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HERBAGE YIELD, NUTRITIVE VALUE AND SOIL PROPERTIES OF ANNUAL RYEGRASS (*LOLIUM MULTIFLORUM* LAM) AS AFFECTED BY SOWING TIME AND VARYING LEVELS OF NITROGEN

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SUMMARY

A field experiment was conducted at research farm of Department of Agronomy, Forages and Grassland Management, CSK HPKV, Palampur during *Rabi* 2015-16 to assess the effect of date of sowing and nitrogen fertilization on herbage yield and nutritive value of annual rye grass. The experiment was laid out in factorial randomized block design with three replications, consisting of fifteen treatment combinations. Annual ryegrass produced significantly highest total green (662.52 q/ha) and dry (136.37 q/ha) forage yields with the application of 160 kg N/ha under sowing time of 2nd fortnight of October. Early sowing in 2nd fortnight of October as well as application of 160 kg N/ha resulted in significantly higher CPC and CPY. Also, the significantly minimum NDF content (41.76%) was recorded with the application of 160 kg N/ha. The higher values of NPK content and uptake were recorded under sowing time of 2nd fortnight of October as well as application of 160 kg N/ha. Soil properties did not affected significantly at the end of experiment except soil available nitrogen, which increased with increasing levels of nitrogen levels up to 120 kg N/ha.

Key words : Annual ryegrass, forage yield, N levels, crude protein, ADF, NDF

Annual ryegrass (*Lolium multiflorum* Lam.) is a cool season annual bunchgrass native to Southern Europe. High palatability and digestibility of this short duration grass makes it highly valued for livestock. The grass is mostly adapted to cool moist climate and grows best in a temperature range of 20 to 25 °C. It is tolerant to acidic and alkaline soils (pH 5.0 to 7.8). The suitable planting time and nutrient management are important aspects for consideration in order to achieve higher forage yields (Fessehazion *et al*., 2011). Date of sowing is an important non-monetary input for deciding growth and yield of crops. All the physiological processes in plants depend on temperature modifications in environment which is altered by sowing dates. This further gives an opportunity to the crop to get optimum temperature for germination and at subsequent growth stages to maximize the production. A principal limiting factor in ryegrass crops can be water deficit, and among mineral elements, nitrogen impedes the growth and yields the most (Simic *et al*., 2009). The main effect of nitrogen fertilization on grasses is to increase the yield and quality of leaf material. Adequate nitrogen supply in forage crops helps to improve herbage growth rate, tiller density, height and ultimately total herbage production. The nitrogen content is the greatest individual nutritional factor affecting the growth and development of annual ryegrass (Griffith *et al*., 1997). Therefore, the proper information on sowing time and optimum nutrients requirement, especially of nitrogen could be of great use in getting higher forage yield of this grass under mid hill conditions of Himachal Pradesh.

MATERIALS AND METHODS

The field experiment was conducted during *Rabi* 2015-16 at research farm of Department of Agronomy, Forages and Grassland Management, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (Himachal Pradesh), India. The climate is mild temperate with annual rainfall of 1500-2500 mm per

annum and average of 2000 mm. Soil samples from 0-15 cm soil depth were collected randomly from different spots and composite soil sample was prepared before the commencement of experiment and analysed for physico-chemical properties of soil by the standard procedures. The soil of the experimental field was silty clay loam in texture, moderately acidic in reaction (pH 5.7), medium in organic carbon (0.68%), available nitrogen (282.2 kg/ha), and available potassium (260.4 kg ha^{-1}) and high in available phosphorus (32.4 kg ha^{-1}). The experiment was laid out in factorial randomized block design with three replications, consisting of fifteen treatment combinations having three sowing times *viz.* 2nd fortnight of October (D_1), 1st fortnight of November (D_2) and 2nd fortnight of November (D_3) and five levels of nitrogen *viz.* No nitrogen, 40, 80, 120 and 160 kg N/ha. The crop was sown in a plot size of 4.5 m × 3.6 m. The healthy seeds of annual ryegrass (Variety: *Makkhan grass*) were sown by hand drilling in the rows opened 30 cm apart with the help of hand plough using 15 kg seed rate per hectare. The fertilizer applied was nitrogen as per treatment and 60 kg P_2O_5 and 30 kg K_2O per hectare through urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively. The entire quantity of phosphorus (60 kg/ha) and potassium (30 kg/ha) and half dose of nitrogen as per treatment were applied at the time of sowing as basal dose. Remaining nitrogen dose was applied by top dressing after each cut. The four cuts of the crop were taken when sown during D_1, while three cuts were taken when sown at D_2 and D_3. Total nitrogen was determined by the modified Micro-kjeldahl method (AOAC 1970) and crude protein (CP) was calculated as N×6.25. Acid detergent fibre (ADF) and Neutral detergent fibre (NDF) content were analysed by the procedures outlined by Soest *et al*. (1991) and Soest & Snifftn (1984), respectively. In case of significant results, critical difference (CD at 5%) was calculated for testing the significance of the difference between two treatments at 5% level of probability.

RESULTS AND DISCUSSION

Forage yield

The date of sowing and nitrogen application interacted significantly with green as well as dry forage yield (Table 1). The total green and dry forage yield increased consistently and significantly with increasing nitrogen levels from no nitrogen to 160 kg N/ha when annual ryegrass was sown in 2nd fortnight of October and 1st fortnight of November. However, the crop sown under 2nd fortnight of November responded upto 120 kg N/ha. Annual ryegrass sown during the 2nd fortnight of October applied with 160 kg N/ha gave highest total green and dry forage yield of 662.52 q/ha and 136.37q/ha amongst all other treatment combinations. Environmental stresses particularly the low temperature and shorter day length with delayed sowing and thereby poor growth and development of the root system might have resulted in slow vegetative growth. Whereas, earlier planting provided longer period for photosynthesis and growth which might be responsible for higher yields (Ukai et al. 2016). Also, early sown crop may have enjoyed the ideal environmental conditions especially the temperature and solar radiation which resulted in higher forage

TABLE 1
Interaction effect of sowing time and nitrogen levels on total green and dry fodder yield (q/ha) of annual ryegrass (total four cuts)

Sowing time	Nitrogen levels (kg/ha)				
	Control	40	80	120	160
Green fodder yield					
2nd fortnight of October	314.15	473.72	554.29	620.90	662.52
1st fortnight of November	199.32	292.71	345.95	387.99	413.96
2nd fortnight of November	174.00	242.87	295.05	337.46	348.31
S. Em±	4.55				
C. D. (P=0.05)	13.43				
Dry fodder yield					
2nd fortnight of October	65.07	97.75	113.81	128.93	136.37
1st fortnight of November	41.13	59.38	70.18	78.12	83.69
2nd fortnight of November	35.94	50.15	60.90	70.48	73.25
S. Em±	2.01				
C. D. (P=0.05)	5.98				

yields (Khurram *et al*., 2002). The beneficial effects of nitrogen on cell division and elongation, formation of nucleotides and co-enzymes which might have resulted in increased meristematic activity and photosynthetic area and hence more production & accumulation of photosynthates, yielding higher green fodder and dry matter. This is in conformity with results of Corkran *et al*. (2015), Soheir El-Sherbenyetal. (2012) and Ullah *et al*. (2015).

Quality parameters

Crude protein content (CPC) and Crude Protein Yield (CPY)

A keen observation of data in Table 2 indicated that sowing time and nitrogen levels had significant effect on CPC and CPY of the herbage. Early sowing in 2nd fortnight of October resulted in highest CPC (11.50%) and CPY (12.66 q/ha) of annual ryegrass followed by the crop sown in 1st fortnight of November. The improvement in total crude protein yield due to 2nd fortnight of October sown annual ryegrass was 66.36 and 94.47 per cent over 1st fortnight of November and 2nd fortnight of November, respectively. The better quality in early sowing may be due to more number of green leaves having higher contents of nitrogen and other nutrients owing to more conducive environmental conditions for the growth of the crop (Sood *et al*., 1992). Further, CPC and CPY increased significantly and consistently with increasing levels of nitrogen up to 160 kg N/ha. The significantly highest values of CPC (12.24 %) and CPY (12.15 q/ha) were observed with the application of 160 kg N/ha. The magnitude of increase in total CPY with 160 kg N/ha over no nitrogen, 40, 80 and 120 kg N/ha was 146.45, 63.52, 32.95 and 11.16 per cent, respectively. The improvement in quality may be due to the fact that nitrogen being as essential constituent of chlorophyll, protoplast, protein and nucleic acids is essential for protein synthesis. As such adequate available nitrogen enhanced the protein synthesis, which resulted in higher content as well as yield of crude protein (Ratan *et al*., 2016). Similar results were also reported by Pathan and Bhilare 2008 and Shekara *et al*. 2008.

Acid detergent fibre (ADF) and Neutral detergent fibre (NDF) content

An observation of data indicated that sowing time had no significant effect on ADF and NDF contents of annual ryegrass (Table 2). However, numerically, the lowest ADF (28.22 %) and NDF (42.80 %) contents were recorded under sowing time of 2nd fortnight of Nov. The data further indicated that nitrogen application did not exhibit any significant effect on ADF content of annual ryegrass, however, NDF content showed a decreasing trend with increasing levels of nitrogen. Application of 160 kg N/ha recorded significantly minimum NDF content of 41.76% compared to rest of the treatments. The reduction in NDF content of annual rye grass with increased nitrogen levels might be due to increased leaf biomass of grass than that of stem. These results are in line with the findings of Bora *et al*. (2011) and Sharma *et al*. (2012).

TABLE 2
Effect of sowing time and nitrogen levels on quality attributes of annual ryegrass (mean of four cuts)

Treatments	Crude protein content (%)	Crude protein yield (q/ha)	Acid detergent fibre content (%)	Neutral detergent fibre content (%)
Sowing dates				
2nd fortnight of October	11.50	12.66	28.78	44.65
1st fortnight of November	11.26	7.61	28.35	43.40
2nd fortnight of November	10.86	6.51	28.22	42.80
S. Em±	0.09	0.12	0.32	0.30
C. D. (P=0.05)	0.27	0.35	NS	NS
Nitrogen levels (kg N/ha)				
Control	10.35	4.93	29.52	46.05
40	10.68	7.43	28.02	44.34
80	11.21	9.18	27.71	43.30
120	11.76	10.93	28.17	42.63
160	12.24	12.15	28.83	41.76
S. Em±	0.11	0.16	0.42	0.39
C. D. (P=0.05)	0.30	0.45	NS	0.80

TABLE 3
Effect of sowing time and nitrogen levels on NPK content (%) and NPK uptake (kg/ha) by annual ryegrass

Treatment	Content			Uptake			Soil pH	Organic carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
	N	P	K	N	P	K					
Sowing time											
2nd fortnight of October	1.79	0.52	1.73	187.03	24.18	176.63	5.70	0.68	243.29	23.23	221.79
1st fortnight of November	1.71	0.48	1.70	122.47	18.00	118.64	5.67	0.69	255.49	24.27	224.70
2nd fortnight of November	1.63	0.42	1.60	110.74	15.31	104.90	5.67	0.66	263.59	24.95	225.22
S. Em±	0.03	0.01	0.03	2.42	0.42	3.43	0.02	0.02	3.43	0.76	3.29
C. D. (P=0.05)	0.08	0.03	0.09	7.51	1.23	10.24	NS	NS	10.30	NS	NS
Nitrogen levels (kg N/ha)											
Control	1.41	0.39	1.15	78.87	11.83	60.97	5.72	0.68	234.23	25.59	230.38
40	1.53	0.43	1.47	109.97	16.90	100.70	5.69	0.71	247.18	24.77	227.13
80	1.69	0.48	1.71	139.29	20.13	135.60	5.68	0.68	251.08	23.98	223.57
120	1.88	0.52	1.95	171.14	22.48	170.13	5.66	0.64	262.65	23.49	219.84
160	2.03	0.54	2.09	201.14	24.47	199.54	5.65	0.66	275.48	22.92	218.58
S. Em±	0.04	0.01	0.03	3.40	0.54	4.43	0.03	0.03	4.30	0.98	4.25
C. D. (P=0.05)	0.11	0.03	0.08	10.02	1.62	13.29	NS	NS	13.29	NS	NS

NPK content and uptake

The content and uptake of all the three nutrients *viz.* N, P and K (Table 3) by annual ryegrass was significantly higher when crop was sown during 2nd fortnight of October than 2nd fortnight of November. However, N & K content in forage of annual ryegrass sown on 2nd fortnight of October and 1st fortnight of November was statistically similar with each other. Though, the total N, P & K uptake was significantly highest when crop was sown on 2nd fortnight of October followed by 1st fortnight of November and lowest in crop sown during 2nd fortnight of November. Jehangir *et al*. (2013) opined that higher uptake under earlier sowing may be attributed to the increased fodder and dry matter yield. The NPK content and uptake increased consistently and significantly with increasing levels of nitrogen from no nitrogen to 160 kg N/ha except P content where significant response was found up to 120 kg N/ha. The higher NPK content and uptake under 160 kg N/ha may be due to vigorous vegetative as well as profuse root growth, which might have led to better absorption of nutrients from soil and resulted in better crop growth, forage yield and improvement in nutrient contents due to increased availability (Jehangir *et al*., 2013; Ukai *et al*., 2016).

Soil properties

An observation of data (Table 3) revealed that soil pH, soil organic carbon, phosphorus and potassium were not influenced significantly by sowing time and nitrogen levels after the completion of the experiment. The soil had significantly higher available nitrogen when the crop was sown during 2nd fortnight of November as compared to 2nd fortnight of October and it was at par with 1st fortnight of November. Further, available soil nitrogen increased significantly with increase in the nitrogen levels and significantly higher available nitrogen (275.48 kg/ha) was recorded when 160 kg N/ha was applied, though this treatment remained at par with 120 kg N/ha. The increase in soil available nitrogen with the increase in nitrogen levels might be due to the added nitrogen as per each treatment to some extent and better growth of annual ryegrass with nitrogen application might have added more organic matter to the soil, hence better soil nitrogen status with increasing nitrogen levels (Devi *et al*., 2010).

CONCLUSION

Second fortnight of October was adjudged as the best time of sowing for annual ryegrass under mid hill conditions of Himachal Pradesh. The forage yield of annual ryegrass increased consistently with increasing nitrogen application from 0 to 160 kg N/ha under sowing time of 2nd fortnight of October and 1st fortnight of November. However, under late sown condition (2nd fortnight of November), the crop responded only upto 120 kg N/ha. In terms of nutritional quality, application of 160 kg N/ha recorded maximum crude protein content and crude protein yield. The treatments failed to influence the soil properties under study except soil available nitrogen was increased with the increase in nitrogen application.

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