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Effect of Phosphorous Level and Phosphorous Solubilizing Bacteria (PSB) on Yield Attributes and Yield of Berseem (*Trifolium alexandrinum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was conducted at Research farm of R.A.K., college of Agriculture, Sehore, Madhya Pradesh during 2020-21. The experiment was laid out using Randomized Block Design with different levels of Phosphorus with or without PSB application (T_1- 45 kg P_2O_5/ha, T_2- 60 kg P_2O_5/ha, T_3- 75 kg P_2O_5/ha,T_4 -90 kg P_2O_5/ha, T_5 - 45 kg P_2O_5/ha + PSB @ 5g/kg seed, T_6 - 60 kg P_2O_5/ha + PSB @ 5g/kg seed, T_7 - 75 kg P_2O_5/ha + PSB @ 5g/kg seed, T_8 - 90 kg P_2O_5/ha + PSB @ 5g/kg seed).Treatment T_7 found to be best for yield and yield attributes of berseem. Maximum no. of capsules/m^2 (466), no. of seeds/capsule (28.81), Test weight (2.01 g), Seed yield (0.46 g/plant, 0.478 kg/plot, 239 kg/ha), Green fodder yield (63.75 kg/plot, 31870 kg/ha) and HI (10.21).While minimum recorded with treatment T_1 (45kg P_2O_5/ha without PSB application).

Keywords: Phosphorous level; phosphorous solubilizing bacteria; yield attributes.

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1. INTRODUCTION

"Berseem (*Trifolium alexandrinum* L.) is one of the most important fodder crops of the world. It is belongs to the family Fabaceae with basic chromosome number, 2n = 16. Probable native of this crop is Syria and it was introduced into Egypt in the 6th century" [1].

Berseem also known as Egyptian clover, is widely adaptable and valuable forage crop since 1916 grown as winter forage crop and considered as "King of fodder". It is an annual leguminous crop, well adapted to the semi-arid conditions of the Northern India with good nitrogen fixing ability. It provides very nutritious succulent, palatable and high yielding valuable forage to the ruminants. It stimulates milk production of cows and buffaloes.

"On an average berseem fodder contains 20-21% crude protein, 25.9% crude fiber, 40.7% Nitrogen free extract, 14.16% ash, 1.92% calcium, 0.28% phosphorus, 70-72% dry matter digestibility and also rich in calcium. In India, productivity of berseem is very low. There are many constraints for low yield of berseem, but improper fertilizer application is considered to be a major limiting factor. The correct and judicious fertilizer application can enhance yield up to 50%" [2] and can also improve the quality of fodder [3].

"Berseem being a multi-cut nature crop, its fodder production ability is very high. A well-managed berseem crop can give 45-50 t/ha green fodder in three cuttings before leaving the crop for seed production. The average seed yield is 0.3 - 0.4 t/ha. It is grown in India, Pakistan, Turkey, Egypt and countries of Mediterranean region. In India, it is grown mainly in irrigated area of Northern India and Western part of country. The main state growing this crop are Punjab, Haryana, Delhi, Rajasthan, Uttar Pradesh, Gujarat, and some parts of Bihar, Maharashtra, and Andhra Pradesh", [4].

Phosphorus is considered as one of the major essential plant nutrients after nitrogen required by plants for growth and development and is the second most deficient plant nutrients, [5]. Phosphorus plays an important role as a structural component of cell constituents and metabolically active compounds. It plays important role in energy transformation and metabolic process of plants. The protein synthesis is controlled by the supply of phosphorus in plants. It is well recognized that legumes like beseem require adequate quantity of phosphate fertilizers for obtaining higher yields [6]. According to Hamid and Sarwar [7], "the crop uses only 15-33% of the applied phosphorus and the rest results in the buildup of residual phosphorus".

"Phosphorus availability is increased through the use of phosphate solubilizing bacteria (PSB), and it may enhance the forage yield and improve the quality of berseem. The microorganism capable of solubilizing phosphate can produce and release organic acids and protons in their surroundings that decrease the pH in that area and thus solubilize calcium-phosphorus complexes. Due to these organic acids, PO_4^{-2} is exchanged by acid anion or is cheated and thus becomes dissolved mineral phosphate", [8].

2. MATERIALS AND METHODS

Experimental site: The experiment was laid out at research farm of R.A.K. college of Agriculture, Sehore (M.P.) 466001, India, during *rabi* 2020-21 on 612.75 m^2 area having fairly uniform topography, normal fertility status and soil homogeneity.

Climate and Weather conditions: Sehore is situated in the Eastern part of Vindhyan Plateau in sub-tropical zone at the latitude of 23^0 12' North and longitude of 77^0 05' East at an altitude of 498.77 m from mean sea level in Madhya Pradesh, India. The average annual rainfall varies from 1000 to 1200 mm concentrated mostly from June to September. The mean annual maximum and minimum temperatures are 31.16^0C and 18.5^0C, respectively. The summer months are hot and May is the hottest month having a maximum temperature up to 49.8^0C. December is the coldest month as temperature reaches down to 3.5^0C. The weekly meteorological data viz., rainfall, temperature, relative humidity and number of rainy days during crop season were recorded in meteorological observatory of R.A.K. College of Agriculture, Sehore (M.P.) India.

Preparation of field and layout of the experiment: The land was prepared with tractor-drawn plough, followed by harrowing to obtain a well-pulverized seed bed. After this, field was divided into blocks equal to the number of replications. In each block, 8 plots were made

equal to the number of treatments of size 20 m^2 (4.0 m × 5.0 m).

Fertilizer application: Phosphorus fertilizer was applied with SSP as per the treatments (Table 1). Besides, a common dose of nitrogen at 20 kg/ha through urea and potash at 40 kg/ha through MOP were applied at the time of sowing.

Sowing: Berseem variety "Bar-Bar" was sown 25 kg seed/ha. The seeds were inoculated with PSB culture using standard method, dried in shade and were sown by broadcasting method.

3. RESULTS AND DISCUSSION

1. Number of capsules/m^2

The number of capsules/m^2 (466) recorded significantly higher under treatment T_7 (75 kg P_2O_5/ha + PSB @5 g/kg seed) than all other treatments under study except treatment T_8 (90 kg P_2O_5/ha + PSB @ 5 g/kg seed) *i.e.,* 457, which was at par with each other. Minimum number of capsules/m^2 (348) was recorded in treatment T_1 (45 kg P_2O_5/ha).

The possible reason could be due to the fact that, there was more vegetative growth in berseem which leads to production of more heads (Saeed *et al*., 2011). These results are in conformity with Vaez and Zadeh [9]. They also reported that phosphorus had significant effect on seed production of berseem clover.

2. Number of seeds/capsule

The data (Table 1) revealed that, the number of seeds/capsule recorded significantly highest with treatmentT_7 (75 kg P_2O_5/ha + PSB @ 5 g/kg seed). Although, the treatment T_8 (90 kg P_2O_5/ha + PSB 5 g/kg seed) *i.e.,* 27.99 was *at par* with the treatment T_7. Minimum number of seeds/capsule was recorded in treatment T_1 (45 kg P_2O_5/ha) *i.e.*, 23.24.

The possible reason could be due to more branching capacity of berseem with more well filled heads which resulted in greater number of seeds $head^{-1}$ (Saeed *et al*., 2011). The same results were founded by Mukharjee and Mandal [10], who reported that the phosphorus levels had significant effect on the number of seed $head^{-1}$.

3. Test weight (g)

The data (Table-1) revealed that, different treatments had significantly influenced the test weight (g). Maximum test weight 2.01 g was observed with the treatment T_7 (75 kg P_2O_5/ha + PSB 5 g/kg seed). Minimum number of buds per shoot was recorded in treatment T_1 (45 kg P_2O_5/ha) *i.e.*, 1.78 g.

The probable reason for this might be due to more healthy plants in berseem which in turn resulted in healthier and plump seed formation (Saeed et al., 2011). Our findings are in close agreement with Jamriska [11], who also reported that phosphorus and potassium had significant effect on the yield and quality of berseem.

4. Green fodder yield

The data (Table 1) revealed that, the different treatments had significantly influenced the green fodder yield (kg/plot). Maximum green fodder yield (63.75 kg/plot and 31877 kg/ha) was observed with the treatment T_7(75 kg P_2O_5/ha + PSB 5 g/kg seed). Although, the treatment T_8 (90 kg P_2O_5/ha + PSB 5g/kg seed) *i.e.,* 61.31 kg/plot and 30655 kg/ha were *at par* with the treatment T_7. Minimum green fodder yield observed with treatment T_1 (45 kg P_2O_5/ha) i.e*.,* 49.21 kg/plot and 24610 kg/ha.

It might be the results of higher plant height, no. of branches per plant, leaf stem ratio and of course, the better root development which provides a better habitat for the activity of biological nitrogen fixing bacteria [12]. The less response of increasing levels on growth & yield might be the result of poor organic carbon content of soil and coarse texture nature representing poor water retention capacity. Hence poor mineralization take place, resulted poor solubility and availability of P to plant roots, therefore less absorption by roots. The results are close conformity with the findings of Shrivastava et al., [13], Ayub et al. [14] and Chauhan and Bajpal [15]. Our results are in line with Naveen and Sood [16] and Saeed et al., (2011) who also reported that phosphorus had significant effect on the yield and quality of berseem.

Table 1. Effect of Phosphorous Level and Phosphorous Solubilizing Bacteria (PSB) on Yield Attributes and Yield of Berseem (*Trifolium alexandrinum* L.)

Seed Yield Treatments		Number of capsules/m^2	Number of seeds/capsule	Test weight (g)	Seed yield/ plant (g)	Seed Yield (kg/plot)	Seed Yield (kg/ha)	Green Fodder Yield (kg/plot)	Green Fodder Yield (kg/ha)	H.I. (%)
T_1	45 kg P_2O_5/ha	348.00	23.24	1.78	0.22	0.358	179	49.21	24607	9.08
T_2	60 kg P_2O_5/ha	360.33	25.69	1.86	0.32	0.370	185	51.90	25952	9.21
T_3	75 kg P_2O_5/ha	436.33	27.49	1.96	0.44	0.433	224	58.81	29403	10.09
T_4	90 kg P_2O_5/ha	422.00	26.92	1.95	0.38	0.429	216	57.61	28807	9.85
T_5	45 kg P_2O_5/ha + PSB 5 g/kg seed	376.33	26.02	1.91	0.37	0.386	193	55.15	27572	9.14
T_6	60 kg P_2O_5/ha + PSB 5 g/kg seed	398.33	26.55	1.94	0.37	0.408	204	56.22	28108	9.50
T_7	75 kg P_2O_5/ha + PSB 5 g/kg seed	466.00	28.81	2.01	0.46	0.478	239	63.75	31877	10.21
T_8	90kg P_2O_5/ha + PSB 5 g/kg seed	457.00	27.99	2.00	0.45	0.469	234	61.31	30655	10.12
S.Em±		**5.07**	**0.36**	**0.03**	**0.007**	**0.004**	**2.0**	**1.14**	**0570.0**	**0.16**
CD (5%)		**15.21**	**1.08**	**0.08**	**0.021**	**0.013**	**6.0**	**3.42**	**1730.0**	**0.48**

5. Seed Yield

The data (Table 1) revealed that different treatments had significantly influenced the seed yield. Maximum seed yield (0.46 g/plant, 0.478 kg/plot and 239 kg/ha) was observed with the treatment T_7 (75 kg P_2O_5/ha + PSB 5 g/kg seed), which were statistically similar with the treatment T_8 (90 kg P_2O_5/ha + PSB 5 g/kg seed) *i.e.,* 0.45 g/plant, 0.469 kg/plot and 234kg/ha. Minimum seed yield was recorded with treatment T_1 (45 kg P_2O_5/ha) *i.e.*, 0.22 g/plant, 0.358 kg/plot and 179 kg/ha.

This might be due to the fact that higher number of plants emerged with more branches, better filled heads and sound and plump seeds which in turn yielded more seed in berseem (Saeed *et al*., 2011). These results are in close proximity to Singh and Virendra [17,18] who also reported that phosphorus and potassium has significant effect on seed production of berseem.

6. Harvest Index

The data on account harvest index (%), presented in Table 1 revealed that different treatments had significantly influenced the harvest index (%). Maximum harvest index 10.21 was observed with the treatment T_7 (75 kg P_2O_5/ha + PSB 5 g/kg seed). Although, the treatment T_8 (90 kg P_2O_5/ha + PSB 5 g/kg seed) *i.e.,* 10.12, T_3 (60 kg P_2O_5/ha) *i.e.,* 10.09 and T_4 (90 kg P_2O_5/ha) *i.e.,* 9.85 was *at par* with the treatment T_7. Minimum harvest index observed in the treatment T_1 (45 kg P_2O_5/ha) *i.e.,* 9.08. It might be due to higher yield of grain (*i.e*., seed).

4. CONCLUSION

On the basis of results obtained in present investigation it is concluded that treatment T_7 (75kg P_2O_5/ha + PSB 5 g/kg seed) was found to be the best and it was statistically similar with the treatment T_8 (90kg P_2O_5/ha + PSB 5g/kg seed) for yield and yield attributing parameters like number of capsules per meter square, number of seeds per capsule, test weight, green fodder yield and seed yield. So, there may be saved 15 kg P_2O_5 with the seed inoculation of PSB.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Hannaway BC, Larson C. Berseem clover (*Trifolium alexandrium* L.). Oregon State University, Spiecies Selection Information System; 2004.
2. Zia MS, Gill MA, Aslam M, Hussain MF. Fertilizer use efficiency in Pakistan. Prog Farming. 1991;11:35-38.
3. Keshwa GL, Singh H. Response of bajra varieties to nitrogen grown mixed with cluster bean for forage production in summers. Haryana. J Agron. 1992;8: 157-9.
4. Vijay D, Manjunatha N, Maity A, Kumar S, Wasnik VK, Gupta CK et al. BERSEEM-intricacies of seed production in India [technical bulletin]. Jhansi: ICAR-Indian Grassland and Fodder Research Institute. 2017;47.
5. Marschner H. Mineral nutrition of higher Plants. 2nd ed. London: Academic Press, Hacourt Brace and Company; 1997.
6. Kamani JT, Mishra MN. Response of berseem to phosphobacteria cultures under different levels ofphosphate and farm yard manure. Curr Agric. 1981;5(3 and 4):128-32.
7. Hamid A, Sarwar G. Effect of methods and time of application on uptake of Fertilizer phosphorus by wheat. Exp Agric. 1977; 13(4):337-40.
   DOI: 10.1017/S0014479700008097
8. Bajpal PD, Rao WVBS. Phosphate solubilizing bacteria. Part 2. Extracellular production of organic acids by selected bacteria solubilizing insoluble phosphate. Soil Sci Plant Nutr. 1971;17:44-5.
9. Vaez AK, Zadeh A. Determination the effect of P and irrigation intervals on seed production of berseem clover in Iran. Nice, France; 1995.
10. Mukharjee AK, Mandal SR. Effect of dates of sowing, cutting management and levels of P application on seed yield of shaftal and berseem. Environ Econ. 2000; 18(2):506-8.
11. Jamriska P. Effect of Phophorus and potassium fertilization rates and application time on the yield and quality of berseem and shaftal. Soils Fertil. 2000;38(9):304-8.
12. Roy DC, Ray M, Tudu NK, Kundu CK. Impact of phosphate solubilizing bacteria and phosphorus application on forage yield and quality of berseem in West Bengal. I.J.A.E.B.. Intern Jour of Agricul Environ and Biotech. 2015;8(2):315-21.

DOI: 10.5958/2230-732X.2015.00039.X
13. Shrivastava AK, Sarvade S, Bisen NK, Prajapati B, Agrawal SB, Goswami P. Growth and yield of rabi season forage crops under Chattisgarh plain of Madhya Pradesh, India. Int J Curr Microbiol Appl Sci. 2020; 9(2):878-85.
DOI: 10.20546/ijcmas.2020.902.105
14. Ayub M, Nadeem MA, Naeem M, Tahir M, Tariq M, Ahmad W. Effect of different levels of P and K on growth, forage yield and quality of cluster bean (*Cyamopsis tetragonolobus*). J Anim Plant Sci. 2012; 22(2):479-83.
15. Chauhan A, Bajpal MR. Note on the response of rainfed guar to phosphorus and nitrogen. Ann Arid Zone. 1979;18:272-3 [Absts FC: 3463].
16. Naveen K, Sood BR. Effect of K and P levels on forage yield and quality of oat and berseem mixture. Bhartiya Krishi Anusandhan Patrika. 1995;10(2):80-4.
17. Singh B, Virendra S. Agronomic studies on seed production of Berseem in India. Newslet. Int. Seed H, producer. Res. 1999; 21:14-5.
18. Beena S, Yasser D, Hasina G, Ahmad S, Said W, Muhammad A, et al. Forage yield of berseem (*Trifolium alaxandrium*) as affected by phosphorus and potassium fertilization. Afr J Biotechnol. 2011; 10(63):13815-7.
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