-169.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field study was carried out at Forage Research Farm, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar on sandy loam soil low in available N, medium in available P and rich in available K. The experiment consisting of 10 treatments viz., control (T₁), *Azotobacter* (T₂), 100 per cent RDF (T₃), 15 t FYM/ha (T₄), 25% RDF+11.25 t FYM/ha (T₅), 50 per cent RDF+7.50 t FYM/ha (T₆), 75 per cent RDF+3.75 t FYM/ha (T₇), 25 per cent RDF+11.25 t FYM/ha+*Azotobacter* (T₈), 50 per cent RDF+7.50 per cent t FYM/ha+*Azotobacter* (T₉) and 75 per cent RDF+3.75 t FYM/ha+*Azotobacter* (T₁₀) was replicated thrice in a randomized block design. The results indicated that the application of 100 per cent RDF significantly improved the green fodder and dry matter yield over the remaining treatments. The treatments having substitution of 25 per cent N through FYM alongwith 75 per cent RDF+*Azobacter* proved superior for green fodder and dry matter yield over other combinations of organic and inorganic fertilizers. The highest crude protein content and IVDMD (%) in sorghum fodder was recorded with the application of 15 t FYM/ha, whereas the crude protein and DDM yield was higher when 100 per cent RDF was applied to the crop. The highest net returns of Rs. 10,014 were obtained with the application 100 per cent recommended dose of fertilizers.

22. TIWANA, U. S. AND D. P. CHAUDHARY 2009. **EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON THE YIELD AND QUALITY OF FORAGE SORGHUM.** *Forage Res.*, **35 (1): pp. 56-58.** Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

A field experiment was conducted to find out the response of sorghum to integrated nutrient management (INM). The experiment consisted control, 100 per cent recommended dose of fertilizers (RDF)–100 kg N+20 kg P₂O₅/ha, 100 per cent RDF+15 kg Zn/ha, 100 per cent RDF+20 kg Zn/ha, 100 per cent RDF+25 kg Zn/ha, 75 per cent RDF+25 per cent N through FYM, 50 per cent RDF+50 per cent FYM, 75 per cent RDF+25 per cent N through vermicompost and 50 per cent RDF+50 per cent N through vermicompost. The application of 100 per cent RDF+25 kg Zn/ha recorded highest green fodder. The 100 per cent RDF alone or alongwith Zn and INM treatments

increased the green fodder yield and dry matter yield of sorghum significantly over control. The difference between 100 per cent RDF alone or with Zn and substitution of 25 per cent N and 50 per cent N through FYM or vermicompost alongwith 75 or 50 per cent RDF were non-significant. The highest crude protein content (7.43%) was observed with 100 per cent RDF as compared to 5.68 to 6.56 per cent with INM treatments. Whereas the highest IVDMD (59.2%) was obtained with 75 per cent RDF+25 per cent N through FYM or vermicompost than 50 per cent RDF+50 per cent N through FYM or vermicompost and 100 per cent RDF alone or with Zn.

23. SHEKARA, B. G., H. C. LOHITHASWA AND R. PAVAN 2009. **EFFECT OF DIFFERENT SOURCES OF NUTRIENTS ON GREEN FORAGE YIELD AND QUALITY OF MULTICUT FODDER SORGHUM [SORGHUM BICOLOR (L.) MOENCH].** *Forage Res.*, **35 (3) : pp. 137-142.** Department of Forage Crops (AICRP), Zonal Agricultural Research Station, V. C. Farm, Mandya (Karnataka), India

A field experiment was conducted at Zonal Agricultural Research Station, Visweswaraiah Canal Farm, Mandya (Karnataka) during **kharif** seasons of 2005 to 2009 to study the effect of different sources of nutrients on green forage yield and quality of multicut fodder sorghum in fodder sorghum-cowpea cropping systems under protective irrigated condition. The experiment consisting of nine treatments was tested in randomized block design replicated three times. The mean of four years' data indicated that application of 50% recommended dose of nutrients (RDN) through inorganic fertilizer+50% N with available P & K through FYM recorded significantly higher green fodder yield (538.64 q/ha) and nutrient use efficiency (108.77%). Whereas 100% RDN through inorganic fertilizer+VAM recorded higher dry matter production (128.81 q/ha), crude protein yield (6.34 q/ha), net monetary returns (Rs. 54857/ha) and benefit : cost ratio of 5.03 followed by 50% RDN through inorganic and 50% N with available P & K through FYM (122.53 q/ha, 5.97 q/ha, Rs. 48199/ha and 4.05, respectively).

24. PATEL, H. H., T. U. PATEL, H. M. PATEL, P. S. PATEL AND A. N. LAD 2009. **EFFECT OF LAND CONFIGURATION AND NUTRIENT MANAGEMENT IN RABI SORGHUM [SORGHUM BICOLOR (L.) MOENCH] UNDER SOUTH GUJARAT CONDITIONS.** *Forage Res.*, **35 (3) : pp. 165-168.** Department of Agronomy, Navsari Agricultural University, Navsari-396 450 (Gujarat), India

An experiment was carried out on clay textured low in available nitrogen soil to access the land configuration and nutrient management on growth, yield and economics of **rabi** sorghum crop at College Farm, Navsari. The results revealed that different treatments of land configuration gave significant variation in most of the growth as well as yield attributes. Ridge and furrow method (L₁) recorded the highest values for plan height, number of internodes per plant, girth of stem, length of earhead, girth of earhead, weight of grains per plant and test weight. Significantly the highest grain yield (34.38 q/ha) and fodder yield (93.03 q/ha) were recorded under ridge and furrow (L₁) method of sowing. Further, the treatment 100 per cent RDF (N₁) recorded significantly higher grain yield (32.25 q/ha) remaining on par with bio-compost @ 6 t/ha+50 per cent RDF (N₂). Treatment L₁N₁ (ridge and furrow+100% RDF) recorded the maximum net realization of Rs. 26749/ha and BCR of 3.07.

25. SINGH, P. AND H. K. SUMERIYA 2010. **EFFECT OF NITROGEN LEVELS ON FODDER AND ECONOMICS OF MULTICUT FORAGE SORGHUM [SORGHUM BICOLOR (L.) MOENCH] GENOTYPES.** *Forage Res.*, **36 (1) : pp. 15-18.** Department of Agronomy, Maharana Pratap University of Agriculture and Technology, Udaipur-313 001 (Rajasthan), India

A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur during **kharif** 2007. Data revealed that UTMCH-1302 recorded maximum green as well as dry fodder during both the cuttings (596.44 & 209.45 and 151.61 & 67.51 q/ha) of green as well as dry fodder at I and II cuttings, respectively. Among nitrogen levels, application of 150 kg N/ha recorded higher DMA/plant, plant height, green as well dry fodder yield, net return and B : C ratio over control and 50 kg N/ha. However, this level was found statistically at par with 100 kg N/ha. Application of 100 kg N/ha recorded 18.71, 33.11, 20.64 and 9.35 per cent higher total green and dry fodder, net returns and B : C ratio over control.

26. KUMAR, R., P. SINGH AND H. K. SUMERIYA 2010. **EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND PRODUCTIVITY OF FORAGE SORGHUM [SORGHUM BICOLOR (L.) MOENCH].** *Forage Res.*, **36 (1) : pp. 19-21.** Department of Agronomy, Maharana Pratap University of Agriculture and Technology, Udaipur-313 001 (Rajasthan), India

A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur during **kharif** 2007. Data reported that application of RDF (80 kg N+40 kg P₂O₅/ha)+25 kg ZnSO₄/ha significantly recorded maximum green (409.85 q/ha) as well as dry fodder (116.36 q/ha), N, P and Zn uptake, net returns and B : C ratio. This treatment also recorded maximum uptake of CP, CF, EE, mineral ash, NFE and TDN, which was found significantly higher over control.

27. MEENA, R. M., DASHORA, L. N., SINGH, P. AND SUMERIYA, H. K. 2010. **EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD AND QUALITY OF SINGLE CUT FORAGE SORGHUM [SORGHUM BICOLOR (L.) MOENCH].** *Forage Res.*, **36 (1) : pp. 61-63.** MPUA&T, Udaipur.

A field experiment conducted at Research farm of MPUA&T, Udaipur, it was concluded that increasing fertility increased the net returns and B:C ratio up to RDF through inorganic fertilizers + biofertilizers; however, variation between RDF through inorganic fertilizer + biofertilizer was found at par with RDF through inorganic fertilizers/ha.

28. TRIVEDI, J., S. L. MUNDRA, M. K. KAUSHIK AND P. SINGH 2010. **RESPONSE OF FODDER SORGHUM [SORGHUM BICOLOR (L.) MOENCH] GENOTYPES TO NITROGEN FERTILIZATION IN SOUTHERN RAJASTHAN.** *Forage Res.*, **36 (2) : pp. 115-117.** Department of Agronomy, Maharana Pratap University of Agriculture & Technology, Udaipur-313 001 (Rajasthan), India

Field experiment was conducted during summer season of 2010 to study the response of fodder sorghum [*Sorghum bicolor* (L.) Moench] genotypes to nitrogen fertilization in southern Rajasthan. Results revealed that variety Pratap Chari 1080 showed superiority over rest of the genotypes in terms of fodder yield. The incremental levels of nitrogen showed increasing trend with respect to fodder yield. Amongst the various nitrogen levels, 120 kg N/ha produced the maximum green fodder yield of 585.1 q/ha and dry fodder yield of 181.0 q/ha which was superior over control and 40 kg N/ha and was found statistically at par with 80 kg N/ha.

29. MEENA, L. R., J. S. MANN, O. H. CHATURVEDI AND S. C. GILL 2010. **RESPONSE OF NEWLY DEVELOPED FORAGE SORGHUM GENOTYPES TO ZINC LEVELS AND AZOSPIRILLUM UNDER SEMI-ARID CONDITIONS OF RAJASTHAN.** *Forage Res.*, **36 (3) : pp. 128-132.** Grassland and Forage Agronomy Section, Central Sheep and Wool Research Institute, Avikanagar-304 501 (Rajasthan), India

An experiment was conducted during summer seasons of 2005 and 2006 to study the production performances of newly developed genotypes of forage sorghum in order to apply zinc and *Azospirillum* inoculation. The experiment consisted of three genotypes of forage sorghum (V₁-SSG-1000, V₂-SSG-117 and V₃-SSG-887), three levels of zinc (Zn₁-0, Zn₂-10 and Zn₃-20 kg Zn/ha) and two levels of *Azospirillum* inoculation (I₀-Without *Azospirillum* and I₁-With *Azospirillum*). Among the genotypes, SSG-887 produced significantly higher ancillary characters viz., plant height, dry matter accumulation/plant, number of green leaves/plant, nodes/plant and shoots/m² as compared to other two genotypes i. e. SSG-1000 and SSG-117. The maximum mean green fodder and dry matter production were recorded in SSG-887 (333.04 and 61.05 q/ha) followed by SSG-117 (312.16 and 55.25 q/ha). The gross return (Rs. 20, 602/ha), net return (Rs. 11,627/ha) and benefit : cost ratio (2.29) were also higher from the same genotype i. e. SSG-887 in comparison to other two genotypes (SSG-1000 and SSG-117). Application of zinc to forage sorghum genotypes gave encouraging results in the tune of growth attributes, green fodder yield and economic return. The maximum growth attributes, green fodder and dry matter yields alongwith monetary return from sorghum genotypes were attained with highest level of zinc i. e. 20 kg Zn/ha. The seed inoculation of forage sorghum genotypes with *Azospirillum* (I₁) caused significant increase in green fodder (7.53%) and dry matter production (5.48%) as compared to uninoculated seed.

30. CHANDRA, RAMESH, SHYAM SINGH, Y. P. JOSHI AND KEWALANAND 2011. **RESPONSE OF MULTICUT FORAGE SORGHUM GENOTYPES TO CUTTING INTERVAL AND NITROGEN LEVELS—A MULTILOCATIONAL STUDY.** *Forage Res.*, **36 (4) : pp. 205-209.** Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar-263 145 (Uttarakhand), India

Field experiments were conducted to evaluate suitable cutting interval and nitrogen level for newly developed multicut forage sorghum genotypes under Pantnagar and Lakhaoti conditions during **kharif** seasons of 2007 and 2008. The growth parameters and yields were more under Lakhaoti condition compared to Pantnagar. The hybrid CSH-20MF yielded significantly higher green fodder, dry matter, crude protein and digestible dry matter compared to UTMC-532 at both the locations. Harvesting of the crop at 55 days interval yielded significantly higher green and dry fodder at both the locations; however, crude protein and digestible dry matter yields were significantly influenced by cutting intervals only at Lakhaoti condition. Increasing levels of nitrogen significantly increased the yield of green fodder, dry matter, crude protein and digestible dry matter at both the locations. Under N_0 and N_{50} , the dry matter accumulation by CSH-20MF and UTMC-532 was similar at Pantnagar, while at Lakhaoti this effect was only due to N_{50} . With respect to quality of fodder and net return, Lakhaoti location was found superior over Pantnagar condition.

31. KAUSHIK, M. K., PRIYANKA PAREEK, P. SINGH & H. K. SUMERIYA 2010. **RESPONSE OF FODDER SORGHUM [SORGHUM BICOLOR (L.) MOENCH].** *Forage Res.*, **36 (3) : pp. 181-184.** Department of Agronomy, MPUA&T, Udaipur-313001 (Rajasthan), India

In sorghum the application of RDF+15 kg $ZnSO_4$ at sowing+0.2 per cent $ZnSO_4$ as plair application at 15 and 30 DAS significantly increased green and dry fodder yield by 29.5 and 25.8 per cent over RDF alone moreover, it also increased significantly problem, under fibre, ether export, mineral ash and their uptake over RDF alone and control.

(ii) Pearlmillet

32. YADAVA, N. S. AND N. S. SOLANKI 2002. **EFFECT OF LEVELS OF NITROGEN AND ITS TIME OF APPLICATION ON FODDER PRODUCTION OF PEARLMILLET.** *Forage Res.*, **28 (1) : pp. 6-7** AICRP on Forage Crops, Agricultural Research Station, Bikaner (Rajasthan), India

A field experiment on effect of levels of nitrogen and its time of application on fodder production of pearlmillet was conducted at ARS, Bikaner for three consecutive years (1996, 1997 and 1998). Treatments comprised three levels of nitrogen (40, 80 and 120 kg N/ha) with a control and four methods of its application (all basal, $\frac{1}{2}$ basal+ $\frac{1}{2}$ at 35 DAS, $\frac{1}{3}$ basal+ $\frac{1}{3}$ top dress at 20 DAS+ $\frac{1}{3}$ top dress at 35 DAS and $\frac{1}{4}$ basal+ $\frac{1}{4}$ top dress at 20 DAS+ $\frac{1}{4}$ top dress at 35 DAS+ $\frac{1}{4}$ top dress at 50 DAS). Results revealed that application of nitrogen upto 120 kg/ha significantly increased green fodder yield of pearlmillet, representing 174.20, 41.12 and 19.9 per cent increase over control, 40 and 80 kg N/ha, respectively. In terms of dry matter production, significant increase was recorded only upto 80 kg N/ha. Application of nitrogen in three splits proved to be a superior practice as green fodder yield recorded under this treatment (262.96 q/ha) was significantly higher over rest of the treatments. As compared to basal application, nitrogen application in three splits significantly increased the dry matter production (57.99 q/ha).

33. TIWANA, U. S., K. P. PURI AND SUKHPREET SINGH 2003. **FODDER YIELD AND QUALITY OF MULTICUT PEARL MILLET (*PENNISETUM GLAUCUM*) AS INFLUENCED BY NITROGEN AND PHOSPHORUS UNDER PUNJAB CONDITIONS.** *Forage Res.*, **28 (4) : pp. 190-193.** Department of Plant Breeding, Punjab Agricultural University, Ludhiana-141 004 (India)

The experiment was carried out at Punjab Agricultural University, Ludhiana during **kharif** 1999 and 2000 to study the response of multicut pearl millet to nitrogen and phosphorus. The experiment consisting of five levels of nitrogen (0, 25, 50, 75 and 100 kg N/ha/cut) and three levels of phosphorus (0, 25 and 50 kg P_2O_5 /ha) was laid out

in factorial randomized block design with four replications. Three cuttings of multicut pearl millet forage can be taken successfully under Punjab conditions. It recorded 35.50, 44.82 and 19.68 per cent green fodder, and 30.46, 45.08 and 24.46 per cent dry matter in the first, second and third cuttings, respectively. Each increment of nitrogen increased the green fodder yield of pearl millet upto 100 kg N/ha/cut. The magnitude of increase with 100 kg N/ha/cut was 105.2, 46.5, 16.4 and 7.8 per cent in green fodder, and 108.4, 55.2, 30.4 and 14.6 per cent in dry matter yield over 0, 25, 50 and 75 kg N/ha/cut, respectively. Crude protein, crude fat, mineral matter and nitrogen free extract increased but crude fibre content decreased with increase in nitrogen levels upto 100 kg N/ha/cut. Nitrate-nitrogen content increased with increase in nitrogen levels upto 100 kg N/ha/cut (1363 ppm) but was within safe limits. Phosphorus application at 50 kg P₂O₅/ha increased the green fodder and dry matter yield (669.7 and 171.9 q/ha) significantly over 0 (486.8 and 121.6 q/ha) and 25 kg P₂O₅/ha (594.0 and 151.0 q/ha). Phosphorus application also improved the quality parameters (crude protein, crude fat, crude fibre, mineral matter and nitrogen free extract) of multicut pearl millet.

34. DADHICH, L. K. AND A. K. GUPTA 2003. **PRODUCTIVITY AND ECONOMICS OF PEARL MILLET FODDER AS INFLUENCED BY SULPHUR, ZINC AND PLANTING PATTERN.** *Forage Res.*, **28 (4) : pp. 207-209.** Department of Agronomy, Rajasthan Agricultural University, Jober 303 329 (Raj.), India

To evaluate the effect of sulphur, zinc and planting pattern on fodder yield of pearl millet and net return from fodder pearl millet under semi-arid eastern plain zone of Rajasthan. The present study was carried out during 1999 and 2000. The results showed that application of 40 kg S ha⁻¹ significantly increased plant height, green and dry fodder yield over 0 and 20 kg S ha⁻¹ and net return upto 60 kg S ha⁻¹ in both the years except that the dry fodder yield increased significantly upto 60 kg S ha⁻¹ in the year 2000. Further, data showed that application of 10 kg Zn ha⁻¹ significantly increased the plant height, green fodder yield over control and 5 kg Zn ha⁻¹ in both the years with non-significant increase in net return. Pearl millet in pure stand produced less green and dry fodder in comparison to that under intercropping with cowpea.

35. HOODA, R. S., HARBIR SINGH AND ANIL KHIPPAL 2004. **EFFECT OF CUTTING MANAGEMENT AND GENOTYPES ON GREEN FODDER, GRAIN AND STOVER YIELD AND ECONOMICS OF CULTIVATION OF SUMMER PEARL MILLET [*Pennisetum glaucum* (L.) R. BR. EMEND. STUNTZ].** *Forage Res.*, **30 (2) : pp. 89-91.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

At Hisar, five genotypes (HHB 67, HHB 146, HHB 94, HC 10 and HC 20) of pearl millet [*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz] were compared regarding the impact of cutting management on the green fodder, grain and stover yield and economics of cultivation during summer season of 2000-01 and 2001-02. Pearl millet when cut for green fodder at 45 days after sowing, and ratoon allowed to set grain, though recorded significantly lower grain and stover/dry fodder yield over no cut for fodder treatment but gave additional fodder yield of 112.71 q/ha and improved the economics of cultivation in terms of gross and net returns. Among pearl millet genotypes, composites (HC 10 and HC 20) recorded comparatively higher green fodder and stover yields than hybrids (HHB 67, HHB 146 and HHB 94). Pearl millet hybrid HHB 94 being at par with HHB 146 recorded higher grain yield and improved gross as well as net return than rest of the genotypes.

36. HOODA, R. S., HARBIR SINGH AND ANIL KHIPPAL 2004. **CUTTING MANAGEMENT AND NITROGEN EFFECTS ON GREEN FODDER, GRAIN AND STOVER YIELD AND ECONOMICS OF PEARL MILLET CULTIVATION DURING SUMMER.** *Forage Res.*, **30 (3) : pp. 118-120.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Field experiment conducted during summer seasons of 2000 and 2001 on sandy laom soil of the CCS Haryana Agricultural University, Hisar revealed that pearl millet when cut for green fodder at 45 days after sowing, and ratoon allowed to set grain, though yielded significantly lower grain and stover over without cut treatment but

gave an additional fodder yield of 72.17 q/ha and improved economics in terms of gross and net returns. Increasing levels of nitrogen application increased the grain, stover and green fodder yield and also improved the gross and net returns and benefit : cost ratio.

37. HEGDE, R., M. DEVARAJA AND SUBHASH GUMASTE 2004. **GROWTH AND FORAGE YIELD OF FORAGE PEARL MILLET (*PENNISETUM TYPHOIDES*) AS INFLUENCED BY STAGE OF HARVESTING OF SEED CROP, NITROGEN AND PHOSPHORUS LEVELS.** *Forage Res.*, **30 (3) : pp. 125-127.** National Bureau of Soil Survey & Land Use Planning, Hebbal, Bangalore-560 024 (Karnataka), India

A field experiment was conducted during **kharif** season on black clayey soils at the Agricultural College Farm, Dharwad (Karnataka) to study the effect of stage of harvesting of seed crop, nitrogen and phosphorus levels on the growth and forage yield of forage pearl millet. The results revealed that harvesting at milk stage recorded a higher dry forage yield of seed crop (14.65 t ha) and significantly lower dry forage yield in ratoon crop (3.62 t ha), while it was reverse when harvested at flag leaf stage. Increasing nitrogen levels from 80 to 120 kg ha⁻¹ resulted in significantly higher growth and dry forage yield of seed crop only and not the ratoon crop. While the reverse trend was noticed with increased phosphorus levels. Harvesting at milk stage with application of 120 : 60 kg NP ha⁻¹ could result in higher dry forage yield in black soils of northern Karnataka (zone 8).

38. KUMAR, M., PARVENDER SHEORAN AND HARBIR SINGH 2005. **PHENOLOGY OF PEARL MILLET HYBRIDS IN RELATION TO THERMAL INDICES UNDER DIFFERENT NITROGEN LEVELS.** *Forage Res.*, **31 (2) : pp. 81-84.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted during the **kharif** season of 2000 at Crop Research Farm of CCSHAU, Hisar to assess the thermal requirement of promising pearl millet hybrids grown under varying nitrogen levels. Among hybrids HHB 60 consumed maximum growing degree days (1468), heliothermal (9235 degree day hours) and photo-thermal (19987 degree day hours) units followed by HHB 94, HHB 117 and HHB 60 to reach maturity. Thermal units requirement of pearl millet hybrids increased with increase in dose of nitrogen application but it was par with recommended dose. The accumulated heat units, heliothermal and photo-thermal units were maximum in case of crop fertilized with 150 kg N/ha (1360, 8333 and 18592), while minimum in case of crop with no nitrogen application (1395, 8631 and 19046), respectively, at maturity.

39. TIWANA, U. S. AND K. P. PURI 2005. **EFFECT OF NITROGEN LEVELS ON THE FODDER YIELD AND QUALITY OF PEARL MILLET VARIETIES UNDER RAINFED CONDITIONS.** *Forage Res.*, **31 (2) : pp. 142-143.** Forage section, PAU, Ludhiana 141004.

The investigation indicated that the variety Gaint Bajra gave significantly higher fodder yield than others. The varieties responded upto 90 kg N/ha.

40. MUJALDE, S., HARBIR SINGH, R. S. HOODA, R. K. JHORAR, A. L. PATEL AND D. S. TONK 2005. **MODELS FOR PREDICTING GRAIN, STOVER (DRY FODDER) AND BIOLOGICAL YIELD OF SUMMER PEARL MILLET [*PENNISETUM GLAUCUM* (L.) R. BR. EMEND. STUNTZ] AS INFLUENCED BY WATER USE.** *Forage Res.*, **31 (3) : pp. 163-169.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Results are presented of a field study comparing performance of some water use and yield models for summer pearl millet under seven irrigational treatments viz., three irrigations, one each at tillering, flowering and milking; two irrigations, one each at tillering and flowering; two irrigations, one each at tillering and milking; two irrigations, one each at flowering and milking; one irrigation at tillering; one irrigation at flowering; and one irrigation

at milking stage. Crop water use yield models, relating to grain, stover (dry fodder) and biological yield of pearl millet with consumptive use of water (CU)/ evapotranspiration (ET) with and without consideration of time of water deficit during crop growth sub-periods, were derived. The total growing season of pearl millet was divided into four sub-periods. Eleven water production functions/models, including seven that did not consider growth stage during water deficit and four that did, were tested to quantify the relationship between pearl millet grain, stover (dry fodder) and biological yield and CU. Values of R² for water use yield models relating to grain yield of pearl millet and total season CU (ET) were significant (P<0.05 or P< 0.01) and ranged from 0.9537 to 0.9901. Pearl millet was sensitive to water deficit during crop growth spanning over flowering to milking stage (reproductive phase). In general, crop water use and yield models that considered growth stages during water deficit explained well-observed yield differences.

41. RAM NIWAS, C. V. S. SASTRI, M. L. KHICHAIR AND MAHENDER SINGH 2005. **INFLUENCE OF THERMAL INDICES ON CROP GROWTH RATE AND YIELD OF PEARL MILLET CULTIVARS.** *Forage Res.*, **31 (3) : pp. 192-195.** Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Field experiments were conducted to study the influence of thermal indices on crop growth rate and yield of pearl millet cultivars. Three pearl millet cultivars (Pusa-23, HHB-60 and HHB-67) were sown in north-south and east-west directions. The growth parameters : specific leaf area index, crop growth rate, net assimilation rate and relative growth rate were computed at different growth stages. The allocation ratios for stem, leaf, earhead and root were determined for pearl millet cultivars. The allocation ratios for leaves were negative during anthesis to maturity, indicating the mobilization of reserved biomass in leaves to earheads. Thermal indices based regression models were developed for dry biomass and yield prediction of pearl millet crop.

42. KUMAR, A., BIKRAM SINGH AND JAGDEV SINGH 2006. **CROP ESTABLISHMENT STUDIES IN PEARL MILLET (*Pennisetum glaucum*) UNDER RAINFED CONDITIONS.** *Forage Res.*, **32 (1) : pp. 43-46.** Medicinal, Aromatic and Under Utilized Plants Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted at CCS Haryana Agricultural University Regional Research Station, Bawal for three consecutive years to study the effect of different crop establishment techniques in the pearl millet. Dry seeding in second fortnight of June had earliest 50 per cent flowering, whereas higher number of effective tillers/plant was found with spreading of 5 t FYM/ha and sowing in north-south direction. Sowing of pearl millet in north-south direction, spreading of 5 t FYM/ha over planted rows, mechanical crust breaking and dry seeding in second fortnight of June produced 34.5, 26.8, 18.7 and 12.3 per cent higher mean grain yield than compaction behind plough which resulted in lowest yield. Spreading of 5 t FYM/ha over planted rows and sowing in north-south direction resulted in 32.9 and 32.4 per cent higher dry fodder yield/ha than the seed mixing treatment i. e. pearl millet (75%)+moongbean (25%). Maximum gross returns of Rs. 10, 410/ ha were achieved in 5 t FYM/ha treatment; however, highest net returns of Rs. 2,769/ha with more B : C ratio of 1.37 were recorded in north-south direction sowing.

43. CHAURASIA, M., D. R. CHAUHAN AND JAGDEV SINGH 2006. **EFFECT OF IRRIGATION, NITROGEN AND PHOSPHORUS LEVELS ON FODDER PRODUCTION OF BAJRI (*Pennisetum glaucum* L.)- A LOCAL RACE OF BAJRA.** *Forage Res.*, **32 (2) : pp. 128-129.** RRS, Bawal-123501.

The green and dry fodder at each cut was statistically at par with application of irrigation at 0.4 and 0.6 ID/CPC ratios and were significantly higher over 0.2 ratio. Application of 25 and 50kg P₂O₅/ha significantly increased the plant height, tiller/m, green and dry fodder yield over no phosphorus.

44. CHAURASIA, M., D. R. CHAUHAN, JAGDEV SINGH AND BIKRAM SINGH 2006. **INFLUNCE OF IRRIGATION, NITROGEN AND PHOSPHORUS LEVELS ON FODDER QUALITY OF BAJRI (*PENNISETUM GLAUCUM* L.).** *Forage Res.*, **32 (3) : pp. 133-143.** RRS, Bawal-123501.

Phosphorus application upto 50 kg/ha significantly increased the crude protein and ash content and their fodder at the three cuts. Whereas, nitrogen free extract in fodder at all the cuts was decreased significantly.

45. KUMAR, A., JAGDEV SINGH AND BIKRAM SINGH 2007. **DROUGHT STRESS AMELIORATION STUDIES IN PEARL MILLET (*PENNISETUM GLAUCUM*).** *Forage Res.*, **32 (4) : pp. 257-259.** MA&UUP, CCS Haryana Agricultural University, Hisar

Internal water stress in the initial 15-20 days and terminal water stress resulted in substantial reduction in the grain yield of the pearl millet crop practices (Table 1). Spray of 0.1 per cent thiourea at tillering and flowering stage produced maximum grain (14.40 q/ha) and fodder (25.15 q/ha) yield. Maximum net returns (Rs. 8077/ha) and B : C ratio (1.68) were observed when pearl millet was sprayed with 0.1 per cent thiourea at tillering+flowering stage.

46. SUNEETHA DEVI, K. B. AND G. PADMAJA 2007. **REPOSE OF FORAGE PEARL MILLET VARIETIES TO DIFFERENT NITROGEN LEVELS.** *Forage Res.*, **33 (3) : pp. 185-187.** AICRP on Forage CROPS, LRI, Acharya N. G. Ranga Agricultural University, Rajendranagar.

The entries JKHB-576 and GHB-558 performed well in terms of green fodder yield but the seed yield of pre-released entry GHB-558 was significantly less.

47. SHEORAN, R. S., U. S. TIWANA, N. S. YADAV AND U. N. JOSHI 2008. **EVALUATION OF PROMISING FORAGE PEARL MILLET (*PENNISETUM GLAUCUM*) VARIETIES FOR FODDER AND SEED PRODUCTION WITH DIFFERENT NITROGEN LEVELS UNDER VARYING ENVIRONMENTS.** *Forage Res.*, **33 (4) : pp. 206-211.** Forage Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The present field study was carried out at three locations viz, CCS Haryana Agricultural University, Hisar, Punjab Agricultural University, Ludhiana and Rajasthan Agricultural University, Bikaner during **kharif** 2007 season to evaluate eight entries/varieties of forage pearl millet including two checks (PBH-2172 JHPM 05-01, NDFB-2, BAIF Bajra, JHPM 05-2, NDFB-9, Raj Bajra Chari-2 and Giant Bajra) with three levels of nitrogen (50,75 and 100 kg N/ha). The experiment was laid out in factorial randomised block design and replicated thrice at all the locations. The results revealed that variety JHPM 05-1 significantly outyielded the remaining varieties including checks for green fodder and dry matter yield on location mean basis. It also proved its superiority over the other varieties for leaf : stem ratio and crude protein yield (7.0 q/ha). With regard to seed production, variety PBH-2172 gave significantly higher seed yield than the other varieties at all the locations as well as on pooled data basis. The green fodder, dry matter, seed yield and crude protein yield of forage pearl millet increased significantly with the increasing levels of nitrogen upto 100 kg/ha over the lower levels, on pooled mean basis.

48. SHARMA, S. K. AND JAGDEV SINGH 2008. **PEARL MILLET GRAIN AND FODDER PRODUCTIVITY UNDER VARIOUS DROUGHT MANAGEMENT PRACTICES IN DRYLAND CONDITIONS** *Forage Res.*, **34 (2) : pp. 94-96.** Dryland Agriculture, Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted at Dryland Agricultural Research Farm, CCS Haryana Agricultural University, Hisar during rainy seasons (**kharif**) of 2003 to 2006 to study the effect of drought management practices on pearl millet grain and fodder productivity under dryland conditions. In timely sown crop, adoption of drought management practices at 30 DAS like every 3rd row removal for fodder, straw mulching and mulching of every 3rd row of dhaincha in pearl millet was most productive and economical. While under delayed sowing, harvesting of every 3rd

row for fodder at 30 DAS was most profitable practice under dryland conditions. This practice provided 18 to 20 q/ha green fodder under dryland conditions.

49. KUMAR, M., PARVENDER SHEORAN, HARBIR SINGH AND SHER SINGH 2008. **DRY WEIGHT AND YIELD OF PEARL MILLET HYBRIDS AS INFLUENCED BY VARYING NITROGEN LEVELS UNDER IRRIGATED CONDITIONS.** *Forage Res.*, **34 (2) : pp. 101-104.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Field investigation was conducted to study the dry matter accumulation and partitioning of pearl millet hybrids (HHB 94, HHB 117, HHB 67 and HHB 60) under varying nitrogen levels (0, 30, 60, 90, 120 and 150 kg N/ha). Increasing levels of nitrogen increased the dry matter production, its distribution in different plant parts and ultimately grain and stover yield. Application of 150 kg N/ha recorded significantly higher dry weight/plant as compared to its lower doses. On an average, the per cent contribution to final plant dry weight ranged between 8.9-11.5 per cent by leaves, 63.3-67.5 per cent by stem and 19.3-23.3 per cent by earheads due to cultivation of pearl millet hybrids under varying N levels. However, dry matter distribution in earheads increased with a fall in stem/leaves weight indicating reallocation of dry weight due to application of nitrogen. Among hybrids, HHB 94 recorded significantly higher dry matter accumulation/plant, grain and stover yield as compared to other hybrids under study.

50. SHEKARA, B. G. AND H. C. LOHITHASWA 2009. **FODDER AND SEED YIELD OF FORAGE PEARL MILLET GENOTYPES AS INFLUENCED BY DIFFERENT LEVELS OF NITROGEN.** *Forage Res.*, **35 (1): pp. 45-47.** All India Co-ordinated Research Project on Forage Crops, Zonal Agricultural Research Station, V. C. Farm, Mandya-571 405 (Karnataka), India

The field experiment was carried out at Zonal Agricultural Research Station, V. C. Farm, Mandya, University of Agricultural Sciences, Bangalore, Karnataka, under All India Co-ordinated Research Project on Forage Crops during **kharif** seasons of 2007 and 2008 under rainfed condition to evaluate eight varieties of forage pearl millet (PHB-2172, JHPM-05-1, NDFB-2, BAIF bajra, JHPM-05-2, NDFB-9, Raj bajra chari-2 and Giant bajra) with three levels of nitrogen (50, 75 and 100 kg N/ha). The experiment was laid out in factorial randomized design with three replications. The research results revealed that JHPM-05-1 significantly outyielded remaining varieties except BAIF bajra for green forage yield (415.08 q/ha), dry matter yield (75.67 q/ha), leaf : stem ratio (0.55) and crude protein yield (5.87 q/ha) on pooled mean basis. With regard to seed yield, variety BAIF bajra recorded significantly higher seed yield (14.99 q/ha) over other genotypes except JHPM-05-1, which were on par with each other. The higher seed yield may be attributed to significantly higher ear length (38.06 cm), earhead girth (4.78 cm) and 1000-grain weight (10.23 g). The green fodder, dry matter, seed yield and crude protein yield of forage pearl millet increased significantly with the increasing levels of nitrogen upto 100 kg N/ha over other levels during both the years and on pooled mean basis.

51. NEELAM, ANIL KUMAR AND SINGH, V.P. 2009. **EFFECT OF FERTILIZER APPLICATION IN CONJUNCTION WITH BIOFERTILIZERS ON GROWTH AND YIELD OF PEARL MILLET UNDER RAINFED CONDITIONS.** *Forage Res.*, **35 (2) : pp. 121-123.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

In a field experiment conducted at CCS HAU, Hisar to study the effect of fertilizer application in conjunction with biofertilizers on growth and yield of pearl millet under rainfed conditions, it was observed that increasing levels of inorganic fertilizers in association with biofertilizers improved most of the yield attributing characters. Grain yield in RDF was found maximum.

52. GOLADA, S. L. B. J. PATEL, P. SINGH AND L. R. BULDAK 2010. **EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON PRODUCTIVITY OF FORAGE PEARL MILLET (Pennisetum glaucum L.).** *Forage Res.*, **36 (3) : pp. 185-187.** Department of Agronomy, S. D. Agricultural University, Sardar Krushinager (Gujarat), India

In pearl millet application of FYM 10 t/ha significantly enhanced total green forage as well as dry matter yield. The increasing level of N upto 120 kg/ha significantly increased yields in both the cuts. Inoculation of pearl millet seed with biofertilizer significantly increased the yield over without inoculation.

(iii) Maize

53. GIRIJA DEVI, L. 2002. **FORAGE YIELD OF MAIZE (ZEA MAYS L.) AS INFLUENCED BY NITROGEN LEVELS AND BIOFERTILIZERS.** *Forage Res.*, **27 (4) : pp. 263-266.** College of Agriculture, Vellayani-695 522, Trivandrum, India

A six x four factorial experiment conducted at College of Agriculture, Vellayani, under All India Co-ordinated Research Project on Forage Crops showed that the fodder maize variety African Tall produced significantly higher green forage and dry matter yields with higher dose of nitrogen. Green forage yield increased significantly upto 125 kg N/ha, while 75 and 100 kg N/ha also produced significant yield difference compared to 0, 25 and 50 kg N/ha. Biofertilizers (Azotobacter and Azospirillum inoculation) had no significant effect on forage yields.

54. TRIPATHI, S. B. AND C. R. HAZRA 2002. **FORAGE PRODUCTIVITY OF WINTER MAIZE UNDER LEGUME COVERS AS INFLUENCED BY NITROGEN FERTILIZATION.** *Forage Res.*, **28 (2) : pp. 55-58.** Indian Grassland and Fodder Research Institute, Jhansi-284 003 (U. P.), India

Field study on a calcareous soil with nitrogen application (0, 30, 60, 90 and 120 kg N/ha) under preceding cowpea grown for fodder and green manuring including **kharif** fallow indicated that the forage yield and nutrients uptake (N, P and K) of maize increased significantly higher to a level of 90 kg N/ha after green manuring of cowpea and to a level of 120 kg N/ha after fodder cowpea and fallow land. The response of fodder and N uptake of maize to added nitrogen application was found maximum when crop was grown after green manuring followed by fodder cowpea. The status of soil nutrients (N, P and K) improved considerably in plots receiving cowpea green manuring followed by fodder cowpea and **kharif** fallow.

55. DUDHAT, M. S., M. G. SAVALIA AND M. V. RAMDEVPUTRA 2004. **RESPONSE OF FORAGE MAIZE TO NITROGEN AND PHOSPHORUS LEVELS.** *Forage Res.*, **30 (1) : pp. 34-35.** G. A. U. Grassland Research Station, Dhari-365 640, Amreli (Gujarat), India

An experiment was conducted to study the effect of nitrogen and phosphorus levels on the forage yield of maize during **kharif** seasons of 1997-98 to 2001-02 on medium black soils of G. A. U. Grassland Research Station, Dhari (Gujarat). The treatments comprised four levels of nitrogen (0, 40, 60 and 80 kg/ha) and three levels of phosphorus (0, 20 and 40 kg/ha). They were tested in randomized block design with four replications. The results revealed that increases in level of N from 0 to 80 kg/ha progressively increased the green and dry forage yields as well as additional net monetary return, whereas the highest net ICBR was recorded by the treatment of 60 kg N/ha. Application of phosphorus did not produce any significant effect on green and dry forage yields. Considering all the factors, a dose of 60 kg N/ha was found an economic optimum dose.

56. KUMAR, S., S. S. SAINI AND B. D. SHARMA 2004. **EFFECT OF GRADED LEVELS OF NITROGEN, PHOSPHORUS AND PLANT GEOMETRY ON THE PRODUCTIVITY OF SPRING MAIZE (*ZEA MAYS* L.).** *Forage Res.*, **30 (1) : pp. 62-63.** Department of Agronomy, CCS Haryana Agricultural University, Hisar

Effect of graded levels of nitrogen, phosphorus and plant geometry on the productivity of spring maize (*Zea mays* L.) was studied at Department of Agronomy, CCS Haryana Agricultural University, Hisar. The number of cobs/plant, length of cob, grain weight/cob, grains/cob, 100-seed weight and grain and stover yields increased significantly upto 150 kg N/ha and 60 kg/P₂O₅.

57. BARIK, A. K. AND A. CHAUDHURI 2005. **RESIDUAL EFFECT OF INTEGRATED NUTRIENT MANAGEMENT IN KHARIF RICE ON SUCCEEDING WINTER MAIZE (FODDER).** *Forage Res.*, **31 (1) : PP. 70-71.** Institute of Agriculture, Visva Bharati Sriniketan-7311236 (W.B.).

Application of NPK fertilizers along with vermicompost or FYM in kharif rice left higher residual organic carbon, available nitrogen and phosphorus after maize harvest compared with NPK fertilizers alone.

58. GOUR, V., P. C. PATEL, M. R. PATEL, AND N. N. PATEL 2006. **EFFECT OF SOWING DATE AND HARVESTING STAGE ON YIELD AND QUALITY OF MAIZE.** *Forage Res.*, **31 (4): pp. 267-268.** Main Forage Research Station, AAU, Anand-388110 (Gujarat).

Early sowing of maize recorded significantly higher dry matter, crude protein and digestible dry matter yield. Harvesting of maize crop at milking stage produced significantly higher dry matter, rude protein and digestible dry matter production.

59. PATEL, A. S., A. C. SADHU, M. R. PATEL AND P. C. PATEL 2007. **EFFECT OF ZINC, FYM AND FERTILITY LEVELS ON YIELD AND QUALITY OF FORAGE MAIZE (*ZEA MAYS* L.).** *Forage Res.*, **32 (4) : pp. 209-212.** Main Forage Research Station, AAU, Anand.

A field experiment conducted at Main Forage Research Station, Anand showed that application of 100 per cent RD + 10 t FYM/ha significantly increased the green forage, dry matter and crude protein yields of forage maize than other fertility levels except 75 per cent RD+10 t FYM/ha for green forage yield. This combination also recorded higher dry matter and crude protein contents than 100 per cent RD alone. The soil application of 25 kg ZnSO₄ gave significantly higher green forage, dry matter and crude protein yields than control and foliar application of 0.5 per cent ZnSO₄ at 20 and 40 days after sowing. However, different zinc levels had non-significant effect on the dry matter and crude protein contents of forage maize. Hence, the application of 100 per cent RD alone without FYM and zinc reduced the dry matter and crude protein yields of forage maize grown in zinc deficient soils of middle Gujarat.

60. MAY MAY KHIN AND MOHINDER SINGH 2007. **PHOSPHORUS AND SULPHUR INTERACTIONS ON DRY MATTER YIELD, NUTRIENTS CONCENTRATION AND THEIR UPTAKE IN MAIZE (*ZEA MAYS*).** *Forage Res.*, **33 (2) : pp. 82-86.** Department of Soil Science, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A screen house experiment was conducted in pots with four levels each of P and S i. e. 0, 30, 60 and 90 mg/kg soil to study the interaction of P and S in maize. The basal doses of N, K and Zn were applied in each pot. The dry matter yield of maize significantly increased with 60 mg P/kg soil and 30 mg S/kg soil application. The maximum dry matter yield (47.30 g/pot) was recorded with the combined application of 60 mg P/kg soil and 30 mg S/kg soil clearly depicting the beneficial effect of balanced nutrition. The P x S interaction was synergistic at their lower levels but antagonistic at their higher levels on dry matter yield of maize. The concentration of P and S significantly increased with each level of their application. The application of 30 mg P/kg soil significantly increased the S concentration over control. Similarly, the application of 30 mg S/kg soil significantly increased the P concentration over control. The uptake of P significantly increased at each level of application upto 60 mg/kg both of P and S. The uptake of S

significantly increased with the subsequent application of 60 mg P/kg soil and 90 mg S/kg soil. The interactions between P and S were significant on concentration and uptake of P and S. The concentrations of Ni, Zn, Fe, Mn and Cu significantly decreased with increasing levels of applied P and S, whereas their uptake increased significantly upto 60 mg P/kg soil and 30 mg S/kg soil. The interactions of P x S were significant on uptake of N, Ni, Zn, Fe, Mn and Cu.

61. JOSHI, Y.P. AND KULDEEP KUMAR 2007. **EFFECT OF NITROGEN LEVELS AND SEED RATES ON GROWTH, YIELD AND QUALITY OF FODDER MAIZE VARIETY 'AFRICAN TALL'**. *Forage Res.*, **33 (3) : pp. 171-173**. Department of Agronomy, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

A field experiment on effect of nitrogen levels and seed rates on growth, yield and quality of fodder maize was conducted at Instructional Dairy Farm, G. B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) during **kharif** 2005 and 2006. The experiment consisted of five nitrogen levels (0, 40, 80, 120 and 160 kg/ha) and four seed rates (50, 60, 70 and 80 kg/ha). Conclusions were drawn on the basis of pooled analysis of two years' experimental data. Experimental results revealed that increase in nitrogen level from 0 to 120 kg/ha recorded significantly higher green fodder yield than other levels of nitrogen. However, dry matter, crude protein and digestible dry matter yield increased upto 160 kg N/ha. Increase in seed rate from 50 to 60 kg/ha significantly increased dry matter, crude protein and digestible dry matter yield, however, significant increase in green forage yield was upto 70 kg seed/ha.

62. SINGH, A., M. L. CHOUDHARY AND J. S. KANG 2008. **INFLUENCE OF NITROGEN AND CROP GEOMETRY ON SEED YIELD AND QUALITY OF FORAGE MAIZE**. *Forage Res.*, **34 (1): PP. 17-20**. Department of Agronomy, Agrometeorology and Forestry, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

Field experiments were conducted on forage maize at Punjab Agricultural University, Ludhiana during late **kharif** seasons of 2003 and 2004. Results revealed that application of the highest level of nitrogen 150 kg/ha produced higher seed yield over 90 and 120 kg N/ha. The plant geometry of 60 x 15 cm gave significantly higher seed yield over 60 x 20, 45 x 15, 30 x 20 and 30 x 15 cm which was at par with 45 x 20 cm. The application of 150 kg N/ha produced higher 1000-seed weight, number of seeds per cob, number of seeds per row and number of seed rows per cob over 120 and 90 kg N/ha. The highest 1000-seed weight, number of seeds per cob, number of seeds per row, seed weight per cob and number of seed rows per cob were obtained from the plant geometry of 60 x 20 cm which was significantly higher over all other plant geometry. Protein content in seed significantly increased with each successive dose of nitrogen upto the highest level of 150 kg/ha. Similar trend in the protein yield was observed during both the years. Significantly higher protein content was recorded under the plant geometry of 60 x 20 and 60 x 15 cm as compared to 45 x 20, 45 x 15, 30 x 20 and 30 x 15 cm which was at par under 60 x 15 cm plant geometry during 2003. In the second year, the protein content was statistically higher in the seed of crop planted with 60 x 20 cm plant geometry than the crop planted with all other plant geometries. However, the protein yield was significantly highest under the plant geometry of 60 x 15 cm as compared to rest during both the years.

63. PURI, K. P. AND U. S. TIWANA 2008. **EFFECT OF ORGANIC AND INORGANIC SOURCES OF NITROGEN IN FORAGE MAIZE**. *Forage Res.*, **34 (1) : pp. 62-63**. Forage and Millet Section, PAU, Ludhiana-141004.

It may be concluded that maize should be fertilized with 25t FYM and 100 kg N/ha to get palatable and nutritious fodder in large quantities.

64. KATOCH, R., N. KUMAR, J. C. BHANDARI AND S. A. FARAQUI 2009. **ASSESSMENT OF YIELD, QUALITY AND PRODUCTION ECONOMICS OF FODDER FROM DIFFERENT MAIZE VARIETIES GROWN FOR BABY CORN.** *Forage Res.*, **35 (1): pp. 30-35.** Department of Crop Improvement, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062 (H. P.), India

Field experiment was conducted at the Research Farm of CSK HPKV, Palampur, H. P. during **kharif** 2007 to evaluate the potential of different maize varieties grown for diverse use patterns for maximum economic returns. These varieties were investigated for yield parameters, biochemical traits and production economics. Fourteen varieties generally grown for seed, baby corn, green cobs and fodder were investigated for different morpho-physiological, yield, biochemical and economical attributes. Varieties Early Composite, KH-581, VL-78 and African Tall were observed with higher green fodder yield. Baby corn yield (q/ha) ranged between 7.40 and 33.60. The varieties HIM-129, VL-Baby corn-1, VL-Makka-42, Kesri and Seetal gave statistically higher baby corn yield. Maize green fodder equivalent yield (q/ha) ranged between 363 and 715. The varieties HIM-129, Early Composite, Seetal, VL-Baby corn-1, VL-Makka-42, PMH-2 and VL-78 gave much higher maize green equivalent yield as compared to African Tall. The dry matter yield (q/ha) of various varieties was statistically similar and ranged from 42.33 to 86.95. Gross returns (Rs./ha) from varieties investigated varied from 36,366 to 71,233. Net returns from the varieties Early Composite, HIM-129, Seetal, VL-Baby corn-1 and VL-78 were observed better than that from African Tall. The results of the study revealed that the cultivation of dual/multi-purpose maize varieties was better than the cultivation of only fodder type varieties. Such cultivation gives better green fodder yield, maize green fodder equivalent yield and net returns. The quality traits of the dual purpose maize varieties were also found to be comparable to the variety African Tall grown solely for fodder purpose.

65. MAHDI, S. S., BADRUL HASAN, R. A. BHAT AND M. A. AZIZ 2010. **YIELD AND ECONOMICS OF FODDER MAIZE (*ZEA MAYS* L.) AS INFLUENCED BY NITROGEN, SEED RATE AND ZINC UNDER TEMPERATE CONDITIONS.** *Forage Res.*, **36 (1): pp. 22-25.** Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir (SKUAST-K), Shalimar-191 121, Srinagar (Jammu & Kashmir), India

Field experiment carried out during **kharif** seasons of 2009 and 2010 showed that green and dry fodder yield as well as their pooled yield over two years recorded significant and consistent increase with increase in the levels of nitrogen from 60 to 120 kg/ha. Varying seed rates upto 80 kg/ha increased green fodder yield markedly, whereas dry fodder yield and its pooled yield over two years recorded with 60 and 80 kg seed rate being at par, was significantly highest than 40 kg seed rate/ha. The soil application of ZnSO₄ at 10 kg/ha recorded discernible increase in green, dry fodder over no application of ZnSO₄. Gross and net returns were realized higher with treatment combination N₁₂₀S₈₀Z₁₀, whereas benefit : cost ratio was highest with treatment combinations N₁₂₀S₆₀Z₁₀ and N₁₂₀S₈₀Z₁₀ during both the years of experiment.

(iv) Napier Bajra Hybrid

66. KAJALE, K. M., B. G. DESAI AND E. R. PATIL 2001. **EFFECT OF DIFFERENT LEVELS OF NITROGEN, PHOSPHORUS AND POTASH ON THE PRODUCTION OF HYBRID NAPIER GRASS (VAR. NB 21).** *Forage Res.*, **27 (2): pp. 91-96.** Department of Animal Husbandry and Dairying, Konkan Krishi Vidyapeeth, Dapoli-415 712 (M. S.), India

Performance of the hybrid napier grass [*Pennisetum purpureum* Schum. x *Pennisetum americanum* (L.) Leek.] variety NB 21 was studied for three successive years (1991-92, 1992-93 and 1993-94) at College of Agriculture, Dapoli, Maharashtra state. Three levels each of nitrogen (30, 60 and 90 kg N/ha/cut), phosphorus (0, 15 and 30 kg P₂O₅/ha/cut) and potash (0, 30 and 60 kg K₂O/ha/cut) were replicated thrice in split plot (sub-plot factorial) design. Total 17 cuts were obtained during three years with an interval of 62 days between cuttings. Pooled analysis revealed that the green fodder, dry matter and crude protein yield increased with the increased levels of nitrogen, phosphorus

and potash. Considering cost of cultivation and benefit : cost ratio, it was recommended to apply 90 kg nitrogen+30 kg P₂O₅+30 kg K₂O per hectare per cut for maximum benefit which in this investigation was 1.26 for each rupee invested with 572.454 t/ha green fodder during three years under the lateritic soils of Konkan region of Maharashtra.

67. SINGH, D., VIRENDRA SINGH AND Y. P. JOSHI 2002. **HERBAGE YIELD AND YIELD ATTRIBUTES OF NAPIER BAJRA HYBRID AT DIFFERENT CUTS AS AFFECTED BY CUTTING INTERVALS AND VARYING LEVELS OF NITROGEN.** *Forage Res.*, **27 (4) : pp. 267-272.** Department of Agronomy, G. B. Pant University of Agriculture and Technology, Pantnagar-263 145 (Uttaranchal), India

The present study was carried out at G. B. P. U. Agri. & Tech., Pantnagar to study the herbage yield and yield attributes of Napier Bajra hybrid as influenced by cutting intervals and nitrogen levels at different cuts. Two years' pooled data indicated that GFY, DMY, plant height, number of leaves/bunch, LAI, dry matter accumulation in leaves and stem increased with increased cutting interval, however, number of tillers/bunch decreased with cutting interval at all the cuts. Increase in nitrogen application increased GFY, DMY, plant height, number of tillers/bunch, number of leaves/bunch, LAI and dry matter accumulation through leaves and stem at all the cuts.

68. TIWANA, M. S., K. P. PURI, U. S. TIWANA AND AJAIB SINGH 2004. **FORAGE PRODUCTION POTENTIAL OF NAPIER BAJRA HYBRID VARIETIES UNDER DIFFERENT NITROGEN LEVELS.** *Forage Res.*, **30 (2) : pp. 83-85.** Department of Plant Breeding, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

An experiment was conducted at Punjab Agricultural University, Ludhiana to evaluate the response of napier **bajra** hybrid varieties under different levels of nitrogen during **kharif** 1996-99. During first year of the study (1996), variety PBN-83 gave the highest fodder yield, whereas during rest of the years variety PBN-233 recorded significantly higher green fodder and dry matter yields over PBN-83 but was at par with PBN-231. On the basis of four years' average, the variety PBN-233 gave 12.4 higher green fodder yield and 14.0 per cent higher dry matter yield over the existing variety PBN-83. The variety PBN-233 was also superior in quality over the recommended variety PBN-83. The nitrogen application increased the fodder yield of napier **bajra** hybrid significantly upto 75 kg N/ha/cut. The application of 75 kg N/ha/cut recorded 24.1 and 12.8 per cent higher green fodder yield; and 22.1 and 11.7 per cent higher dry matter yield over 25 and 50 kg N/ha/cut, respectively. The mortality of stumps decreased with increase in nitrogen dose. Nitrogen application also improved the quality of napier **bajra** hybrid.

69. PATEL, J. R. 2005. **RESPONSE OF FODDER NAPIER TO ORGANIC AND INORGANIC FERTILIZER.** *Forage Res.*, **31 (1): pp. 62-63.** College of Veterinary Science & A. H., Anjora, Durg-491001(C.G.).

Application of farm yard manure 5t/ha produced significantly higher green and dry fodder yield. Effect of N and P fertilization showed significant improvement in forage yield.

70. PATHAN, S. H. AND R. L. BHILARE 2008. **INFLUENCE OF VARYING SPACING AND FERTILIZER LEVELS ON YIELD PERFORMANCE OF HYBRID NAPIER VARIETIES.** *Forage Res.*, **34 (1): pp. 60-61.** Forage Crops Research Project, Mahatma Phule Krishi Vidyapeeth, Rahuri-413722 (Maharashtra).

The results indicated that planting of hybrid Napier variety RBN-13 at the spacing of 90 x 60 cm with application of 62.50 : 50 : 25 kg NPK+25 kg N after cut showed better proposition for achieving higher forage yield of hybrid Napier.

(v) Oat

71. KUMAR, S., C. R. RAWAT, C. R. HAZRA, K. SINGH AND O. N. ARYA 2001. **RESPONSE OF INTEGRATED WEED MANAGEMENT PRACTICES ON GROWTH, YIELD AND ECONOMICS OF FODDER OAT.** *Forage Res.*, 27 (1) : pp. 15-20. All India Coordinated Project for Research on Forage Crops, Indian Grassland and Fodder Research Institute, Jhansi-284 003, India

Field studies were conducted to study the effect of herbicides and cultural practices on forage yield of oat (JHO-822) during 1995-96 and 1996-97. Treatments consisted on nine combinations of use of 2, 4-D (Na salt) @ 0.37 and 0.75 kg/ha at six weeks crop stage (WCS), hand weeding at 4 and 5 WCS and use of weeder-cum-mulcher at 3, 4 and 6 WCS. Significantly higher weed control efficiency was noted under weed free situation. Maximum green and dry forage yield was also recorded under weed free situation. However, maximum net return of benefit : cost ratio was realised with hand weeding at 4 WCS+use of 2, 4-D @ 0.37 kg/ha at 6 WCS.

72. SHARMA, S. K., S. R. BHUNIA AND D. K. YADAVA 2001. **RESPONSE OF OAT (AVENA SATIVA L.) TO CUTTING MANAGEMENT, METHOD OF SOWING AND NITROGEN.** *Forage Res.*, 27 (3) : pp. 167-170. R. A. U., Agricultural Research Station, Sriganaganagar-335 001 (Rajasthan), India

A field experiment was conducted during winter (**rabi**) seasons of 1997-98 and 1998-99 at Rajasthan Agricultural University Agricultural Research Station, Sriganaganagar to study the effect of cutting management, methods of sowing and nitrogen doses on forage and grain yield of oat (*Avena sativa* L.). No cut treatment gave higher grain (26.05, 28.40 q/ha) and straw (82.83, 86.55 q/ha) yields over cutting at 65 or 85 days after sowing (DAS). However, higher fodder yield (158.08, 168.80 q/ha) was recorded when cutting was taken at 85 DAS. Economics of the experiment revealed that net return (Rs. 15619) and benefit : cost (2.50) ratio were higher with one cutting at 65 DAS and then the crop was left for grain production. Line sown crop recorded higher forage (142.23, 153.05 q/ha) and grain (19.40, 20.56 q/ha) yield as well as net return (Rs. 17329) and benefit : cost (2.85) ratio than that of broadcasted crop. Increasing level of nitrogen recorded higher yield, yield attributes as well as net return and benefit : cost ratio. The highest yield of forage (158.97, 169.90 q/ha), grain (23.55, 23.73 q/ha), net return (Rs. 20129), and benefit : cost (3.24) ratio were recorded with 80 kg nitrogen per hectare.

73. SUHRAWARDY, J. AND U. KALITA 2001. **EFFECT OF CUTTING MANAGEMENT AND NITROGEN FERTILIZATION ON FODDER YIELD OF RAINFED OAT (AVENA SATIVA).** *Forage Res.*, 27 (3) : pp. 185-188. AAU Regional Agricultural Research Station, Gossaigaon-783 360 (Assam), India

Field investigations were carried out with three cutting management practices at three levels of nitrogen as basal and split application on fodder yield of rainfed oat during **rabi** seasons of 1994-95, 1995-96 and 1996-97 at Assam Agricultural University Regional Agricultural Research Station, Gossaigaon, Assam. Oat variety 'Kent' was sown in rows 25 cm apart with 100 kg seeds/ha on 19, 18 and 22 November in 1994, 1995 and 1996, respectively. Phosphatic and potassic fertilizers were applied as basal @ 20 kg P₂O₅ and 20 kg K₂O/ha, respectively. The treatment combination consisting of cutting management, one at 60 days after sowing and the other at 50 per cent flowering alongwith 80 kg N/ha applied 50 per cent basal and 50 per cent as top dressing after first cut recorded the highest green fodder and dry matter yield.

74. NAIK, K. R., N. P. SHAIKH, S. B. AGRAWAL AND K. M. DUBEY 2001. **INTEGRATED WEED MANAGEMENT IN FODDER OAT (AVENA SATIVA L.).** *Forage Res.*, 27 (3) : pp. 193-198. Department of Agronomy, Jawaharlal Nehru Krishi Vishva Vidyalaya, Jabalpur-482 004 (M. P.), India

A field experiment, to explore the suitable practice for minimizing the weed flora in fodder oat, was conducted during **rabi** 1996-97 at J. N. Krishi Vishva Vidyalaya, Jabalpur. Two cultural methods viz., two hand weedings or weeder-cum-mulcher twice or weeder-cum-mulcher supplemented with HW reduced the weed intensity and weed

biomass. These treatments also recorded the highest WCE of 88.2, 78.6 and 83.5 per cent, respectively. The highest yield of green fodder (511.11 q ha⁻¹) and dry matter (120.6 q/ha) was obtained from hand weeding twice, one at 21 and another after 42 days of sowing. Application of herbicide as metsulfuron methyl 4 g/ha or 2, 4-D 0.75 kg/ha at 42 DAS proved economically viable method with the maximum net profit (Rs. 12378 and 12080/ha) and BCR (3.06 and 3.01), respectively.

75. SHEORAN, R. S., D. S. RANA AND R. P. S. GREWAL 2002. **INFLUENCE OF AZOTOBACTER INOCULATION IN CONJUNCTION WITH GRADED DOSES OF NITROGEN ON FORAGE YIELD OF OAT (*AVENA SATIVA* L.).** *Forage Res.*, **28 (1) : pp. 8-12.** Forage Research Section, Department of Plant Breeding, Haryana Agricultural University, Hisar-125 004, India

Field studies were conducted at CCS Haryana Agricultural University, Hisar, India during winter seasons of 1992-93 and 1993-94 to determine the effect of different nitrogen levels (0, 40, 80 and 120 kg N/ha) and *Azotobacter* inoculation on growth and fodder yield of two varieties of oats (OS-6 and JHO-822) and nitrogen economy in fodder oats. Sixteen treatment combinations keeping varieties and nitrogen levels in main plots and biofertilizer (*Azotobacter*) in sub-plots were replicated thrice in a split-plot design. Results indicated that both the varieties remained statistically at par for growth and fodder yield. The green as well as dry matter yield increased significantly with the increasing doses of nitrogen upto 80 kg/ha. Inoculation of oats seed with *Azotobacter* was found beneficial in terms of increased forage yield and higher nitrogen use efficiency over uninoculated treatments. The optimum dose of nitrogen was lower with *Azotobacter* in comparison to the treatments having no inoculation.

76. PATEL, M. R., A. C. SADHU, P. C. PATEL AND J. P. YADAVENDRA 2003. **EFFECT OF CUTTING MANAGEMENT AND NITROGEN LEVELS ON GRAIN PRODUCTION OF OATS (*AVENA SATIVA* L.).** *Forage Res.*, **29 (3) : pp. 107-109.** Main Forage Research Station, Gujarat Agricultural University, Anand-388 110 (Gujarat), India

No cutting for fodder gave higher grain and straw production of oats and also gave higher net returns, while cutting for fodder at 50 DAS drastically reduced the grain yield of oats. Oats for grain production should be fertilized with 40 to 80 kg N/ha.

77. SHARMA, K. K., SANGHAMITRA SHARMA AND S. BORA NEOG 2004. **INTEGRATED NUTRIENT MANAGEMENT IN OAT (*AVENA SATIVA* L.).** *Forage Res.*, **29 (4) : pp. 195-197.** Department of Agronomy, Assam Agricultural University, Jorhat-785 013 (Assam), India

A field experiment was conducted at the ICAR farm of AAU, Jorhat during **rabi** seasons of 1997-98, 1998-99 and 1999-2000 to find out the effects of integrated nutrient management in oat (*Avena sativa* L.). The experiment was laid out in randomized block design with three replications. The treatments comprised 10 combinations of vermicompost (VC) @ 5.0 and 2.5 t/ha, FYM @ 5.0 and 2.5 t/ha and inorganic fertilizer @ 100 and 50 per cent of recommended dose of fertilizer (RDF) alongwith control. The soil of the experimental site was sandy loam in texture having pH 4.6, high in organic carbon (0.8 per cent) but low in available P (13.15 kg/ha), available K (120.09 kg/ha) and available N (225 kg/ha). All the growth characters like plant height and leaf stem ratio were significantly influenced by different treatments. The treatment receiving 50 per cent RDF+VC @ 2.5 t/ha+FYM @ 2.5 t/ha (T₁₀) recorded the highest green forage yield (288.26 q/ha) and dry matter yield (68.61 q/ha). From the economic point of view, the highest net return per rupee invested (Rs. 1.58/ha) was obtained in the treatment T₁₀ followed by T₈ (Rs. 1.55/ha) receiving 50 per cent RDF+VC @ 2.5 t/ha. In a nutshell, considering the yield and economics, application of 50 per cent RDF+VC @ 2.5 t/ha+FYM @ 2.5 t/ha was found to be the best among all the treatments.

78. TIWANA, U. S. AND K. P. PURI 2004. **EFFECT OF AZOTOBACTER AND NITROGEN LEVELS ON THE SEED YIELD OF OATS (*AVENA SATIVA* L.).** *Forage Res.*, 29 (4) : pp. 210-211. PAU, Ludhiana.

The experiment was conducted at PAU, Ludhiana to find out the response of Azotobacter under different N levels on seed yield of oat. Azotobacter did not increase the seed yield and straw yield of oats. The application of 60 kg N/ha significantly increased the seed and straw yield of oats.

79. SINGH, V. P., S. S. VERMA AND R. CHANDRA 2005. **EFFECT OF FERTILITY LEVELS WITH BIOFERTILIZERS AND CUTTING MANAGEMENT ON SEED YIELD OF OATS.** *Forage Res.*, 31 (1) : pp. 57-58. Department of Agronomy, G.B.P.A. &T., Pantnagar-263145.

Application of fertilizer N75P40 kg/ha+ inoculation of seed with Azotobacter produced highest seed and stover yield. No cut produced higher seed yield than cutting managements.

80. SHARMA, K. C. AND R. S. VERMA 2005. **EFFECT OF N AND P FERTILIZERS AND BIOFERTILIZERS ON THE YIELD, MARGINAL RATE OF RETURN, ENERGY RELATIONSHIP, ECONOMICS AND RESIDUAL EFFECT ON SOIL IN FODDER OATS (*AVENA SATIVA* L.).** *Forage Res.*, 31 (2) : pp. 118-122. R. B. S. College, Bichpuri, Agra-283 105 (U. P.), India

The field study was undertaken at Agra during **rabi** season of 1996-97 and 1997-98 to study the effect of chemical (N & P) and biofertilizers on the fodder oats (*Avena sativa* L.). Marginal rate of return analysis on mean yield basis revealed that application of 100 kg N/ha, 20 kg P₂O₅/ha and combined inoculation of *Azotobacter chroococcum* and *Pseudomonas striata* (PSB) to oats recorded the highest net returns. Computation of energy relationship showed that application of 100 kg N/ha and combined inoculation *Azotobacter* and PSB recorded the highest values of above both the attributes viz., energy ratio and energy productivity. However, each increase in phosphorus application rates drastically reduced the values of both above attributes. Economic analysis showed that application of 150 kg N/ha and combined inoculation *Azotobacter* and PSB gave the highest net return and net return per rupee invested. However, each increase in P rates sharply decreased the values of above attributes. At expiry of experiment, available N, P and K status of soil showed that increased rates of nitrogen application did not remarkably affect the N and K status of soil but P content of soil decreased. Increasing P rates upto the highest level viz., 60 kg P₂O₅/ha recorded the higher values of available P contents of soil. Respective biofertilizers inoculation i. e. *Azotobacter* (N-fixer) and *Pseudomonas* (PSB) were found beneficial and improved the available N and P status of soil in both the years of investigation.

81. SHEORAN, R. S., D. S. RANA AND K. P. SINGH 2005. **INTEGRATED NUTRIENT MANAGEMENT FOR SUSTAINABLE FODDER YIELD OF OAT (*AVENA SATIVA* L.) UNDER SEMI-ARID CONDITIONS.** *Forage Res.*, 31 (2): pp. 126-129. Forage Research Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted at CCS Haryana Agricultural University, Hisar during 1997-98 to 1999-2000 on sandy loam soils low in available nitrogen, medium in phosphorus and high in potash content. The treatments were comprised of control, 50 and 100 per cent recommended dose of fertilizers (RDF), vermicompost @ 5 and 10 t/ha, farmyard manure @ 5 and 10 t/ha, 50 per cent RDF+ vermicompost @ 5 t/ha, 50 per cent RDF + farmyard manure @ 5 t/ha and 50 per cent RDF+vermicompost @ 5 t/ha + FYM @ 5 t/ha. These treatments were replicated thrice in a randomized block design. The results indicated that application of 50 per cent RDF + vermicompost 5 t/ha + FYM 5 t/ha gave significantly higher green fodder and dry matter yield than other treatments except 50 per cent RDF either with vermicompost or FYM @ 5 t/ha. The yield obtained with 100 per cent RDF was statistically at par with 50 per cent RDF+vermicompost or FYM @ 5 t/ha. The yield obtained with the application of vermicompost or FYM @ 5 t/ha was also statistically at par with that obtained from the use of 50 per cent RDF.

82. BARIK, A. K., S. ROY AND ARINDAM DAS 2005. **FEASIBILITY OF GROWING OATS FODDER (AVENA SATIVA L.) ON RESIDUAL FERTILITY AFTER INTEGRATED NUTRIENT MANAGEMENT IN KHARIF RICE.** *Forage Res.*, 31 (2) : PP. 144-146. Institute of Agriculture, Visva-Bharti University, Sriniketan-731236 (W. B.), India

It was observed that a sizable quantity of green oats fodder can be obtained from the residual fertility accrued from integrated nutrient management through organic and chemical sources in preceding kharif rice.

83. PATHAN, S. H., R. M. GETHE, M. R. MANJARE AND A. D. KADLAG 2005. **RESPONSE OF MULTICUT OAT TO SPACING AND NITROGEN FOR GREEN FORAGE YIELD.** *Forage Res.*, 31 (2) : pp. 150-151 (2005). AICRP on Forage Crops, M.P.K.V., Rahuri-413722(Maharashtra).

The oat variety RO-19 yielded significantly the highest green, dry matter and crude protein yield as compared to var. Kent. Sowing at 30 cm spacing between rows recorded significantly the highest dry matter yield.

84. SHARMA, K. C. AND R. S. VERMA 2006. **EFFECT OF WEATHER PARAMETERS ON THE YIELD ATTRIBUTES AND YIELD OF MULTICUT FODDER OATS (AVENA SATIVA L.).** *Forage Res.*, 31 (4) : pp. 238-240. R. B. S. College, Bichpuri, Agra-283 105 (U. P.), India

The field experiment was conducted for two consecutive years during **rabi** season of 1996-97 and 1997-98 at R. B. S. College, Bichpuri, Agra (Uttar Pradesh) to study the effect of integrated nutrient management on the productivity of multicut fodder oats (*Avena sativa* L.). Mean data of effect of different treatment variables at different cuts revealed that there was a clear-cut variation in the yield attributes and fodder yields at different cuts due to weather parameters viz., rainfall, potential evaporation, sunshine hours, etc. in both the years. Rainfall occurrence, lower mean sunshine hours/day and potential evaporation were found to be beneficial for growth of oats plant and recorded higher fodder yield attributes viz., crop growth rate (CGR), leaf area index (LAI), etc. and fodder yields at second cut in the first year and at third cut in the second year of experimentation followed by first cut and minimum at rest cut.

85. KUMAR, N. AND NALEENI RAMAWAT 2006. **EFFECT OF NPK AND SULPHUR APPLICATION ON FORAGE PRODUCTION OF OAT (AVENA SATIVA L.) UNDER RAINFED CONDITIONS OF NORTH-WESTERN HIMALAYA.** *Forage Res.*, 32 (1): pp. 1-3. Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062 (Himachal Pradesh), India

The field experiment was conducted at CSK HPKV, Palampur (H. P.), during rabi (winter) seasons of 1999-2000, 2000-01 and 2001-02 to study the effect of NPK and sulphur application on forage production of oat. The study revealed that application of 100 per cent recommended NPK (80-60-30 kg ha⁻¹) resulted in more plant height, shoot number, per unit area, green and dry forage yields of oat during all the years than 75 per cent recommended dose of NPK. Plant growth parameters and forage yield increased significantly with the application of sulphur upto 40 kg ha⁻¹. Green and dry forage yields of oat increased with further increase in the dose of sulphur upto 60 kg ha⁻¹ but remained at par with 40 kg ha⁻¹. Economic optimum dose of S was worked out to be 49.7 kg ha⁻¹.

86. JOSHI, Y. P., S. S. VERMA AND R. L. BHILARE 2007. **EFFECT OF ZINC LEVELS ON GROWTH AND YIELD OF OAT (AVENA SATIVA L.).** *Forage Res.*, 32 (4) : pp. 238-239. Department of Agronomy, GBPUA&T, Pantnagar

Pooled results revealed that growth attributes viz., plant height, number of shoots and leaves per 0.5 m row length were recorded higher with application of 100 per cent recommended dose of NPK along- with 20 kg ZnSO₄ ha, and took minimum days to attain 50 per cent flowering. Maximum green forage yield (400 q/ha was obtained with application of 100 per cent recommended dose of NPK with 20 kg ZnSO₄ ha⁻¹. The same treatment also recorded significantly higher dry matter yield (92 q ha⁻¹) and crude protein yield (10.6 q ha⁻¹) than all other treatments. However,

higher digestible dry matter yield was registered with application of 75 per cent N through fertilizer+ 25 per cent N through FYM along with 20 kg ZnSO₄ ha⁻¹.

87. PATEL, A. S., T. N. BARE VADIA, M. R. PATEL, A. C. SADHU AND H. P. PARMAR 2007. **EFFECT OF NITROGEN AND DIFFERENT MANAGEMENT PRACTICES ON GROWTH AND SEED PRODUCTION OF OAT (*AVENA SATIVA* L.).** *Forage Res.*, **32 (4)** pp. 264-266. Main Forage Research station, AAU, Anand

The findings indicated that for obtaining maximum seed yield, oat crop should be given 40 kg N/ ha and harvested for seed production without taking any cut for forage. However, early cutting for fodder at 30 days or 40 days after sowing marginally reduced the seed yield, but gave an additional green forage yield of 30 and 87 q/ha, respectively.

88. PATHAN, S. H., R. L. BHILARE, K. B. NAWALE AND V. T. JADHAV 2007. **RESPONSE OF MULTICUT OAT VARIETIES TO NITROGEN LEVELS.** *Forage Res.*, **32 (4)** : pp. 269-270. Forage Crops Research Project, MPKV, Rahuri

The field experiment was conducted at Forage Crops Research Project, MPKV, Rahuri during rabi season of 2005-06. Thus, it could be concluded that for higher productivity of multicut oat, variety RO-19 should be grown with application of 120 kg N/ha.

89. SHARMA, K. C. AND R. S. VERMA 2007. **EFFECT OF WEATHER PARAMETERS ON THE YIELD ATTRIBUTES AND YIELD OF MULTICUT FODDER OATS (*AVENA SATIVA* L.).** *Forage Res.*, **33 (1)** : pp. 13-16. R. B. S. College, Bichpuri, Agra-283 105 (U. P.), India

The field experiment was conducted for two consecutive years during **rabi** seasons of 1996-97 and 1997-98 at R. B. S. College, Bichpuri, Agra (Uttar Pradesh) to study the effect of integrated nutrient management on the productivity of multicut fodder oats (*Avena sativa* L.). Mean data of effect of different treatment variables at different cuts revealed that there was a clear-cut variation in the yield attributes and fodder yields at different cuts due to weather parameters viz., rainfall, potential evaporation, sunshine hours, etc. in both the years. Rainfall occurrence, lower mean sunshine hours/day and potential evaporation were found to be beneficial for growth of oats plant and recorded higher fodder yield attributes viz., crop growth rate (CGR), leaf area index (LAI), etc. and fodder yields at second cut in the first year and at third cut in the second year of experimentation followed by first cut and minimum at rest cut.

90. KARWASRA, R. S., Y. KUMAR, VINOD KUMAR AND ANIL KUMAR 2007. **INTEGRATED NUTRIENT AND CUTTING MANAGEMENT IN OAT.** *Forage Res.*, **33 (1)**: pp. 63-64. Department of plant Breeding, CCSHAU, Hisar-125004.

The fertility treatments F3 (N75+ P40 kg/ha+ Azotobacter inoculation) and F4 (N100+P60 kg/ha) being at par produced significantly higher seed yield. No cut treatment had produced statistically higher seed yield than other cutting treatments.

91. SINGH, S. D. AND S. N. DUBEY 2007. **SOIL PROPERTIES AND YIELD OF FODDER OAT (*AVENA SATIVA* L.) AS INFLUENCED BY SOURCES OF NUTRIENT AND CUTTING MANAGEMENT.** *Forage Res.*, **33 (2)** : pp. 101-103. Department of Agronomy, Amar Singh College, Lakhaoti, Bulandshahr-245 407, Ch. Charan Singh University, Meerut (U. P.), India

The experiment was conducted during **rabi** seasons of 1999-2000 and 2000-01 at Research Farm of Amar Singh College, Lakhaoti, Bulandshahr, Ch. Charan Singh University, Meerut (U. P.) to study the effect of nitrogen and its sources as well as cutting management on fodder yield and their subsequent effect on soil properties. Application

of 80 kg N/ha gave highest green fodder yield of 478.0 and 508.1 q/ha during 1999-2000 and 2000-01, respectively, and found significantly superior over the lower N levels. Similarly, addition of FYM @ 5 t/ha alongwith seed inoculation with *Azotobacter* significantly enhanced the fodder yield and gave 12.90 and 11.40 per cent higher yield than control. This treatment also improved the organic carbon (0.61%) and soil porosity (1.32 mg/m³) over 0.45 per cent and 1.35 mg/m³ recorded under control.

92. SHEORAN, R. S., N. S. YADAV, U. S. TIWANA AND U. N. JOSHI 2008. **MULTI-LOCATIONAL EVALUATION OF PROMISING OAT (*AVENA SATIVA* L.) VARIETIES FOR FORAGE YIELD AND QUALITY UNDER VARYING NITROGEN LEVELS.** *Forage Res.*, **34 (2): pp. 90-93.** Forage Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was carried out at three locations viz., CCS Haryana Agricultural University, Hisar; Punjab Agricultural University, Ludhiana and Rajasthan Agricultural University, Bikaner during **rab**i 2007 season to evaluate four varieties of oat (JHO-2004-4, UPO-04-1, Kent and OS-6) with four levels of nitrogen (0, 40, 80 and 120 kg N/ha). The treatments were tested in a factorial randomized block design and replicated thrice at all the locations. The results indicated that oat variety UPO-04-1 proved its superiority over the standard check varieties Kent and OS-6 for green fodder, dry matter and crude protein yield on location mean basis. It also performed better than the other varieties for plant height, number of tillers per metre row length and leaf : stem ratio. Increasing rates of nitrogen application upto 120 kg N/ha significantly enhanced the forage yield, crude protein and other ancillary characters over the lower doses of nitrogen at all the locations of experimentation.

93. SINGH, S. D. AND S. N. DUBEY 2008. **EFFICIENCY OF *AZOTOBACTER* TO ENHANCE THE GROWTH AND YIELD OF FODDER OAT (*AVENA SATIVA* L.) UNDER DIFFERENT LEVELS OF NITROGEN AND FYM.** *Forage Res.*, **34 (2) : pp. 116-118.** Department of Agronomy, A. S. College, Lakhaoti, Bulandshahr-245 407 (U. P.), India

The experiment was conducted during **rab**i seasons of 1999-2000 and 2000-01 at Research Farm of A. S. College, Lakhaoti, Bulandshahr, C. C. S. University, Meerut (U. P.), India to study the efficiency of *Azotobacter* to enhance the growth and yield of fodder oat (*Avena sativa* L.) under different levels of nitrogen and FYM. Results revealed that an application of nitrogen upto 80 kg/ha significantly increased the growth and produced 493 and 98.75 q/ha green and dry fodder yields, respectively. *Azotobacter* inoculation as seed treatment alongwith addition of FYM @ 5 t/ha enhanced the forage yield significantly and gave 408 and 84.74 q/ha green and dry matter yields, respectively. Two cuttings one at 55 and subsequent cutting at 50 per cent flowering proved to be superior over single cut.

94. SHEKARA, B. S., H. C. LOHITHASWA, D. SREEDHAR AND S. K. SARITHA 2008. **RESPONSE OF SINGLE CUT OAT GENOTYPES TO NITROGEN LEVELS.** *Forage Res.*, **34 (3): pp. 199-200.** AICRP on Forage Crops, Zonal Agricultural Research Station, V. C. Farm, Mandya-571405 (Karnataka).

It was observed that oat genotype OS-6 with N/ha was found suitable for southern dry zone of Karnataka during winter season.

95. SHEKARA, B. G., H. C. LOHITHASWA AND R. PAVAN 2009. **INFLUENCE OF FORAGE LEGUMES ON GREEN FODDER YIELD AND QUALITY OF HYBRID NAPIER (*PENNISETUM PURPUREUM* SCHUM.).** *Forage Res.*, **35 (2) : pp. 107-109.** Department of Forage Crops (AICRP) Zonal Agricultural Research Station, V. C. Farm, Mandya (Karnataka), India

A field experiment was conducted at Zonal Agricultural Research Station, V. C. Farm, Mandya, Karnataka, for three consecutive years from 2007 to 2009 to study the performance of forage legumes as inter crop and their effect on green fodder yield and quality of hybrid Napier. The experiment comprised seven forage legumes viz., cowpea, horsegram, lucerne, fodder soybean, centrocema, sirratro and *Stylosanthes hamata* which were tested in a

randomized block design with three replications. Among legumes, cowpea followed by lucerne recorded higher green fodder yield (18.44 t/ha), dry matter yield (31.04 t/ha), crude protein yield (3.29 t/ha), total biomass yield (149.17 t/ha), net monetary returns (Rs. 66,653/ha) and benefit : cost ratio (6.31). The organic carbon content of soil (0.37%), available nitrogen (253 kg/ha) and potassium (198.65 kg/ha) was higher with Napier intercropped with cowpea followed by lucerne and available phosphorus was higher with inter crop of sirratro (25.67 kg/ha).

96. UMA DEVI, R. K. JOON, MEENA SEWHAG AND SURESH KUMAR 2009. **GROWTH STUDIES OF MULTI-CUT OATS AS INFLUENCED BY LEVELS OF NITROGEN, ORGANIC MANURES AND AZOTOBACTER INOCULATION.** *Forage Res.*, **35 (3): pp. 152-156.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Field experiment on growth studies of multi-cut oats as influenced by levels of nitrogen, organic manures and *Azotobacter* inoculation was conducted during 2003-04 and 2004-05 at Research Farm, CCSHAU, Hisar. The experiment was laid out in split-plot design allocating four nitrogen levels (0, 40, 80 and 120 kg N/ha) and two inoculation levels (no inoculation and inoculation with *Azotobacter chroococcum*) in main plots and five levels of organic manures (control, FYM @ 5 t/ha, FYM @ 10 t/ha, vermicompost @ 5 t/ha and vermicompost @ 10 t/ha) in sub-plots, replicated thrice. Application of nitrogen levels significantly improved plant growth parameters upto 80 kg N/ha. Inoculation of oats seed with *A. chroococcum* improved significantly growth parameters of oats. Among five levels of organic manures, application of vermicompost @ 10 t/ha produced significant effect on growth parameters which were statistically at par with FYM @ 10 t/ha.

97. RANA, D. S., SINGH, B. AND JOSHI, U.N. 2009. **RESPONSE OF OAT GENOTYPES TO NITROGEN LEVELS.** *Forage Res.*, **35 (3) : pp. 184-185.** Forage Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted at CCS HAU, Hisar during rabi and it was concluded that oat variety OS 6 produced significantly higher green fodder and dry matter over all other varieties. Increased level of N up to 80 kg /ha resulted in a significant increase in green as well as dry matter yield over the lower doses. The crude protein and IVDMD also increased in nitrogen level up to 120 kg /ha.

98. RAWAT, A. AND S. B. AGRAWAL 2010. **EFFECT OF SOIL ENRICHMENT IN CONJUNCTION WITH BIO-ORGANICS AND CHEMICAL FERTILIZERS ON YIELD AND QUALITY OF FODDER OAT (AVENA SATIVA L.).** *Forage Res.*, **35 (4): pp. 190-192.** Department of Agronomy, Jawaharlal Nehru Krishi Vishva Vidyalaya, Jabalpur (M. P.), India

A field experiment was conducted during **rabi** seasons of 2003-04, 2004-05 and 2005-06 at Livestock Farm, JNKVV Jabalpur, Madhya Pradesh to study the effect of bio-organics and chemical fertilizers on growth, yield and economics of fodder oat. Results of the study revealed that an application of nitrogen significantly increased the growth and yields of fodder oat. The maximum plant height and number of leaves per plant, green fodder, dry matter and crude protein yields (103.3 cm, 25.7/plant, 361.5, 100.2 and 7.37 q/ha), respectively, were recorded under 100 kg N/ha. However, 80 and 100 kg N/ha was found at par with each other with respect to plant height, green fodder and dry matter yields but significantly superior to rest of the levels. Application of vermicompost 5 t/ha alongwith inoculation of *Azotobacter* @ 2 kg/ha enhanced the fodder, dry matter and protein yields and maximum yields of 360.1, 93.4 and 7.40 q/ha, respectively, were recorded. The same treatment also gave 3.76 q/day fodder supply with net profit of Rs. 14199.8/ha.

99. KUMAR, A., R. K. ARYA AND S. K. PAHUJA 2010. **EFFECT OF CUTTING AND FERTILIZER MANAGEMENT ON SEED QUALITY PARAMETERS OF OAT (*AVENA SATIVA* L.).** *Forage Res.*, **35 (4) : pp. 198-200.** Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Four cultivars (viz. HJ-8, OS-6, OS-7 and HFB-114) of oat (*Avena sativa* L.) were evaluated with a view to study the effect of cutting and fertilizer management on seed quality parameters at CCS Haryana Agricultural University in the laboratory of Seed Science and Technology Department, at Hisar. The results on effect of cutting and fertilizer management on seed quality revealed that application of fertilizer dose of nitrogen and phosphorus (25% higher than recommended) improved germination per cent, seedling length, vigour index and germination per cent under stress conditions also. In cutting management no cut system was found better than one cut from seed quality point of view except seedling length which was increased in one cut system.

100. PATEL, M. R., T. G. MEISHERI AND A. C. SADHU 2010. **EFFECT OF IRRIGATION, NITROGEN AND BIO-FERTILIZER ON FORAGE YIELD AND QUALITY OF OAT (*AVENA SATIVA* L.).** *Forage Res.*, **35 (4) : pp. 231-235.** Main Forage Research Station, Anand Agricultural University, Anand-388 110 (Gujarat), India

An experiment was conducted to study the effect of irrigation, nitrogen and bio-fertilizer on oat during rabi 2003-04 and 2004-05 at Anand. Eighteen treatment combinations of three irrigation levels (0.7, 0.9 and 1.1 IW : CPE ratio), three nitrogen levels (40, 80 and 120 kg N/ha) and two bio-fertilizer treatments (no inoculation and *Azotobacter* inoculation) were tested in split plot design with four replications. The results revealed that frequent irrigations at 1.1 IW : CPE ratio significantly increased the plant height, tillers per metre row and leaf : stem ratio and produced significantly higher green forage, dry matter and crude protein yields during both the years and in pooled results and registered the highest net returns. However, lower irrigation level of 0.7 IW : CPE ratio was significantly superior in WUE than 1.1 IW : CPE ratio. Successive increase in nitrogen application increased the yield attributes, leaf : stem ratio, crude protein content as well as WUE and application of 120 kg N/ha recorded significantly higher green forage, dry matter and crude protein yields of oat and gave the highest net returns. Similarly, *Azotobacter* inoculation increased plant height, tillers per metre row, leaf : stem ratio and produced significantly higher green forage, dry matter and crude protein yields resulting in higher net realization as compared to no bio-fertilizer inoculation.

101. KUMAR, A. AND DUDI, HETRAM. 2010. **RESPONSE OF CUTTING AND FERTILIZER MANAGEMENT ON QUALITY SEED PRODUCTION IN OAT (*AVENA SATIVA* L.).** *Forage Res.*, **35 (4) : pp. 246-247.** CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field study was conducted at research area of department of Seed Science and Technology, CCS HAU, Hisar. It was concluded that application of 25 % higher dose of N & P fertilizers than the recommended gives significantly higher seed yield. Likewise one cutting at 60 days after sowing, lodging could be reduced significantly whereas maximum seed yield was obtained with OS 6 as it showed maximum response to cutting and fertilizer management practices.

102. UMA DEVI, K. P. SINGH, MEENA SEWHAG, SURESH KUMAR AND SUNIL KUMAR 2010. **EFFECT OF NITROGEN LEVELS, ORGANIC MANURES AND *AZOTOBACTER* INOCULATION ON NUTRIENT UPTAKE OF MULTI-CUT OATS.** *Forage Res.*, **36 (1): pp. 9-14.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Field experiment was conducted during 2003-04 and 2004-05 at Research Farm, CCSHAU, Hisar. The experiment was laid out in split-plot design comprising four nitrogen (0, 40, 80 and 120 kg N/ha) and two bio-fertilizer (no inoculation and inoculation with *Azotobacter chroococcum*) levels in main plots and five levels of organic manures (control, FYM @ 5 t/ha, FYM @ 10 t/ha, vermicompost @ 5 t/ha and vermicompost @ 10 t/ha) in sub-

plots, replicated thrice. Nitrogen content in fodder, grain and straw as well as in soil after harvest of oats crop was significantly influenced by nitrogen levels. Application of nitrogen also improved protein content in fodder, grain and straw during both the years. Inoculation of oats seed with *A. chroococcum* improved significantly the nutrient contents and uptake by oats during both the years. Among five levels of organic manures, application of vermicompost @ 10 t/ha produced significant effect on nutrients content and uptake which were statistically at par recorded in FYM @ 10 t/ha. Nitrogen, contents in soil after harvest of oats crop increased significantly upto 120 kg N/ha, however, 80 kg/ha being statically at par with it. Phosphorus and potassium contents in soil were not influenced by N levels. Inoculation of oats seed with *Azotobacter* significantly influenced the NPK contents in soil after harvest of oats. Application of organic manures did not influence residual soil nutrients during the two years.

- 103. SHEORAN, R. S. AND U. N. JOSHI 2010. AGRONOMIC EVALUATION OF OAT VARIETIES FOR GROWTH, FORAGE YIELD AND QUALITY WITH VARYING LEVELS OF NITROGEN UNDER SEMI-ARID CONDITIONS. *Forage Res.*, 36 (1) : pp. 32-33. Forage Research Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India**

A field study was conducted at Forage Research Farm of CCS Haryana Agricultural University, Hisar during **rabi** 2008-09 to study the effect of nitrogen application on growth, fodder yield and quality of oat. The soil of the experimental field was sandy loam, low in available nitrogen, medium in phosphorus and high in potash content. The treatment combinations were comprised of five varieties (JO-03-91, OS-346, UPO-06-1, Kent and OS-6) and four levels of nitrogen (0, 40, 80 and 120 kg/ha). These treatments were replicated thrice in a factorial randomized block design. The results revealed that oat variety UPO-06-1 significantly outyielded the other varieties for green fodder and dry matter yield. Lowest fodder yield was obtained from OS-6. The maximum crude protein content was recorded in variety Kent but UPO-06-1 gave highest crude protein yield. Likewise, variety JO-03-91 ranked first for *in vitro* dry matter digestibility, whereas highest digestible dry matter yield was recorded with variety UPO-06-1. Green fodder, dry matter, plant height, crude protein content and crude protein yield were significantly increased upto 120 kg N/ha. The number of tillers per running metre row length was observed to be increased only upto 40 kg N/ha.

- 104. MEENA, L. R. AND J. S. MANN 2010. RESPONSE OF OAT (*AVENA SATIVA* L.) TO MODES OF FERTILIZATION, PRECEDED LEGUMES AND SHEEP MANURE UNDER SEMI-ARID CONDITION OF RAJASTHAN. *Forage Res.*, 36 (3): pp. 154-160. Grassland and Forage Agronomy Section, Central Sheep and Wool Research Institute, Avikanagar-304 501 (Rajasthan), India**

A field experiment was conducted during **kharif** and **rabi** seasons of 2003-04 and 2004-05 to study the effect of modes of fertilization, cropping sequences and sheep manure application on seed yield of legumes, green herbage production of oat and economic returns on the basis of both season crops. Pooled results revealed that maximum seed yield was obtained from guar (20.18 q/ha) followed by groundnut (13.60 q/ha) and cowpea (10.45 q/ha) when sheep manure was applied @ 5 t/ha in association with recommended dose of fertilizers to both crops and aonla. Growth attributes of oat were significantly influenced as preceded by legumes. However, these were recorded higher under cowpea-oat crop sequence. The maximum total green fodder (408.15 and 418.47 q/ha) and dry matter (70.05 and 99.22 q/ha) yield was recorded with fertilization to both crops as well as in aonla. The crude protein content and nutrients uptake increased markedly with modes of fertilization. The maximum uptake was recorded with fertilization to crops and aonla (94.04 kg N, 23.41 kg P and 55.63 kg K/ha). Higher net return (Rs. 39,265/ha and benefit : cost ratio (1.94) were obtained with fertilization to crops and aonla. Cowpea-oat sequence produced higher green fodder (389.40 and 439.36 q/ha) and dry matter yield (75.30 and 94.49 q/ha) than other cropping sequences. But green and dry fodder yields of oat were higher when cowpea sown as preceded crop. Crude protein content was higher (9.09%) in oat when it was grown after cowpea as compared to remaining legume crops. The uptake of nutrients was significantly higher in cowpea-oat cropping sequence (91.50 kg N, 22.08 kg P and 51.29 kg K/ha) than in other cropping sequences. The more economic returns and benefit : cost ratio were estimated with cowpea-oat sequence (Rs.40,382/ha and 1.89). Application of sheep manures @ 5 t/ha had paramount effects on green herbage

and dry matter production of oat over no sheep manure. The sheep manure resulted in significant increase in crude protein content over no sheep manure application. The uptake of nutrients like N, P and K was influenced by the application of sheep manure. Higher economic returns in the form of net profit and benefit : cost ratio (Rs. 39,030/ha and 1.84) were obtained with sheep manure applied @ 5 t/ha.

- 105.** SANGWAN, V. P., V. S. MOR, AXAY KUMAR AND O. S. DAHIYA 2011. **EFFECT OF PRE-SOWING SEED TREATMENTS ON SEED QUALITY AND YIELD IN OAT (*AVENA SATIVA* L.)** *Forage Res.*, **36 (4) : pp. 233-235**. Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The effects of various pre-sowing seed priming treatments on two seed lots of oat variety OS-6 viz., fresh seed lot having germination 10 per cent above IMSCS and revalidated seed lot having germination 10 per cent below IMSCS were studied during **rabi** 2007-08 and 2008-09 at CCS Haryana Agricultural University, Hisar. The results exhibited the superiority of all the seed priming treatments over the control. The pre-sowing seed hydration of oat seeds with 0.5 per cent KNO_3 (16-18 h) and drying at room temperature, followed by 2 per cent KH_2PO_4 hydration (16-18 h) and drying at room temperature were found to be superior as these treatments significantly invigorated seed quality in terms of improved germination, field emergence and seed yield in both the seed lots. The response to different pre-sowing treatments was almost similar in both fresh and revalidated seed lots.

(vi) Barley

- 106** SINGH, M., HARPHOOL SINGH, R. CHOUDHARY AND B. L. JAT 2004. **EFFECT OF DATE OF SOWING AND SEED RATE ON FORAGE PRODUCTION OF BARLEY (*HORDEUM VULGARE* L.)**. *Forage Res.*, **30 (3) : pp. 137-139**. Agricultural Research Station, Fatehpur-Shekhawati, Sikar-332 301 (Rajasthan), India

A field experiment with three dates of sowing in main plots with seven levels of seed rate was conducted during **rabi** seasons of 2000-01 to 2002-03 at Agricultural Research Station, Fatehpur-Shekhawati, Sikar to study the effect of date of sowing and seed rate on forage production of barley (*Hordeum vulgare* L.). The results of three years' study revealed that maximum green fodder yield was recorded when sowing was done on 30 October (333 q/ha). The early (15 Oct.) and late sowing (15 Nov.) produced less fodder yield. The results also showed that seed rate of 160 kg ha⁻¹ gave significantly higher green fodder yield of barley over all the lower doses on 2000-01 (442 q/ha) and 2001-02 (369 q/ha). Higher seed rates (175 and 190 kg/ha) resulted in decreased forage yield as compared to seed rate of 160 kg/ha in year 2002-03 (309 q/ha). Among various dates of sowing, 30 October gave maximum net return (Rs. 23380/ha), whereas 160 kg/ha seed rate gave maximum net return (Rs. 26215/ha) as compared to other seed rates.

- 107.** SINGH, H., M. SINGH AND S. R. NAGA 2005. **EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON HERBAGE YIELD AND QUALITY OF BARLEY (*HORDEUM VULGARE* L.)**. *Forage Res.*, **31 (1) : pp. 69**. Agricultural Research Station, Fatehpur-Shekhawati-332301(Raj.).

Application of 100 per cent recommended dose of N (60 kg/ha) and P (20 kg P₂O₅/ha) through urea and DAP produced significantly higher green forage of barley than others except the application of vermicompost @ 7.5t/ha+50 per cent RDF.

108. KARWASRA, R. S., A. S. YADAV, AND S. N. GUPTA 2006. **EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON HERBAGE YIELD AND QUALITY OF BARLEY (*HORDIUM VULGARE* L.).** *Forage Res.*, **32 (2) : pp. 130-131.** Department of Plant Breeding, CCSHAU, Hisar-125004

Application of vermicompost @ 7.5 t/ha also recorded slightly forage yield over FYM. Results also indicated that application of vermicompost with 50 per cent RDF recorded more protein yield over vermicompost alone.

109. BISHT, J. K., SUPRADIP SAHA AND A. K. SRIVASTVA 2009. **AGRONOMIC PERFORMANCE AND FODDER OF DUAL PURPOSE BARLEY CULTIVARS UNDER RAINFED CONDITION OF N-W HIMALAYA.** *Forage Res.*, **35 (1): PP. 12-16.** Vivekananda Institute of Hill Agriculture (ICAR), Almora-263 601 (Uttarakhand), India

Field experiments were conducted using 12 barley varieties during 2003-04 and 2004-05 in N-W Himalayan condition. Barley variety BHS-366 produced significantly higher green biomass (63.1 and 52.7 q/ha) during both the cropping seasons than rest of the varieties tested along with 25 and 26 q/ha grain yield during 2003-04 and 2004-05, respectively. On the basis of average green forage yield of both the years variety BHS-366 produced 9 and 24 per cent more green forage (57.9 q/ha) than BHS-352 and BHS-365, respectively. The forage protein content of different varieties varied from 20 to 31 per cent, whereas P and K content varied between 0.15-0.22 and 2.07-3.01 per cent. However, the highest protein yield was recorded from variety BHS-367 (4.63 q/ha) and the lowest from VLB-1 (1.45 q/ha). Variety BHS-364 had the highest NPK content in forage. Thus, it can be concluded that BHS-366 and BHS-365 are superior dual purpose varieties for obtaining good amount of quality green fodder along with a fairly good grain yield and economic output under mid hill conditions.

110. KUMAR, N., RAMNIWAS, M. L. KHICHA AND J. K. MANI 2010. **INTERCEPTION OF RADIATION ENERGY AND ITS EFFICIENCY FOR DRY MATTER PRODUCTION IN BARLEY.** *Forage Res.*, **35 (4) : pp. 215-218.** Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The four varieties of barley viz., BH 393, BH 75, BH 338 and DWR 28 were sown in east-west and north-south row directions to study the interception of radiation energy and its efficiency for dry matter production in barley. Intercepted photosynthetically active radiation initially increased slowly upto flag leaf then at faster rate and attained maxima at dough stage thereafter declined upto harvest. Radiation use efficiency was highest in BH 393 followed by BH 338, BH 75 and DWR 28. It also differed significantly between the directions of sowing in barley cultivars. The maximum value of radiation use efficiency was higher in north-south direction as compared to east-west direction sown crop.

2. Legume Forages

(i) Cowpea

111. YADAV, J. S., VIRENDER KUMAR, B. D. YADAV AND U. N. JOSHI 2001. **EFFECT OF PRODUCTION FACTORS ON SEED YIELD AND QUALITY OF COWPEA UNDER RAINFED CONDITION.** *Forage Res.*, **27 (2) : pp. 111-114.** CCSHAU Regional Research Station, Bawal-123 501 (Haryana), India

A field experiment was conducted at CCS Haryana Agricultural University Regional Research Station, Bawal during **kharif** seasons of 1996 and 1997 to evaluate the contribution of weed control, fertilizer use and plant protection towards seed yield of cowpea. The results revealed that weed control and fertilizer singly as well as jointly resulted in marked increase in yield attributes (branching, pods/plant, seeds/pod, pod length and test weight), seed yield, stover yield and economic returns over control. However, the combined effect of these above inputs was much

pronounced in comparison to their individual effects. Plant protection could not affect yield attributes, seed yield, stover yield and economic returns but it significantly improved seed protein content and thereby protein yield.

- 112.** SINHA, R., A. KAWATRA AND S. SEHGAL 2002. **NITROGENOUS CONSTITUENTS OF FIVE WHITE CULTIVARS OF COWPEA [VIGNA UNGUICULATA (L.) WALP.].** *Forage Res.*, **27 (4) : pp. 285-288.** Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar-125 004, India

Nitrogenous constituents of five white cultivars of cowpea were studied. The total nitrogen of whole seeds ranged from 3.93-4.50 per cent of which 8.55-10.17 per cent was non-protein N. True protein varied from 21.97 to 25.52 per cent. Among different protein fractions, globulin formed the major fraction and constituted 50 to 55.0 per cent of total protein. Albumin was in the range of 5.27 to 6.71 g/100 g flour. Protein and glutelin were present in small amount.

- 113.** JAMADAGNI, B. M., V. N. SHETYE AND B. V. INGALE 2002. **RESPONSE OF FORAGE YIELD OF COWPEA TO DIFFERENT LEVELS OF PHOSPHORUS.** *Forage Res.*, **28 (1) : pp. 23-25.** Agricultural Research Station, Mulde, Sindhudurg-416 520 (Maharashtra), India

A field investigation was undertaken to assess the response of two forage cowpea genotypes viz., EC 4216 and Konkan Forage Cowpea-1 to five levels of phosphorus. The data pooled over three years revealed that fodder yield increased with increase in phosphorus levels linearly. The regression equation $Y=6.194+0.036X$ ($R=0.90$) described the dependence of forage yield on phosphorus level. Fifteen kg P₂O₅ per hectare was found to be optimum dose for maximum forage yield in economic sense.

- 114.** ABRAHAM, T. AND R. B. LAL 2002. **SUSTAINABLE ENHANCEMENT OF YIELD POTENTIAL OF FODDER COWPEA [VIGNA UNGUICULATA (L.) WALP.] THROUGH INTEGRATED NUTRIENT MANAGEMENT (INM) IN A LEGUME BASED CROPPING SYSTEM FOR THE INCEPTISOLS.** *Forage Res.*, **28 (3) : pp. 147-152.** Department of Agronomy, Allahabad Agricultural Institute-Deemed University, Allahabad-211 007 (Uttar Pradesh), India

A field experiment was conducted during zaid seasons of 1998 and 1999 at Allahabad Agricultural Institute-Deemed University, Allahabad to study the effect of fertilizer levels, organic manures and biofertilizer alongwith organic spray on the yield of fodder cowpea under soybean-mustard-fodder cowpea system. One hundred per cent RDF level significantly increased the yield parameters and yield over 33 per cent RDF and control. Organic manure significantly increased the yield over no manure application. Biofertilizer and organic spray helped increasing the DMP (dry matter production), over no biofertilizer application. A positive interaction between the different forms of nutrient carriers entails the exploitation of potentials through INM for legume based cropping systems.

- 115.** BHILARE, R. L. AND V. S. PATIL 2002. **RESPONSE OF FORAGE COWPEA VARIETIES TO PHOSPHORUS APPLICATION.** *Forage Res.*, **28 (3) : pp. 179-180.** MPKV, Rahuri.

The experiment was done at MPKV, Rahuri to study the response of forage cowpea varieties to phosphorus application. The results indicated that growing of cowpea var. UPC-951 with application of 60 kg P₂O₅/ha showed better proposition for achieving higher green forage and dry matter yield.

- 116.** SINGH, V. P., RAKESH KUMAR, J. V. SINGH AND S. SINGH 2003. **COWPEA [VIGNA UNGUICULATA (L.) WALP.] : A POTENTIAL FOOD LEGUME FOR DIVERSIFICATION IN RICE-WHEAT SYSTEM.** *Forage Res.*, **29 (2) : pp. 88-90.** CCSHAU Regional Research Station, Kaul (Haryana), India

For breaking of the monotony of rice-wheat system, the inclusion of food legumes like cowpea may be a good proposition. Out of the 69 genotypes evaluated in replicated experiments in the late **kharif** season (mid August to the end of October) during the years from 1999 to 2002 at Karnal and Kaul locations, only four genotypes viz., HC

96-26 (11.90 q/ha), HC 98-45 (12.30 q/ha), HC 98-48 (11.90 q/ha) and CAZC-9 (12.30 q/ha) in 1999; six genotypes viz., HC 98-30 (15.40 q/ha), HC 98-40 (11.80 q/ha), HC 98-52 (14.70 q/ha), HC 98-60 (13.50 q/ha), HC 98-45 (14.20 q/ha) and TC 99-1 (12.70 q/ha) in 2000; two genotypes viz., COVV 702 (14.2 q/ha) and SKUA-1 (12.40 q/ha) in 2001 and one genotype viz., HC 98-45 (18.43 q/ha) in the year 2002 have been judged as significantly superior to the check in respective years. Based on the three years' performance, the genotypes viz., HC 98-45 (13.89 q/ha), HC 98-52 (13.72 q/ha) and CPD 15 (12.81 q/ha) have been found numerically better in yield and superior for other traits also than the check GC 3 (12.70 q/ha). The general mean and range of seed yield were observed as 7.0, 10.30, 9.60 and 15.28 q/ha; 3.70 to 12.34, 5.24 to 15.41, 5.80 to 14.10 and 11.07 to 18.43 q/ha during the years 1999 to 2002, respectively.

- 117. INDORIA, A. K., S. P. MAJUMDAR AND V. L. MAJUMDAR 2005. EFFECT OF COMPACTION, NITROGEN AND PHOSPHORUS ON THE PERFORMANCE OF COWPEA [*VIGNA UNGUICULATA* (L.) WALP.] IN TYPIC USTIPSAMMENTS. *Forage Res.*, **31** (2) : pp. 112-114.** Department of Soil Science and Agricultural Chemistry, S.K.N. College of Agriculture, Jobner-303 329 (Rajasthan), India

An experiment was conducted to study the effect of compaction, nitrogen and phosphorus levels on the performance of cowpea [*Vigna unguiculata* (L.) Walp.] in Typic Ustipsamments. The results showed that compaction (2 passing of 500 kg iron roller) significantly increased the total biomass yield of cowpea over no compaction. The N and P content and their uptake by seed and stover were also significantly influenced by compaction. An application of 10 kg N ha⁻¹ significantly increased the crop yield and content and uptake of N and P by seed and stover. Further addition of N (i. e. 20 kg N ha⁻¹), however, did not improve biomass production as well as N and P uptake. Application of 40 kg P₂O₅ ha⁻¹ resulted in a significant increase in yield, and N and P uptake over the P control and 20 kg P₂O₅ ha⁻¹. The moisture retention in different soil layers at various stages of crop growth was higher by about 1.5 to 2.5 per cent (by weight) in the compaction treatment as compared to the compaction control. Saturated hydraulic conductivity decreased in all the compacted soil layers.

- 118. SHEORAN, R. S. AND D. S. RANA 2007. EVALUATION OF FORAGE COWPEA VARIETIES FOR SEED PRODUCTION UNDER DIFFERENT ROW SPACINGS. *Forage Res.*, **32** (4): pp. 243-244.** Forage Section, CCS Haryana Agricultural University, Hisar

A field study was carried Out at CCS Haryana Agricultural University, Hisar during kharif 2003 and 2004 to evaluate the forage cowpea varieties for seed production under varying row spacing. Twelve treatment combinations of four varieties of forage cowpea (Bundel Lobia, UPC-9202, UPC-4200 and IUFRI 95) and three row spacing (30, 60 and 90 cm) were tested in a factorial randomized block design with three replications. The results revealed that variety IGFRI-95 gave significantly higher grain yield than the other varieties followed by Bundel Lobia. The lowest grain yield was recorded in variety UPC-9202. The highest stover yield was obtained from UPC-9202. Different row spacings had no significant effect on grain yield, stover yield and yield attributing traits. However, the highest grain yield and stover yield was recorded with 60 and 30 cm row spacing, respectively.

- 119. KURUBETTA, K. D., S. C. ALAGUNDAGI, C. P. MANSUR AND S. V. HOSAMANI 2007. EFFECT OF TIME OF SOWING, SPACING AND SEED RATE ON YIELD AND PROXIMATE COMPOSITION OF FODDER COWPEA SEEDS. *Forage Res.*, **33** (2) : pp. 125-126.** Department of Agronomy, University of Agricultural Sciences, Dharwad-580005 (Kanataka).

The interaction effect of time of sowing, row spacing and seed rate was non-significant for seed yield of cowpea and contents of seed quality parameters. However, June/II fortnight sowing with 30 cm row spacing at 30 kg/ha seed rate produced higher seed yield.

120. SUNEETHA DEVI, K. B. AND V. SATYANARAYANA RAO 2007. **EFFECT OF SPACING AND VARIETIES ON SEED YIELD OF FORAGE COWPEA.** *Forage Res.*, **33 (3) : pp. 161-163.** AICRP on Forage Crops, Livestock Research Institute, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad-500 030 (A. P.), India

A field trial was conducted at AICRP on Forage Crops, Livestock Research Institute, Acharya N. G. Ranga Agricultural University, Hyderabad during **kharif** seasons of 2002 to 2004. The experiment consisted of four cowpea varieties (three pre-released entries viz., UPC 4200, UPC 9202 and IGFRI 95 and Bundel lobia-1) and three spacings (30, 60 and 90 cm) in factorial randomized block design replicated thrice. Among the entries, Bundel lobia-1, UPC 9202 and UPC 4200 reported higher plant population by withstanding initial pest attack, whereas IGFRI 95 recorded less plant population/m². Plant height, number of branches/plant and number of leaves/plant were higher with UPC 9201 followed by UPC 4200 and Bundel lobia-1. Lowest growth parameters were reported by entry IGFRI-95. Grain yield of national check Bundel lobia-1 was significantly higher over other entries. Grain yield of entries UPC 9202 and UPC 4200 was on par and higher over other entry IGFRI 95. The two parameters, which differed with spacing, were plant population/sq. m and number of grains/pod due to which grain yield also differed. Grain yield at 30 cm spacing was significantly higher followed by grain yield at 60 and 90 cm spacing. Interaction effect of cowpea entries and spacings was found significant in respect of plant population/m², number of grains/seed, dry fodder yield and seed yield.

121. DEEPAK, K. C., M. SHANTI AND G. PADMAJA 2008. **RESIDUAL EFFECT OF BIOGAS POULTRY MANURE ON PERFORMANCE OF COWPEA (VIGNA UNGUICULATA).** *Forage Res.*, **34 (3) : pp. 182-185.** College of Agriculture, Rajendranagar, Hyderabad-500 030 (A. P.), India

A field experiment was conducted during the **rabi** season of 2007 on a sandy loam soil to study the residual effect of biogas poultry manure (BPM) on cowpea yield. Application of 50, 75 and 100 per cent N through poultry manure (PM) to previous crop of maize resulted in a significant increase in green fodder yield of cowpea than biogas poultry manure treatments. The soil fertility status of available major nutrients (N, P₂O₅ and K₂O) and micronutrients (Fe, Mn, Cu and Zn) was significantly higher in the treatments that received 100 per cent N through poultry manure and biogas poultry manure, whereas the physico-chemical properties of soil were unaffected.

122. KURUBETTA, K. D., ALAGUNDAGI, C. P. MANSUR AND S. V. HOSAMANI. 2009. **EFFECT OF TIME OF SOWING, SPACING AND SEED RATE ON SEED YIELD, HAULM YIELD AND QUALITY OF FODDER COWPEA [VIGNA UNGUICULATA (L.) WALP.].** *Forage Res.*, **34 (4) : pp. 244-245.** Department of Agronomy, University of Agricultural Sciences, Dharwad-580005(Karnataka), India

The field experiment was conducted to study the effect of sowing, spacing and seed rate on seed yield, haulm yield and quality of fodder cowpea. Sowing in June II fortnight recorded significantly higher seed yield (925kg/ha) and haulm yield (4442 kg/ha) as compared to July I and July II fortnight sowing. Among the row spacing, 30cm recommended significantly higher seed yield (743 kg/ha) and haulm yield (4198 kg/ha) over 45 cm. The effect of seed rates was non-significant. The dry matter yield of cowpea haulm and quality parameters were not influenced significantly by the time of sowing, spacing seed rate.

123. KUMAR, S., S. A. FARUQUI, SHIVA DHAR AND G. K. SINGH 2010. **HARVEST INDEX, SEED YIELD AND ITS ATTRIBUTES OF FORAGE COWPEA (VIGNA UNGUICULATA L.) VARIETIES AS INFLUENCED BY DIFFERENT ROW SPACINGS IN SEMI-ARID SITUATION.** *Forage Res.*, **35 (4) : pp. 193-197.** All India Coordinated Research Project on Forage Crops, Indian Grassland and Fodder Research Institute, Jhansi-284 003 (Uttar Pradesh), India

A field experiment was conducted during **kharif** 2003 to 2005 at Indian Grassland and Fodder Research Institute, Jhansi to find out suitable forage cowpea variety with appropriate row-to-row spacing for augmentation of seed yield. Four promising forage cowpea varieties with diverse growth habit i. e. Bundel lobia-1 (semi- spreading)

UPC-9202 and UPC-4200 (spreading) and IGFRI-95 (erect) were grown with three row-to-row spacings viz., narrow (30 cm), medium (60 cm) and wide (90 cm). Among varieties, Bundel lobia-1 recorded significantly higher seed yield on yearly and pooled mean basis with medium row to row spacing of 60 cm. In semi-arid situation, neither erect nor spreading type varieties could surpass the semi-spreading type cv. Bundel lobia-1 for seed yield attributes and seed yield. Yearly variation in seed yield was also found due to rainfall variation during cropped period in different years. Based on three years' pooled results it is concluded that seed productivity of forage cowpea may be enhanced by selecting semi-spreading variety with greater harvest index under moderate plant density in semi-arid situation.

124. SHEKARA, B. G., H. C. LOHITHASWA, M. GOVINDAPPA AND R. PAVAN 2010. **RESPONSE OF FODDER COWPEA GENOTYPES TO VARIED LEVELS OF PHOSPHORUS.** *Forage Res.*, **36 (2) : pp. 91-93.** 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, V. C. Farm, Mandya (Karnataka) during **kharif** 2009 and 2010 to study the response of fodder cowpea genotypes (UPC-621, UPC-622, UPC-623, Bundel lobia-1 and UPC-5286) to varied levels of phosphorus (40, 60 and 80 kg P₂O₅/ha), The experiment was land out in factorial randomised design with three replications. The pooled data of two years' results revealed that among genotypes UPC-622 recorded significantly higher green forage yield (644.2 q/ha), dry matter yield (116.2 q/ha), crude protein yield (15.9 q/ha), net monetary returns (Rs. 32554/ha) and B : C ratio (6.34). Application of 80 kg P₂O₅/ha recorded significantly higher green fodder (572.2 q/ha), dry matter (101.4 q/ha), crude protein yield (14.1 q/ha) and net monetary returns (Rs. 27115/ha). The benefit : cost ratio was higher with 40 kg P₂O₅/ha (4.85).

(ii) Guar

125. HENRY, A. 2003. **IMPROVEMENT RESEARCH ON CLUSTERBEAN AT CAZRI.** *Forage Res.*, **29 (3) : pp. 107-109.** Central Arid Zone Research Institute, Jodhpur-342 003 (Rajasthan), India

India is single major producer of clusterbean or guar [*Cyamopsis tetragonoloba* (L.) Taub.] in the world. Rajasthan accounts for 83 per cent of the total area and 58 per cent of production where its average productivity is 227 kg per hectare. The growth trend in productivity indicated that it was decreasing over the years. Traditionally, clusterbean is used as green forage and its seeds are boiled and fed to cattle as a high protein source. Of late, it has become the source of galactomannan (gum), a polysaccharide, which has diversified industrial uses and export potential. The by-product of guar gum industries is guar meal (churi and korma) which contains protein content to the extent of 42 per cent, a nutritious cattle feed equivalent to oilseed cake. Looking to the importance of the crop in arid areas, the first All India Guar Research and Development Workshop was organized at CAZRI in 1977 and work of different centres was reviewed. Since then the work of genetic improvement on clusterbean was started at this centre with the following objectives viz., (a) to develop short duration, drought resistant and high yielding varieties, (b) to develop determinate plant type genotypes, (c) to evaluate existing guar germplasm/varieties in a coordinated manner for identifying suitable genotypes for crossing programmes and selection of high yielding genotypes, (d) to screen varieties/genotypes for inter/mixed cropping with pearl millet as well as for legume based intercropping systems and (e) to evaluate the promising varieties for quality parameters like protein and gum content. The research experiments on above mentioned objectives were carried out under rainfed conditions at this centre and the results obtained are being discussed in the paper.

126. YADAV, B. D., R. K. JOON AND ATTAR SINGH 2004. **EFFECT OF THIOUREA AND KINETIN ON PRODUCTIVITY OF CLUSTERBEAN UNDER RAINFED CONDITIONS.** *Forage Res.*, **30 (1) : pp. 36-38.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was carried out for two years during **kharif** seasons of 1999 and 2000 on sandy loam soils at Hisar to know the most economical treatment for drought amelioration in clusterbean. On the basis of two

years' mean, seed soaking in thiourea (0.05%)+two sprays of TU (0.1%) at 25 and 45 DAS gave significantly higher grain yield (11.28 q/ha) in comparison to control (9.76 q/ha) and seed soaking in water (9.87 q/ha) and thereby increased the seed yield to the tune of 19.87 and 18.54 per cent, respectively. This treatment also gave additional net profit of Rs. 2260/ha, whereas two sprays of TU gave additional profit of Rs. 1678/ha over control. Seed soaking in 5 ppm solution of kinetin+its two sprays at 25 and 45 DAS also remained statistically comparable in seed yield but it was not economical due to high price of the chemical. Hence, on the basis of two years' results, it may be concluded that seed soaking in 0.05% TU solution for 4 h+0.1% spray of TU at 25 and 45 DAS was found to ameliorate the adverse effect of drought and improve the crop yield of clusterbean.

- 127.** KUMAR, V., B. D. YADAV, J. S. YADAV AND RAMESH KUMAR 2004. **SPATIO-TEMPORAL MANAGEMENT FOR SEED PRODUCTION OF CLUSTERBEAN HG 563 IN LIGHT TEXTURED SOIL OF SOUTHERN HARYANA.** *Forage Res.*, **30 (2) : pp.72-74.** CCSHAU Regional Research Station, Bawal-123 501, Rewari (Haryana), India

Field experiment was conducted at CCS Haryana Agricultural University's Regional Research Station, Bawal on loamy-sand soil during **kharif** seasons of 2001 and 2002 to study the response of clusterbean genotype HG 563 to row spacing (30 and 45 cm) and seed rates (10, 15 and 20 kg/ha) for seed production. In another experiment during 2000, the genotype HG 563 was evaluated against RGC 936 under two sowing periods (June 20-25 and July 10-15) and three seed rates (10, 15 and 20 kg/ha). The results revealed that HG 563 gave significantly higher seed yield (22.34 q/ha) over RGC 936 (18.20 q/ha). Sowing done during June 20-25 produced significantly higher seed yield (22.0 q/ha) over July 10-15 (18.54 q/ha) recording 18.6 per cent increase. Early sown crop attained more height, produced more branches and pods/plant. Row spacing of 30 cm produced significantly higher grain yield than 45 cm spacing. Amongst varying seed rates, 15 kg seed/ha was appropriate, which gave higher yield over 10 kg/ha and yielded at par with 20 kg/ha.

- 128.** PRAJAPATI, B. H., G. K. CHAUDHARI, H. D. PARMAR AND S. B. S. TIKKA 2004. **OPTIMUM PLOT SIZE FOR FIELD EXPERIMENTS IN CLUSTERBEAN (*CYAMOPSIS TETRAGONOLOBA*).** *Forage Res.*, **30 (3) : pp. 121-124.** Department of Agricultural Statistics, Gujarat Agricultural University, Sardar Krushinagar-385 506 (Gujarat), India

Optimum plot size for rainfed clusterbean crop, experimentation was worked out using uniformity trial data. Three methods viz., (1) Maximum curvature method, (2) Fair-field Smith's variance law, and (3) Comparable variance method were used for the purpose. A plot of 10.8 sq. m size having shape of 4 m length (E-W) and 2.7 m cross width (6 rows in N-S) is optimum size (net) and shape for rainfed clusterbean crop experiment. The minimum number of replications was 9 at 5 per cent S. Em and 3 at 8 per cent S. Em for the same.

- 129.** BHADORIA, R. B. S. AND P. C. JAIN 2005. **CROP-WEED COMPETITION STUDIES ON CLUSTERBEAN UNDER RAINFED CONDITION.** *Forage Res.*, **31 (2) : pp. 97-98.** College of Agriculture, Gwalior-474 002 (Madhya Pradesh), India

Field experiment was conducted on sandy loam soils of Research Farm Campus, College of Agriculture, Gwalior during **kharif** 1992 and 1993 to study the crop-weed competition in clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] under rainfed condition. Amongst different weed control treatments, weed-free plot had the maximum seed yield (19.19 q/ha) and weed control efficiency (79.3%). Weed-free treatment for 60, 45 and 30 DAS and interculture at 30 DAS were next in order. Weeds growing throughout the crop season in clusterbean caused 47 per cent reduction in seed yield. In order to obtain higher seed yield of clusterbean, the crop should be kept free from weeds during the first 30 days of sowing.

130. YADAV, B. D., V. K. YADAV AND U. N. JOSHI 2006. **EFFECT OF DIFFERENT SOURCES, LEVELS AND MODES OF SULPHUR APPLICATION ON YIELD AND SEED QUALITY OF CLUSTER BEAN.** *Forage Res.*, **32 (3) : pp. 173-175.** Forage Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted during **kharif** seasons of 2000 and 2001 at the Regional Research Station, Bawal of CCS Haryana Agricultural University, Hisar to find out the best source, optimum level and mode of sulphur application. Among different sources of S, application of 20 kg S/ha through gypsum gave significantly 7.44 and 11.90 per cent higher seed yield and elemental sulphur enhanced 12.08 and 10.33 per cent in 2000 and 2001 crop season, respectively, than control. Application of S treatments gave significantly higher seed yield, more gum and protein content over control. Application of 20 kg S/ha (50% through gypsum at sowing +50% through elemental sulphur at 21 DBS) gave significantly higher gum and protein content over remaining S treatments. Further increase in S dose to 40 kg/ha did not show any significant difference with regards to seed yield and its quality. Application of 20 and 40 kg S/ha i. e. 50 per cent through gypsum at sowing+50 per cent through elemental sulphur at 21 DBS was found at par with 20 per cent through gypsum at sowing+80 per cent through elemental sulphur at 21 DBS in respect of seed yield and its attributes. Application of sulphur through different sources, levels and modes statistically increased the number of branches/plant, pods/plant, seeds/pod and 1000-seed weight over control.

(iii) Berseem

131. PATEL, J.R. AND S., RAJAGOPAL, S 2001. **EFFECT OF FARM YARD MANURE AND SOWING METHOD ON FORAGE YIELD OF BERSEEM.** *Forage Res.*, **27 (2) : pp. 141-142.** College of Veterinary Sciences, Anjora (Durg), M.P.

An experiment was conducted at the fodder farm, College of Veterinary Sciences, Anjora (Durg), M.P. It was observed that manula line sowing (25 cm apart) outyielded other sowing methods in individual years as well as mean data.

132. MISHRA, G. C. AND A. K. MUKHERJEE 2002. **EFFECT OF NPK DOSES WITH AND WITHOUT POULTRY MANURE AND LEVELS OF SULPHUR ON GROWTH AND HERBAGE YIELD OF EGYPTIAN CLOVER.** *Forage Res.*, **28 (2) : pp. 98-103.** Department of Agronomy, Mohanpur-741 245 (West Bengal), India

Experimental results revealed that application of 50 per cent recommended NPK dose+2 t poultry manure ha⁻¹ recorded the maximum plant growth, height and number of branches plant⁻¹ in berseem followed by 100% recommended NPK dose. Plant growth parameters were significantly increased with application of sulphur upto the dose of 40 kg ha⁻¹. Application of 50 per cent recommended NPK+2 t poultry manure ha⁻¹ recorded the highest green forage yield in all the cuts and total of all the cuts. Green forage yield of berseem was significantly enhanced with increase in the dose of sulphur upto 40 kg ha⁻¹. The economic optimum level of S was found at 59.19 kg ha⁻¹.

133. TIWANA, U. S. AND K. P. PURI 2003. **RESPONSE OF BERSEEM (*TRIFOLIUM ALEXANDRINUM* L.) TO SULPHUR UNDER DIFFERENT FERTILIZER LEVELS.** *Forage Res.*, **29 (2) : pp. 94-96.** Department of Plant Breeding, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

An experiment was conducted during **rabi** seasons of 1996-97, 1997-98 and 1998-99 at Punjab Agricultural University, Ludhiana to see the response of berseem to sulphur (0, 20, 40 and 60 kg S/ha) under different fertilizer levels (50, 75 and 100% of recommended i. e. 25 kg N/ha+75 kg P₂O₅/ha). On the basis of three years' mean, the 100 per cent of recommended fertilizer level produced significantly higher green fodder and dry matter yield of berseem over 50 per cent of recommended fertilizer level but was at par with 75 per cent of recommended fertilizer level.

The magnitude of increase with 100 per cent of recommended fertilizer level was 9.7 and 5.0 per cent in green fodder yield; and 11.4 and 4.8 per cent in dry matter yield over 50 and 75 per cent of recommended fertilizer levels, respectively. The crude protein content of berseem increased from 18.1 to 22.3 per cent with increase in fertilizer levels upto 100 per cent of the recommended level. Berseem did not show significant response to sulphur but slightly higher green fodder and dry matter yield was recorded with increase in sulphur upto 60 kg S/ha. Application of sulphur improved the crude protein content of berseem.

134. SHEORAN, R. S., D. S. RANA AND R.K. JOON 2003. **COMPARATIVE PERFORMANCE OF PROMISING VARIETIES OF BERSEEM UNDER DIFFERENT DATES OF SOWING.** *Forage Res.*, **29 (2): pp. 104.** Forage Section, CCS Haryana Agricultural University, Hisar

Comparative performance of promising varieties of berseem under different dates of sowing was studied at CCSHAU, Hisar. The variety HFB-600 and JHB-146 outyielded the existing variety Wardan by giving 8.5 and 9.1 per cent higher green fodder and dry matter yields, respectively.

135. KEWAT, M. L., S. B. AGRAWAL AND V. K. SHUKLA 2005. **EFFECT OF WEED CONTROL ON SEED YIELD OF BERSEEM (*TRIFOLIUM ALEXANDRINUM* L.).** *Forage Res.*, **31 (2) : pp. 78-80.** Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur-482 004 (M. P.), India

Field experiment was carried out at research farm of J. N. Krishi Vishwa Vidyalaya, Jabalpur during **rabi** seasons of 2000-01 and 2001-02 to evaluate the effect of different weed control treatments on weeds and seed yield of berseem. Application of butachlor at 2 kg ha⁻¹ as pre-emergence and post-emergence application of imazethapyr 0.15 kg ha⁻¹ scaled down the population of *Cichorium intybus* and other weeds including their dry weight appreciably. Pre-sowing treatment of berseem seeds with 10 per cent common salt was also effective in curbing the infestation of weeds. However, the effect of trifluralin and fluchloralin against dominant weeds was not to the desirable level when fluchloralin was applied at 0.6 and 1.2 kg ha⁻¹ and trifluralin applied at 1.2 kg ha⁻¹ (PPI) and caused phytotoxicity on berseem plants. Plots receiving pre-emergence application of butachlor 2.0 kg ha⁻¹ registered the maximum green forage (982 q ha⁻¹) and seed yield (6.24 q ha⁻¹) of berseem followed by imazethapyr 0.15, butachlor 1.0 kg ha⁻¹, and imazethapyr 0.10 kg ha⁻¹ and seed treatment with 10 per cent common salt. Pre-emergence application of butachlor at 2 kg ha⁻¹ attained the maximum net monetary returns (Rs. 52345 ha⁻¹) and benefit (3.4) per rupee of investment closely followed by 10 per cent common salt (Rs. 49628 ha⁻¹ and 3.4).

136. KUMAR, H., S. KUMAR AND S.S. YADAV 2007. **INTEGRATED NUTRIENT MANAGEMENT IN BERSEEM (*TRIFOLIUM ALEXANDRINUM* L.).** *Forage Res.*, **33 (1) : pp. 67-69.** AICRP on Forage Crops, IGFR, Jhansi-284003.

It is concluded that the complementary use of organic and inorganic fertilizer is advantageous. In nut shell, considering the yield and economics, application of 50 per cent N through FYM and 50 per cent NPK through inorganic fertilizer to berseem proved to be economically viable as compared to 25 per cent N through FYM and 50 per cent NPK through inorganic fertilizer inoculated with Rhizobium may be second option which needs to be validation by repeated experimentation.

(iv) Lucerne

137. PATEL, D. B., C. L. PATEL, R. R. KASWALA AND H. C. PARMAR 2004. **EFFECT OF IRRIGATION SCHEDULING AND PHOSPHORUS ON GREEN FODDER YIELD OF LUCERNE.** *Forage Res.*, **29 (4) : pp. 192-194.** G. A. U. Narmada Irrigation Research Project, Khandha (Gujarat), India

A field experiment was carried out during 1989-90 to 1992-93 to study the effect of irrigation scheduling and phosphorus on green fodder yield of lucerne. Treatments consisted of four levels each of irrigation based on irrigation

water : cumulative pan evaporation (IW/CPE) ratio (0.5, 0.7, 0.9 and 1.1) and phosphorus (0, 40, 80 and 120 kg P₂O₅/ha). Scheduling of irrigation at 1 : 1 IW/CPE ratio with 80 mm depth recorded significantly the highest green fodder yield of lucerne and remained at par with 0.9 IW/CPE ratio. Water requirement was increased from 560 to 1120 mm. Application of phosphorus influenced green fodder yield significantly upto 80 kg P₂O₅/ha and it increased 35 per cent green fodder yield in comparison to control. The maximum ICBR values of 1 : 40.26 and 1 : 8.27 were recorded at 0.9 IW/CPE ratio and 40 kg P₂O₅/ha, respectively.

138. PATEL, P. C., J. P. YADAVENDRA, A. V. KOTTECHA AND K. P. PATEL 2004. **EFFECT OF SULPHUR THROUGH DIFFERENT SOURCES ON SEED YIELD AND NUTRIENT UPTAKE BY LUCERNE (*MEDICAGO SATIVA L.*)** *Forage Res.*, **29 (4) : pp. 206-209**. Main Forage Research Station, Gujarat Agricultural University, Anand-388 110 (Gujarat), India

To study the effect of sulphur fertilization through different sources on seed yield and nutrient uptake in lucerne (GAUL-1), a field study was carried out at the University Farm, Anand during **rabi** seasons of 1998-2001 in factorial design. The soil was alluvial with pH 8.2, medium in available N and sufficient in available P and K. The available S was 13.7 ppm. The treatment consisted of two sources of S (gypsum and elemental sulphur) and three levels of S (20, 40 and 60 kg ha⁻¹). The fertilizer was applied with 25+50+50 kg NPK ha⁻¹ alongwith 10 t FYM ha⁻¹. The sowing of lucerne variety GAUL-1 was carried out during second week of November using 5 kg seed ha⁻¹. The first cut of green forage was taken at 60 DAS and second cut at 30 days after first cut. The crop was left for seed production in the third week of February and the seed crop was ready to harvest in May. The three years' results indicated that application of S significantly increased seed yield of lucerne by 17.9 per cent over control. Application of S @ 40 kg ha⁻¹ significantly increased seed yield of lucerne by 13.5 per cent as compared to 20 kg S ha⁻¹. Application of S significantly increased S uptake by 37.5 per cent in lucerne seed as compared to control. The uptake of S was significantly higher (20.8%) in lucerne seed by the application of S through gypsum as compared to elemental sulphur. The increase in S level from 20 to 40 kg S ha⁻¹ significantly increased the uptake of S (30.5%) by lucerne seed. This result suggested that 40 kg S ha⁻¹ was sufficient for the better utilization of N and S. A moderate dose of 40 kg S ha⁻¹ through gypsum was sufficient for growing lucerne variety GAUL-1 in a soil having marginal to deficient available sulphur status as a basal dose to obtain higher seed yield of lucerne, net returns and net ICBR.

139. MALIK, J. S., JAGDEV SINGH AND R. S. DHANKHAR 2004. **EFFECT OF CUTTING MANAGEMENT, IRRIGATION AND PHOSPHORUS LEVELS ON SEED PRODUCTION OF LUCERNE.** *Forage Res.*, **30 (2) : pp. 104-105**. CCS HAU Regional Research Station, Bawal

An experiment was conducted at CCSHAU, RRS, Bawal to study the effect of cutting management, irrigation and phosphorus levels on seed production of Lucerne. With increased application of P the seed of Lucerne also increased.

140. PATEL, P. C. AND A. V. KOTTECHA 2006. **FORAGE YIELD AND QUALITY OF LUCERNE AS AFFECTED BY PHOSPHORUS AND POTASSIUM APPLICATION.** *Forage Res.*, **31 (4) : pp. 269-270**. Main Forage Research Station, AAU, Anand-388110 (Gujrat)

Increasing level of potassium significantly increased the green fodder, dry matter and crude protein yield of Lucerne but, no significant increase was noticed due to phosphorus application. However, interaction effect of variety and P x K significantly influenced the Lucerne green forage dry matter yields.

141. SHARMA, K. C. AND SUBHASH CHANDER 2006. **EFFECT OF INTERGRATED WEED MANAGEMENT OF THE PRODUCTIVITY OF LUCERNE (*MEDICAGO SATIVA*) IN ARID REGION OF RAJASTHAN.** *Forage Res.*, **32 (2) : pp. 93-97.** GFA Section, Central Sheep and Wool Research Institute, Arid Region Campus, Bikaner-334 006 (Rajasthan), India

A field experiment was conducted during rabi seasons of 2002-03 and 2003-04 at Agricultural Research Farm of Central Sheep and Wool Research Institute, Arid Region Campus, Bikaner to find out the effective and economical weed control method in lucerne (*Medicago sativa*). All weed control treatments significantly reduced weed intensity and biomass, which in turn significantly increased the green and dry fodder yields of lucerne except use of pendimethalin compared with weedy check in both the years. However, pre-emergence application of pendimethalin exerted its phytotoxic effect on germination and growth of crop and drastically reduced the fodder yields. Pooled data over two years revealed that among the weed control treatments, highest green fodder (70.1 t/ha) and dry matter (18.5 t/ha) yields were recorded under weed-free treatment followed by two hand weedings (68.4 t/ha). Weed-free treatment of different weed control treatments resulted in highest net return of Rs.50,250/- ha followed by one hand weeding (Rs. 49,830/- ha). However, one hand weeding at 30 DAS provided highest benefit : cost ratio (2.57) followed by pre-plant incorporation of fluchloralin at 0.75 kg/ha (2.50).

142. REDDEY, B. P., A. C. SADHU, M. R. PATEL AND P. C. PATEL 2006. **EFFECT OF FARMYARD MANURE AND FERTILITY LEVELS ON FORAGE YIELD AND QUALITY OF LUCERNE (*MEDICAGO SATIVA* L.).** *Forage Res.*, **32 (2) : pp. 126-127.** Main Forage Research Station, AAU, Anand-388110

The result shows that application of 10t FYM/ha produced significantly higher green forage, dry matter and crude protein yields of lucerne in total yield of five cuts than no FYM. However, dry matter increased significantly up to 20 t FYM/ha. Application of sufficient quantity of fertilizers viz., 50 kg N/ha+50 kg K₂O/ha as basal before sowing is required for higher yield and good quality forage production in Lucerne.

143. PATEL, M. R., A. C. SADHU, P. C. PATEL, C. C. PATEL AND H. P. PARMAR 2007. **EFFECT OF FERTILIZER MANAGEMENT ON SEED PRODUCTION OF LUCERNE (*MEDICAGO SATIVA* L.).** *Forage Res.*, **32 (4) : pp. 267-268.** Main Forage Research station, AAU, Anand

Thus, for securing the higher seed yield, the lucerne crop should be fertilized with 0.5 kg Mo/ha and 4.0 kg Bo/ha along with recommended fertilizer dose in sandy loam soils under middle Gujarat conditions.

144. TANDON, A. AND C. L. PATEL 2009. **INFLUENCE OF PHOSPHORUS MANAGEMENT ON GROWTH, YIELD AND QUALITY OF LUCERNE (*MEDICAGO SATIVA* L.).** *Forage Res.*, **35 (1): pp. 5-8.** N. M. College of Agriculture, Navsari Agricultural University, Navsari-396 450 (Gujarat), India

Field experiments were carried out during 2006-07 and 2007-08 to study the effect of phosphorus management on growth, yield and quality of lucerne. The treatments consisted of three levels and two sources of phosphorus [25, 50 and 75 kg P₂O₅/ha from SSP and 250, 500 and 750 kg rock phosphate (RP)/ha] alongwith and without VAM (Vasicular Arbuscular Mycorrhiza) @ 2.0 kg/ha as soil inoculant and control (without P and VAM). All the growth, yield and quality (except crude protein and nitrogen free extract) parameters were recorded higher under 75 kg P₂O₅/ha from SSP with VAM, closely followed by 75 kg P₂O₅ without VAM and 50 kg P₂O₅/ha from SSP with VAM. Lower nitrogen free extract (NFE) was recorded under all phosphorus management treatments than control.

145. KUMAR, D. S. P., B. M. CHITTAPUR, S. C. ALAGUNDAGI, S. I. HALIKATTI AND S. M. HIREMATH 2009. **EFFECT OF FERTILIZER LEVELS AND SEED RATES ON FORAGE YIELD AND ECONOMICS OF LUCERNE (*MEDICAGO SATIVA* L.) UNDER IRRIGATION.** *Forage Res.*, **35 (3) : pp. 180-183.** Department of Agronomy, University of Agricultural Sciences, Dharwad-580 005 (Karnataka), India

A field experiment was conducted at University of Agricultural Sciences, Dharwad during **kharif, rabi** and summer 2005-06 under irrigation to evaluate the effect of fertilizer levels (25 : 100 : 25, 37.5 : 150 : 37.5 and 50 : 200 : 50 kg N : P₂O₅ : K₂O/ha) and seed rates (6, 9, 12, 15, 18 and 21 kg/ha) on forage yield and economics of lucerne (*Medicago sativa* L.) cv. RL-88. The fertilizer levels did not influence significantly the growth parameters and forage yield. Significantly higher plant height (67.7 cm) was observed with the seed rate of 6 kg/ha. Significantly higher net income and B : C ratio were observed in 37.5 : 150 : 37.5 kg N : P₂O₅ : K₂O/ha with recommended seed rate of 6 kg/ha i. e. F₂ x S₁ (Rs. 54996/ha and 2.38, respectively), followed by the treatment combination of recommended fertilizer (25 : 100 : 25 kg N : P₂O₅ : K₂O/ha) with recommended seed rate of 6 kg/ha (F₁ x S₁) which recorded a B : C ratio of 2.27.

(v) Fenugreek

146. KHIRIYA, K. D., B. P. SINGH AND R. S. SHEORAN 2001. **EFFECT OF FARM YARD MANURE AND PHOSPHORUS LEVELS ON YIELD AND PHOSPHORUS USE EFFICIENCY OF FENUGREEK (*TRIGONELLA FOENUM-GRAECUM* L.).** *Forage Res.*, **27 (2) : pp. 131-136.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004, India

A field experiment was conducted during the winter seasons of 1996-97 and 1997-98 at CCS Haryana Agricultural University, Hisar to study the efficiency of phosphorus fertilizer applied to fenugreek (*Trigonella foenum-graecum* L.) genotypes under different doses of farm yard manure. The results revealed that genotype NLM proved its superiority over HM-65 in terms of higher yields and phosphorus use efficiency. Higher optimum dose of phosphorus was also worked out for NLM as compared to HM-65. Maximum seed yield was obtained from the crop when applied 15 tonnes farm yard manure ha⁻¹. Increasing levels of phosphorus upto 40 kg/ha significantly increased the yield of fenugreek over the lower doses. However, phosphorus use efficiency and its apparent recovery declined with the increasing rates of phosphorus application.

147. BISHT, J. K., S. CHANDRA, R. D. SINGH AND V. P. MANI 2001. **EFFECT OF CUTTING DAYS ON THE FORAGE YIELD AND QUALITY OF COWPEA (*VIGNA UNGUICULATA*) AND GAHAT (*MACROTYLOMA UNIFLORUM*).** *Forage Res.*, **27 (3) : pp. 171-176.** Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICAR), Almora-263 601 (U. P.), India

A field experiment was conducted during 1995 to 1997 at Research Farm of Vivekananda Parvatiya Krishi Anusandhan Sansthan, Hawalbag Distt. Almora to study the effect of different cutting days on the quantity and quality of fodder cowpea and gahat. Cowpea produced the highest green forage at 60 DAS, thereafter yield decreased. However, gahat gave the highest green forage at 80 DAS. Dry matter accumulation pattern did not follow the trend of green forage in cowpea. Both crops exhibited the highest dry matter production at 80 DAS. To obtain highest quantity of quality green forage, cowpea should be harvested at 60 DAS and gahat at 80 DAS.

148. SIYAG, S. AND NAGENDRA BHARDWAJ 2002. **EVALUATION OF VARIOUS FENUGREEK (*TRIGONELLA FOENUM-GRAECUM* L.) CULTIVARS FOR YIELD AND YIELD ATTRIBUTES UNDER DIFFERENT PLANTING DATES.** *Forage Res.*, **27 (4) : pp. 289-292.** Department of Botany, Rajasthan University, Jaipur (Rajasthan), India

A field experiment was conducted at Rajpura, Jaipur during 1995-96 and 1996-97 to study the effect of five sowing dates (1 October, 15 October, 1 November, 15 November and 1 December) on yield and yield attributes of 10

fenugreek cultivars [Lam Selection-1, CO-1, GC-77, HEM-65, EC 26177-3, IC-5487, IL-326-1, PEB-1, Prabha (NLM) and RMT-1]. The experiment was laid out in factorial randomized block design and replicated thrice on a sandy loam soil. The results revealed that crop sown on 15 October gave significantly higher seed and biological yield than sown on 1 November sowing after 15 October reduced the yield consistently. The yield attributing characters were also found to be declined with delayed planting. The fenugreek cultivar PEB-1 proved to be superior to the other cultivars for yield and yield attributes during both the years.

149. KHIRIYA, K. D., B. P. SINGH AND K. D. TANEJA 2003. **EFFECT OF FARM YARD MANURE AND PHOSPHORUS LEVELS ON YIELD, QUALITY AND NUTRIENT UPTAKE BY FENUGREEK (*TRIGONELLA FOENUM-GRAECUM L.*)**. *Forage Res.*, **28 (4)** : pp. 210-214. Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004, India

A field experiment was conducted during the winter seasons (**rabi**) of 1996-97 and 1997-98 at CCS Haryana Agricultural University, Hisar to study the effect of farm yard manure (0, 5, 10 and 15 t ha⁻¹), phosphorus (0, 20, 40 and 60 kg ha⁻¹) on growth, yield and quality of two fenugreek (*Trigonella foenum-graecum L.*) genotypes (HM-65 and NLM). Genotypes and FYM were kept in main plots and levels of phosphorus in sub-plots. Thirty-two treatment combinations were replicated thrice in split plot design. Two years' field study revealed that the concentration of N and P in seed and straw was higher in genotype HM-65 than NLM, whereas the uptake of N, P and K in both the genotypes was found at par. Higher crude protein content was observed in HM-65 but crude protein yield was higher in NLM with respect to grain. Application of FYM significantly enhanced protein content, NPK content and uptake in seed and straw of fenugreek upto 15 t FYM ha⁻¹. Higher seed and straw yield was obtained when 15 t FYM was applied ha⁻¹. NPK content in seed and straw and N & P uptake in seed, straw and total uptake was significantly increased upto 60 kg P₂O₅ ha⁻¹. However, P uptake in seed, straw and their total uptake the response was upto 40 kg P₂O₅ ha⁻¹ only. Phosphorus, crude protein content and uptake in seed and straw increased with increasing levels of phosphorus. Application of increasing levels of phosphorus upto 40 kg ha⁻¹ significantly increased higher seed and straw yield over the lower doses.

150. SHEORAN, R. S., R. K. PANNU, B. S. DUHAN AND B. S. JHORAR 2004. **EFFECT OF PHOSPHORUS FERTILIZATION AND SOWING TIMES ON YIELD OF FENUGREEK (*TRIGONELLA FOENUM-GRAECUM L.*) AND FERTILITY STATUS OF SOIL**. *Forage Res.*, **30 (3)** : pp. 155-158. Forage Research Section, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted during **rabi** seasons of 1995-96 and 1996-97 at CCS Haryana Agricultural University, Hisar to study the effect of three sowing times (Nov. 16, Dec. 1 and Dec. 16) and four levels of phosphorus (0, 30, 60 and 90 kg P₂O₅/ha) on seed yield of two fenugreek genotypes (HM 65 and T 8) and fertility status of soil after the harvest of the crop. Twenty-four treatment combinations keeping genotypes and dates of sowing in main plots and phosphorus in sub-plots were replicated thrice in a split plot design. The results indicated that genotype HM 65 was significantly superior to T 8 in terms of seed and straw yield. Significantly higher seed and straw yields were obtained from Dec.1 sown crop as compared to Nov. 16 and Dec. 16 sown crop. Increasing levels of phosphorus upto 60 kg/ha significantly increased the yield of fenugreek over their lower doses. The available N, P and K in soil (0-15 cm) was found significantly higher in the treatments having genotype T 8 than HM 65 during both the years except available N during 1995-96. Delay in sowing resulted in higher residual N and P in soil. Increase in dose of phosphorus significantly improved the residual N and P over their preceding doses during both the years. None of the treatments had significant effect on the residual N, P and K content in 15-30 cm soil during both the years.

(vi) Mothbean

151. BABU RAM, B. D. YADAV, R. K. NANWAL AND SATYAJEET 2007. **GROWTH AND YIELD OF MOTHBEAN [VIGNAACONITIFOLIA (JACQ) MARECHAL] AS INFLUENCED BY VARIETIES, ROW SPACING AND SEED RATE UNDER RAINFED CONDITIONS.** *Forage Res.*, **33 (2) : pp. 95-97.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment on mothbean crop was conducted during **kharif** seasons of 2003 and 2004 at CCS Haryana Agricultural University, Hisar. The treatments consisted of four varieties and two spacings in main plots and three seed rates in sub-plots were laid out in split plot design with three replications. The varieties RMO 225 and RMO 435 produced significantly more grain yield over RMO 40 and CAZRI Moth-1, whereas biological yield over RMO 40 only. However, the variety CAZRI Moth-1 proved its superiority over RMO 40, RMO 225 and RMO 435 in respect of dry matter accumulation and crop growth rate (CGR). Row spacing of 45 cm proved superior to 30 cm. There was significant increase in grain yield (6.68 and 8.37 q/ha) and biological yield (30.47 and 31.78 q/ha) with 10 kg seed/ha compared to 15 kg/ha.

152. BABU RAM, B. D. YADAV AND RAMESH KUMAR 2008. **GROWTH AND YIELD OF MOTHBEAN (VIGNAACONITIFOLIA) AS INFLUENCED BY NITROGEN AND PHOSPHORUS FERTILIZATION.** *Forage Res.*, **34 (2) : pp. 87-89.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

The experiment was conducted at CCS Haryana Agricultural University, Hisar during 2003 and 2004 on sandy loam soils using factorial randomized block design with three replications. The experiment consisted of four treatments each of nitrogen and phosphorus. Dry matter accumulation and crop growth rate (CGR) increased with the application of 20 and 30 kg N/ha over control and 10 kg N/ha, respectively. The yield and yield attributes were also significantly higher with 20 kg N/ha over control. Further, increase in N level upto 30 kg N/ha had virtually no effect on grain yield. Application of 40 kg P₂O₅/ha significantly improved growth parameters, yield attributes, grain and biological yields over control and 20 kg P₂O₅/ha. Based on two years' study, it may be concluded that the crop may be supplied with 20 kg N and 40 kg P₂O₅/ha for achieving higher yield.

3. Brassica spp.

153. SINGH, B., K. R. SUNARIA, A. KUMAR, YASHPAL YADAV AND R. S. DHANKHAR 2003. **EFFECT OF SULPHUR ON THE YIELD AND QUALITY OF BRASSICA OIL CAKE.** *Forage Res.*, **29 (3) : pp. 107-109.** CCS HAU Regional Research Station, Bawal-123 501 (Haryana), India.

Effect of sulphur on the yield and quality of Brassica oil cake was studied at RRS, Bawal (Haryana). Oilcake and protein production of Brassicas increase significantly with each successive increase in S level.

154. VIKRANT, B. S. VERMA, VISHWAS RAJ AND B. P. SINGH 2004. **INTERACTIVE EFFECT OF MUSTARD VARIETIES WITH NITROGEN LEVELS.** *Forage Res.*, **30 (2) : pp. 109-111.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Present study on interactive effect of mustard varieties with nitrogen levels was conducted at CCSHAU, Hisar. It was observed that the seed and oil yield increased with increased nitrogen level.

155. KHICHAR, M. L. AND RAM NIWAS 2005. **EFFECT OF NITROGEN LEVELS ON HEAT USE EFFICIENCY, GROWTH, BIOMASS AND YIELD OF GOBHI SARSON (*BRASSICA NAPUS*)**. *Forage Res.*, **31 (2) : pp. 130-133**. Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was carried out to study the effect of nitrogen levels on heat use efficiency, crop growth and yield of gobhi sarson (*Brassica napus*) var. GHS-2 during **rabi** season of 1995-96 and 1996-97. The heat unit, heliothermal unit, photothermal unit and heat use efficiency were computed in different nitrogen levels. It was observed that consumption of thermal indices increased with increase in nitrogen application i.e. from 0 to 120 kg N/ha. Leaf area index increased with advancement of crop growth period and attained maxima at most brown seed phenological stage. Plant height, primary and secondary branches, leaf area index and pods/plant increased significantly with increase of application of nitrogen fertilizer. Impact of nitrogen was much pronounced on dry matter as well as crop yield. The crop fertilized with 120 kg N/ha produced highest grain yield 11.0 and 12.5 q/ha during the season of 1995-96 and 1996-97, respectively.

156. SINGH, S., RAM NIWAS AND M. L. KHICHAR 2005. **EFFECT OF SOWING DATES ON HEAT USE EFFICIENCY, YIELD ATTRIBUTES AND YIELD OF *BRASSICA* SPECIES**. *Forage Res.*, **31 (3) : pp. 205-208**. Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was carried out to study the effect of sowing dates on heat use efficiency, biomass and yield of *Brassica* species. Thermal indices : heat unit, heliothermal unit, photothermal unit and heat use efficiency were computed in all the treatments. *Brassica napus* consumed maximum thermal indices followed by *Brassica carinata*, *Brassica juncea* and *Brassica campestris*. Among the *Brassica* species, leaf area index was maximum in *B. juncea* followed by *B. carinata*, *B. napus* and *B. campestris*. *B. juncea* cv. Laxmi produced maximum seed yield (21.57 q/ha) among all the *Brassica* species. *B. juncea* also showed maximum efficiency (0.63 g m⁻² °C⁻¹ day) in heat unit consumption. The seed yield of *Brassica* species was 14.96, 16.37 and 13.45 q/ha in 30 September, 20 October and 10 November sowing dates, respectively.

157. TIWANA, U. S., D. P. CHAUDHARY AND PRITPAL SINGH 2009. **EFFECT OF SEED RATE ON THE FODDER YIELD AND QUALITY OF RAPESEED AND MUSTARD VARIETIES**. *Forage Res.*, **35 (1): pp. 39-41**. Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

The field experiment was carried out at Punjab Agricultural University, Ludhiana during **rabi** seasons of 2006-07 and 2007-08 to find out the optimum seed rate (5, 7.5, 10 and 12.5 kg/ha) of rapeseed and mustard varieties (Raya, African sarson and Chinese cabbage) for fodder. African sarson gave significantly higher green fodder yield (447.9 q/ha) by a margin of 59.3 and 22.6 per cent and dry matter yield (53.6 q/ha) by 54.9 and 59.1 per cent over Raya and Chinese cabbage, respectively. Chinese cabbage recorded significantly higher green fodder yield over Raya and magnitude of increase was 30 per cent, but in dry matter yield Raya out yielded Chinese cabbage by a margin of 2.7 per cent. The seed rate of 10 kg/ha recorded 31.9 and 13.6 per cent higher green fodder, and 28.0 and 12.9 per cent higher dry matter yield over 5 and 7.5 kg seed/ha, respectively.

158. PATEL, B. B., P. T. PATEL AND V. K. BHATT 2008. **YIELD AND QUALITY OF FORAGE SORGHUM AS INFLUENCED BY INTERCROPPING OF COWPEA AND NITROGEN UNDER RAINFED CONDITIONS**. *Forage Res.*, **34 (3) : pp. 170-173**. Department of Agronomy, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar-385 506 (Gujarat), India

A field experiment was conducted during 2003 and 2004 under rainfed conditions on clay soil involving forage sorghum-cowpea intercropping superimposing levels of nitrogen to find out appropriate row ratio of intercropping and optimum dose of nitrogen. Intercropping of forage sorghum with cowpea in the row ratio of 2 : 1

produced significantly higher yield (green and dry) over sorghum alone. Cowpea as an intercrop helped to enhance crude protein content of sorghum and the maximum (7.84%) was achieved with the row ratio of 1 : 2. The reduction in crude fiber content (34.07-35.62%) was noticed with intercrop treatment over sole crop of sorghum (36.22%). Total ash and HCN content were not significantly influenced by intercropping. Crude protein, total ash and HCN content as well as green and dry fodder yield were increased significantly up to 60 kg N/ha. Higher N application lowered crude fiber content. Interaction of intercropping and N levels contributed positively in enhancement of crude protein content of forage sorghum. Successive increase in N level, either in sole sorghum or intercropped sorghum exhibited improvement in protein content. The combination of sorghum+ cowpea (1 : 2) and 60 kg N/ha realized maximum crude protein content of 7.87 per cent, whereas the lowest with sorghum alone without nitrogen (6.64%).

4. Other Crops

159. SINGH, J. AND SATYAVIR SINGH YADAV 2004. **EFFECT OF AMOUNT AND TIME OF NITROGEN APPLICATION ON GREEN FODDER, SEED YIELD AND ECONOMIC RETURNS OF CHICORY.** *Forage Res.*, **30 (1) : pp. 6-9.** CCSHAU Regional Research Station, Bawal-123 501, Rewari (Haryana), India

A field experiment was conducted at CCSHAU Regional Research Station, Bawal during winter seasons of 1996-97 and 1997-98 to find out the optimum nitrogen application schedule for chicory (*Cichorium intybus*), locally known as *Kasni*. Eleven treatments viz., no nitrogen application, 15 and 30 kg N/ha each applied in one, two and three splits and 45 and 60 kg N/ha each applied in two and three splits, were laid out in randomized block design with three replications. Number and length of leaves, green fodder yield seed yield attributes and seed yield increased significantly by the time of nitrogen application. Application of 45 kg N/ha in two or three equal splits at sowing, at first cut and at second cut for fodder produced green fodder and seed yield at par with 60 kg N/ha either applied in two or three splits and was significantly better than lower nitrogen levels. The net returns and benefit : cost ratio were maximum in 60 kg N/ha level under both two and three split schedules; however, these were not remarkably higher than 45 kg N/ha level applied in three splits. At higher levels of nitrogen application, the net returns were higher from fodder component, while at lower nitrogen levels, the net returns were higher from seed component of the crop.

160. PURI, K. P. AND U. S. TIWANA 2004. **EFFECT OF DIFFERENT LEVELS OF NITROGEN AND HOSPHORUS ON THE FORAGE AND SEED YIELD OF RYEGRASS (*LOLIUM PERENNE L.*).** *Forage Res.*, **30 (1) : pp. 10-12.** Department of Plant Breeding, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

The research studies on fodder and seed production of ryegrass (*Lolium perenne L.*) comprising 12 treatment combinations with four levels of nitrogen (30, 60, 90 and 120 kg/ha/cut) and three levels of phosphorus (0, 50 and 100 kg P₂O₅/ha) were carried out in a randomized block design with four replications. The mean of two years indicated that nitrogen at 120 kg/ha/cut increased the green fodder (834 q/ha) and dry matter yield (129 q/ha) significantly over the lower doses. After leaving the same crop for seed production during mid March, nitrogen at the rate of 60 kg/ha gave the highest seed yield (7.61 q/ha). Beyond this dose, seed yield decreased drastically due to lodging. Phosphorus at the rate of 50 kg P₂O₅/ha gave 5.0 per cent higher dry matter (99.6 q/ha) and 7.4 per cent higher seed yield (7.26 q/ha) over control.

161. SAREEN, S., RAM SINGH AND INDER DEV 2005. **EFFECT OF PHOSPHORUS LEVEL ON HERBAGE QUALITY OF WHITE CLOVER GENOTYPES.** *Forage Res.*, **30 (4) : pp. 207-208.** IGFR Regional Research Centre, CSK Himachal Pradesh Krishi Vishwavidyalaya Campus, Palampur-176 062 (H. P.), India

Seven better performing genotypes of white clover, identified on basis of morphological, yield and quality parameters, were used to study the effect of phosphorus application on biomass quantity and quality in pot trial. Four levels 0, 13, 27 and 40 mg/kg soil of phosphorus fertilizer were applied and five replicates were used. The genotypes

differed significantly in biomass production from four cuts taken in one year of the study. The study revealed that whereas with the increase in phosphorus level, the biomass production decreased, the crude protein (%) increased. It can be attributed to role of phosphorus in root and nodule development and thereby indirectly in N fixation.

- 162.** SATAPATHY, M. R., H. SEN, M. K. NANDA AND B. K. MOHAPATRA 2005. **EFFECT OF NITROGEN LEVELS AND CUTTING MANAGEMENT ON TUBER AND FODDER PRODUCTION OF SWEET POTATO CULTIVARS.** *Forage Res.*, **31 (2) : pp. 99-102.** Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia (West Bengal), India

A field experiment was conducted at the Teaching Farm of the Bidhan Chandra Krishi Viswavidyalaya during **rabi** seasons of 2000-01 and 2001-02 to see the suitability of sweet potato cultivars for both tuber and fodder production under different nitrogen levels and cutting management practices. Highest tuber yield of 16.53 t ha⁻¹ was obtained from cultivar Sree Bhadra, whereas the total green herbage yield was higher in IB-90-12-29 (21.24 t ha⁻¹). With increase in levels of nitrogen from 50 to 100 kg ha⁻¹, the tuber yields increased from 8.91 to 12.85 t ha⁻¹ and the total green herbage yield from 16.08 to 23.68 t ha⁻¹. No cut treatment recorded higher tuber yield (14.07 t ha⁻¹), however, the total cumulative green herbage yield increased with increase in number of cuttings being maximum (21.60 t ha⁻¹) in two-cut treatment.

- 163.** PATEL, M. R., A. C. SADHU, P. C. PATEL, C. C. PATEL AND N. N. PATEL 2007. **FORAGE YIELD AND QUALITY OF PANDADIU (*CHICORIUM INTYBUS L.*) AS INFLUENCED BY SEED RATE AND NITROGEN LEVELS UNDER MIDDLE GUJARAT CONDITIONS.** *Forage Res.*, **32 (4): pp. 233-235.** Main Forage Research Station, AAU, Anand

A field experiment was conducted at Main Forage Research Station, G. A. U., Anand during **rabi** seasons of 1999-2000 to 2002-03 to evaluate the effect of different seed rates (6, 8, 10 and 12 kg/ha) and levels of nitrogen (15, 30 and 45 kg N/ha) on forage yield and quality of Pandadiu (*Chicorium intybus L.*). The seed rate of 10 kg/ha produced significantly higher green forage and dry matter yields than lower seed rates of 6 and 8 kg/ha. Increase in nitrogen application upto 45 kg N/ha after each cut significantly increased the green forage yield, but dry matter and crude protein yields increased only upto 30 kg N/ha after each cut. The interaction effect of seed rate and nitrogen levels revealed that the application of 45 kg N/ha after each cut as top dressing along with the seed rate of 10 kg/ha or 12 kg/ha recorded higher forage production and net realization of Pandadiu.

- 164.** PATEL, H. D., P. T. PATEL AND D. M. PATEL 2008. **SEED RATE AND NITROGEN MANAGEMENT IN FORAGE CHICORY (*CHICORIUM INTYBUS L.*) UNDER NORTH GUJARAT AGRO-CLIMATIC ZONE.** *Forage Res.*, **33 (4) : pp. 233-235.** Department of Agronomy, S. D. Agricultural University, Sardarkrushinagar-385 506, District Banaskantha (Gujarat), India

Field investigations were conducted during **rabi** seasons of 2002-03 and 2003-04 at Agronomy Instructional Farm, SDAU, Sardarkrushinagar to examine the effect of varying seed rates (4, 6, 8 and 10 kg/ha) and levels of nitrogen (0, 15, 30 and 45 kg/ha after each cut), on growth and yield of forage chicory. With successive increase in seed rate, increasing trend in plant height and leaf length was observed. However, dry matter production per plant was found decreasing with increase in seed rate. A remarkable improvement in plant height, leaf length as well as higher plant density with 10 kg/ha seed rate, attributed to realize significantly the highest yield of green (1266.7 q/ha) and dry forage (173.36 q/ha) of chicory. A linear increase in yield has been recorded with increase in seed rate upto 10 kg/ha. Use of high seed rate (10 kg/ha) was also found more profitable than rest of the lower seed rates. Nitrogen application to chicory after each cut brought significant improvement in plant height, leaf length, leaf area and dry matter production. Successive increase in N levels led to linear increase in these yield attributes. Due to favourable effect of N on yield parameters, application of 45 kg/ha after each cut achieved significantly the highest green (1467.3 q/ha) and dry forage (183.08 q/ha) yield.

165. PURI, K. P. AND U. S. TIWANA 2008. **EFFECT OF TIME OF LEAVING AND NITROGEN APPLICATION TO LAST CUT ON THE SEED YIELD OF RYEGRASS.** *Forage Res.*, **34 (3) : pp. 197-198.** Department of Plant Breeding and Biotechnology, PAU, Ludhiana-141004.

This study concluded that the ryegrass crop left for seed production during February 25 to March 7 gave good seed yield (4.93 to 5.16 q/ha) with 25 kg nitrogen per hectare (4.98 q/ha) applied at the time of leaving the crop for seed production.

166. SMITHA PATEL, P. A., S. C. ALAGUNDAGI, C. P. MANSUR, S. V. HOSAMANI AND V. S. KUBSAD 2010. **FODDER YIELD AND QUALITY OF AMARANTH GENOTYPES UNDER DIFFERENT ROW SPACINGS AND SEED RATES.** *Forage Res.*, **36 (2): pp. 82-86.** Department of Agronomy, University of Agricultural Sciences, Dharwad-580 005 (Karnataka), India

A field experiment was conducted at University of Agricultural Sciences during **kharif** 2009 to study the fodder yield and quality of amaranth genotypes (Suvarna, Gujarat Amaranth-1 and SKNA-504) under different row spacings (30 and 45 cm) and seed rates (2.0, 2.5 and 3.0 kg/ha). The row spacing of 45 cm recorded significantly higher green forage (36.77 t/ha), higher dry matter yield (2.33 t/ha) and yields of all the fodder quality parameters compared to 30 cm row spacing. Among the genotypes, Gujarat Amaranth-1 (GA-1) produced significantly higher green forage (37.64 t/ha), dry matter yield (2.59 t/ha), contents and yield of fodder quality parameters compared to Suvarna and SKNA-504 genotypes. Seed rate of 2.5 kg/ha produced significantly higher green forage (36.30 t/ha), dry matter yield (2.26 t/ha) and higher yields of fodder quality parameters compared to 3.0 kg/ha seed rate. Significantly higher green forage yield (43.53 t/ha), dry matter yield (3.01 t/ha) and yield of fodder quality components can be obtained with genotype GA-1 in 45 cm row spacing at 2.5 kg/ha seed rate.

167. PATHAN, S. H. AND R. L. BHILARE. 2008. **RESPONSE OF TEOSINTE (*EUCHLAENA MAXICANA*) VARIETIES TO NITROGEN LEVELS.** *Forage Res.*, **33 (4): pp. 253-254.** Mahatma Phule Krishi Vidyapeeth, Rahuri-413722(Maharashtra).

It was observed that for higher productivity and tonnage of teosinte, variety JHT 04-2 should be fertilized with 90 kg N/ha.

168. SATPAL, R. A. SINGH AND RAJESH KATHWAL 2010. **EFFECT OF ORGANIC AND INORGANIC SOURCES OF NITROGEN APPLICATION ON WHEAT DRY FODDER PRODUCTION AND ITS CONTRIBUTING TRAITS.** *Forage Res.*, **36 (3) : pp. 161-165.** Department of Agronomy, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumargang), Faizabad-224 229 (U. P.), India

A field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad during 200-06 to study the effect of organic and inorganic sources of nitrogen application on wheat dry fodder production and its contributing traits. The results revealed that the plant height, number of tillers per row metre length, dry matter accumulation and leaf area index increased significantly at all the stages of crop growth with the application of 100 per cent nitrogen through inorganic source. Straw yield was highest with the recommended dose of nitrogen through inorganic source followed by inorganic source based on soil test value.

5. Inter/Mixed Cropping

169. SHIVRAN, D. R. AND R. G. PAREEK 2001. **EFFECT OF NITROGEN, PHOSPHORUS AND CROPPING SYSTEM ON PHYSIOLOGICAL PARAMETERS, YIELD AND QUALITY OF PEARL MILLET (*Pennisetum americanum*) FODDER.** *Forage Res.*, 27 (1) : pp. 29-34. Department of Agronomy, R. A. U. SKN College of Agriculture, Jobner-303 329 (Rajasthan), India

An experiment with three levels of nitrogen and phosphorus each and two cropping systems was conducted in RBD during summer 1995 at Jobner (Rajasthan), to study their effects on physiological parameters, green and dry fodder yields as well as quality parameters of pearl millet fodder. The successive levels of nitrogen from 30 to 90 kg ha⁻¹ significantly enhanced the LAI and LAR at first cutting and CGR and RGR at both the cuttings, green and dry fodder yields and crude protein content. Phosphorus fertilization at 60 kg ha⁻¹ significantly enhanced physiological parameters viz., LAI, CGR and RGR and green and dry fodder yields over 20 kg P₂O₅ ha⁻¹. Mixed cropping of pearl millet with clusterbean significantly enhanced the green and dry fodder yields as well as crude protein content.

170. NANWAL, R. K., S. K. SHARMA AND K. S. PANWAR 2001. **INTERCROPPING STUDIES OF DIFFERENT FODDER CROPS IN INDIAN MUSTARD (*Brassica juncea* L.) UNDER CONSERVED SOIL MOISTURE CONDITIONS.** *Forage Res.*, 27 (1): pp. 63-66. Dryland Agriculture Research Project, CCS Haryana Agricultural University, Hisar-125 004, India

A study was undertaken to find out suitable fodder intercrops out of mustard, gobbia sarson, toria, Chinese cabbage, barley and oats for mustard alongwith economic assessment of all the intercropping systems at Dryland Agriculture Research Farm, CCS Haryana Agricultural University, Hisar during winter seasons of 1995-96 and 1996-97. The different fodder intercrops taken between paired rows of mustard (2 : 1, 30/60 cm) did not affect significantly the seed yield of base crop mustard under conserved soil moisture conditions. Seeding of mustard in paired row system with gobbia sarson (*Brassica napus*) as intercrop recorded maximum total mustard equivalent (18.6 and 21.7 q ha⁻¹) followed by mustard+oat (*Avena sativa*) having total mustard equivalent of 18.5 and 21.2 q ha⁻¹ as compared to sole crop of mustard (15.8 and 16.9 q ha⁻¹) in the respective years.

171. KALIA, R., KAPIL SAROCH AND NAVEEN KUMAR 2001. **PRODUCTION POTENTIAL OF OAT (*Avena sativa*) BASED FORAGE INTERCROPPING SYSTEMS UNDER SUB-HUMID MID HILL CONDITIONS OF HIMACHAL PRADESH.** *Forage Res.*, 27 (2) : pp. 79-82. Department of Plant Breeding and Genetics, Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062 (H. P.), India

A field experiment was conducted during **rabi** seasons of 1995-96, 1996-97 and 1997-98 to assess the comparative performance of forage vetch and shaftal with oat in 1 : 1, 1 : 3 and 3 : 1 intercropping systems under sub-humid mid hill conditions of H. P. Pure oat produced more plant height than pure vetch and shaftal, whereas oat+vetch in 1 : 1 ratio significantly reduced the oat plant height. Among intercrops vetch had more height than shaftal. Intercropping of vetch with oat in 1 : 3 was more productive with respect to green forage yield (414.18 q/ha) and gave 14.59, 21.93 and 52.17 per cent higher yield than sole oat, vetch and shaftal, respectively, whereas oat+vetch in 3 : 1 system resulted in more dry forage production.

172. KUMAR, K. R. AND V. B. BHANUMURTHY 2001. **EFFECT OF STAGGERED SOWING AND RELATIVE PROPORTION OF COWPEA ON THE PERFORMANCE OF MAIZE+COWPEA INTERCROPPING SYSTEM.** *Forage Res.*, 27 (2): pp. 105-110. Department of Agronomy, College of Agriculture, Rajendranagar, Hyderabad-500 030, India

An experiment was conducted during **kharif** 1998 and summer 1999 to assess the optimum proportion of maize and cowpea in intercropping system and also the time of sowing of cowpea in the system and the optimum time of harvest for green fodder. The proportions of maize and cowpea tested were 1 : 1, 1 : 2 and 2 : 1. There were

two times of sowing of cowpea viz., normal i. e. simultaneously with maize and staggered sowing 15 days later. The crops were cut for green fodder during two different periods i. e. when maize was either at tasselling or at milk stage. The intercropping systems were compared with sole crops. The performance of maize was better in 2 : 1 system compared to other systems tested. Here again, maize yield increased further when the intercrop of cowpea was staggered sown 15 days later. However, cowpea was totally dominated by maize and its yield decreased drastically in the intercropping systems compared to sole cropping. The total green fodder yield was 36 to 42 t/ha during **kharif** 1998 and 27.8 to 30.6 t/ha during summer 1999, in the intercropping system with 2 : 1 ratio. The crude protein yields were higher with sole cowpea. Considering the green fodder as well as crude protein yields, intercropping maize and cowpea in 2 : 1 ratio was found to be better and staggered sowing of cowpea in this system showed measurable advantage. Tasselling stage of maize was found to be the optimum time for harvesting both the crops for green fodder.

- 173.** LAKSHMI, S., L. GIRIJADEVI, M. ACHUTHANNAIR AND C. VIDYA 2002. **YIELD AND ECONOMICS OF FODDER LEGUME HYBRID NAPIER INTERCROPPING SYSTEMS.** *Forage Res.*, **28 (1) : pp. 13-15.** Department of Agronomy, College of Agriculture, Vellayani-695 522 (Kerala), India

A field experiment was carried out at Instructional Farm, College of Agriculture, Vellayani, Kerala during 1996-97 and 1997-98 to select a suitable intercrop combination for hybrid napier and to study the economics of this fodder based intercropping system. Results indicated that the treatment combination involving hybrid napier+*Stylosanthes hamata* produced the highest tonnage of green fodder (172.55 t ha⁻¹) and dry matter of 87.30 t ha⁻¹. This perennial combination also recorded the maximum B : C ratio of 3.31. Among the annual legumes, cowpea was found to be the best intercrop for hybrid napier with a green fodder yield of 136.94 t ha⁻¹ and dry fodder yield of 50.10 t ha⁻¹. The B : C ratio of this combination was 2.5.

- 174.** DESALE, J. S., S. H. PATHAN, R. L. BHILARE, R. M. BABAR, V. S. PATIL AND A. G. HIRAY 2002. **INTERCROPPING OF SORGHUM WITH SOYBEAN UNDER RAINFED CONDITION.** *Forage Res.*, **28 (1) : pp. 52-54.** Forage Crops Research Project, at MPKV, Rahuri.

An experiment on intercropping of sorghum with soybean under rainfed condition was conducted under Forage Crops Research Project, at MPKV, Rahuri. The trends of gross monetary returns, sorghum grain equivalent yield and LER showed that normal planting of sorghum at 45cm and intercropped one row of sorghum appeared to be the most efficient and profitable cropping system under rainfed in Maharashtra.

- 175.** YADAVA, N. S. AND N. S. SOLANKI 2002. **EFFECT OF INTERCROPPING OF FORAGE LEGUMES WITH PEARL MILLET AND SORGHUM IN ARID REGION.** *Forage Res.*, **28 (2) : pp. 77-79.** AICRP on Forage Crops, Agricultural Research Station, Bikaner (Rajasthan), India

Cereals (pearl millet and sorghum) and legumes (cowpea and guar) were grown for fodder as sole crop and in combination with each other (using 1 : 1 and 2 : 2 row proportions) for three consecutive years i. e. 1996, 1997 and 1998 in **kharif** season at Agricultural Research Station, Bikaner, Rajasthan. Results of the study revealed that among sole crops, pearl millet gave the highest green fodder (263.16 q/ha) and dry matter yield (64.35 q/ha) followed by sole crop of guar (218.85 and 39.33 q/ha green and dry fodder, respectively). When pearl millet grown in combination with guar and cowpea, green fodder yield obtained from pearl millet plus guar under 2 : 2 row proportion was significantly higher than the sole crop of pearl millet. Sorghum either as a sole crop or as an intercrop was not found beneficial.

176. NYAMAGONDA, S. S., S. S. ANGADI AND BASAVARAJ YENAGI 2002. **EFFECT OF SEED PROPORTION MIXTURES ON YIELD AND QUALITY OF FORAGE MAIZE-LEGUME MIXED CROPPING SYSTEM.** *Forage Res.*, **28 (2) : pp. 94-97.** College of Agriculture, University of Agricultural Sciences, Dharwad-580 005 (M. S.), India

Field experiment was carried out to study the effect of seed proportion mixtures on yield and quality of forage maize-legume mixed cropping system at Main Research Station, University of Agricultural Sciences, Dharwad during **kharif** 1999. Maize, cowpea, horsegram and fieldbean were raised as pure and mixed in 100 : 25, 100 : 50, 100 : 75 and 100 : 100 seed proportions. The results showed that maize, when mixed with fieldbean in 100 : 50 proportion, resulted in significant increase in the green forage yield (73.43 t/ha), dry matter yield (14.47 t/ha) and crude protein yield (1336 kg/ha) with superior palatability (96.23%). Performance of maize-legume combinations was better than pure stand.

177. PATEL, J. R. AND S. RAJAGOPAL 2002. **PERFORMANCE OF SORGHUM AND COWPEA FORAGE IN INTERCROPPING.** *Forage Res.*, **28 (3) : pp. 181-182.** College of Veterinary Sciences, Anjora (Durg), (M. P.), India

The experiment on sorghum and cowpea forage in intercropping was conducted during **kharif** 1997 at the Farm of the College of Veterinary Sciences, Anjora (Durg), M.P. From the present study, it can be concluded that intercropping of sorghum+cowpea in 4:3 row ratio with 50+50 kg N/ha was found better for higher fodder yield, LER net profit.

178. REDDY, D. M., K. B. SUNEETHA DEVI AND MIR AZAM SULTAN 2004. **FODDER BASED INTERCROPPING FOR HIGHER BIOMASS AND QUALITY FODDER PRODUCTION.** *Forage Res.*, **29 (4) : pp. 217-218.** Livestock Research Institute, Acharya N. G. Ranga Agricultural University, Rajendranagar.

Fodder based intercropping for higher biomass and quality fodder production study was conducted at Livestock Research Institute, Acharya N. G. Ranga Agricultural University, Rajendranagar. It was found that 4:1 system of intercropping maize and cowpea can be good option for higher green fodder yield. For dry matter and crude protein yields 2:2 and 2:1 systems could be recommended for the dairy farmers for reaping higher returns.

179. CHOUDHARY, S. K., R. B. THAKUR AND S. K. THAKUR 2004. **EFFECT OF RELATIVE PROPORTION OF FERTILITY ON THE PERFORMANCE OF MAIZE+BERSEEM INTERCROPPING SYSTEM.** *Forage Res.*, **30 (1) : pp. 22-24.** Department of Agronomy, Rajendra Agricultural University, Pusa, Samastipur-848 125 (Bihar), India

An experiment was conducted for three consecutive **rabi** seasons during 1995-96 to 1997-98 in silty clay soil with low fertility status under mid-land condition of north Bihar to assess the possibility and feasibility of growing maize for grain together with berseem for fodder under varying fertility levels in randomised block design replicated thrice. Maximum yield in terms of maize grain equivalent was obtained in treatment comprising berseem+maize with fertility levels of 140-120-70, whereas treatment in which berseem was grown with maize in paired row system with 120-60-40 fetched maximum benefit : cost ratio.

180. RANA, N. S., S. K. SAINI AND SANJAY KUMAR 2004. **COMPATIBILITY AND YIELD PERFORMANCE OF FORAGES IN INTERCROPPING WITH SUGARCANE RATOON.** *Forage Res.*, **30 (1) : pp. 25-27.** Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar-263 145 (Uttaranchal), India

A field experiment was conducted to find out suitability of forages as intercrop in winter initiated sugarcane ratoon at GBPUA&T, Pantnagar during 2000-02. Fourteen treatments, comprising seven cropping systems i. e. sole ratoon and intercropping with berseem (*Trifolium alexandrinum*), lucerne (*Medicago sativa*), oat (*Avena sativa*)—

single cut & multicut, shaftal (*Trifolium* sp.) and methi (*Trigonella foenum-graecum*), with 100 and 75 per cent of recommended N for sugarcane (180 kg/ha) were tested in sugarcane crop ratooned in 3rd week of December. Forage legumes were given 25 : 60 kg of N and P₂O₅/ha, whereas oat was fertilized with 80 : 40 kg of N and P₂O₅/ha on row basis. The results revealed that all the intercrops except berseem reduced cane yield attributed to less number of millable canes and lower cane weight, though the reduction was significant only with two cuts from oat cv. UPO-212. Mean reduction in cane yield was 9.5, 10.5, 2.6, 4.2 and 8.4 per cent with oat single cut, oat multicut, lucerne, shaftal and methi. The highest mean green forage yield was obtained from oat cv. UPO-212 (46 t/ha) and the lowest from methi (14 t/ha). Berseem, oat and lucerne gave statistically similar forage yield being 36.5, 32.6 and 41.5 t/ha, respectively. Sugarcane ratoon+berseem gave highest mean cane equivalent yield (114.6 t/ha) being 17.1, 11.6, 7.5, 2.27, 7.5 and 18.3 per cent more than sole cane and with oat one cut, oat two cuts, lucerne, shaftal and methi. Sugarcane intercropped with berseem gave highest net return of Rs. 74654 followed by sugarcane+lucerne (Rs. 72472) as against Rs. 62442 of sugarcane ratoon.

- 181. SINGH, B., R. S. DHUKIA AND B. P. SINGH 2004. NUTRIENT CONTENT AND UPTAKE OF FORAGE CROPS AS AFFECTED BY INTERCROPPING MANAGEMENT. *Forage Res.*, 30 (3) : pp. 167-169.** Department of Agronomy, CCS Haryana Agricultural University, Hisar.

Nutrient content and uptake of forage crops as affected by intercropping management was tested at CCSHAU, Hisar and observed that sorghum + cowpea (2:1) intercropping resulted in maximum uptake of nitrogen.

- 182. DADHEECH, R. C., ARJUN KUMAR VERMA AND H. K. SUMERIYA 2005. INFLUENCE OF LEGUME MIXTURE AND NUTRIENT LEVELS ON YIELD AND QUALITY OF FODDER OAT (*AVENA SATIVA* L.). *Forage Res.*, 30 (4) : pp. 179-183.** Department of Agronomy, Maharana Pratap University of Agriculture & Technology, Udaipur (Rajasthan), India

A field experiment was conducted during **rabi** seasons of 2001-02 and 2002-03 at Instructional Farm, Rajasthan College of Agriculture, Udaipur to study the effect of balanced fertilization and legume mixture on fodder yield and quality of oat. Legume mixture oat+berseem (2 : 1) and oat+lucerne (2 : 1) significantly improved green and dry fodder yield over sole oat to the magnitude of 22.87 and 20.85, and 129.38 and 16.66 per cent, respectively. Application of 120 kg N+60 kg P₂O₅+30 kg K₂O significantly increased green and dry fodder yield over sole nitrogen application to the magnitude of 31.38 and 10.19 per cent, respectively. Legume mixture oat+berseem (2 : 1), oat+lucerne (2 : 1) significantly improved crude fat content, crude fibre, mineral matter, NFE and TDN production over sole oat. Further, application of 120 kg N+60 kg P₂O₅+30 kg K₂O/ha significantly enhanced crude fibre and NFE content and crude fat, crude fibre, mineral matter, NFE and TDN yield over sole nitrogen.

- 183. SARDANA, V. AND S. S. NARWAL 2005. EFFECT OF ROW SPACING AND CUTTING MANAGEMENT OF COMPONENT CROPS ON THE FODDER AND SEED YIELD IN BERSEEM BASED INTERCROPPING SYSTEMS. *Forage Res.*, 30 (4) : pp. 184-188.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Field investigations were conducted at CCS Haryana Agricultural University, Hisar to study the effect of different *Brassica* crops on the fodder and seed yield of berseem in the intercropping system (ICS). Results revealed that the green fodder yield was higher when both berseem and intercrops (mustard/*gobhi sarson*/chinese cabbage) were sown by broadcast method compared to sole crop of berseem. The highest total green fodder yield was obtained when *Brassica* crops were sown in rows 100 cm apart and given two fodder cuttings. However, green fodder yield in berseem+chinese cabbage (broadcast sown) was slightly higher than when chinese cabbage was sown in rows 100 cm apart and given two fodder cuttings. Total green fodder yield in berseem+mustard was lower than berseem+*gobhi sarson* or berseem+chinese cabbage. Sole crops produced significantly higher seed yield which decreased in the ICS. Seed yield of berseem in the ICS was higher when *Brassica* crops were sown in wider row spacing of 150-200 cm and cut once or twice for fodder as compared to their narrow row spacing and uncut

treatment. However, mustard/*gobhi sarson*/chinese cabbage in the ICS produced higher seed yield when sown in narrow row spacing and left uncut. Among the three intercrops, reduction in seed yield of berseem in the ICS compared to sole crop yield was lowest in berseem+*gobhi sarson*, while the maximum reduction was noticed in berseem+mustard ICS. Thus, *gobhi sarson* was found to be the most compatible crop of intercropping with berseem.

- 184.** PURI, K. P., M. S. TIWANA, U. S. TIWANA AND I. S. THIND 2005. **FORAGE YIELD AND QUALITY PERFORMANCE OF MIXING RYEGRASS IN SHAFTAL+OATS AND SHAFTAL+SARSON MIXTURE.** *Forage Res.*, **31 (1) : pp. 18-20.** Forage Section, Punjab Agricultural University, Ludhiana-141 004 (Punjab) India

The experiment was conducted during **rabi** 1994-95 to 1998-99 at Punjab Agricultural University, Ludhiana to study the effect of ryegrass in mixture with shaftal+oats and shaftal+sarson. Shaftal pure produced the lowest green fodder (889 q/ha) and dry matter (111 q/ha) yield. Shaftal+oats, shaftal+sarson and shaftal+ryegrass mixtures gave higher fodder yield over shaftal pure, only significant response was observed with shaftal+ryegrass. Whereas shaftal+oats+ryegrass and shaftal+sarson+ryegrass mixtures gave significantly higher fodder yield over shaftal+oats and shaftal+sarson mixtures, respectively. On an average of five years, from the total cuttings, the mixture of shaftal+oats+ryegrass produced 11.4 per cent higher green fodder and 23.7 per cent higher dry matter yield over shaftal+oats mixture. Similarly, shaftal+sarson mixture gave 12.7 per cent higher green fodder and 21.6 per cent higher dry matter yield over shaftal+sarson mixture. These mixtures also gave higher green fodder and dry matter yield in the first cutting. The mixture of shaftal+oats/sarson+ryegrass also improved the quality of fodder.

- 185.** SHARAM, K. M. AND P. SINGH 2005. **EFFECT OF MIXING DIPLOID-TETRAPLOID BERSEEM AND LUCERN SEEDS IN VARIOUS RATIOS ON FORAGE AND NUTRIENTS YIELD.** *Forage Res.*, **31 (1) : pp. 55-56.** Department of Agronomy, Rajasthan College of Agriculture, Udaipur-313001.

Out of thirteen treatments, the maximum cumulative green forage yield was recorded with ½ diploid +1/2 tetraploid seed mixture which was 6.72 and 11.09 per cent higher over pure diploid and pure tetraploid berseem, respectively.

- 186.** SINGH, B., R. KUMAR, R. S. DHUKIA AND B. P. SINGH. 2005. **EFFECT OF INTERCROPPING ON THE YIELD OF SUMMER FODDERS.** *Forage Res.*, **31 (1) : pp. 59-61.** Department of Agronomy, CCS Haryana Agricultural University, Hisar

Intercropping combination of sorghum+cowpea (2 : 1) gave maximum green and dry matter yield over all intercrop combinations.

- 187.** VERMA, A. K. AND R. C. DADHEECH 2005. **YIELD AND ECONOMICS OF FODDER OAT AS INFLUENCED BY BALANCED FERTILIZATION AND LEGUME MIXTURE.** *Forage Res.*, **31 (2) : pp. 73-74.** Department of Agronomy, Maharana Pratap University of Agriculture & Technology, Udaipur (Rajasthan), India

A field experiment was conducted during **rabi** season of 2001-02 and 2002-03 at Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) to study the effect of balanced fertilizer and legume mixture on yield and economics of fodder oat. Legume mixture oat+berseem (2 : 1 row ratio) and oat+lucerne (2 : 1 row ratio) significantly enhanced green fodder, dry fodder yield, net return and B : C ratio over sole oat. Similarly, application of 120 kg N+60 kg P₂O₅+30 kg K₂O/ha significantly improved the fodder yield, net return and B : C ratio over nitrogen application alone.

- 188. TULASA RAM 2006. EFFECT OF INTERCROPPING/COMPANION CROP ON GROWTH AND FODDER YIELD OF LUCERNE (*MEDICAGO SATIVA L.*) UNDER VARYING SOWING ENVIRONMENTS. *Forage Res.*, **31 (4) : pp. 231-233.** Regional Agricultural Research Sub-Station, Sher-e-Kashmir University of Agricultural Science & Technology, Kargil, Ladakh (J & K), India**

A field experiment was conducted at Regional Agricultural Research Sub-Station, Kargil, Ladakh (J & K) for three consecutive years from 2001 to 2003. The treatments were comprised of four dates of sowing (21 May, 6 June, 21 June and 5 July) and five intercropping systems of companion crops i. e. lucerne alone, lucerne+mustard, lucerne+buckwheat, lucerne+foxtail millet and lucerne+chickpea. The results revealed that delay in sowing from 21 May resulted in decline in the survival and resprouting of lucerne seedlings. Intercropping of buckwheat in lucerne increased the survival as well as resprouting of lucerne over other companion/intercrops. The green fodder and dry matter yields were found to decrease with delay in sowing upto 21 June during both the years. The highest fodder yield was recorded in 21 May sowing followed by 6 June and 5 July sowings. The lucerne crop with companion/intercrops gave significantly higher fodder yield than pure crop of lucerne. Intercropping of buckwheat in lucerne resulted in significantly higher fodder yield than the other intercropping systems.

- 189. NAVEEN KUMAR AND NALEENI RAMAWAT 2006. PRODUCTION POTENTIAL AND ECONOMICS OF MAIZE (*ZEA MAYS*) + GUINEA GRASS (*PANICUM MAXIMUM*) CROPPING IN DIFFERENT PROPORTIONS UNDER SUB-TROPICAL CONDITIONS. *Forage Res.*, **32 (3) : pp. 159-162.** Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Palampur-176 062 (H P), India**

Field experiment was conducted during kharif seasons of 2001 and 2002 to find out the suitable seed proportions and cropping methods of guinea grass with grain and fodder maize. Maize and guinea grass were sown in 1 : 1, 1 : 2 and 2 : 1 seed proportions in inter and mixed cropping systems and were compared with respective sole stands. No significant reduction in maize grain yield was observed in inter or mixed cropping. Sole cropping of fodder maize was advantageous in terms of net returns as well as benefit : cost ratio than either sole grain maize or guinea grass. Total productivity in terms of guinea grass equivalent yield was highest in guinea grass+fodder maize. Intercropping proved superior to mixed cropping with respect to dry fodder yield of guinea grass. However, reduction in yield of guinea grass was 48.27 and 50.10 q/ha under inter and mixed cropping, respectively, compared to sole stand. High mean guinea grass equivalent yield (613.68 q/ha), LER (1.33) and net return (Rs. 34,332 ha⁻¹) were recorded when guinea grass was sown with maize using a seed proportion of 1 : 1. Sowing of guinea grass in association with fodder maize produced 109.87 ha⁻¹ more guinea grass equivalent yield as compared to its association with grain maize.

- 190. TIWANA, U. S., K. P. PURI AND D. P. CHAUDHARY 2008. FODDER PRODUCTIVITY, QUALITY AND SEED YIELD OF MULTICUT OAT GROWN PURE AND IN MIXTURE WITH DIFFERENT SEED RATES OF SARSON. *Forage res.*, **33 (4) : PP. 224-226.** Department of Plant Breeding, Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India**

The experiment was conducted during **rabi** seasons of 2005-06 and 2006-07 at Punjab Agricultural University, Ludhiana to see the effect of mixing different seed rates (1.25, 1.88, 2.50 and 3.18 kg/ha) of sarson (*Brassica spp.*) in the full seed rate (62.5 kg/ha) of multicut oat. In the first cut, the mixture of oat+1.25 kg/ha sarson recorded 77.2 per cent higher green fodder (459.2 q/ha) and 59.3 per cent higher dry matter yield (50.5 q/ha), whereas in the second cut, the fodder yield oat+sarson mixtures decreased significantly with increase in seed rates of sarson than pure oat. The total green fodder yield of both the cuts was significantly higher with oat+sarson mixtures over pure oat, but the total dry matter yield decreased with increase in seed rates of sarson. The seed yield of second cut of oat was highest in pure oat which was significantly higher than oat+2.5 and 3.18 kg/ha sarson but was at par with oat+1.25 and 1.88 kg/ha mixtures. The fodder equivalent yield (fodder yield of first cut and seed yield of second cut) and crude protein yield of oat was significantly higher in oat+sarson mixtures over pure oat.

191. SINGH, S., KEWALANAND AND RAMESH CHANDRA 2008. **EFFECT OF INTEGRATED NUTRIENT SOURCES ON FODDER YIELD AND QUALITY OF SWEET SORGHUM AND PHILLIPESARA INTERCROPPING SYSTEM.** *Forage Res.*, **34 (3) : pp. 141-145.** Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar-263 145 (Uttarakhand), India

Field experiment was conducted during **kharif** seasons of 2007 and 2008 to evaluate the eco-friendly source of nutrients for quality fodder production of sweet sorghum and phillipesara intercropping system. The green and dry fodder yield and quality parameters viz., crude protein content, crude protein yield and digestibility of sweet sorghum increased in both sole and intercropping systems due to application of all integrated sources of nutrients, significantly higher being with application of nitrogen 50 per cent through inorganic source+50 per cent through vermicompost. However, the green and dry fodder yield and all quality parameters of phillipesara were significantly higher under sole crop compared to its intercropping with sweet sorghum.

192. PATEL, M. R., A. C. SADHU AND P. C. PATEL 2009. **MIXED CROPPING OF LUCERNE (*MEDICAGO SATIVA* L.) AND PANDADIU (*CHICORIUM INTYBUS* L.) AS INFLUENCED BY SEED RATIOS AND NITROGEN LEVELS.** *Forage Res.*, **35 (1): pp. 27-29.** Main Forage Research Station, Anand Agricultural University, Anand-388 110 (Gujarat), India

A field experiment was carried out at Main Forage Research Station, Anand during **rabi** seasons of 2001-02 to 2004-05 to find out the optimum seed ratio and nitrogen requirement for the mixed cropping of lucerne and *pandadiu*. Mixed cropping of lucerne+*pandadiu* with seed ratio proportion of 7.5+2.5 kg/ha, respectively, alongwith application of 30 kg N/ha as basal and 15 kg N/ha after each cutting produced higher green forage, dry matter and crude protein yields and gave higher net realization. Inclusion of lucerne in the system improved the quality of fodder due to increase in crude protein content and decrease in oxalic acid content as compared to *pandadiu* grown alone.

193. JAKHAR, S. P., B. S. PATEL, B. J. PATEL, R. K. BHATT AND V. K. BHATT 2009. **EFFECT OF ROW SPACING AND SEED RATIO ON GREEN FORAGE YIELD AND ECONOMICS OF LUCERNE AND CHICORY UNDER DIFFERENT MIXED/INTERCROPPING SYSTEMS.** *Forage Res.*, **35 (3) : pp. 157-160.** Department of Agronomy, S. D. Agricultural University, Sardarkrushinagar-385 506 (Gujarat), India

An experiment was conducted at Agronomy Instructional Farm, S. D. Agricultural University, Sardarkrushinagar during **rabi** 2003-04. The experiment consisting of three row spacing (Broadcast, 15 and 22.5 cm row spacing) and three seed rates (33 + 67%, 50 + 50% and 67 + 33% seed ratios of lucerne + chicory, respectively) and three row ratios (1 : 1, 2 : 1 and 1 : 2 row ratios of lucerne and chicory, respectively) under different mixed/intercropping systems with control was laid out in randomized block design with three replications. There were total 21 treatments. Six cuttings of lucerne and chicory for green forage were taken from each crop treatment. When lucerne and chicory crops were sown keeping 1 : 2 row ratio at 15 cm recorded on an average 13 and 18 per cent higher plant height of lucerne and 16 and 18 per cent higher plant height of chicory, 5 and 8 per cent higher number of leaves per plant of lucerne, 17 and 27 per cent higher number of leaves per plant of chicory, 9 and 14 per cent higher leaf area per plant of chicory than that recorded in lucerne 67% + chicory 33% seed ratio broadcasted and sole lucerne broadcasted. However, number of leaves per plant, leaf area and leaf : stem ratio of lucerne were not significantly affected. Same treatment recorded higher green forage yield (1009.73 q/ha) due to higher values of above growth parameters. It also gave the higher net realization (Rs. 78565/ha) and BCR (3.50).

194. SHYAM SINGH, KEWALANAND, RAMESH CHANDRA AND Y. P. JOSHI 2010. **EFFECT OF NITROGEN SOURCES AND INTERCROPPING ON ETHANOL PRODUCTION FROM SWEET SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH].** *Forage Res.*, **36 (3) : pp. 166-170.** Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar-263 145, U. S. Nagar (Uttarakhand), India

Field experiment was conducted during **kharif** seasons of 2007 and 2008 at Instructional Dairy Farm of G. B. Pant University of Agriculture and Technology, Pantnagar to evaluate suitable sources of nitrogen for sweet

sorghum+phillipesara (*Phaseolus trilobus* Ati) intercropping to enhance the juice, its quality and ethanol production. Intercropping and application of nitrogen 50 per cent through inorganic source+50 per cent through vermicompost (F₃) and 50 per cent nitrogen through inorganic+25 per cent through vermicompost+25 per cent through FYM (F₆) significantly increased the leaf area index, dry matter accumulation and yield of cane, juice, sugar and ethanol over sole crop and inorganic nutrient source during both the years. Juice percentage in cane was significantly enhanced due to intercropping and application of F₃, however, brix, available sugar, sucrose and purity coefficient remained unaffected due to intercropping as well as different nitrogen sources. Intercropping and all the sources of nutrients caused significantly higher cane equivalent yield with higher land equivalent ratio (>1) over sole cropping.

- 195.** BHAGAT SINGH, SANT KUMAR, A. K. DHAKA AND SATISH KUMAR 2011. **INTERCROPPING OF CEREALS AND LEGUMES FOR FORAGE PRODUCTION IN KHARIF SEASON—A REVIEW.** *Forage Res.*, **36 (4) : pp. 189-196.** Department of Agronomy, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Intercropping, which is defined as the growing of two or more crop species simultaneously in the same field during a growing season, is an old and commonly used cropping practice which aims at matching efficiently crop demands to the available growth resources and labour. The most common advantage of intercropping is the production of greater yield on a given piece of land by making more efficient use of the available growth resources using a mixture of crops of different rooting ability, canopy structure, height, and nutrient requirements based on the complementary utilization of growth resources by the component crops. Moreover, intercropping improves soil fertility through biological nitrogen fixation with the use of legumes and increases soil conservation through greater ground cover than sole cropping. Intercropping reduces damage caused by pests and diseases and improves forage quality through the complimentary effects of two or more crops grown simultaneously on the same area of land. In this paper, forage production and quality of different cereals-legumes intercropping are discussed, where different legumes had different effect on forage quality when intercropped with specific cereal. Regarding the forage quality and quantity, different cereals also led to different production of forage. The selection of an appropriate intercropping system for each case is quite complex as the success of intercropping systems depends much on the interactions between the component species, the available management practices, and the environmental conditions. This review provides an overall view and evaluation of intercropping in *kharif* forages, summarizing its main advantages supported by the literature which points out its great value in the context of increased forage quantity and quality.

- 196.** SINGH, SHYAM, KEWALANAND, RAMESH CHANDRA AND Y. P. JOSHI 2011. **EFFECT OF INTEGRATED NITROGEN SOURCES ON FODDER YIELD AND QUALITY OF SWEET SORGHUM AND PHILLIPESARA INTERCROPPING SYSTEM.** *Forage Res.*, **36 (4) : pp. 200-204.** Department of Agronomy, G. B. Pant University of Agriculture & Technology, Pantnagar-263 145, U. S. Nagar (Uttarakhand), India

Field experiment was conducted during *kharif* seasons of 2007 and 2008 to evaluate the ecofriendly source of nitrogen for quality fodder production of sweet sorghum and phillipesara (*Phaseolus trilobus* Ati.) intercropping system. The growth parameters viz., plant height, leaf : stem ratio, dry matter accumulation; quality parameters viz., crude protein content and yield, digestibility, green and dry fodder yield of sweet sorghum increased in both sole and intercropping systems due to application of all integrated sources of nutrients, but significantly higher being with application of nitrogen 50 per cent through inorganic source+50 per cent through vermicompost. However, all growth parameters except plant height and green and dry fodder yield of phillipesara were significantly higher under sole crop compared to its intercropping with sweet sorghum.

6. Cropping System

197. LAKSHMI, S., S. JANARDANAN PILLAI, M. R. ANITA AND P. SARASWATHI 2003. **FODDER PRODUCTION POTENTIAL OF CEREALS AND LEGUMES IN RICE FALLOWS.** *Forage Res.*, **29 (2)** : pp. 102-103. CSRC, Kerala Agricultural University, Kerala.

Fodder production potential of cereals and legumes in rice fallows was tested at CSRC, Karamana, Kerala Agricultural University. The results revealed that maize as sole crop gave significantly higher green and dry fodder yield followed by maize+cowpea intercropping.

198. PATEL, M. R., A. C. SADHU, P. C. PATEL AND J. P. YADAVENDRA 2003. **PRODUCTIVITY AND ECONOMICS OF FORAGE BASED CROPPING SYSTEMS UNDER IRRIGATED CONDITIONS OF MIDDLE GUJARAT.** *Forage Res.*, **29 (3)** : pp. 107-109. Gujarat Agricultural University, Anand-388 110 (Gujarat), India

Cropping system of hybrid napier+cowpea (**kharif**)+lucerne (**rabi**) should be adopted for getting maximum and year round forage production and for obtaining the highest returns. However, food and fodder production system of **bajra** for grain (**kharif**)-potato (**rabi**)-forage **bajra**+cowpea (summer) was found most profitable.

199. SUNEETHA DEVI, K. B., D. M. REDDEY AND MIR AZAM SULTAN 2004. **COMPARISON OF FOOD AND FODDER BASED CROPPING SYSTEM FOR SUSTAINED PRODUCTIVITY UNDER IRRIGATED CONDITIONS.** *Forage Res.*, **30 (1)** : pp. 49-52. Rajender Nagar (A. P.), India

Comparison of food and fodder based cropping system for sustained productivity under irrigated conditions was done at LRI, Rajender nagar (A.P.). It can be concluded that HBN+cowpea/berseem and lucerne (F)-lucerne (G)-maize(G) are the profitable forage-based cropping system that can compete with prominent food-based cropping system i.e.sorghum+redgram (G)-tomato of Andhra Pradesh.

200. JAIN, K. K. AND S. K. SHARMA 2005. **EFFECT OF KHARIF FODDER CROPS ON PRODUCTIVITY AND ECONOMICS OF SUCCEEDING RABI CROPS.** *Forage Res.*, **30 (4)**: pp. 189-191. Department of Agronomy, Rajasthan Agricultural University, Bikaner-334 006 (Rajasthan), India

A field study on the effect of pearl millet, sorghum and maize fodder on yield attributes and yield of mustard, gram and barley was undertaken in rainfed condition on clay loam soil at Udaipur (Rajasthan). The local fodder varieties of pearl millet, sorghum and maize were sown in second week of July and harvested for green fodder in the second week of September. These fodder crops were succeeded by mustard, gram and barley during **rabi** season, thereby making nine treatment combinations replicated four times in randomized block design. The results revealed that yield attributing characters of **rabi** crops viz., plant population, number of siliquae, branches, tillers per plant and test weight were not affected significantly in mustard and barley when these crops followed different cereal fodders. However, significantly higher number of branches was observed in gram proceeded by maize (55/plant) as compared to pearl millet-gram (40/plant) and sorghum-gram (48/plant). Similarly, the number of pods per plant was influenced significantly due to crop sequences and maximum 413 pods/plant were obtained in maize-gram sequence. The maximum grain (9.30 q/ha) and straw (30 q/ha) yield of mustard was obtained when it followed pearl millet fodder as compared to maize (7.92 and 28.41 q/ha) and sorghum (8.58 and 25.74 q/ha) fodder. The significantly higher grain and straw yield of gram was obtained when it was taken after maize fodder (21.47 and 36.96 q/ha, respectively) as compared to sorghum (17.25 and 29.45 q/ha, respectively) and pearl millet (16.83 and 28.66 q/ha, respectively). The maximum grain and straw yield of barley was recorded in maize-barley sequence (20.46 and 31.5 q/ha, respectively) as compared to sorghum-barley (18.90 and 25.9 q/ha, respectively) and pearl millet-barley sequence (16.42 and 30 q/ha, respectively). Gross and net returns of mustard were not affected due to preceding fodder crops. Gram and barley gave maximum gross and net return when grown after maize fodder. Significantly higher net return of Rs.

5807/ha was obtained by maize (fodder)-gram sequence followed by sorghum (fodder)-gram (Rs. 4909/ha) and sorghum (fodder)-mustard (Rs. 4889/ha) sequence. The lowest net return of Rs. 3387/ha was obtained by pearl millet (fodder)-barley sequence.

- 201.** TIWANA, U. S., V. K. SINDHU AND K. P. PURI 2006. **EFFECT OF WINTER CROPS ON THE GROWTH, YIELD AND ECONOMICS OF SUCCEEDING FODDER MAIZE AND PEARL MILLET UNDER DIFFERENT NITROGEN LEVELS.** *Forage Res.*, **31 (4) : pp. 244-247.** Department of Plant Breeding, Forage Section Genetics & Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

A field experiment was conducted to compare the maize and pearl millet fodders under different nitrogen levels succeeding winter crops. The experiment consisting of three winter crops (wheat, ryegrass and berseem) and four levels of nitrogen (0, 75, 100 and 125 kg N/ha) applied to maize and pearl millet, was carried out in split plot design with four replications. Growth parameters such as plant height and leaf area index were influenced significantly by preceding crops. Maize after berseem produced 5.2 and 10.9 per cent higher green fodder yield; and 6.4 and 9.7 per cent higher dry matter yield than maize succeeding ryegrass and wheat, respectively. Similarly, pearl millet after berseem gave 15.0 and 20.9 per cent higher green fodder; and 11.7 and 17.3 per cent higher dry matter yield over pearl millet succeeding ryegrass and wheat, respectively. The cropping systems having berseem resulted in higher wheat equivalent yield, production efficiency and B : C ratio. Berseem-pearl millet cropping sequence proved to be the most remunerative followed by berseem-maize, whereas lowest productivity was observed with wheat-maize and wheat-pearl millet. Maize fodder succeeding berseem responded upto 100 kg N/ha, whereas after wheat and ryegrass response was observed upto 125 kg N/ha. Pearl millet responded upto 75, 100 and 125 kg N/ha succeeding berseem, ryegrass and wheat, respectively.

- 202.** SINDHU, V. K., U. S. TIWANA AND K. P. PURI 2006. **EFFECT OF PRECEDING CROPS ON FORAGE QUALITY OF MAIZE AND PEARL MILLET UNDER DIFFERENT NITROGEN LEVELS.** *Forage Res.*, **32 (1) : pp. 61-63.** Department of Plant Breeding, Genetics and Biotechnology, PAU, Ludhiana

Maize and pearl millet grown after berseem recorded marginal improvement in quality parameters as compared to that followed by wheat and ryegrass. The quality parameters of maize and pearl millet fodder considerably increased with nitrogen application.

- 203.** JAIN, M. K., S. KUMAR AND S.S. YADAV 2007. **INFLUENCE OF PRECEDING CROPS ON PERFORMANCE OF RABI FOOD AND FORAGE CROPS UNDER IRRIGATED CONDITION OF BUNDELKHAND.** *Forage Res.*, **33 (1) : pp. 70-72.** AICRP on Forage Crops, IGFR, Jhansi-284003

The change in soil fertility status was not substantial with soil pH, organic carbon, available N, P, K over initial soil fertility status after one season. However, available N and K were reduced in the sequence (C1, C3 and C5) where wheat was taken as a rabi crop. In the treatments having berseem as a rabi crop, slight improvement was observed in available N over initial fertility status. The available phosphorus and potassium slightly reduced after rabi crops.

- 204.** KAUTHALE, V. K., P. S. TAKAWALE AND D. L. SALE 2007. **PRODUCTION POTENTIAL AND ECONOMICS OF DIFFERENT CROPPING SEQUENCES UNDER IRRIGATED CONDITIONS OF WESTERN MAHARASHTRA.** *Forage Res.*, **33 (3) : pp. 164-167.** BAIF Development Research Foundation, Uruli Kanchan, District Pune (Maharashtra), India

A field experiment was conducted over a period of five years (2000-01 to 2004-05) to find out the most remunerative cropping sequence suitable for the western Maharashtra region at Central Research Station of BAIF Development Research Foundation, Uruli Kanchan. There were six cropping sequences replicated four times in randomized block design. The five years' pooled data indicated that the legume based fodder cropping sequence of

berseem in **rabhi** season, sorghum in summer and maize in **kharif** (rainy) season has given significantly highest gross monetary returns (Rs. 1,21,855/ha/year), net monetary returns (Rs. 58,562/ha/year), benefit : cost ratio (1.93), profitability (Rs. 275.24/day/ha) and maize fodder equivalent yield (732 q/ha). The gross monetary returns, net monetary returns and maize fodder equivalent yield were 42.5, 54 and 54 per cent higher than the most adopted cropping sequence (wheat-cowpea-soybean). This cropping sequence has also maintained soil fertility status after five years of the experiment.

205. TANDON, A. AND C. L. PATEL 2009. **PRODUCTION POTENTIAL AND ECONOMICS OF LUCERNE-FODDER SORGHUM CROPPING SYSTEM AS INFLUENCED BY NUTRIENT MANAGEMENT.** *Forage Res.*, **35 (1): pp. 48-51.** N. M. College of Agriculture, Navsari Agricultural University, Navsari-396 450 (Gujarat), India

Field experiments were conducted during 2006-07 and 2007-08 to investigate the effect of nutrient management on production potential and economics of lucerne-fodder sorghum cropping system. The results revealed that through the application of 75 kg P₂O₅/ha from SSP with VAM recorded significantly the highest green and dry fodder yields of lucerne. Application of 50 kg P₂O₅/ha from SSP with VAM to preceding lucerne and 50 per cent RDF (40 kg N+20 kg P₂O₅/ha) to succeeding fodder sorghum gave higher green and dry fodder yield with optimum net realization (Rs. 59609/ha) and benefit : cost ratio (1.50) from lucerne-fodder sorghum cropping system.

206. ROY, D. P., A. K. BARIK AND G. C. DE 2009. **PRODUCTION POTENTIALITY, ECONOMICS AND NUTRIENT UPTAKE OF WINTER FODDER CROPS ON RESIDUAL FERTILITY AFTER WET SEASON RICE UNDER IPNS IN RED AND LATERITIC SOIL.** *Forage Res.*, **35 (1): pp. 52-55.** Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan-731 236 (West Bengal), India

In an on-farm trial conducted during winter seasons of 2002-03 and 2003-04 to study the feasibility and production potentiality of winter fodder crops on residual fertility after rice, the highest green, dry fodder and crude protein yields (26.78, 4.15 and 0.41 t/ha, respectively), gross return (Rs. 20,086/ha), net return (Rs. 11,761/ha) and return per rupee invested (2.42) were from berseem followed by oats, *Lathyrus* and fenugreek in the respective rice-based fodder cropping systems. Berseem removed higher quantity of soil nitrogen and phosphorus, whereas oats removed higher amount of potassium. A significant response was from residual fertility of **kharif** rice grown with IPNS on growth, yield attributes and yield, economics and nutrient uptake of various winter fodders. The highest green and dry fodder, crude protein, economics and plant nutrient uptake were from the residual fertility of 50 per cent recommended dose (RD) of NPK + FYM @ 10 t/ha in **kharif** rice. This was succeeded by 50 per cent RD of NPK + green manure *dhaincha* and 100 per cent RD of NPK. Such system would open up the scope of crop diversification with food and fodder production and help convert mono-cropped areas to double-cropped areas with the least irrigation facilities.

207. TIWANA, U. S., K. P. PURI AND D. P. CHAUDHARY 2009. **FODDER YIELD, QUALITY AND NITROGEN UPTAKE OF SORGHUM AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT IN SORGHUM-WHEAT CROPPING SYSTEM.** *Forage Res.*, **35 (3) : pp. 161-164.** Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

The experiment was conducted at Punjab Agricultural University, Ludhiana during **kharif** seasons of 2005 and 2006 to study the effect of bio-fertilizer (with and without *Azospirillum*) and six combinations of organic and inorganic fertilizers [control, 20 t FYM, 100% recommended dose of fertilizer (RDF), 75% RDF+5 t FYM, 50% RDF+10 t FYM and 25% RDF+15 t FYM/ha] on the fodder yield and quality of forage sorghum in sorghum-wheat cropping system. *Azospirillum* did not influence the crude protein content and crude protein production of sorghum alone and in combination with organic and inorganic fertilizers. FYM at 20 t/ha increased the green fodder yield of sorghum by 14.8 per cent and dry matter yield by 11.5 per cent over no FYM. The 100 per cent RDF through inorganic fertilizers increased the green fodder (603.6 q/ha) by 3.7, 9.2, 13.7, 16.6 and 33.9 per cent and dry matter

yield (157.5 q/ha) by 2.3, 7.2, 10.8, 18.4 and 30.9 per cent over 75 per cent RDF+5 t FYM, 50 per cent RDF+10 t FYM, 25 per cent RDF+15 t FYM, 20 t FYM/ha and control, respectively. The crude protein content, production and nitrogen uptake increased with all the combinations of organic and inorganic fertilizers over control but were highest with 100 per cent RDF.

- 208.** DEGRA, M. L., B. L. PAREEK, R. K. SHIVRAN, R. D. JAT AND DEEPAK SINGH 2010. **SULPHUR FERTILIZATION AND INTEGRATED WEED MANAGEMENT ON INDIAN MUSTARD (*BRASSICA JUNCEA*) AND SUCCEEDING FODDER PEARL MILLET.** *Forage Res.*, **36 (2) : pp. 100-104.** Agricultural Research Station, Durgapura, Jaipur-203 012 (Rajasthan), India

A field experiment was conducted at the Agronomy Farm, ARS Durgapura, Jaipur during 2003-05 on loamy sand soils analyzing low in available N and S and medium in available P and K. The increasing rates of S did not influence the weed density by markedly increasing the dry matter of weeds. Hand weeding twice showed the maximum control of weeds, which was significantly superior to other treatments. The successive rates of S nutrition upto 60 kg S/ha markedly enhanced the dry matter, siliquae, seeds/siliqua and seed yield/plant and in both the years. However, plant height and 1000-seed weight showed significant response upto 40 kg S/ha and remained at par with higher levels of S nutrition. The yield of succeeding fodder pearl millet was highest (370.0 q/ha) with 60 kg S/ha. Weed control measures brought about measurable improvement in growth and yield attributes, and yield of mustard compared with the weedy check. The two HW being at par with the herbicides coupled with HW increased the pooled mean seed yield of mustard significantly by 46.3% over weedy check. The application of 60 kg S/ha recorded significantly highest (Rs. 21077/ha) pooled mean net return and B : C ratio (2.51) of mustard over lower levels. Two HW being at par with both the herbicides coupled with HW gave highest net returns (Rs. 20050/ha), whereas B : C ratio was significantly higher under isoproturon @ 0.50 kg/ha.

- 209.** PATEL, M. R., A. C. SADHU, P. C. PATEL AND H. R. KHER 2010. **ENHANCING AND SUSTAINING THE PRODUCTIVITY OF FORAGE CROPPING SYSTEMS THROUGH MANURE AND FERTILIZER MANAGEMENT.** *Forage Res.*, **36 (2) : pp. 105-110.** Main Forage Research Station, Anand Agricultural University, Anand-388 110 (Gujarat), India

A field experiment was conducted during 2000-01 to 2004-05 on a fixed site at Main Forage Research Station, Anand to study the production potential of forage cropping systems and to find out the effect of manure and fertilizer application for sustaining productivity under irrigated conditions. The experiment consisted 20 treatment combinations involving five cropping systems [Sorghum (single cut)–Sunflower–Lucerne, Maize–Cowpea–Maize–Sorghum (multi cut), Sorghum (single cut)–Sunflower–Oat–Cowpea, Fodder **bajra** (multi cut)–Cowpea–Maize–Sorghum (single cut) and **Bajra** (Grain)–Lucerne–Sorghum (single cut)] and four fertility levels (100% RDF to each crop and 100% RDF to each crop alongwith application of 15 t/ha or 22.5 t/ha or 30 t/ha FYM to **kharif** crop only) and was laid out in split plot design with four replications. The results revealed that cropping system of sorghum (Single cut) in **kharif**, sunflower in semi **rabi** and lucerne in **rabi**-summer season recorded maximum forage sorghum equivalent yield and it was significantly superior to other crop sequences in average of five years. Lucerne and sunflower being legume and oil seed forage crops, respectively, also improved the forage quality and these cropping systems registered the highest crude protein yields and the highest net realization in average of five years. Among the fertility levels, application of 100 per cent RDF alone to each crop without addition of organic manure in forage based intensive cropping systems was found not significant for maintaining the productivity and gave lowest production of green forage, dry matter and crude protein yield in the crops grown during different seasons as well as in total yield of a sequence and forage sorghum equivalent yield in individual years and in average of five years. Every addition of FYM significantly increased the forage sorghum equivalent yield. The treatment of 100 per cent RDF to each crop+30 t FYM/ha to **kharif** crops recorded the maximum total green forage, dry matter and crude protein yields of a sequence as well as forage sorghum equivalent yield during individual years and on pooled basis. This fertility level also gave the highest net profit.

210. THAKURIA, K. 2010. **EFFECT OF SOWING DATE AND STAGE OF HARVEST ON FODDER PRODUCTION OF *LATHYRUS (LATHYRUS SATIVUS)* IN RICE BASED RELAY CROPPING.** *Forage Res.*, **36 (1) : pp. 59-60.** Assam Agricultural University, Jorahat.

In a field experiment conducted at Assam Agricultural University, Jorahat, it was found that lathyrus as a relay crop with rice should be sown early and harvested at full poding stage for higher production of quality fodder.

7. Soil Science

211. GEORGE, S. 2001. **EFFECT OF VERMICOMPOST APPLICATION ON PHYSICAL AND CHEMICAL PROPERTIES OF SOIL UNDER A FODDER GRASS.** *Forage Res.*, **27 (2) : pp. 137-140.** College of Agriculture, Vellayani, Kerala

A field experiment was conducted at COA, Vellayani, Kerala to study the effect of vermicompost application on physical and chemical properties of soil under a fodder grass. The available N content of soil under all treatments recorded significant improvement over absolute control. Both vermicompost and FYM treatments showed an increasing trend in available nutrient status with increasing level of applied fertilizers.

212. KUMAR, A. 2002. **EVALUATION OF SUITABLE WINTER FORAGE CROPS IN ROTATION WITH SUDAN GRASS FOR A MODERATE ALKALI SOIL WITH SODIC WATER IRRIGATION.** *Forage Res.*, **28 (3) : pp. 117-123.** Central Soil Salinity Research Institute, Karnal-132 001 (Haryana), India

In a field study, conducted on a moderately alkaline soil (pH 9.29), the effect of gypsum application was studied for three years from 1992-93 to 1995-96 on six winter forage crops viz., berseem (Egyptian clover) (*Trifolium alexandrinum* L.), shaftal (Persian clover) (*Trifolium resupinatum* L.), oats (*Avena sativa* L.), barley (*Hordeum vulgare* L.), senji (Sweet clover) (*Melilotus indica* L.) and metha (Fenugreek) (*Trigonella foenum-graecum* L.). The crops were irrigated by different sodic (alkali) waters obtained from two separate tubewells. Oats, shaftal and berseem were more suitable for such situations. However, berseem gave comparatively lower yield in the first year of cultivation. Application of gypsum at 2 t ha⁻¹ in the second and third year of experimentation increased the yields of forage crops. In comparison with their yields in normal soil, oats showed minimum yield reduction under alkali soil irrigated with alkali water, hence was more tolerant among the forage crops studied.

213. KUMAR, A. 2005. **UTILIZATION OF ALKALI SOILS AND WATERS FOR FORAGE PRODUCTION.** *Forage Res.*, **29 (1) : pp. 28-35.** Central Soil Salinity Research Institute, Karnal-132 001 (Haryana), India

Since **kharif** forage crops are sensitive to high alkali soil conditions, even with the ample availability of amendments, like gypsum, these should not be grown in the beginning. However, Shaftal (*Trifolium resupinatum*) yields successfully in first year itself. Grasses, in general, are more tolerant to alkali conditions because of their better root system, are, therefore, recommended. The advantage of growing forage crops in alkali soils is that these improve physical properties of soils and activate native calcium carbonate; bring down ESP. After reclaiming the alkali soil with grasses, forage crops and other commercial crops can be successfully grown. The basic difference in the reclamation strategies under two conditions is that in alkali soils where good quality water is available, gypsum has to be applied only once in the beginning and with cropping and time space the soils get improved and the soils go round from bad to good while in case of alkali water irrigation, the soils turn from good to bad. For successful growth of crops including forage crops, gypsum needs to be applied to each crop and the quantity of gypsum depends upon the tolerance of the crops and their water requirement.

214. VERMA, S. K. AND S. R. S. RAGHUWANSHI 2005. **PERFORMANCE OF DIFFERENT GRASS SPECIES AT VARIOUS SOIL SODICITY LEVELS IN VERTISOL UNDER RAINFED CONDITION.** *Forage Res.*, **31 (3) : pp. 185-191.** Salt Affected Soils Project, J. N. K. V. V. Campus, College of Agriculture, Indore-452 001 (M. P.), India

A field experiment was conducted at Soil Salinity Research Station, Barwaha 76°0'27" E and 22°14'48" N during 2002-03 to assess the sodicity tolerance of 24 grass species normally recommended for alkali soils under irrigated conditions. The experimental soil belongs to order Vertisols (Haplusterts – Sodic phase) and reveals high CEC 40 cmol (p+) kg⁻¹ and 25, 30, 35 and 40 ESP with low ECe (0.9 to 1.4 dSm⁻¹) and moderate pH (8.2-8.4) values with some minor spatial variability. The grass species were transplanted in plots measuring 1.0 x 3.0 m at planting geometry of 30 x 30 cm during August 2002 in four sodicity levels and three replications with basal application of 50 kg N and 40 kg P₂O₅ ha⁻¹, respectively. The survival per cent of different grasses decreased with the increasing level of soil ESP. The survival levels of Napier, Para, Sawan, Vetiver, Karnal, Rhodes, Marvel, Lemon, Borthriochloa and Deenanath were more than 50 per cent upto 40 ESP, whereas other species failed to survive at this sodicity. The green and dry weight of fodder (total of two cuttings) decreased with increase in soil ESP in all the grasses and at both the cuttings. The highest green fodder yield was recorded either with Para and Napier grasses and was followed by Baru, Marvel/Jerga and Vetiver. Dry matter production of all the grasses also followed the same pattern except Para grass dominated over Napier grass due to difference in their moisture content. Cumulative growth rate and net assimilation rate also exhibited similar pattern. The grasses Borthriochloa, Para, Napier, Vetiver, Sewan, Rhodes, Karnal, Marvel, Baru, Deenanath, Lemon and Paspalum can be grown satisfactorily in moderate alkali black clay soils (ESP 25 and 30) under rainfed conditions. The grasses like Anjan, Spear, Andropogen, Guinea (all varieties) and Setaria were unable to survive, whereas Trysopogen, Fulvus, Rosa and Themada performed poorly in such environments.

215. PATHAN, S. H., R. M. GETHE, A. D. KADLAG AND M. R. MANJARE 2005. **EFFECT OF MOLYBDENUM AND BORON ON SEED YIELD OF LUCERNE.** *Forage Res.*, **31 (3) : pp. 196-199.** Forage Crops Research Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (M. S.), India

An experiment was conducted at All India Coordinated Research Project on Forage Crops, Mahatma Phule Krishi Vidyapeeth, Rahuri during two consecutive **rabi** seasons of 2002-03 and 2003-04 to evaluate the effect of molybdenum and boron on seed yield of lucerne. The field experiment was laid out in randomized block design (factorial) with three replications consisting of three levels each of molybdenum and boron. The initial soil molybdenum content was 0.04 ?g g⁻¹ and boron 0.24 ?g?g⁻¹ ha⁻¹. Two years' pooled results revealed that molybdenum @ 1.0 kg ha⁻¹ and boron @ 4.0 kg ha⁻¹ were applied to lucerne as 50 per cent at sowing through soil and 50 per cent at flower initiation stage as foliar application for seed production of lucerne and maximum net monetary returns.

216. JAIN, P. K. AND B. R. SOOD 2006. **FORAGE AND SEED PRODUCTION FROM SEASONALLY WATERLOGGED WASTELANDS IN MID HILLS OF HIMACHAL PRADESH.** *Forage Res.*, **31 (4) : pp. 259-266.** Department of Agronomy, CSK Himachal Pradesh Krishi Viswavidyalaya, Palampur-176 062 (Himachal Pradesh), India

An experiment was carried out under seasonally waterlogged conditions in wasteland area of CSK Himachal Pradesh Krishi Viswavidyalaya for three consecutive years from July 1999 to December 2001. The experiment was laid out in split plot design with three replications. Crops (Setaria alone and Setaria+Clover mixture) and introduction techniques (zero tilled, single spade raised slice and double spade raised slice) combinations were kept in main plots, and cutting management (seed after one cut, seed after two cuts and forage from all cuts) in sub-plots. Setaria when grown in combination with clover by double spade raised slice technique and left for seed after two cuts was found best for forage and seed production. The Setaria was found to tolerate the seasonally waterlogged conditions and grown successfully. The mean fresh and dry forage yields obtained from Setaria and Setaria+clover plots were 54.28 & 61.18 and 14.27 & 16.40 t/ha during the years following establishment. The mean seed yield obtained from the

Setaria alone and Setaria+clover plots was 105.9 and 121.9 kg/ha. The planting of grasses on the raised spade slices proved superior to the planting on zero tilled plots. The raising of planting-platform provided the grass roots an aerobic environment and also the channels thus made helped in drainage of excess water. The double spade raised slice produced significantly higher fresh and dry forage yield and seed yield over other methods of introduction. The increase in fresh forage, dry forage and seed yield obtained in double spade raised slice was 47.64, 53.17 and 67.18 per cent over zero tilled plots, while this increase was 20.54, 21.60 and 34.71 per cent over single spade raised slice. Seed after one cut produced higher seed yield but low biomass. The treatment with seed after two cuts recorded better production of both biomass and seed as compared to other cutting treatments. The mean fresh forage, dry forage and seed yield obtained from seed after two-cut treatment were 64.00, 17.11 t/ha and 104.20 kg/ha.

- 217.** INDORIA, A. K. AND S. P. MAJUMDAR 2007. **EFFECT OF COMBINED APPLICATION OF NITROGEN AND PHOSPHORUS ON THE PERFORMANCE OF COWPEA [*VIGNA UNGUICULATA* (L.) WALP.] CROP ON TYPIC USTIPSAMMENTS.** *Forage Res.*, **33 (2) : pp. 122-124.** Department of Soil Science and Agricultural Chemistry, S. K. N. College of Agriculture, Jobner (Jaipur), Rajasthan Agricultural University, Bikaner (Rajasthan), India

A field trial was conducted to evaluate the combined effect of different levels of N and P on the performance of cowpea [*Vigna unguiculata* (L.) Walp.] crop on Typic Ustipsamments. There were three levels of nitrogen (N_0 =no nitrogen, N_{10} =10 kg N/ha and N_{20} =20 kg N/ha) and three levels of phosphorus (P_0 =no phosphorus, P_{20} =20 kg P_2O_5 kg/ha and P_{40} =40 kg P_2O_5 kg/ha). Results showed that the total dry matter yield (22.8 q/ha), seed yield (8.0 q/ha) and stover yield (14.8 q/ha) were significantly enhanced due to combined application of $N_{10}P_{40}$ over control (N_0P_0). The yield attributes like nodules, weight of nodules and pods/plant and test weight were increased with the application of 10 kg N and 40 kg P_2O_5 /ha. Similarly, a higher N and P content in both seed and stover and per cent seed protein were observed under $N_{10}P_{40}$ treatment combination. Out of the total nutrients accumulated by crop, 63 to 67 per cent N accumulated in seed and 33 to 37 per cent accumulated in stover, while a reverse trend was observed in case of P accumulation, where total P uptake was 52 to 56 per cent in stover and 44 to 48 per cent accumulated in seed, irrespective of treatment combination.

- 218.** SINGH, M. AND MAY MAY KHIN 2007. **PHOSPHORUS-NICKEL INTER RELATIONSHIP IN MAIZE (*ZEAMAYS*) ON DRY MATTER YIELD AND NUTRIENTS ABSORPTION.** *Forage Res.*, **33 (3) : pp. 152-156.** Department of Soil Science, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A greenhouse study in pots on loamy sand soil with four rates each of P and Ni (0, 30, 60 and 90 mg/kg soil) was undertaken to investigate the P and Ni inter relationship in maize on dry matter yield and nutrients absorption. The basal doses of N, K, S and Zn were applied in each pot. The dry matter yield of maize significantly increased with 90 mg P/kg soil and 30 mg Ni/kg soil application. The interaction between P and Ni was synergistic on dry matter yield at lower levels of P and Ni application. The maximum dry matter yield (47.83 g/pot) was recorded with the combined application of 60 mg P/kg soil and 30 mg Ni/kg soil application. The adverse effect of Ni on dry matter yield was considerably ameliorated with the higher doses of P application. The higher application of P significantly increased the P concentration and uptake but decreased the S and Ni concentration in maize. The higher application of Ni significantly increased the Ni concentration and uptake but decreased the P and S concentration and uptake. The concentrations of Zn, Fe, Mn and Cu significantly decreased with increasing levels of applied P and Ni, whereas their uptake increased significantly upto 60 mg P/kg soil and 30 mg Ni/kg soil.

219. SATYAVAN, V. PHOGAT, S. K. SHARMA AND SANJAY KUMAR 2008. **ALTERNATE USE OF SALINE AND NON-SALINE WATER FOR SUSTAINING PEARL MILLET (*Pennisetum glaucum*) PRODUCTIVITY.** *Forage Res.*, **34 (1) : pp. 21-24.** Department of Soil Science, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A field experiment was conducted during **kharif** seasons of 2003 and 2004 at Soil Science Research Farm, CCS Haryana Agricultural University, Hisar to examine the effect of alternate use of saline and non-saline water on growth, yield and economics of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz.]. The experiment consisted of eight treatments in randomized block design with three replications. Pooled data analysis of the two seasons revealed that all canal irrigation (C) treatment resulted in significantly higher grain and stover yield than all saline (S), 2S : 1C, 1S : 1C, 1S and rest canal irrigation treatments. However, all canal irrigation treatment was at par with 2C : 1S, 1C : 1S and 1C : rest saline treatments. Saline water irrigation treatment reduced the grain yield by 18.7 per cent and stover yield by 20 per cent compared with canal water irrigation. Use of canal water for irrigation at initial stages resulted in yield improvement by 13-20 per cent over saline water alone. Maximum net returns of Rs. 9734 and 11187 and B : C ratio of 1.83 and 1.91 were recorded in canal water irrigation treatment during 2003 and 2004, respectively, followed by 2C : 1S and 1C : 1S, whereas minimum net returns of Rs. 6663 and 5628 and B : C ratio of 1.57 and 1.46 were realized from all saline water irrigation. Maximum salt build-up (7.14 dS/m) was in 0-15 cm surface layer in all saline water irrigation.

220. TAKAWALE, P. S., V. K. KAUTHALE, J. S. DESALE AND P. K. KULKARNI 2008. **EFFECT OF DAIRY SLUDGE APPLICATION ON YIELD AND QUALITY PARAMETERS OF FORAGE CROPS.** *Forage Res.*, **34 (1): pp. 41-43.** Central Research Station, BAIF Development Research Foundation, Urulikanchan, Pune-412 202 (M. S.), India

A field experiment was conducted during 2004-05 at BAIF Development Research Foundation, Urulikanchan, Pune to examine the effect of soil application of dairy sludge on growth, yield and quality of fodder crops and chemical composition of soil. The experiments were conducted in gravel soil having 0.25 EC (dS/m), 7.76 pH and 0.47 per cent organic carbon during **kharif** 2004 and **rabi** 2004-05 replicated five times in a randomized block design. There were four treatments comprising two crops in each season with two treatments i. e. absolute control and sludge application. Pearl millet and cowpea were the **kharif** crops and berseem and oats were the **rabi** season crops. The crops were grown in rotational manner in the same treatment plots. The dairy sludge was applied @ 10 t/ha before sowing of the crops and mixed properly in the soil. The sludge was containing 2.56 per cent N, 9.57 per cent P, 212 ppm K, 1.20 EC (dS/m) and 6.03 pH. The data on crop growth yield and fodder quality parameters were collected and statistically analyzed. The data revealed that green fodder, dry matter and crude protein yields were significantly increased due to sludge application in pearl millet, cowpea, berseem and oats. The per cent increase over control was 23, 30 and 28 in green fodder, dry matter and crude protein yields in pearl millet, respectively. In case of cowpea, the green fodder, dry matter and crude protein yields were 19, 24 and 26 per cent higher than the control, respectively. The data on **rabi** season crops indicated that green fodder, dry matter and crude protein yields were 26, 25 and 22 per cent higher than the control in berseem. In oats, the per cent increase was 64, 40 and 49 in green fodder, dry matter and crude protein yield, respectively. The data also revealed that the soil fertility status nearly remained unchanged due to soil application of dairy sludge.

221. AGRAWAL, S. B., V. K. SUKLA, S. S. TOMAR, S. L. YADAV AND SARITA SINGH 2009. **EFFECT OF MOLYBDENUM AND BORON ON SEED YIELD OF BERSEEM.** *Forage Res.*, **34 (2) : pp. 125-126.** Department of Agronomy, Jawaharlal Nehru Krishi Vishva Vidyalaya, Jabalpur-482004 (M. P.), India

It was observed that seed yield was not influenced significantly due to application of molybdenum. However, boron application @ 2 and 4 kg/ha enhanced the seed and stover yield significantly over the control.

222. SINGH, D., R.S. MALIK, R.P. NARWAL AND R. R. DAHIYA 2009. **RELATIVE PERFORMANCE OF MAIZE GENOTYPES FOR THEIR TOLERANCE TO CADMIUM.** *Forage Res.*, **34 (4) : pp.249-253.** Department of Soil Science, CCS Haryana Agricultural University, Hisar.

Five varieties of maize viz, HM-5, HM-6, HKH-1183, HKH-1191 and HQPM-1 were grown under screen house conditions during 2006 or 45 days to assess their relative tolerance to five rates of Cd application ranging from 0 to 100 mg/kg soil on a sandy loam soil. A significant reduction in dry matter yield in cultivars HM-5, HKH-1183 and KHN-1991 was observed at 20 mg Cd/kg soil, whereas cultivar in the order HKN-1183 > HM-6 > HKH-1191 > HPQM-1. The data indicated that cultivars various HPQM-1 and HKH-1191 could tolerate high level of Cd as compared to other tested cultivars. Conversely, the lower uptake of Cd by HPQM-1 and HKH-1191 and compared to cultivars HKH-1191, HM-6 suggested that the cultivars HKH-1191 and HPQM-1 be preferred over other varieties as fodder crops for animals as having high Cd content. All the biochemical parameters i. e. chlorophyll content, photosynthesis and total leaf area also decreased with increase in Cd concentration in the soil.

223. SINGH, M., RAJESH KUMAR AND B. S. PANWAR 2009. **EFFECT OF PHOSPHORUS ON FODDER YIELD, UPTAKE AND ITS CRITICAL LIMIT IN SOILS FOR INDIAN MUSTARD.** *Forage Res.*, **35 (1): pp. 23-26.** Department of Soil Science, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

To study the effect of P on fodder yield, uptake and to establish the critical limit of available P for Indian mustard crop, a screen house experiment was conducted on P deficit soil (Typic Haplustept). Fifteen graded levels of P from 0 to 300 mg P/kg soil were applied. The application of P significantly increased the fodder yield, N content and uptakes of N, Fe and Cu upto 40 mg P/kg soil. The P content significantly and subsequently increased with all levels of applied P, whereas its uptake was significantly enhanced only upto 80 mg P/kg soil. The contents of heavy metals such as Zn, Fe, Cu, Ni, Cd and Cr were higher in control and then decreased progressively and significantly with increasing levels of applied P, the lowest being at 300 mg P/kg soil. The uptake of Ni, Cd, Cr and Zn was significantly increased upto 20 mg P/kg soil application. Olsen's soil test was found to be the best method for determining available P because of its higher correlation coefficients with the dry matter yield ($r=0.90^{**}$) and P uptake ($r=0.89^{**}$). The critical limit of Olsen's P was established as 13.5 kg P/ha by using linear response plateau model for predicting response to applied P for forage production of Indian mustard crop.

224. KUMAR, D., R. S. MALIK, R. P. NARWAL AND R. R. DAHIYA 2009. **VARIABLE TOLERANCE OF MAIZE GENOTYPES TO EXCESS OF CADMIUM, NICKEL AND CHROMIUM.** *Forage Res.*, **35 (1): pp. 42-44.** Department of Soil Science, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Cadmium (Cd), nickel (Ni) and chromium (Cr) are the most potentially toxic elements present in fodders when grown on sewage irrigated soil. The variation in the ability of maize varieties against the tolerance of heavy metal toxicity was investigated during **kharif** 2006 in a screen house experiment at CCSHAU, Hisar. Under pot experiment five maize varieties (HM-5, HM-6, HKH-1183, HKH-1191 and HQPM-1) were evaluated against the toxicities of Cd, Ni and Cr in sewage irrigated sandy loam soil. The treatments included 0, 20, 40, 80 and 100 mg/kg for Cd; 0, 40, 80, 120 and 160 mg/kg for Ni and 0, 2.5, 5.0, 7.5 and 10.0 mg/kg for Cr. There was considerable difference among all the five varieties in the time of appearance and intensity of toxicity symptoms, yield depression and Cd, Ni and Cr concentrations. All the varieties responded a yield reduction with each successive increase in the levels of Cd, Ni and Cr. Based on per cent depression in yield on soil applied Cd, Ni and Cr, the varieties were grouped as least tolerant (>25% response), moderately tolerant (10-25% response) and tolerant (<10.0% response).

225. SINGH, M. AND MAY MAY KHIN 2009. **SULPHUR AND NICKEL INTERACTIONS ON DRY MATTER YIELD AND NUTRIENTS ABSORPTION BY MAIZE (*ZEA MAYS*)**. *Forage Res.*, **35 (2) : pp. 96-100**. Department of Soil Science, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

To investigate the interactions of S and Ni on dry matter yield, nutrients concentration and their uptake in maize, a screen house experiment in pots was conducted with four levels (i. e. 0, 30, 60 and 90 mg/kg soil) each of applied S and Ni. The basal doses of N, P, K and Zn were also applied in each pot. The dry matter yield of maize significantly increased with the application of 30 mg/kg soil each of S and Ni but their higher doses significantly reduced the dry matter yield. The application of S at all levels significantly and successively increased the S concentration over lower levels but the S uptake significantly increased only upto 60 mg S/kg soil application. The application of Ni significantly increased the Ni concentration at all levels and Ni uptake upto 60 mg Ni/kg soil application. The concentration of N and P increased significantly with the application of 30 mg S/kg soil. The increasing levels of S significantly and successively decreased the concentration of Zn, Fe, Cu and Mn in maize plants. The concentration of Cu and Fe was significantly reduced with the increasing levels of Ni. The uptake of N, P, Zn, Cu and Mn increased significantly with the application of 30 mg S/kg soil each of S and Ni. The S x Ni interactions were significant on uptake of S, Ni, P, N and Zn by maize.

226. SHETA, B. T., N. K. KALYANASUNDARAM AND K. C. PATEL 2009. **INFLUENCE OF N, K AND S ON YIELD OF FORAGE PEARL MILLET [*PENNISETUM GLAUCUM* (L.) R. BR.] AND NUTRIENT DEPLETION IN SOIL**. *Forage Res.*, **35 (3) : pp. 147-151**. DWSR Anand Centre, Anand Agricultural University, Anand-388 110 (Gujarat), India

A field experiment on the forage pearl millet (cv. GFB 1) was conducted during **kharif** 2003 and 2004 to study the influence of N, K and S levels. There were two levels of N viz., 100 (N₁) and 150 (N₂) kg/ha, three treatments of K viz., 0 (K₀), 40 kg K₂O/ha applied entirely as basal (K₁) and 50% as basal and remaining in two equal splits after first and second cuts (K₂) and three levels of S viz., 0 (S₀), 20 (S₁) and 40 (S₂) kg S/ha. The entire doses of N and S were given as basal. The soil texture of the experimental field was loamy sand (Typic Ustochrepts). Initial soil available N, K and S were low, medium and marginal, respectively. The pooled data showed that the green fodder yield was 521.4 and 687.2 q/ha for N₁ and N₂, respectively, due to N₂ over N₁ being 31.8 per cent. The corresponding increase in dry forage yield was 32.0 per cent. The green and dry forage yields of pearl millet were significantly influenced in the order of K₂ > K₁ > K₀, K₂ giving 8.76 and 11.55 per cent higher yield over that of K₁. The significant increase in the fresh forage and dry matter yield due to S treatments was also in the order of S₂ > S₁ > S₀. The per cent increase in the green forage yield due to S₁ and S₂ over S₀ was 3.78 and 7.86, respectively. The available N status significantly improved in soil due to N application at higher level of N (N₂) and K (K₂). At the harvest of crop, the value of available P₂O₅, K₂O and S was less as compared to initial status indicating considerable depletion of nutrients. The interactions N₁K₂, K₂S₁, K₂S₂ and N₁K₂S₂ were found significant for available S in soil at harvest of the crop. Available Fe and Zn were also significantly affected by K x S interaction.

227. GREWAL, K. S. AND R. S. MALIK 2010. **PRODUCTION EFFICIENCY OF MAIZE AND OAT TO POTASSIUM APPLICATION IN TWO TEXTURALLY DIFFERENT SOILS**. *Forage Res.*, **35 (4) : pp. 187-189**. Department of Soil Science, CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

A pot culture experiment was conducted to study the effect of potassium application on production efficiency and K content of maize (cv. Ganga-5) and oat (cv. OS-6) fodder crops for continuously two years on two texturally different soils i. e. a sand and a sandy loam. The pooled average yield data of two years indicated that the response to K was highly significant upto 60 mg K₂O/kg soil application in both the crops. The production efficiency of these crops to K application decreased with increasing levels of potassium in both the years. The trend of decrease of production efficiency was similar in both the soils but with different magnitude. The significant increase in plant K concentration was observed with addition of 60 mg K₂O/kg soil over control. Addition of potassium helped in enhancing the initial available K status of both the soils. An increase of 57.4-60.6 per cent in sand and 46.6-57.6 per cent in sandy loam soil was observed with addition of 120 mg K₂O/kg soil over control.

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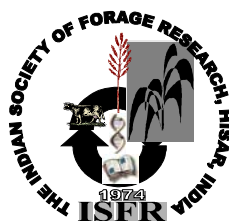
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