



Berseem Quality Under Varying Seed Rate and Phosphorus Fertilization

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Evaluation of Forage Berseem (*Trifolium alexandrinum* L.) for Yield and Nutritive Qualities Under Varying Seed Rates and Phosphorus Fertilization

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ABSTRACT

A field experiment was conducted at agriculture farm, ICAR-Central Institute for Research on Goats, Makhdoom, Mathura (Uttar Pradesh) during the *rabi* season of 2020-21 to study the effect of different seed rates and levels of phosphorus fertilizer on dry matter yield and nutritive value in berseem. The treatments consisted of three seed rates *viz.* 20 kg ha⁻¹, 25 kg ha⁻¹ and 30 kg ha⁻¹ and five levels of phosphorus *viz.* 40 kg P₂O₅ ha⁻¹, 60 kg P₂O₅ ha⁻¹, 80 kg P₂O₅ ha⁻¹, 100 kg P₂O₅ ha⁻¹ and 120 kg P₂O₅ ha⁻¹. The experiment was laid out in factorial randomized block design with three replications. The result showed that maximum total dry matter yield (8.65 t ha⁻¹); crude protein yield (1501.2 kg ha⁻¹) and ether extract yield (317.7 kg ha⁻¹) was recorded with the seed rate of 30 kg ha⁻¹ which was at par with the seed rate of 25 kg ha⁻¹. However, proximate chemical constitute and other quality parameters *viz.* TDN content, dry matter intake, digestible dry matter, relative feed value and quality; and net energy for lactation did not influenced significantly due to different seed rates. Further it was revealed that application of 120 kg P₂O₅ ha⁻¹ recorded highest value of crude protein (19.20, 18.15, 17.12 and 17.05%), TDN content (62.46, 61.62, 60.49 and 59.66 %), dry matter intake (2.71, 2.68, 2.51 and 2.49 %), relative feed quality (137.46, 134.16, 123.80 and 120.90 %) and net energy for lactation (1.51, 1.49, 1.47 and 1.45 Mcal kg⁻¹) in I, II, III and IV cut, respectively. However, application of 100 and 120 kg P₂O₅ ha⁻¹ recorded at par value of all these quality parameters.

KEYWORDS: Berseem, Crude protein, Dry matter intake, Phosphorus fertilization, Relative feed quality, Seed rate

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INTRODUCTION

Berseem (*Trifolium alexandrinum* L.) is one of the most important *rabi* season fodder crop in northern part of India (Kumawat and Khinchi, 2017). It is popular due to its multicut nature, providing fodder for a longer duration, very high quantum of green fodder with high digestibility and palatability (Singh et al., 2019). Seeding rate significantly influenced the plant population, plant growth and forage yield in fodder crops. Higher seeding rate increases competition among plants for nutrients, light and space, while lower seeding rate causes inefficient use of natural resources and inputs (Lone et al., 2010). Therefore, seed rate is a key factor in assessing the yield potential and quality of forage crops. Further, in leguminous forage crops management, phosphorus also play a very important

role as it improve the rooting system of plant which bears root nodules. Phosphorus is an essential mineral nutrient for all animals. It must be balanced in the animal diet with adequate calcium and vitamin D for growth, reproduction, gestation and lactation (Anonymous, 1999). Addition of phosphorus fertilizer to fodder crops improves both quantity and quality of fodder crop (Dhillon et al., 1998). Therefore, the present experiment was designed to study the effect of seed rate and increasing levels of phosphorus fertilization on yield and quality of berseem fodder.

MATERIALS AND METHODS

A field experiment was undertaken to study the effect of different seed rates and phosphorus fertilizer in berseem crop during the *rabi* season of 2020-21 at agriculture farm, ICAR-Central Institute for

Research on Goats, Makhdoom, Mathura (Uttar Pradesh), India. The soil of the experimental field was nearly neutral in reaction (pH 7.2) with EC of 0.27 dS/m. The soil was low in organic carbon (0.24 %) and available nitrogen (238 kg ha⁻¹); and medium in available phosphorus (40 kg ha⁻¹) and potassium (167 kg ha⁻¹). The treatments consist of three seed rates *viz.* 20 kg ha⁻¹, 25 kg ha⁻¹ and 30 kg ha⁻¹ and five levels of phosphorus *viz.* 40 kg P₂O₅ ha⁻¹, 60 kg P₂O₅ ha⁻¹, 80 kg P₂O₅ ha⁻¹, 100 kg P₂O₅ ha⁻¹ and 120 kg P₂O₅ ha⁻¹. The experiment was laid out in factorial randomized block design with three replications. Berseem variety Wardan was sown on 6th November, 2020 by broadcasting method using the seed rate as per the treatments. The entire amount of phosphorus (as per the treatment) was applied as basal dose through single super phosphate. A starter dose of 20 kg N ha⁻¹ was applied to all the plots at the time of sowing. The crop was harvested in four cuttings, first cut was taken at 45 days after sowing, second cut was taken at 40 days after first cut and subsequent third and fourth cut was taken at the interval of 30 days after second and third cut, respectively.

The crude protein was determined by multiplying the N with the factor 6.25, ether extract and ash content was analyzed by AOAC (2005) method. Total digestible nutrients (TDN), digestible dry matter (DDM), dry matter intake (DMI), relative feed value (RFV) and net energy for lactation (NE_l) were estimated according to the following equations adapted from Horrocks and Vallentine (1999) whereas, relative feed quality (RFQ) adapted from Undersander et al. (2010)

$$\text{TDN} = 1.291 \times \text{ADF} + 101.35$$

$$\text{DMI} = 120/\% \text{NDF on dry matter basis}$$

$$\text{DMD} = 88.9 - (0.779 \times \text{ADF})$$

$$\text{RFV} = \text{DMD} \times \text{DMI} \times 0.775$$

$$\text{RFQ} = \frac{(\text{DMI, \% of BW}) \times (\text{TDN, \% of DM})}{1.23}$$

$$\text{NE}_l (\text{Mcal/kg}) = [1.044 - (0.0119 \times \text{ADF})] \times 2.205$$

All the data were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Gomez and Gomez (1984). The replicated means were subjected to ANOVA using MS excel 2010. The critical difference (CD) was found by using $p=0.05$ that shows the results those were significantly different.

RESULTS AND DISCUSSION

Dry matter yield

Different seed rates had significant effect on total dry matter yield (Table 1). The maximum total dry matter yield (8.65 t ha⁻¹) was recorded with the seed rate of 30 kg ha⁻¹. However, seed rate of 25 and 30 kg ha⁻¹ recorded statistically at par value of dry matter yield. Seed rate of 30 kg ha⁻¹ recorded significantly higher dry matter yield (32.87 %) over the seed rate of 20 kg ha⁻¹. Arzani (2000) also recorded that highest dry matter yield of berseem was recorded with higher seed rate. Further, among the different phosphorus fertilizers, application of 120 kg P₂O₅ ha⁻¹ recorded maximum total dry matter yield (9.24 t ha⁻¹). However, application of 100 and 120 kg P₂O₅ ha⁻¹ recorded at par values of dry matter yield of berseem (Table 1).

Table 1. Effect of seed rate and phosphorus fertilization on dry matter yield of forage berseem

Treatments	Dry Matter Yield (t ha ⁻¹)				
	I Cut	II Cut	III Cut	IV Cut	Total
Seed rate					
20 kg ha ⁻¹	1.83	1.77	1.70	1.21	6.51
25 kg ha ⁻¹	2.28	2.24	2.13	1.58	8.24
30 kg ha ⁻¹	2.41	2.36	2.24	1.64	8.65
SEm±	0.06	0.07	0.07	0.07	0.17
CD (P <0.05)	0.18	0.20	0.20	0.19	0.48
Phosphorus Fertilizer					
40 kg P ₂ O ₅ ha ⁻¹	1.56	1.56	1.45	0.97	5.54
60 kg P ₂ O ₅ ha ⁻¹	2.03	1.97	1.86	1.38	7.24
80 kg P ₂ O ₅ ha ⁻¹	2.26	2.20	2.09	1.56	8.12
100 kg P ₂ O ₅ ha ⁻¹	2.46	2.38	2.31	1.70	8.86
120 kg P ₂ O ₅ ha ⁻¹	2.55	2.50	2.42	1.78	9.24
SEm±	0.08	0.09	0.09	0.09	0.22
CD (P <0.05)	0.24	0.26	0.25	0.25	0.62

Application of 120 kg P₂O₅ ha⁻¹ recorded significantly higher dry matter yield by 66.79, 27.62 and 13.79 % over the application of 40, 60 and 80 kg P₂O₅ ha⁻¹, respectively. The results are in close confirmation with Satpal et al. (2020) who reported that significantly highest total dry matter yield of berseem was recorded with the application of 100 kg P₂O₅ ha⁻¹ in total of four cuts.

Proximate constitutes and their yield

Seed rate had no significant effect on crude protein, ether extract and ash content in forage berseem (Table 2), however, yield of these proximate constitutes significantly influenced by different seed rates (Table 3). Significantly highest value of total crude protein yield (1501.2 kg ha⁻¹), ether extract yield (317.7 kg ha⁻¹) and ash yield (1324.0 kg ha⁻¹) was recorded with the seed rate of 30 kg ha⁻¹. However, seed rate of 25 and 30 kg ha⁻¹ recorded at par value of yield's of all these parameters. Seed rate of 30 kg ha⁻¹ recorded significantly higher total crude protein yield (36.95 %), total ether extract yield (38.37 %) and total ash yield (36.85 %) over

the seed rate of 20 kg ha⁻¹. The non significant effect of seed rate on crude protein in berseem are in close confirmation with Tufail et al. (2019) who reported that seed rate had no significant effect on the forage quality parameters of berseem. Similarly, Mekasha et al. (2022) also reported that seeding rate had no significant effect on crude protein in fodder sorghum. Prajapati et al. (2017) also reported that crude protein content, ether extract and ash were not significantly influenced by different seed rates in fodder sorghum. The higher value of yield of these proximate constitute with the seed rate of 30 kg ha⁻¹ might be due to their higher dry fodder yield with this seed rate.

Further, the application of 120 kg P₂O₅ ha⁻¹ recorded highest value of crude protein (19.20, 18.15, 17.12 and 17.05%), ether extract (4.20, 4.03, 3.96 and 3.28 %) and ash content (17.18, 16.62, 15.45 and 13.62 %) in I, II, III and IV cut, respectively. However, application of 100 and 120 kg P₂O₅ ha⁻¹ recorded at par values of crude protein, ether extract and ash content in berseem (Table 2).

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Table 2. Effect of seed rate and phosphorus fertilization on proximate constitute of forage berseem

Treatments	Crude Protein %				Ether Extract %				Ash Content %			
	I Cut	II Cut	III Cut	IV Cut	I Cut	II Cut	III Cut	IV Cut	I Cut	II Cut	III Cut	IV Cut
Seed rate												
20 kg ha ⁻¹	17.8	16.9	16.0	15.8	3.76	3.62	3.45	2.83	16.0	15.4	14.2	12.3
25 kg ha ⁻¹	18.1	17.1	16.1	16.0	3.84	3.69	3.55	2.96	16.2	15.6	14.4	12.6
30 kg ha ⁻¹	18.3	17.4	16.2	16.2	3.88	3.75	3.58	3.01	16.3	15.8	14.6	12.8
SEm±	0.21	0.22	0.22	0.23	0.05	0.05	0.06	0.07	0.18	0.20	0.21	0.22
CD (P <0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus Fertilizer												
40 kg P ₂ O ₅ ha ⁻¹	16.5	15.9	14.9	14.8	3.24	3.16	2.87	2.41	15.0	14.4	13.1	11.1
60 kg P ₂ O ₅ ha ⁻¹	17.5	16.6	15.7	15.5	3.64	3.52	3.33	2.76	15.7	15.1	13.9	12.1
80 kg P ₂ O ₅ ha ⁻¹	18.3	17.3	16.2	16.1	3.95	3.78	3.65	3.02	16.3	15.7	14.6	12.8
100 kg P ₂ O ₅ ha ⁻¹	18.9	17.8	16.7	16.6	4.12	3.93	3.82	3.20	16.9	16.2	15.1	13.3
120 kg P ₂ O ₅ ha ⁻¹	19.2	18.1	17.1	17.0	4.20	4.03	3.96	3.28	17.1	16.6	15.4	13.6
SEm±	0.27	0.28	0.29	0.30	0.06	0.07	0.08	0.08	0.24	0.25	0.27	0.29
CD (P <0.05)	0.78	0.81	0.83	0.87	0.17	0.20	0.22	0.24	0.68	0.73	0.78	0.84

Similarly, highest value of total crude protein yield (1666.1 kg ha⁻¹), total ether extract yield (363.2 kg ha⁻¹) and total ash yield (1474.6 kg ha⁻¹) was also recorded with the application of 120 kg P₂O₅ ha⁻¹.

However, application of 100 and 120 kg P₂O₅ ha⁻¹ recorded at par value of all these parameters as well as their yields (Table 3).

Table 3. Effect of seed rate and phosphorus fertilization on yield of proximate constituents of forage berseem

Treatments	Crude Protein Yield kg ha ⁻¹				Ether Extract Yield kg ha ⁻¹				Ash Yield kg ha ⁻¹							
	I	II	III	IV	Total	I	II	III	IV	Total	I	II	III	IV	Total	
	Cut	Cut	Cut	Cut		Cut	Cut	Cut	Cut		Cut	Cut	Cut	Cut		
Seed rate																
20 kg ha ⁻¹	330	301	273	191	1096	69.9	64.6	60.1	35.0	229	296	273	246	151	967	
25 kg ha ⁻¹	418	389	348	257	1414	89.0	84.1	77.2	47.9	298	374	355	312	203	1246	
30 kg ha ⁻¹	446	415	369	270	1501	95.3	90.0	81.9	50.5	317	399	378	331	214	1324	
SEm±	15.1	15.3	12.4	11.2	34.2	3.2	3.4	2.8	2.2	9.2	13.7	14.0	11.3	9.1	37.4	
CD (P <0.05)	43.6	44.3	36.0	32.3	99.1	9.2	9.8	8.2	6.5	26.6	39.5	40.5	32.8	26.5	108.3	
Fertilizer Phosphorus																
40 kg P ₂ O ₅ ha ⁻¹	256	247	215	144	864	50.3	49.1	41.7	23.5	164	233	223	190	108	755	
60 kg P ₂ O ₅ ha ⁻¹	358	330	293	214	1197	74.4	69.9	62.1	38.3	244	321	300	260	167	1049	
80 kg P ₂ O ₅ ha ⁻¹	416	382	340	251	1390	89.6	83.6	76.5	47.4	297	371	348	306	200	1226	
100 kg P ₂ O ₅ ha ⁻¹	468	427	388	283	1568	101	94.2	88.9	54.7	339	418	389	353	227	1389	
120 kg P ₂ O ₅ ha ⁻¹	491	455	415	303	1666	107	101	96.1	58.6	363	439	417	374	243	1474	
SEm±	19.4	19.8	16.1	14.4	44.2	4.1	4.4	3.7	2.9	11.9	17.6	18.1	14.6	11.8	48.3	
CD (P <0.05)	56.3	57.2	46.5	41.7	127.9	11.8	12.7	10.6	8.4	34.4	51.1	52.3	42.3	34.2	139	

These results are in close confirmation with Satpal et al. (2020) who reported that significantly highest crude protein content and crude protein yield of berseem was recorded with the application of 100 kg P₂O₅ ha⁻¹. Application of adequate amount of nitrogen and phosphorus contributed to increase in

dry matter accumulation per unit area which resulted into more biomass production and thus total ash (Nand et al., 2019). Roy et al. (2015) reported that increase in levels of phosphorus from 40 to 80 kg ha⁻¹ gradually increased the crude protein content, crude protein yield and ether extract of berseem.

Fodder quality

Fodder quality parameters viz. TDN content, dry matter intake, digestible dry matter, relative feed value and quality; and net energy for lactation were not influenced significantly due to different seed rates in berseem (Table 4 and 5). Kim et al. (2021) reported that in forage alfalfa, NDF content was not influenced significantly, while ADF content had

slight increase or decrease with increasing seed rates. As all these forage quality parameters are directly and indirectly related with NDF and ADF content of forage, thus these non significantly influenced with different seed rate. Tufail et al. (2019) also reported that seed rate had no significant effect on the forage quality parameters of berseem.

Table 4. Effect of seed rate and phosphorus fertilization on total digestible nutrients, dry matter intake and digestible dry matter of forage berseem

Treatments	TDN %				DMI %				DDM %			
	I Cut	II Cut	III Cut	IV Cut	I Cut	II Cut	III Cut	IV Cut	I Cut	II Cut	III Cut	IV Cut
Seed rate												
20 kg ha ⁻¹	60.2	58.5	57.1	56.4	2.57	2.53	2.38	2.35	64.0	63.1	62.2	61.8
25 kg ha ⁻¹	60.5	59.6	58.3	57.6	2.63	2.59	2.43	2.40	64.3	63.7	62.9	62.5
30 kg ha ⁻¹	61.1	60.2	58.9	58.2	2.65	2.61	2.45	2.42	64.6	64.0	63.3	62.8
SEm±	0.56	0.61	0.67	0.72	0.03	0.03	0.03	0.04	0.34	0.37	0.40	0.44
CD (P <0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus Fertilizer												
40 kg P ₂ O ₅ ha ⁻¹	58.4	56.9	55.1	54.6	2.51	2.46	2.31	2.27	63.0	62.0	61.0	60.7
60 kg P ₂ O ₅ ha ⁻¹	59.7	58.4	56.9	56.4	2.57	2.52	2.37	2.34	63.8	62.9	62.1	61.7
80 kg P ₂ O ₅ ha ⁻¹	60.8	59.6	58.4	57.7	2.63	2.59	2.43	2.40	64.4	63.7	62.9	62.5
100 kg P ₂ O ₅ ha ⁻¹	61.7	60.7	59.5	58.8	2.67	2.64	2.48	2.45	65.0	64.4	63.7	63.2
120 kg P ₂ O ₅ ha ⁻¹	62.4	61.6	60.4	59.6	2.71	2.68	2.51	2.49	65.4	64.9	64.2	63.7
SEm±	0.73	0.78	0.86	0.93	0.05	0.05	0.04	0.05	0.44	0.47	0.52	0.56
CD (P <0.05)	2.10	2.27	2.49	2.70	0.13	0.13	0.13	0.14	1.27	1.37	1.50	1.63

NS: Non significant; TDN: Total digestible nutrients; DMI: Dry matter intake; DDM: Digestible dry matter.

Further, comparative analysis of different doses of phosphorus fertilizers revealed that highest value of TDN content (62.46, 61.62, 60.49 and 59.66 %), dry matter intake (2.71, 2.68, 2.51 and 2.49 %), digestible dry matter (65.44, 64.92, 64.25 and 63.74 %), relative feed value (137.23, 134.71, 125.28 and 123.09 %), relative feed quality (137.46, 134.16,

123.80 and 120.90 %) and net energy for lactation (1.51, 1.49, 1.47 and 1.45 Mcal kg⁻¹) was found with the application of 120 kg P₂O₅ ha⁻¹ in I, II, III and IV cut of berseem, respectively. However, application of 100 and 120 kg P₂O₅ ha⁻¹ recorded at par value of all these quality parameters (Table 4 and 5).

Table 5. Effect of seed rate and phosphorus fertilization on relative feed value, relative feed quality and net energy for lactation of forage berseem

Treatments	RFV %				RFQ %				NE _l (Mcal/kg)			
	I Cut	II Cut	III Cut	IV Cut	I Cut	II Cut	III Cut	IV Cut	I Cut	II Cut	III Cut	IV Cut
Seed rate												
20 kg ha ⁻¹	127.9	124.1	115.1	112.9	126.3	121.1	111.1	108.4	1.47	1.43	1.40	1.39
25 kg ha ⁻¹	131.2	128.0	118.6	116.4	129.6	125.6	115.3	112.6	1.47	1.45	1.43	1.41
30 kg ha ⁻¹	133.0	129.7	120.3	117.9	132.1	128.0	117.6	114.7	1.49	1.47	1.44	1.43
SEm±	2.16	2.20	2.21	2.30	2.53	2.60	2.63	2.73	0.01	0.01	0.01	0.01
CD (P <0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus Fertilizer												
40 kg P ₂ O ₅ ha ⁻¹	122.6	118.6	109.4	107.0	119.4	114.1	103.9	101.2	1.43	1.40	1.36	1.35
60 kg P ₂ O ₅ ha ⁻¹	127.1	123.3	114.1	111.9	125.0	120.0	109.9	107.3	1.46	1.43	1.40	1.39
80 kg P ₂ O ₅ ha ⁻¹	131.6	128.1	118.9	116.4	130.4	125.9	115.7	112.7	1.48	1.46	1.43	1.42
100 kg P ₂ O ₅ ha ⁻¹	134.8	131.7	122.4	120.2	134.4	130.4	120.2	117.3	1.50	1.48	1.45	1.44
120 kg P ₂ O ₅ ha ⁻¹	137.2	134.7	125.2	123.0	137.4	134.1	123.8	120.9	1.51	1.49	1.47	1.45
SEm±	2.79	2.84	2.85	2.97	3.27	3.36	3.40	3.53	0.01	0.02	0.02	0.02
CD (P <0.05)	8.09	8.24	8.26	8.59	9.46	9.73	9.84	10.2	0.04	0.05	0.05	0.05

NS: Non significant; RFV: Relative feed value; RFQ: Relative feed quality; NE_l: Net energy for lactation.

Satpal et al. (2020) reported that, with the increase in phosphorus level ADF and NDF decreased significantly and was lowest at 100 kg P₂O₅ ha⁻¹. According to Carmi et al. (2006) TDN content in forage is inversely related with ADF concentration in feed therefore, as concentration of ADF increases, there is a decline in TDN content which limits an animal's ability to utilize the nutrients that are present in the forage. Dry matter intake is negatively correlated with NDF, whereas digestible dry matter is negatively correlated with ADF. Horrocks and Vallentine (1999) also reported that where NDF is high, forage quality and dry matter intake are low. Relative feed value (RFV) is an index which is used to predict intake and energy value of forage which is derived from DMD and DMI (Lithourgidis et al., 2006). According to Jeranyama and Garcia (2004) RFQ index takes into consideration the differences in digestibility of the fiber fraction and can be used to more accurately predict animal performance and match animal needs

it is derived from DMI and TDN. NE_l includes energy used for maintenance and milk production because energy is used with the same efficiency whether for milk production or for maintenance. Using databases containing the ADF content of feeds and the NE_l content of those feeds, regression equations have been developed to predict NE_l from the ADF content of a feed. According to Ondarza (2000) as ADF increases, NE_l decreases.

CONCLUSION

The research finding revealed that seed rate had no significant effect on proximate constituents and other quality parameters *viz.* TDN content, dry matter intake, digestible dry matter, relative feed value and quality and net energy for lactation in berseem. However, maximum total dry matter yield and yield of proximate chemical constituents was recorded with the seed rate of 30 kg ha⁻¹ which was at par with the seed rate of 25 kg ha⁻¹. Further, application of 120 kg P₂O₅ ha⁻¹ recorded highest

value of proximate chemical constituents and their yield; and other quality parameters viz. TDN content, dry matter intake, digestible dry matter, relative feed value and quality and net energy for lactation in berseem which was at par with application of 100 kg P₂O₅ ha⁻¹. Hence, this investigation recommended seed rate of 25 kg ha⁻¹ and application of 100 kg P₂O₅ ha⁻¹ in berseem for obtaining highest dry matter yield and quality.

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