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GENOTYPIC RESPONSE OF BERSEEM (*TRIFOLIUM ALEXANDRINUM* L.) TO DIFFERENT PHOSPHORUS LEVELS

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SUMMARY

An experiment was carried out during *rabi* season, 2019-20 at Forage Research Farm, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar (Haryana) for evaluating the effect of promising genotypes of berseem yield and quality at different phosphorus levels in semi-arid and sub-tropical climate. The experiment consisted of 15 treatment combinations *viz.*, five promising genotypes (Three genotypes *i.e.* JHB-17-1, JHB-17-2 & PC-91, one national check *i.e.* Wardan and one zonal check for North West zone *i.e.* Bundel Berseem-2) of berseem were kept in main plots and three phosphorus levels (60, 80 and 100 kg/ha) in sub plots which were replicated thrice in a split plot design. The results of experiment showed that entry JHB-17-1 performed best in respect of green fodder yield (582.6 q/ha), dry matter yield (80.5 q/ha), crude protein yield (16.72 q/ha) and B: C (1.79). Whereas, Bundel Berseem-2 was performed best in case of crude protein content (20.78%). Application of 100 kg P_2O_5/ha was proved superior in case of green fodder yield (560.4 q/ha), dry matter yield (77.8 q/ha), crude protein content (20.75%), crude protein yield (16.14 q/ ha) and B: C (1.70) which was statistically on a par with application 80 kg P_2O_5/ha.

Key words : Berseem, genotypes, fodder yield, phosphorus levels, crude protein

Livestock rearing is an important part of rural livelihood with cattle breeding and milk production being the main professions in rural India. Most often, livestock is the only source of cash income for subsistence farms and also serves as insurance in the event of crop failure. With increasing health awareness and purchasing power, the demand of milk and milk product is increasing for which livestock have to play a significant role. The milk production is growing by 35.61% during the last six years to 198.4 million tonnes in 2019-20. Milk production in the country has increased from 146.3 million tonnes in 2014-15 to 198.4 million tonnes in 2019-20 as compared to 2018-19, it has increased by 5.70 percent (Anonymous, 2021). The productivity of livestock often remains low in Indian condition, which is 20 to 60% lower than the global average. The non-availability of quality fodder which leads to malnutrition, under nutrition or combination of both in livestock, along with poor genetic potential is a major factor for poor productivity. The major feed resources for livestock are grasses, community grazing on common lands and harvested fields, crop residues and agricultural by-products, cultivated fodder, edible weeds, tree leaves from cultivated and uncultivated lands and agro-industrial by-products. Crop residues include fine straws, coarse straws, leguminous straws, sugarcane tops etc. and are the single largest bulk feed material available easily to the farmers for feeding ruminants. Fodder is cultivated on approximately 5 per cent of the gross cropped area in the country, which has remained nearly same over the last few decades. In India, there is a deficit of 11.24 and 23.4% in green and dry fodder availability. Total green fodder and dry fodder availability is 734.2 and 326.4 mt against demand of 827.19 and 426.1 mt, respectively, (Roy *et al.,* 2019). The ever increasing demand of fodder and feed for enhancing livestock production can be fulfilled through escalating the overall productivity of fodder. The adequate supply of quality fodder and feed with superior nutritive composition is a key factor for controlling the efficiency and so on the overall productivity of the livestock. While

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success has been achieved to a great extent in fodder production due to improved varieties coupled with technological advancement and farmers initiative, but further commitment is needed to meet the nutritional requirement of animals by providing quality fodder.

Among different *rabi* annuals, berseem (*Trifolium alexandrinum* L.) is one of the most vital leguminous fodder crops of the country. In Northern India, this crop is grown in *rabi* season as a multi-cut fodder crop which provide quality green fodder from November to April months. It supply a major part of the animal nutrition as it contains 15.8-26.7% crude protein, 14.9-28.3% crude fiber, 1.4-3.0% ether extract, 1.40-2.58% calcium and 2.52-4.25% nitrogen content and about 0.14-0.20% phosphorus content (Devi and Satpal, 2019). Furthermore, its wider adaptability, fast vegetative growth, multi-cut nature, better output and supply of fodder for prolonged period with high palatability and maximum nutritive value liked by variety of animal. It contains about 62% total digestible nutrients (Gondal *et al.,* 2021). For increased and sustained production, a continuous collection of germplasm and subsequent development of newer material in the form of varieties are the basis of crop improvement programme (Jindal *et al*., 2018). The vegetative growth of any crop is largely dependent upon the genotype potential, nutrient management, ability of the soil to supply the nutrients to the crop and capacity of the plants to take and use the nutrients from soil. The fodder production and productivity is limited by the non availability of improved genotypes of berseem crop to the farmers. Berseem, being multi-cut in nature is also highly responsive to fertilizers specially phosphorus, having good source of macro (N, P, K, Ca, Mg and S) as well as micro (Fe, Mn, Cu, B, Co, Cl, Na etc.) nutrients. Phosphorus being an essential nutrient for plant is required for the root growth. It also plays a vital role in absorption of different plant nutrients. Berseem as a leguminous crop requires adequate quantity of free form of phosphorus for proper nodulation. Furthermore, it plays a significant role in number of enzymatic reactions and protein synthesis. Therefore, it is very important to find out the optimum dose of phosphorus to realize the potential yield of newly tested berseem genotypes. Keeping these aspects in view, the present investigation was carried out to evaluate the response of promising genotypes of berseem (*Trifolium alexandrinum* L.) to different phosphorus levels.

MATERIALS AND METHODS

An field experiment was carried out during *rabi* season, 2019-20 at Forage Section Research Farm of CCS Haryana Agricultural University, Hisar (Haryana), India (29°10' N of 75°46' E, at an average elevation of 215.2 m above mean sea level). The climate of site was semi-arid and sub-tropical with hot dry summers and severe cold winters. Average annual rainfall is about 450 mm, of which 75 per cent is received in three months, from July to September during South-West monsoon. Weekly weather parameters *i.e*. temperature (°C), relative humidity (%) and rainfall (mm) during the crop period are depicted in Fig 1. The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction (pH 8.2), low in available nitrogen (155.8 kg/ha), medium in available phosphorus (12.9 kg/ ha) and potassium (241.9 kg/ha). The experiment was carried out in split plot design and replicated thrice. The main plot consisted of five promising genotypes (Three genotypes *i.e.* JHB-17-1, JHB-17-2 and PC-91, one national check *i.e.* Wardan and one zonal check *i.e.* Bundel Berseem-2, for North West zone) whereas sub-plot had three phosphorus levels (60, 80 and 100 kg P_2O_5/ha). The berseem genotypes were sown manually on November 16, 2019 as per treatment in opened furrows at 30 cm apart using the seed rate of 25 kg/ha. All the other standard agronomic practices for the cultivation of berseem were followed uniformly in all the treatments. Nitrogen was uniformly applied at the rate of 20 Kg/ha as basal in each plot. Total four cuts were taken, of which first cut was taken at 60 days after sowing. Thereafter, cuts were taken 30-40

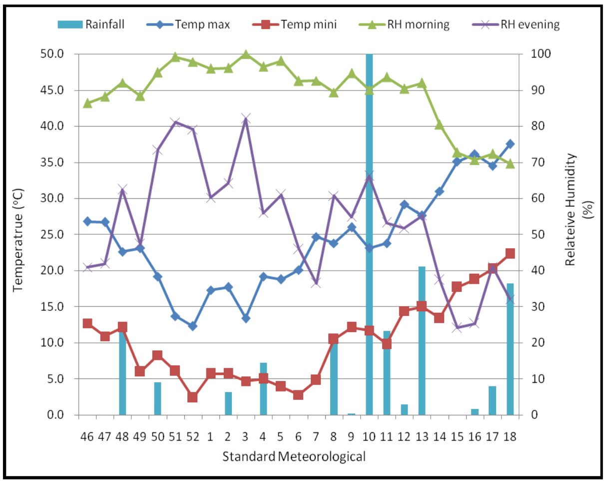

Fig. 1. Weekly weather parameters during *Rabi* 2019-20 at the experimental site.

days intervals. The green fodder harvested from each plot was weighed in situ in kg/plot which was converted into q/ha. At the time of green fodder harvesting, a random sample of 500 g was taken from each plot, chopped well and pack into paper bag. By making small holes all over these bags were aerated. Firstly, the samples were dried in the sun for 15 days and then moved into an electric hot air oven for drying at a temperature of 60±5°C till constant weight was observed. Then, the green fodder yield was converted into dry matter yield (q/ha) based on these samples. Quality analysis of berseem samples were also done in lab. The average crude protein content (%) was estimated through dried and grinded samples (2 mm sieve size), collected after each cut. The crude protein content was calculated by multiplying the nitrogen percentage with 6.25 which was estimated by conventional micro-kjeldal method (AOAC, 1995). Crude protein yield was estimated by multiply the crude protein content with dry matter yield (q/ha). Economics calculation was carried out by considering the prevailing market prices of inputs and outputs. The trial data were analyzed by using OPSTAT software which is available on CCS Haryana Agricultural University official site (Sheoran *et al*., 1998).

RESULTS AND DISCUSSION

Effect of genotypes (Four cuts were taken)

Data presented in Table 1 revealed that among different genotypes, average plant height (cm) was not affected significantly, although it was found highest with entry JHB-17-1. Furthermore, leaf stem ratio was observed highest (0.82) with entry JHB-17-1 which was significantly higher than all other genotypes. The average numbers of tillers per meter row length were also recorded maximum (108.4) with JHB-17-1 which was significantly higher than all other genotypes. The differences in growth characters may be attributed due to the difference in inherent capability of different genotypes. Total green fodder (582.6 q/ha) and dry matter (80.5 q/ha) yield were recorded maximum in JHB-17-1 which was significantly higher than all other genotypes. The per day productivity of green (3.86 q/ha/day) and dry fodder (0.53 q/ha/day) were recorded highest with entry JHB-17-1 which was significantly higher than all other genotypes. This may be ascribed that the differences in growth and yield attributing character of genotypes are due to their different genetic potential and the entry JHB-17-1 recorded significantly

TABLE 1
Growth, quality and productivity of berseem promising genotypes as influenced by phosphorus levels

Treatment	Plant height at harvest (cm)	No. of tillers/ mrl	Leaf to stem ratio	Per day productivity (q/ha/day)		Total green fodder yield (q/ha)	Total dry fodder yield (q/ha)	Crude protein content (%)	Crude protein yield (q/ha)
				Green fodder	Dry fodder				
A. Genotypes									
JHB-17-2	55.3	98.9	0.72	3.46	0.46	522.4	69.3	20.62	14.32
BB-2 (ZC)	53.4	94.9	0.68	3.41	0.45	513.6	67.3	20.78	14.01
PC-91	56.3	100.3	0.74	3.48	0.47	526.8	70.5	20.36	14.37
Wardan (NC)	56.4	101.1	0.75	3.49	0.48	527.5	71.9	20.14	14.50
JHB-17-1	57.4	108.4	0.82	3.86	0.53	582.6	80.5	20.77	16.72
SEm (±)	0.9	1.8	0.02	0.06	0.01	9.6	1.9	0.13	0.42
CD (P=0.05)	NS	5.9	0.06	0.21	0.04	32.0	6.4	0.41	1.38
B. Phosphorus levels (kg P_2O_5/ha)									
60	53.5	96.5	0.70	3.32	0.42	502.4	64.2	20.18	12.96
80	56.2	101.1	0.75	3.59	0.49	540.9	73.7	20.68	15.25
100	57.6	104.5	0.78	3.70	0.52	560.4	77.8	20.75	16.14
SEm (±)	0.7	1.3	0.01	0.05	0.01	7.4	1.4	0.08	0.30
CD (P=0.05)	2.0	3.7	0.04	0.16	0.03	22.0	4.2	0.24	0.89
Factor(B) at same level of A									
SEm (±)	1.5	3.1	0.03	0.11	0.02	16.7	3.4	0.22	0.72
CD (P=0.05)	NS	NS	0.06	NS	NS	NS	NS	NS	NS
Factor(A) at same level of B									
SEm (±)	1.5	2.9	0.02	0.12	0.02	16.6	3.2	0.20	0.69
CD (P=0.05)	NS	NS	0.06	NS	NS	NS	NS	NS	NS

higher growth attributes character which resulted in higher yield as compared to other genotypes. Maximum crude protein content (20.78%) was recorded in Bundel Berseem-2 which was significantly higher than PC-91 and Wardan, whereas crude protein yield (16.72 q/ha) was significantly higher with JHB-17-1 than all other treatments. Data presented in Table 2 revealed that among different genotypes, maximum B: C ratio (1.79) was fetched in JHB-17-1 followed by Wardan and PC-91. Several workers Tongel and Albayrak (2006), Nargesh (2012) and Kumawat and Khinchi (2017) have also reported the difference in forage yield and other growth characteristics. Godara *et. al.* (2016) also observed genotypic differences in entries for yields and quality of fodder.

TABLE 2

Economics of promising genotypes of berseem as influenced by phosphorus levels

Treatment	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B : C ratio
Genotypes				
JHB-17-2	65140	104484	39344	1.60
BB-2 (ZC)	65140	102727	37587	1.58
PC-91	65140	105351	40211	1.62
Wardan (NC)	65140	105509	40369	1.62
JHB-17-1	65140	116527	51387	1.79
Phosphorus levels (kg P_2O_5/ha)				
60	64240	100489	36249	1.56
80	65140	108184	43044	1.66
100	66040	112085	46045	1.70

Effect of phosphorus levels

The growth parameters, green fodder yield, dry matter yield, crude protein content and crude protein yield increased with increasing phosphorus levels. This was due to the fact that phosphorus being a essential plant nutrient it play a vital role in root growth, and also helps in providing different plant nutrients through the life cycle of berseem crop. Data presented in Table 1 revealed that among different phosphorus levels, average plant height (57.6 cm) was recorded highest with the application of 100 kg P_2O_5/ha which was statistically on a par with 80 kg P_2O_5/ha. Furthermore, leaf stem ratio (0.78) was observed maximum with the application of 100 kg P_2O_5/ha which was significantly superior to 60 kg P_2O_5/ha. The results are in close agreements with Roy *et al.* (2015) who also reported a significant effect of phosphorus application on leaf stem ratio of berseem. Furthermore, Ayub *et al.* (2012) also observed a significant variation in leaf stem ratio of cluster bean with increasing levels of phosphorus application. The average numbers of tillers per meter row length (104.5) were recorded maximum with the application of 100 kg P_2O_5/ha which was significantly higher than 60 kg P_2O_5/ha. This might be possible as berseem being a leguminous crop need adequate quantity of phosphorus in free form for enhanced nodulation which will result in increased nitrogen fixation in plant roots. Phosphorus also plays a primary role in several enzymatic reactions. Besides this, it is a critical part of DNA, RNA needed for protein synthesis and plays a significant role in energy transfer system (ADP, ATP) (Satpal *et al.,* 2020). Likewise, total green fodder yield (560.4 q/ha) and dry fodder yield (77.8 q/ha) were recorded maximum with the application of 100 kg P_2O_5/ha which was statistically on a par with 80 kg P_2O_5/ha. The per day productivity of green (3.70 q/ha/day) and dry fodder (0.52 q/ha/day) were recorded highest with application of 100 kg P_2O_5/ha which was significantly higher than 60 kg P_2O_5/ha. The feasible cause may be that the increasing phosphorus doses resulted in better accumulation of carbohydrates, protein and their translocation to the productive organs, that may enhanced growth and fodder yield. This could also be attributed to more tillers which resulting in the overall enhancement and production of sufficient photosynthates. The results support the effort of Mahmud *et al.* (2003), Kumawat and Khinchi (2017) and Satpal *et al.,* 2020. Crude protein content (20.75%) and crude protein yield (16.14 q/ha) were found maximum with 100 kg P_2O_5/ha which were statistically at par with 80 kg P_2O_5/ha. The better root growth with higher application of phosphorus ultimately provides a better environment for the activity of biological nitrogen fixing bacteria. Moreover, the higher root mass exploits the soil from nearby more efficiently and enhance the nutrients accessibility for crop plants. These results are in agreement with Yadav *et al.* (2011) who also reported significant effect of phosphorus on crude protein percentage in cluster bean. Data presented in Table 2 revealed that among different phosphorus levels, maximum B: C ratio (1.70) was fetched with 100 kg P_2O_5/ha followed by 80 kg P_2O_5/ha.

CONCLUSION

From one year study, it can be concluded that the entry JHB-17-1 performed superior in respect of yield (green fodder, dry matter, crude protein) and fetched better monetary returns. Whereas, Bundel Berseem-2 performed better in terms of crude protein content followed by JHB-17-1 and JHB-17-2. Berseem responded to phosphorus fertilization up to 100 kg P_2O_5/ha. Application of 100 kg P_2O_5/ha improved the yield (green fodder, dry matter yield and crude protein) to maximum but it was on a par with 80 kg P_2O_5/ha. Maximum BC ratio fetched with 100 kg P_2O_5/ha was only 2.4 % higher over 80 kg P_2O_5/ha. Application of 80 kg P_2O_5/ha is sufficient for berseem to realize the higher fodder yield, quality and better remuneration.

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