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Research Article

Growth and Yield Analysis of Berseem (*Trifolium alexandrinum* L.) Genotypes under Phosphorus Fertilization in Indo-Gangetic Plains of India

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Abstract

A Field experiment was carried out at Instructional Dairy Farm, G B pant University of Agriculture and Technology, Pantnagar during winter season of 2020-21 to study the growth and yield analysis of berseem (*Trifolium alexandrinum* L.) genotypes under phosphorus fertilization in Indo-Gangetic plains of India. Berseem genotype BM-4 produced significantly highest green fodder yield that was 10.2, 14.3 and 38.4% higher than Wardan, JB-07-15 and BB-2, respectively. The highest crude protein content and crude protein yield were estimated in BM-4 that was significantly equal to Wardan but the NDF and ADF contents were significantly equal among genotypes. Application of 100 kg P_20_5/ha gave 7.4 and 14.0% higher green fodder yields than 80 and 60 kg P_20_5/ha, respectively. The crude protein content and its yield increased with P application rates and significantly highest values were recorded at 100 kg P205/ha which gave 11.1 and 24.4% higher than 80 and 60 kg P_20_5/ha, respectively. The NDF and ADF content increased with phosphorus levels with the highest values at 100 kg P_20_5/ha but remained non-significant to each other. Therefore it is concluded that berseem genotypes BM-4 may be grown at application of 100 kg P_20_5/ha for higher growth, yield and quality of berseem fodder in Indo-Gangetic plains of India.

Keywords: Crude Protein, Genotypes, ADF, NDF, L:S ratio

Introduction

Berseem (*Trifolium alexandrinum* L.) is the most important fodder crop of India grown in winter season mainly in Northern part of the country because of suitable climate and better irrigation facilities. The green foliage of berseem is very palatable and remains soft and succulent throughout the growth period. It provides 5-6 cuttings in 120-150 days from November to April months. Berseem can also be grown without irrigation in areas with high water table and waterlogged conditions. Berseem is believed to be indigenous to Egypt. It is the main forage legume in Syria and Persia where it forms the principal green forage for horses, donkeys and camels. It was introduced into India in 1904. Berseem is now a prominent fodder legume in irrigated areas of the Punjab, Delhi, Rajasthan, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Bihar and other parts of Western and Northern India. It is widely grown both for fodder and green manure. Berseem is shrubby annual, sparsely hairy and erect forage legume growing with 60-90 cm high. The main, succulent stem gives off branches terminating in two or three leaves. These stems become fibrous after the flowering stage. The leaves are small, oblong and rounded at the extremities, bright green and slightly hairy. Berseem has a potential to produce 80 to 100 tons of green fodder per hectare that is sufficient to 10 cows for 250 days. Berseem fodder is not only highly palatable due to its succulence but also it is highly nutritious with 20% crude protein, 62% TDN, 35-38% ADF, 24-25% cellulose, 7-10% hemicelluloses and high Ca and P that improve the milching capacity of livestock. It is a multipurpose crop grown for hay, forage and seed [6].

Berseem is an N-fixing legume. It may require rhizobium inoculation outside its native area [8]. As a winter crop it provides soil cover and prevents erosion. As a green manure, berseem intercropped with oats in a maize/soybean/oat+berseem rotation increased maize yield by 10% and returned 43 kg N/ha [7]. The highest fodder yield of berseem was harvested at application of 60 kg P_20_5/ha [2] and 90 kg P_20_5/ha [12] and at 100 kg P_20_5/ha [14,17]. It revealed that production potential of berseem differed with agro-climatic zones.

Plant nutrition is a major player to affect the yield and quality of berseem [1]. Among the major plant nutrients, **p**hosphorus is essential for the formation of adenosine triphosphate (ATP) which is currency the energy for living things and also for nicotinamide adenine dinucleotide phosphate (NADP) which is very important for the process of photosynthsis. Moreover, phosphorus is also an integral part of myo-inositol phosphate which may be tri, tetra or hexa-inositol [1-6] and myo-inositol hexkisposphtae also called Phytic acid [4]. Phosphorus also helps in maintaining structural integrity, respiration and also provides strength to straw to withstand lodging [3], while plants uptake phosphorus till its maturity [10]. Considering the above facts of phosphorus role in berseem production, the present field investigation was carried out with objective to optimize the phosphorus dose for berseem production in *Tarai* region of Himalyan foothills of Uttarakhand.

Materials and Methods

A field experiment was carried out at Instructional Dairy Farm, G B Pant University of Agriculture and Technology, Pantnagar during winter season of 2020-21 to study the effect of cultivars and phosphorus level on yield and quality of berseem (*Trifolium alexandrinum* L). The experimental site was sandy loam with neutral soil pH and available nitrogen, phosphorus and potassium were 278.5, 27.7 and 232.8 kg/ha, respectively. The experiment consisted of four berseem genotypes i.e. 'BM-4, JB-07-15', 'Bundel Berseem-2 (BB-2)' and 'Wardan' and three phosphorus levels i.e. 60, 80 and 100 kg/ha, was planted during Rabi season 2020-21 under split plot design with three replications. The crop was fertilized with uniform 20 kg N and 30 kg K_20/ha at the time of sowing. Pendimethalin @ 3.3 l/ha was applied as pre emergence application for weed control. The crop was planted at 25 kg seed rate/ha with 30cm x 10cm planting geometry. The harvesting was started after 55 days of sowing (I cut) and subsequent cutting were taken at 30 days interval up to 2nd week of April and total 4 cutting were taken. The growth, fodder yield, crude protein, NDF and ADF were estimated with standard methodology at different cuttings and pooled data were analyzed for average values.

Results and Discussion

Effect of genotypes

Growth attributes

The plant height, number of branches/plant and leaf: stem ratio were affected significantly by berseem entries (Table.1). Berseem genotype Wardan had the tallest plants that were significantly equal to BM-4 but BB-2 had the shortest plants. The variation in plant height among varieties might be attributed to genetic make-up of the varieties. Jaiswal RK *et al*. also reported variation in plant height among berseem varieties. The number of branches/plants was counted highest in Wardan that was non-significant with BM-4. Berseem entry BB-2 exhibited the lowest number of branches and remained significantly similar to JB-07-15. The L:S ratio differed greatly among berseem entries and the highest value was found in BM-4 followed by JB-07-15, however remained non-significant among each other. The higher L:S ratio was the result of comparatively longer and wider leaves that is the indicator of good fodder quality. The plant stand differed greatly and the highest plant stand was recorded in BM-4 genotypes at both 20 DAS and at harvest. Patel JR. *et al* noted higher L:S ratio at 90 kg P_20_5/ha. The distinct growth attributes are governed by genetic make-up of the variety, so the varietal difference in growth attributes were identified [18].

Fodder yield

Berseem genotype BM-4 produced significantly highest green fodder yield that was 10.2, 14.3 and 38.4% higher than Wardan, JB-07-15 and BB-2, respectively. Similarly the dry fodder yield was recorded in BM-4 that was statistically at par with Wardan and lowest value was found in BB-2. Similar trend was also observed for per day productivity of green and dry fodder yield with highest values in BM-4 followed by Wardan, JB-07-15 and the lowest in BB-2. The genotype BM-4 had the highest plant stand and L:S ratio, while Wardan had the higher plant height and number of branches/plant but significantly similar to BM-4, resulting higher green and dry fodder compared to other genotypes. Hence, the higher green fodder and dry fodder yields were the cumulative contribution of better growth attributes i.e. plant height, number of branches/plant and L:S ratio and also higher plant stand. The positive and significant association between fodder yield and number of branches and L:S ratio was observed [19]. Devi U and Satpal also reported genotypic variations among genotypes for fodder yields and quality.

Fodder quality

Berseem genotypes differed significantly in crude protein content, crude protein yield, ADF and NDF (Table.2). The highest crude protein content and crude protein yield were estimated in BM-4 that was significantly equal to Wardan. Variety BB-2 had the lowest crude protein content as well as the crude protein yield. The higher crude protein yield was contributed by higher dry matter yield and crude protein content. The NDF content was recorded significantly equal in all tested berseem genotypes, however the lowest value was found in Wardan followed by JB-07-15 but the ADF value was recorded lowest in JB-07-15 followed by BB-2 and the highest in Wardan. The research findings also concluded that berseem varieties differed among quality attributes due to its genetic constitutions [13,14 and 17].

Effect of phosphorus fertilization

Growth attributes

Growth attributes were influenced greatly by phosphorus levels and increased with increasing P levels with maximum values at 100 kg P_20_5/ha, however the plant height and number of tillers/m row length increased significantly up to 80 kg P_20_5/ha but L:S ratio remained non-significant among P levels (Table 1). The tallest plants were measured at 100 kg P_20_5/ha that was statistically at par with 80 kg P_20_5/ha and similar trend was observed in case of number of tillers/m row length. The plant stand increased with increasing level of phosphorus and maximum values were counted at application of 100 kg P_20_5/ha though remained non-significant with 60 and 80 kg P_20_5/ha. The L:S ratio was also increased from 60 to 100 kg P_20_5/ha but remained non-significant among P levels and supported by [14]. Phosphors fertilization improves root and shoot strength, enzymatic activities, photosynthetic characters and metabolic profile and finally growth attributes.

Treatment	Pl ht (cm)	No. of branches/pl	L:S ratio	Green fodder yield (t/ha)	Dry fodder yield (t/ha)	GFY (kg/ha/Day)	DFY(kg/ha/day)	Plant stand/m (Initial-20 DAS)	Plant tand/m (Harvest)
Genotypes									
BM-4	52.56	6.27	0.82	49.34	7.73	3.50	0.55	68.78	34.89
JB-07-15	50.14	6.11	0.76	43.13	6.79	3.06	0.48	59.67	33.89
BB-2	47.77	6.10	0.75	35.66	5.64	2.53	0.40	57.22	20.67
Wardan	54.80	6.40	0.75	44.77	7.31	3.18	0.52	60.33	32.22
SEm±	0.79	0.06	0.04	1.04	0.18	0.07	0.01	2.48	2.04
CD (0.05)	2.80	0.21	NS	3.63	0.63	0.26	0.45	NS	7.20
Phosphorus fertilization									
P_1(60 kg/ha)	49.62	6.18	0.78	4.05	6.41	2.87	0.45	60.58	28.33
P_2 (80 kg/ha)	51.53	6.24	0.75	42.99	6.85	3.05	0.49	57.33	30.67
P_3(100 kg/ha	52.81	6.25	0.79	46.18	7.36	3.28	0.52	66.58	32.25
SEm±	0.55	0.04	0.03	0.47	0.06	0.03	0.01	2.67	1.30
CD (0.05)	1.65	NS	NS	1.42	0.19	0.10	0.01	NS	NS
Interaction	NS	NS	NS	NS	S	NS	S	NS	NS

Table 1: Effect of phosphorus fertilization on growth and fodder yield of promising berseem Genotypes.

Fodder yield

The green and dry fodder yield increased significantly with increasing P levels from 60 to 100 kg P_20_5/ha which gave significantly highest green and dry fodder yields. Application of 100 kg P_2O_5/ha gave 7.4 and 14.0% higher green fodder yields than 80 and 60 kg P_2O_5/ha, respectively. Similarly, the application of 80 kg P_2O_5/ha had a 6.2% higher green fodder yield than 60 kg P_2O_5/ha. The dry fodder yield was recorded 7.4 and 14.7% higher dry fodder yield than 80 and 60 kg P_2O_5/ha, respectively, while 80 kg P_2O_5/ha exhibited 9.0% higher values than 60 kg P_2O_5/ha. The per day green and dry fodder productivity differed significantly with P levels and increased up to 100 kg P_2O_5/ha with maximum values. The higher values were attributed to higher plant stand, taller plants, more tillers, and better L:S ratio mainly because phosphorus contributed to enhanced photosystems [3] and uptake [10] leading to better plant growth and development. Pal MS also stated that phosphorus application @ 100kg/ha produced significantly higher green and dry fodder yield that was 4.8% and 4.7% greater than 80 kg P levels, respectively. Satpal *et al.* also observed similar results at Hisar (India). However, higher fodder yield of berseem was noted application of 80 kg phosphorus/ha [11].

Fodder quality

Phosphorus had a significant effect on the crude protein content and crude protein yield of berseem (Table 2). The crude protein content and yield increased with P application rates and the significantly highest values were recorded at 100 kg P_20_5/ha which gave 11.1 and 24.4% higher than 80 and 60 kg P_20_5/ha, respectively. The higher crude protein yield was the result of higher crude protein content and dry fodder yield. Satpal *et al.* recorded significantly higher crude protein yield at 100 kg P than 80 kg P/ha, while Arif *et al.* reported higher crude protein content and yield at 120 kg P_20_5/ha but it was statistically at par with 100 kg P_20_5/ha. The trend of The NDF and ADF content at different P levels indicated that both NDF and ADF increased with P levels with the highest values at 100 kg P_20_5/ha but remained non-significant to each other. Pal MS concluded the non-significant effect of P levels on crude protein NDF and ADF contents in berseem, however lower NDF and ADF content was estimated at higher levels of phosphorus fertilization [17].

Treatment	Crude Protein (%)	Crude Protein Yield (t/ha)	NDF (%)	ADF (%)
Genotypes				
BM-4	19.21	1.49	64.1	53.9
JB-07-15	18.60	1.27	63.8	53.5
BB-2	16.77	0.95	64.16	53.8
Wardan	19.10	1.40	63.0	54.6
SEm±	0.94	0.03	0.3	0.2
CD (0.05)	0.33	0.12	NS	0.6
Phosphorus fertilization levels				
P1(60 kg/ha)	17.66	1.14	63.7	53.9
P2 (80 kg/ha)	18.48	1.27	64.0	54.2
P3(100 kg/ha	19.12	1.42	63.5	53.8
SEm±	0.14	0.01	0.2	0.2
CD (0.05)	0.43	0.04	NS	NS
Interaction	NS	S	NS	S

Table 2: Effect of phosphorus fertilization on crude protein, NDF and ADF content of berseem Genotypes.

Conclusion

The experimental results indicated that berseem genotype BM-4 may be grown at the application of 100 kg P_20_5/ha for higher plant height, L:S ratio, number of branches/plant, fodder productivity and crude protein production of berseem in Indo-Gangetic plains of India.

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