Forage Res., **46** (1) : pp. 63-68 (2020) **http://forageresearch.in**

EFFECT OF FODDER BASED INTERCROPPING SYSTEMS ON HERBAGE YIELD AND QUALITY OF FODDER UNDER *TARAI* REGION OF UTTARAKHAND

BRAJKISHOR PRAJAPATI[1,*], SAPANA TIWARI[2] AND KRANTI KUMAR[3]

[1]Scientist, Department of Agronomy, RHSKVK, Balaghat, M. P., India
[2]Assistant Development Officer, Department of Horticulture, Government of Uttarakhand, India
[3]Assistant Professor, Department of Agronomy, College of Agriculture, GBPUA&T, Pantnagar-263145, India
(e-mail : brajkishorprajapati1@gmail.com)

(Received : 06 May 2020; Accepted : 02 June 2020)

SUMMARY

The experiment was conducted during *rabi* season of 2016-17 at Fodder Agronomy block of Instructional Dairy Farm (IDF), Nagla of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India to evaluate performance of berseem associate with cool season cereal fodder crops for quality fodder production. Randomized block design was used with four replications consisting of 10 treatments as detailed in materials and methods.The results showed that crude protein content in berseem fodder was significantly higher than remaining treatments at all the cuttings. Among intercropping systems, berseem with ryegrass in 2:2 and 1:1 row ratio hadhighestcrude protein content followed by barley+berseem (2:2) compared with remaining treatments anddry matter digestibility of barley+berseem (2:2) mixture was highest at all the cuttings. Among intercropping systems, total green fodder yield (939.0 q/ha) and dry fodder yield (143.1 q/ha) was highest in ryegrass+berseem (1:1) followed by ryegrass+berseem (2:2) fodder mixture than remaining treatments. The total crude protein yield (18.4 q/ha) was significantly higher with ryegrass+berseem (2:2) than remaining treatments except sole berseem and ryegrass+berseem (1:1).Association of berseem with ryegrass improved the quality of fodder and provided higher green fodder, dry fodder, crude protein and digestible dry matter yields under *Tarai* agro climatic situation of Uttarakhand.

Key words : Barley, berseem, crude protein yield, green fodder yield, ryegrass

The human population in India is expected to reach around 1.48 billion by 2030 with the shift in lifestyle and feeding habits towards milk products, meat products and eggs led to increase in demand oflivestock. According 20th livestock census (2019), the livestock population is 536.76 million in India showing an increase of 4.8 % over 19th livestock census (2012). The total livestock population in rural and urban area is 514.11 and 22.65 million respectively (GOI, 2019). According to Kumar *et al.* (2012) India supports more than 20% of the world's livestock population and leader in cattle (16%) and buffalo (5.5%). India has recently emerged as largest producer of milk (187.7 million tonnes) in the world but livestock productivity is very low as compared to the developed countries. As we all know that feeding management plays a very significant role in exploiting the full potential of dairy animals. Fodder requirement of livestock is met from crop residues and byproducts; grasses, weeds and tree leaves gathered from cultivated and uncultivated lands; and grazing on common lands and harvested fields which are not enough for the maintenance of animal health and productivity. At present, the country faces a net deficit of 63% green fodder, 24% dry crop residues and 64%feeds, respectively (Choudhary *et al.*, 2014). The area under fodder crops has almost remained static (8.3 million ha) for the last 3-4 decades (Midha *et al.*, 2014). In order to meet the fodder shortage for the growing animal population, the fodder growing area should ideally be around 12.0 million ha. Intercropping of fodder cereals with legumes is an effective approach for increasing total fodder productivity per unit area and time besides equitable and judicious utilization of land resources and inputs (Marer *et al*., 2007), which also enriches the soil fertility. Intercropping of fodder legumes in cereals was found more productive and remunerative (Sharma, 2008) when compared with their sole crop. The types of intercrop and spatial arrangement in intercropping have important effects

Based on a part M. Sc. thesis of the second author submitted to GBPUA&T, Pantnagar during 2018 (unpublished).

on the balance of competition between component crops and their productivity. Hence, efforts need to be made to intensify fodder productivity and production per unit area and time to achieve maximum qualitative yield. Keeping this in view, the experiment was conducted to find out suitable intercropping for availability of good quality fodder.

MATERIALS AND METHODS

The experiment was conducted during *rabi* season of 2016-17 at Fodder Agronomy Block of Instructional Dairy Farm (IDF), Nagla of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India. The Instructional Dairy Farm issituated in the *Tarai* belt of Shivalik range of Himalayas with humid sub-tropical typeof climate at latitude of 29°N and longitude of 79.3°E and situated at an altitude of 243.84 m above the mean sea level. The soil of experimental site was silty clayloam with neutral reaction (7.58 pH). The nutritional status of soil was rich in organic carbon (0.79 %), available nitrogen (281.45 kg/ha), available phosphorus (21.64 kg/ha) and available potassium (231.74 kg/ha) obtained by following Walkley and Black, 1934, Subbiah and Asija, 1956, Olsen *et al.*, 1954 and Jackson, 1973 methods, respectively. The experiment was laid out in randomized block design with four replications and comprising ten treatments *i.e.* sole ryegrass, sole oat, sole barley, sole berseem, ryegrass+berseem (1:1), ryegrass+berseem (2:2), oat+berseem (1:1), oat+berseem (2:2), barley+berseem (1:1) and barley+berseem (2:2). The recommended fertilizers *viz.* 120:60:40 kg $N:P_2O_5:K_2O$/ha for sole ryegrass, oat and barley, 20:60:40 kg $N : P_2O_5:K_2O$/ha for sole berseem and 80:60:40 kg $N:P_2O_5:K_2O$/ha for intercropping systems, respectively were applied. In basal application, half nitrogen was applied in sole ryegrass, oat, barley and intercropping system crops. Remaining nitrogen was top dressed in twoequal splits after first and second cuttings. In legume crops, whole nitrogen was applied as basal. Total amount of recommended phosphorus (*i.e.* 60 Kg P_2O_5/ha) and potassium (i.e. 40 Kg K_2O/ha) were applied at the time of sowing in all crops.The harvested herbage was weighted immediately for green fodder yield and 500 g fresh sample from each net plot was taken to determine dry matter content. Total N was determined using the CHNS analyzer and crude protein was calculated by multiplying nitrogen per cent with 6.25 (AOAC, 1965). The digestible dry matter content was estimated on dry weight basis following the equation DDM= 88.9-(0.779 x % ADF) adapted from Horrocks and Vallentine (1999). Digestible dry matter yield of each plot was calculated by using fallowing formula :

$$\text{DDMY (q/ha)} = \frac{\text{DDM (\%)} \times \text{DMY (q/ha)}}{100}$$

Where, DDM : Digestible dry matter content, DMY : Dry matter yield.
Crude protein yield was calculated by using the following formula and expressed as q/ha.

$$\text{CPY (q/ha)} = \frac{\text{CP (\%)} \times \text{DMY (q/ha)}}{100}$$

The data was subjectedto analysis of variance (ANOVA) technique using thestatistical programme OPSTAT (www.hau.ernet.in/opstat.html) to draw inference of the results. Valid conclusions were drawn only on significant differencesbetween treatment means at 5% level of probability.

RESULTS AND DISCUSSION

Quality

Dry matter content : At 1stcutting, dry matter content of sole ryegrass was significantly higher over remaining treatments except sole oat and oat+berseem (1:1). At 2ndcutting, ryegrass+berseem (1:1) fodder mixture had highest drymatter content. However, it was at par with ryegrass+berseem (2:2), oat+berseem (1:1), barley+berseem (1:1) and barley+berseem (2:2) intercropping systems but significantly higher over remaining treatments. At 3rdcutting, dry matter content of ryegrass+berseem (1:1) was significantly higher compared to remainingtreatments, which was atpar with ryegrass+berseem (2:2) and barley+berseem (1:1). At all the cuttings, sole berseem had least dry matter content compared to other treatments. Among intercropping systems, the dry matter content in the fodder of oat+berseem (1:1) was significantly higher than all intercropping system except ryegrass+berseem (2:2) at 1stcutting. At 2ndcutting, dry matter content of ryegrass+berseem was highest but it was significant over oat+berseem (2:2). At 3rd cutting, dry matter content in the fodder of ryegrass+berseem (1:1) was significantly higher over oat+berseem (1:1), (2:2) and barley+berseem (2:2) treatments. Legumes

TABLE 1
Quality parameters of fodder as influenced by the intercropping treatments at different stages

Treatments	Dry matter content			Crude protein content			Digestible dry matter content		
	55 DAS (1st cut)	85 DAS (2nd cut)	115 DAS (3rd cut)	55 DAS (1st cut)	85 DAS (2nd cut)	115 DAS (3rd cut)	55 DAS (1st cut)	85 DAS (2nd cut)	115 DAS (3rd cut)
					Cuttings				
Sole Ryegrass	13.5	13.8	15.6	15.5	14.0	11.6	66.5	66.1	64.0
Sole Oat	13.4	13.6	16.3	11.0	9.3	7.3	67.3	66.1	63.0
Sole Barley	13.1	13.4	15.4	12.6	12.3	9.3	65.4	63.5	65.1
Sole Berseem	11.6	13.0	15.1	24.1	23.0	21.6	69.5	69.3	67.2
Ryegrass+Berseem (1:1)	12.4	14.5	17.0	16.6	15.0	12.6	66.6	66.3	64.8
Ryegrass+Berseem (2:2)	13.0	14.3	16.8	19.6	17.0	14.3	69.2	68.6	67.2
Oat+Berseem (1:1)	13.2	14.0	15.6	13.0	12.3	9.0	67.6	66.9	65.0
Oat+Berseem (2:2)	12.6	13.6	15.8	13.6	11.6	9.3	69.3	69.4	66.9
Barley+Berseem (1:1)	12.8	14.2	16.5	14.6	13.0	10.3	68.1	67.7	65.2
Barley+Berseem (2:2)	12.0	14.1	16.0	15.3	14.0	12.6	70.9	70.0	68..0
S. Em±	1.0	0.2	0.2	0.4	0.6	0.6	0.5	0.2	0.3
C. D. (P=0.05)	0.3	0.6	0.6	1.0	1.7	1.7	1.4	0.7	0.8

intercropped with cereals are complementary to each other and providingsignificant amount of nutrients, water and solar energywhich ultimately enhanced dry matter content throughincreased growth parameters. The results areconformity with the finding ofAkman *et al*. (2013) and Nasri *et al*.(2014).

Crude protein content : In general, crude protein content at each cutting exhibited decreasing trendwith the advancing frequency of cuttings.At all the cuttings, highest crude protein content was observed in sole berseemwhich was significantly higher over remaining treatments and least crudeprotein content was of sole oat fodder. Better absorption of nitrogen by legume fodder crop leading to higher crude protein content in its fodder than cereals (Tiwana and Puri, 2003) and when mixed with cereals the crude protein content of mixture remains lower than legume monoculture. Among intercropping systems, significantlyhigher crude protein content was observed in the fodder from ryegrass+berseem (2:2) over remaining treatments at 1st and 2ndcuttings.At 3rd cutting, crude protein content was significantly more due to ryegrass+ berseem (2:2) than remaining intercropping systems except ryegrass+berseem (1:1) and barley+berseem (2:2) treatments.This might be owing to higher crude protein in the fodder of ryegrass and berseem contributes to increase the crude protein content in its mixture.Results of earlier workers suggest that mixture has higher crude protein content than grass monoculture (Dawo *et al.,* 2007; Albayrak *et al*., 2011).

Digestible dry matter content : In general, the decline in dry matter digestibility with advancement of crop is associated with increasing lignin content and a reduction in degradability of polysaccharides other than starch. At all the cuttings, barley+berseem (2:2) intercropping system had significantly more digestible dry matter content over remaining treatments, which was at par with berseem. Digestible dry matter content was increased 6.21, 5.08 and 7.76 per cent at 1st cutting and 5.57, 5.57 and 9.28 per cent at 2nd cutting by barley+berseem (2:2) over sole ryegrass, sole oat and sole barley, respectively. Similar results were also reported by Carr *et al.* (2004) and Ross *et al.* (2004). When comparing the sole crops with intercropping treatments, at all the cuttings, the dry matter digestibility of sole ryegrass fodder was at par with ryegrass+berseem (1:1) and significantly less than ryegrass+berseem (2:2). At 1stcutting,dry matter digestibility of sole oat was at par with oat+berseem (1:1) and significantly less than oat+berseem (2:2) however, at 2nd and 3rd cuttings it was significantly less than it's intercropping treatments. At 1st and 3rdcuttings, the dry matter digestibility of sole barley was significantly less than it's intercropping at all the cuttings. However, at 2ndcutting it was significantly higher than remaining intercropping treatments.This might be due to intercropping of protein rich crops with cereals reduced ADF and NDF content, thus increasing dry matter digestibility of the fodder (Vranic *et al.,* 2009).

Yield

Green fodder yield : At 1st cutting, green fodder yield of sole ryegrass was highestwhich was at par with sole oat and significantly higher over remaining treatments. At 2nd cutting, highest green fodder yield was of sole oat which was significantlyhigher over remaining treatments. At 3rdcutting, yield from fodder mixture ryegrass+ berseem (1:1) was significantly higher over remaining treatments. Least green fodder yield was of sole berseem at all the cuttings. When the components of a mixtureare complementary to each other, a higher yield occurs based on the transfer of symbiotically fixed N to grasses (Lauk and Lauk, 2009; Akman*et al*., 2013). At 1st cutting, green fodder yield of sole ryegrass was significantly higher over it's intercropping treatments. At 2ndand 3rd cuttings, ryegrass+berseem (1:1) caused significantly higher green fodder yield than sole ryegrass and ryegrass+berseem (2:2). It might be due to effective use of resources, including water, nutrients, solar energy under intercropping system (Nasri*et al*., 2014). The sole oatcrop yielded significantly more green fodder compared to its intercropping treatments at all the cuttings. Among intercropping systems, oat+berseem (1:1) treatment caused significantly higher system green fodder yield over remaining intercropping systemsat 1st cutting. However, at 2nd and 3rd cutting ryegrass+berseem (1:1) treatments led to significantly higher system green fodder yield than remaining intercropping systems. The total green fodder yield (939.0 q/ha) was significantly more in the case of sole oat followed by ryegrasss+berseem (1:1) compared to remaining treatments except sole ryegrass, ryegrass+berseem (2:2), oat+berseem (1:1), barley+berseem (1:1) and barley+berseem (2:2), respectively.

Dry fodder yield : At 1stcutting, highest dry fodder yield was observed in sole ryegrass treatment which was at par with sole oat and oat+berseem (1:1)

TABLE 2

Green fodder, dry fodder, crude protein and digestible dry matter yield as influenced by the intercropping treatments at different stages

Treatments	Green fodder yield (q/ha)				Dry fodder yield (q/ha)			
	55 DAS (1st cut)	85 DAS (2nd cut)	115 DAS (3rd cut)	Total yield (q/ha)	55 DAS	85 DAS	115 DAS	Total yield (q/ha)
				Cuttings				
Sole Ryegrass	251.9	255.6	288.9	796.5	34.2	35.2	45.1	114.6
Sole Oat	250.0	327.8	372.2	950.1	33.5	44.6	60.7	138.9
Sole Barley	205.6	233.3	266.7	705.6	26.9	31.3	41.2	99.3
Sole Berseem	160.8	180.7	241.7	583.2	18.7	23.5	36.5	78.6
Ryegrass+Berseem(1:1)	186.2	319.4	433.3	939.0	23.0	46.3	73.7	143.1
Ryegrass+Berseem(2:2)	205.5	300.0	405.6	911.1	26.7	42.9	68.2	137.7
Oat+Berseem(1:1)	225.0	259.7	327.8	812.4	29.7	36.4	51.2	117.3
Oat+Berseem(2:2)	187.2	244.4	300.0	731.7	23.6	33.4	47.4	104.4
Barley+Berseem(1:1)	191.7	277.8	397.2	866.7	24.5	39.5	65.5	129.6
Barley+Berseem(2:2)	169.4	266.7	366.7	802.8	20.4	37.6	58.6	116.7
S. Em±	1.2	1.2	2.0	62.7	1.7	1.8	3.7	11.7
C. D. (P=0.05)	3.4	3.4	5.8	187.5	5.0	5.4	10.9	34.8
	Crude protein yield (q/ha)				**Digestible dry matter yield (q/ha)**			
Sole Ryegrass	5.3	4.9	5.3	15.6	22.7	23.3	28.9	75.0
Sole Oat	3.7	4.2	4.5	12.3	22.5	29.5	38.2	90.3
Sole Barley	3.4	3.9	3.8	11.1	17.6	19.9	26.8	66.0
Sole Berseem	4.5	5.4	8.0	17.7	12.9	16.3	24.5	53.7
Ryegrass+Berseem(1:1)	3.9	7.0	9.4	20.1	15.4	30.7	47.8	93.6
Ryegrass+Berseem(2:2)	5.3	7.3	9.8	22.2	18.4	29.4	45.8	93.6
Oat+Berseem(1:1)	3.9	4.5	4.8	13.2	20.1	24.3	33.4	77.7
Oat+Berseem(2:2)	3.2	3.9	4.5	11.4	16.4	23.2	31.7	71.1
Barley+Berseem(1:1)	3.6	5.2	6.7	15.6	16.7	26.7	42.7	86.1
Barley+Berseem(2:2)	3.1	5.3	7.5	15.9	14.5	26.3	39.9	80.7
S. Em±	0.3	0.3	0.6	1.8	1.2	1.3	2.5	7.8
C. D. (P=0.05)	0.8	1.0	1.9	5.4	3.5	3.7	7.2	23.7

and significantly higher over remaining treatments. At 2nd cutting, dry fodder yieldwas significantly higher obtained due to ryegrass+berseem (1:1) intercropping system compared with remaining treatments, which was at parwith ryegrass+berseem (2:2) and sole oat treatments. At 3rdcutting, highest dry fodder yield was observed due to ryegrass+berseem (1:1) intercropping system which was at par with ryegrass+berseem (2:2) and barley+berseem (1:1) treatmentsand significantly higher over remaining treatments. This might be due to component crops in intercropping system can utilized more efficiently available environmental resources such as water, light and nutrients (Lithourgidis *et al*., 2011). The total dry fodder yield (143.1 q/ha) was significantly more in the case of ryegrass+berseem (1:1) intercropping system compared to remaining treatments except sole ryegrass, sole oat, ryegrass+berseem (2:2), oat+berseem (1:1), barley+berseem (1:1) andbarley+berseem (2:2) respectively. Dry fodder yield increased 19.92, 30.61 and 45.07 per cent by ryegrass+berseem (1:1) over sole ryegrass, sole barley and sole berseem treatments, respectively.

Crude protein yield : At 1stcutting, crude protein yield from sole ryegrass and ryegrass + berseem (2:2) was significantly higher compared toremaining treatments except sole berseem. At 2nd cutting, crude protein yield due to ryegrass+berseem (2:2) was at par with ryegrass+berseem (1:1) but significantly higher over remaining treatments. Similar trend was observed at 3rdcutting. Among intercropping treatments, at all the cuttings, crude protein yield was significantly higher due to ryegrass+berseem (2:2) as compared to remaining intercropping systems, which was at par with ryegrass+berseem (1:1) at 2nd and 3rd cuttings. The total crude protein yield (22.2 q/ha) was significantly higher due to ryegrass+berseem (2:2) intercropping system over remaining treatments except sole berseem and ryegrass+berseem (1:1) treatments. The total crude protein yield was29.73, 44.59, 50.00 and 20.27 per cent by ryegrass+berseem (2:2) over sole ryegrass, sole oat, sole barley and sole berseem, respectively. Since crude protein yield is a function of crude protein content and dry fodder yield, the higher value of dry fodder yield and crude protein content led to highest crude protein yield. These results corroborate with the findings of Joshi *et al*. (2012).

Digestible dry matter yield : At 1st cutting, highest digestible dry matter yield was of sole ryegrass which was at par with sole oat and oat+berseem (1:1) and significantly higher over remaining treatments. The increased in digestible dry matter yieldwas 32.16, 18.94, 11.45, 27.75, 26.43 and 36.12 per cent respectively over ryegrass+berseem (1:1), ryegrass+berseem (2:2), oat+berseem (1:1), oat+berseem (2:2), barley+berseem (1:1) and barley+berseem (2:2) intercropping systems. At2nd and 3rdcuttings, highest digestible dry matter yield was of ryegrass+berseem (1:1) intercroppingsystem which was at par with sole oat and ryegrass+berseem (2:2) treatments at 2ndcutting and ryegrass+berseem (2:2) and barley+berseem (1:1) intercropping systems at 3rdcutting but significantly higher over remaining treatments. Least digestible dry matter yield of different treatments at all the cuttings was of sole berseem treatment. The total digestible dry matter yield from ryegrass+berseem (1:1) and (2:2) intercropping system was significantly more compared to sole barley and sole berseem treatments. Since digestible drymatter yield is a function of digestible dry matter content and dry fodder yield, the higher value of dryfodder yield and digestible dry matter content led tohighest digestible dry matter yield (Prajapati, 2019).

On the basis of the present investigation, it could be concluded that intercropping of berseem with ryegrass in 1:1 and 2:2 row ratio showed better proposition of achieving higher green fodder,dry fodder, digestible dry matter and crude protein yields as well as quality fodder compared to sole crop and berseem associated with oat/barley intercropping in the irrigated *Tarai* region of Uttarakhand.

REFERENCES

Akman, H., A. Tamkoc, and A. Topal, 2013 : Effects onyield, yellow berry and black point disease offertilization applications in Hungarian vetch anddurum wheat intercropping system. DigitalProceeding of the ICOEST'2013, Cappadocia,June, 18-21, Nevsehir, Turkey, 839-847.

Albayrak, S., M. Turk, O.Yüksel, and M.Yilmaz, 2011 : Forage yield and thequality of perennial legume–grass mixtures under rainfed conditions. *Not. Bot.Horti. Agrobot. Cluj.*,**391** : 114-118.

AOAC, 1965 : *Official methods of analysis*. 10th ed. Association of official Agricultural Chemicals.Washington, DC, USA.

Carr, P. M., R. D. Horsley, and W. W. Poland, 2004 : Barley, oat, and cereal–peamixtures as dryland forages in the northern great plains. *Agron. J.*, **96** : 677-684.

Choudhary, K. K., N. S. Yadava, S. L. Yadav, and R. C. Jat, 2014 : Green fodder yield and quality of barley (*Hordeum vulgare* L.) as affected by levels of nitrogen. *Forage Res.*, **39** : 190-196.

Dawo, M. I., J. M. Wilkinson, F. E. T. Sanders, and D. J. Pilbeam, 2007 : The yieldand quality of fresh and ensiled plant material from intercropped maize andbeans (*Phaseolus vulgaris*). *J. Sci. Food and Agric.*, **87** : 1391-1399.

GOI, 2009 : 20th Livestock Census, 2019. All India Report.Department of Animal Husbandry and Dairy.p. 13.

Horrocks, R. D. and J. F. Vallentine, 1999 : Harvested forages, Academic Press,London, UK. pp. 17-47.

Jackson, M. L., 1973 : Soil chemical analysis constable and Co. Ltd. Prentice Hall of India Pvt. Ltd New Delhi.

Joshi, Y. P., S. Kumar, and S. A. Faruqui, 2002 : Production potential and economic feasibility of year round forage production system in *Tarai* region of Uttarakhand. *Range manag. Agroforest.*, **33** : 65-68.

Kumar, A., R. K. Arya, S. Kumar, D. Kumar, S. Kumar and R. Panchta, 2012 : Advances in pearl millet fodder yield and quality improvement through breeding and management practices. *Forage Res.*, **38** : 1-14.

Lauk, R. and N. Lauk, 2009 : Dual intercropping of common vetch and wheat or oats,effects on yields and interspecific competition. *Agron. Res.*, **7** : 21-32.

Lithourgidis, A. S., D. N. Valchostergios, C. A. Dordas, and C. A. Damalas, 2011 : Drymatter yield, nitrogen content, and competition in pea–cereal intercroppingsystems. *Eur. J. Agron.*, **34** : 287-294.

Marer, S. B., B. S. Lingaraju, and G. B. Shashidhara, 2007 : Productivity and economics of maize and pigeonpea intercropping under rainfed condition in northern transitional zone of Karnataka. *Karnataka J. Agric. Sci.*,**20** : 1-3.

Midha, L. K., A. Satyawan, and U. N. Joshi, 2014 : Response of forage sweet sorghum genotypes under differentnitrogen levels. *Forage Res.*, **40** : 116-118.

Nasri, R., A. Kashani, M. Barary, F. Paknejad, and S. Vazan, 2014 : Nitrogen uptake and utilization efficiencyand the productivity of wheat in double croppingsystem under different rates of nitrogen. *Int.J. Biosci.* **4** : 184-193.

Olsen, S. R., C. V. Cole, F. S. Watanabe, and L. A. Dean, 1954 : Estimation of available phosphorus in soils byextraction with sodium bicarbonate. USDA.Circular.Govt printing office Washington D. C. **939** : 1-19.

Prajapati, B., J. Prajapati, K. Kumar, and A. Shrivastava, 2019 : Determination of the relationships between quality parameters and yields of fodder obtained from intercropping systems by correlation analysis. *Forage Res.*, **45** : 219-224.

Ross, S. M., J. R. King, J. T. O'Donovan, and D. Spaner, 2004 : Forage Potentialof Intercropping Berseem Clover with Barley, Oat and Triticale. *Agron. J.*, **96** :1013-1020.

Sharma, K. C., 2008 : Fodder productivity and economics of multi-cut pearl millet (*Pennisetumglaucum*) intercropped with clusterbean (*Cyamopsistetra-gonoloba*). *Indian J. Agron.*, **53** : 51-56.

Subbiah, B. V. and H. L. Asija, 1956 : A rapid procedure forestimation of the available nitrogen in soils. *CurrSci.*, **25** : 259-260.

Tiwana, U. S. and K. P. Puri, 2003 : Response of berseem toSulphur under different fertilizer levels. *Forage Res.*, **29** : 94-96.

Vranic, M., M. Knezevic, G. Perculija, K. Bosnjak, and J. Leto, 2009 : Intake,digestibility, *in vivo*, N utilization and *in sacco*dry matter degradability of grasssilage harvested at three stages of maturity. *Asian-Aust. J. Anim. Sci.*, **22** : 225-231.

Walkley, A. J. and I. A. Black, 1934 : Estimation of soilorganic carbon by the chromic acid titrationmethod. *Soil Science*, **37** : 29-38.