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Ritika
P.G. Department of Agriculture (Agronomy), Khalsa College, Patiala, Punjab, India

Deepak Bawa
P.G. Department of Agriculture (Agronomy), Khalsa College, Patiala, Punjab, India

Mohinder Lal
Assistant Professor, P.G. Department of Agriculture (Agronomy), Khalsa College, Patiala, Punjab, India

Corresponding Author:
Ritika
P.G. Department of Agriculture (Agronomy), Khalsa College, Patiala, Punjab, India

Response of different nutrient management practices on growth and fodder yield of berseem (*Trifolium alexandrinum* L.) at various cutting stages

Ritika, Deepak Bawa and Mohinder Lal

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Abstract
An experiment was conducted during winter season of 2021-22 on berseem (BL 10) crop. The experiment comprised of 12 treatments *viz*. T_1 (Control), T_2 (100% RDF), T_3 **(**FYM 17 tonnes ha^{-1}), T_4 (VC 1.3 tonnes ha^{-1}), T_5 (PM 3 tonnes ha^{-1}), T_6 (*Rhizobium trifolii* + PSB (seed inoculation), T_7 (75% RDF + FYM 11 tonnes ha^{-1}), T_8 (75% RDF + VC 1 tonnes ha^{-1}), T_9 **(**75% RDF + PM 2.0 tonnes ha^{-1}), T_{10} **(**75% RDF + FYM 5 tonnes ha^{-1} + PM 2.5 tonnes ha^{-1}), T_{11} **(**75% RDF + VC 1.2 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation), T_{12} (75% RDF + FYM 5 tonnes ha^{-1} + VC 1 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed Inoculation). Randomized Block Design was used with three replications. The results revealed that the significantly highest plant height (cm), number of shoots per m^2, number of plant population per m^2, leaf: stem ratio and green fodder yield (q ha^{-1}) were observed with the application of treatment **(**75% RDF + FYM 5 tonnes ha^{-1} + VC 1.0 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed Inoculation) fallowed by **(**75% RDF + VC 1.2 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation).

Keywords: Berseem, nutrients, organic manures, PSB, *Rhizobium*

Introduction
Berseem (*Trifolium alexandrinum* L.) is one of the most important winter forage crops growed in India, due to its high forage yield and high nutritive value. It has become a very popular as *rabi* forage crop in mostly irrigated areas and also among various other parts across country. Berseem belongs to the family leguminaceae. Photosynthetically, Berseem is a C_3 plant. It is one of the oldest crops which is being cultivated in India and it was originated from Egypt. It is also known as “King of fodder crops". In India, it is mainly cultivated in northern regions as *rabi* season crop. For dairy and milch animal fodder crops are main source of protein and crude fiber. Berseem is a good quality feed for milch animals provide nutrition and increases the fat content in the milk of the animals. Berseem has no any type of anti- nutritional as well as toxic effects on human or animal body. It is commnly used as green forage crop, but in off season it also used in the form of hay and pallets (Nigam *et al*. 2010) [7]. The protein content varies from 17-21%, 25.9% fibber content, minerals 11-19% and 70% dry matter digestibility. Berseem cultivation also changes chemical, biological, physical properties of soil. Except light sandy soils, it can be cultivated on all types of soils. India has first position in area of cultivation with around 2 million ha^{-1} followed by Egypt (1.1 million ha^{-1}) and Pakistan (0.71 million ha^{-1}). In Punjab cultivated area 2.30 lakh hectares and production recorded for green fodder was 60-110 ton per ha^{-1} in India Anonymous (2022-23) [1].
Nutrient management is a practice where combination of all sources of nutrients such as organic, inorganic and biofertilizer are applied to soils to enhance the yield and quality of produce. Nutrient management is the maintenance or adjustment of soil fertility. Nitrogen is one of the most important elements. It is the major component of protein, chlorophyll, vitamins and hormones are essential for the life. It is responsible for the green colour of leaves of plants, Leaf and stem development is stimulated. Phosphorus helps in early root development and also stimulates growth in seedling stage which causes to establishment of seedling quickly. Phosphorus plays a vital role in various metabolism of plant such as, photosynthesis, respiration,

energy storage and transfer, cell division, cell elongation and several other processes. Potassium also plays its vital role in plant for hardiness from cold, resistance from various diseases, drought resistance, drought tolerance and general durability. Potassium Play a major role in osmo-regulation. Potassium takes part both is uptake of water as well as loss through stomata. Farm yard manure is prepared using cow dung, urine, bedding and straw. Farm Yard manure contains around 0.5% nitrogen, 0. 25% phosphorous and 0.5% potash. It is widely known for its use to improve the fertility of soil and their properties such as productivity. It increases the water retention capacity. (Shafi *et al.* 2012) [10]. Vermicompost is a rich source of nutrient. Vermicompost contains around 3.0% nitrogen, 1.0% Phosphorus and 1.5% Potassium. It is organic manure which improves soil structure, aeration, support root development, which leads to high growth and yield of crop. Poultry manure contains high amount of organic matter content with high value of nutrient content which tends to growth of plant as well as helps to amend the soil (Ryssen *et al.* 1993) [8]. Poultry manure contains 3.03% N, 2.63% P and 1.4% K. The biofertilizers has no anti effect on ecosystem due to their eco friendly nature. These are easy to apply and also have low cost technology which is effective to improve the productivity of crop either by increasing root growth or plant growth hormone secretion along this it also facilitate nutrient uptake. Biofertilizers are a microbial preparation which on application to soil helps in boosting up agricultural production. *Rhizobium*, a nitrogen fixer and phosphate not only fix the atmospheric nitrogen but also synthesis the plant hormones similar to Gibberelic acid and Indole Acetic Acid which enhances the plant growth, photosynthesis and nutrient absorption. The use of phosphate solubilizing bacteria (PSB) may enhance the forage yield and improves the quality of berseem crop. Phosphate solubilizing bacteria (PSB) microbes are an aggregation of helpful microscopic organisms capable of hydrolyzing natural and inorganic phosphorus from insoluble compounds. (Gyaneshwar *et al.* 1998) [6].

Materials and Methods

The present of investigation was carried out during *rabi* season of the year 2021 at the Campus for Research and Advanced studies, Dhablan G.S.S.D.G.S. Khalsa College, Patiala. The experiment was conducted in Randomized Block Design that is replicated three times with different nutrient management practices. The treatment considered in three replication and twelve treatment T_1 (control), T_2 (100% RDF), T_3 **(**FYM 1.7 tonnes ha^{-1}),T_4 (VC 1.3 tonnes ha^{-1}), T_5 (PM 3 tonnes ha^{-1}),T_6 (*Rhizobium trifolii* + PSB (seed inoculation), T_7 (75% RDF + FYM 11 tonnes ha^{-1}), T_8 (75% RDF + VC 1 tonnes ha^{-1}), T_9 **(**75% RDF + PM 2 tonnes ha^{-1}), T_{10} **(**75% RDF + FYM 5 tonnes ha^{-1} + PM 2.5 tonnes ha^{-1}), T_{11} **(**75% RDF + VC 1.2 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation), T_{12} **(**75% RDF + FYM 5 tonnes ha^{-1} + VC 1.0 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed Inoculation). Plant height was taken from randomly selected plants from each plot from the ground level to the base of last fully opened leaf which expressed as average plant height before each cut. The numbers of shoots were counted with quadrate of 30 × 30 cm from two randomly selected places in each plot at the time of every cutting and means were calculated. The numbers of plant population were counted with quadrate of 30 × 30 cm from two randomly selected places in each plot at time of every cutting and means were calculated.

The fresh samples of berseem were taken after harvesting the crop to take the leaf: stem ratio of berseem. After taking samples leaf and stems were separated immediately. The weight of leaf and stem measured separately to calculate the leaf: stem ratio by using the following formula:

$$\text{Leaf: stem ratio} = \frac{\text{Weight of green leaves (g)}}{\text{Weight of green stems (g)}}$$

The crop was harvested for green fodder yield. The first cutting was harvested at 50 days after sowing (DAS) and subsequent cuttings were done at 40 days intervals in winter and 30 days interval in summer with the help of sickle from the net plot area (3.5 × 3.5). The harvested green fodder was weighed plot wise and converted to quintals per hectare.

Results and Discussion

The significantly maximum plant height was recorded with application of 75% RDF + FYM 5 tonnes ha^{-1} + vermicompost 1.0 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation) at first, second and third but statistically at par with application of 75% RDF + vermicompost 1.2 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation), respectively. While the significantly higher over rest of the treatments Table 1. This is due to the reason that plant assimilate and utilize the available amount of nitrogen and phosphorus during their entire grand growth period due to to more time duration availability for regenerated crop, as the results of increase the plant height. All these factors were responsible for enhance cell division and cell expansion which raise the height of plants. These results are in close conformity with the findings obtained by Valiki *et al.* (2015) [11], and Gyaneshwar *et al.* (2002) [5].

The significantly higher number of shoots per m^2 was recorded with application of 75% RDF + FYM 5 tonnes ha^{-1} + vermicompost 1.0 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation) at first, second and third cut which were statistically at par with application of 75% RDF + vermicompost 1.2 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation) compared to other treatments Table 2. In addition to this, their combined application also accelerates the root development which ultimately increase nutrients uptake by plant system. This leads to hike in cell elongation and cell division which improved the overall vegetative growth of plants. Apart from this, more availability of plant nutrients, especially nitrogen helps to formation of strong cell walls and hence strong shoots which resulted into profuse shoots of plants. These results are already in proved with those reported by Saeed *et al.* (2011) [9].

The number of plant population per m^2 was recorded at the first, second and third cut of growth. The data showed that the effect of different nutrient management practices on number of plant population per m^2. In all cuts of berseem crop, the difference in plant population per m^2 the result was found to be non-significant at all growth stages Table 3. These results might be due to the effect of number of plant population per m^2 in this treatment are mainly due to the increased supply of plant nutrients by combined application of RDF, organic manure, biofertilizer *Rhizobium trifolii* and PSB (seed inoculation) is that the plant population was uniform in all the treatment. During second cut, the plant population is increased this is due to tillering nature of crop. Observed that the higher nitrogen use efficiency with application of biofertilizer with saving the 20% nitrogenous fertilizer and the application of PSB are more effective and more uptake of N, P, Ca, Mg. The similar findings were also reported by (Chaverkar *et al*., 2013) [4].

The significantly higher Leaf: stem was recorded with application of 75% RDF + FYM 5 tonnes ha^{-1} + vermicompost 1 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation) at first, second and third cut which were statistically at par with

application of 75% RDF + vermicompost 1.2 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation), respectively. While the significantly higher over rest of the treatments Table 4. The combined seed inoculation with *Rhizobium trifolii* + PSB improved N and P status of soil and increased N and P uptake which enhanced growth parameters. The leaf: stem ratio significantly increased in number of cuts upto second cut only but decreased in third cut due to more plant height result to show in the higher weight of stem portion. Similarly, synergetic effects are recorded with the combination of organic and inorganic fertilizers which was observed by Ayub *et al*. (2012) [2].

The significantly higher green fodder yield was recorded with application of 75% RDF + FYM 5 tonnes ha^{-1} + vermicompost 1 tonnes ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation), Table 5. The highest green fodder yield is due to the cumulative effect might be the results shows that higher plant height, number of shoots per m^2, number of plant population per m^2 and leaf: ratio, better root development provides good surrounding for the activity of biological nitrogen fixing bacteria. The combined application of RDF, organic manure and biofertilizer. Nitrogen enhances the vegetative growth of berseem and phosphorus increases the photosynthetic activity in leaves of berseem fodder. Whereas, the potassium accelerates the translocation of photosynthates from source to sink. These findings corroborate the results of Chauhan and Bajpal (1979) [3].

Table 1: Effect of different nutrient management practices on plant height (cm) of berseem

Treatment	Plant height (cm)		
	First cut	Second cut	Third cut
T_1: Control	38.54	39.42	47.69
T_2: 100% RDF	42.44	42.77	52.53
T_3: FYM 17 t ha^{-1}	39.13	39.74	48.89
T_4: VC 1.3 tonnes ha^{-1}	40.17	40.67	50.72
T_5: Poultry manure 3 t ha^{-1}	39.91	40.60	49.44
T_6: *Rhizobium trifolii* + PSB (seed inoculation)	38.95	39.52	48.30
T_7: 75% RDF + FYM 11 t ha^{-1}	40.22	41.34	50.80
T_8: 75% RDF + VC 1 t ha^{-1}	41.40	42.30	51.56
T_9: 75% RDF + Poultry manure (PM) 2 t ha^{-1}	41.16	41.79	51.42
T_{10}: 75% RDF + FYM 5 t ha^{-1} + Poultry manure (PM) 2.5 t ha^{-1}	42.63	43.01	52.67
T_{11}: 75% RDF + VC 1.2 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	43.30	44.03	53.19
T_{12}: 75% RDF + FYM 5 t ha^{-1} + VC 1 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	44.39	45.14	55.48
SE (d) ±	0.44	0.60	0.79
CD (5%)	1.27	1.81	2.29

Table 2: Effect of different nutrient management practices on number of shoots per m^2 of berseem

Treatment	No. of Shoots per m^2		
	First cut	Second cut	Third cut
T_1: Control	267.07	320.15	407.04
T_2: 100% RDF	272.67	328.89	415.14
T_3: FYM 17 t ha^{-1}	269.93	322.86	409.25
T_4: Vermicompost (VC) 1.3 t ha^{-1}	270.77	325.37	411.32
T_5: Poultry manure (PM) 3 t ha^{-1}	270.03	324.81	410.63
T_6: *Rhizobium trifolii* + PSB (seed inoculation)	268.19	321.11	408.08
T_7: 75% RDF + FYM 11 t ha^{-1}	271.14	326.81	412.88
T_8: 75% RDF + VC 1 t ha^{-1}	272.00	328.34	414.98
T_9: 75% RDF + Poultry manure (PM) 2 t ha^{-1}	271.67	327.86	413.25
T_{10}: 75% RDF + FYM 5 t ha^{-1} + Poultry manure (PM) 2.5 t ha^{-1}	273.64	329.83	415.97
T_{11}: 75% RDF + VC 1.2 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	274.63	330.22	417.11
T_{12}: 75% RDF + FYM 5 t ha^{-1} + VC 1 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	275.71	331.67	418.00
SE (d) ±	0.57	0.50	0.46
CD (5%)	1.64	1.45	1.33

Table 3: Effect of different nutrient management practices on plant population per m2 of berseem

Treatment	Plant population per m^2		
	First cut	Second cut	Third cut
T_1: Control	96.12	108.67	101.46
T_2: 100% RDF	98.21	110.83	103.53
T_3: FYM 17 t ha^{-1}	96.14	108.87	101.48
T_4: Vermicompost (VC) 1.3 t ha^{-1}	96.16	109.37	101.50
T_5: Poultry manure (PM) 3 t ha^{-1}	96.15	108.98	102.49
T_6: *Rhizobium trifolii* + PSB (seed inoculation)	96.13	108.74	102.47
T_7: 75% RDF + FYM 11 t ha^{-1}	97.17	109.43	102.51
T_8: 75% RDF + VC 1 t ha^{-1}	97.20	109.98	102.53
T_9: 75% RDF + Poultry manure (PM) 2 t ha^{-1}	97.19	109.67	103.52
T_{10}: 75% RDF + FYM 5 t ha^{-1} + Poultry manure (PM) 2.5 t ha^{-1}	98.26	110.86	103.54
T_{11}: 75% RDF + VC 1.2 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	98.27	110.88	103.55
T_{12}: 75% RDF + FYM 5 t ha^{-1} +Vermicompost 1 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	98.28	110.89	103.56
SE (d) ±	0.003	0.001	0.004
CD (5%)	NS	NS	NS

Table 4: Effect of different nutrient management practices on leaf: stem ratio of berseem

Treatment	Leaf: stem ratio		
	First cut	Second cut	Third cut
T_1: Control	1.01	1.16	0.86
T_2: 100% RDF	1.15	1.31	1.21
T_3: FYM 17 t ha^{-1}	1.04	1.21	1.05
T_4: Vermicompost (VC) 1.3 t ha^{-1}	1.06	1.25	1.10
T_5: Poultry manure (PM) 3 t ha^{-1}	1.05	1.23	1.07
T_6: *Rhizobium trifolii* + PSB (seed inoculation)	1.02	1.19	1.02
T_7: 75% RDF + FYM 11 t ha^{-1}	1.08	1.26	1.14
T_8: 75% RDF + VC 1 t ha^{-1}	1.10	1.29	1.20
T_9: 75% RDF + Poultry manure 2 t ha^{-1}	1.09	1.28	1.18
T_{10}: 75% RDF + FYM 5 t ha^{-1} + Poultry manure 2.5 t ha^{-1}	1.16	1.33	1.23
T_{11}: 75% RDF + VC 1.2 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	1.17	1.35	1.27
T_{12}: 75% RDF + FYM 5 t ha^{-1} +VC 1 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	1.18	1.36	1.32
SE (d) ±	0.013	0.007	0.026
CD (5%)	0.039	0.020	0.075

Table 5: Effect of different nutrient management practices on green fodder yield (q ha^{-1}) of berseem

Treatment	Green fodder yield (quintal ha^{-1})		
	First cut	Second cut	Third cut
T_1: Control	96.78	132.45	162.23
T_2: 100% RDF	118.54	174.56	200.34
T_3: FYM 17 t ha^{-1}	101.56	143.56	173.46
T_4: Vermicompost (VC) 1.3 t ha^{-1}	109.67	154.23	184.34
T_5: Poultry manure (PM) 3 t ha^{-1}	104.67	151.23	179.45
T_6: *Rhizobium trifolii* + PSB (seed inoculation)	98.56	138.45	165.34
T_7: 75% RDF + FYM 11 t ha^{-1}	110.09	157.34	187.34
T_8: 75% RDF + Vermicompost 1 t ha^{-1}	117.67	173.67	199.23
T_9: 75% RDF + Poultry manure 2 t ha^{-1}	113.23	167.34	191.12
T_{10}: 75% RDF + FYM 5 t ha^{-1} + Poultry manure (PM) 2.5 t ha^{-1}	134.35	195.34	238.56
T_{11}: 75% RDF + Vermicompost (VC) 1.2 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	136.37	201.46	242.12
T_{12}: 75% RDF + FYM 5 t ha^{-1} +Vermicompost (VC) 1 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation)	149.23	215.34	263.35
SE (d) ±	0.67	0.68	0.58
CD (5%)	1.93	1.96	1.69

Conclusion

On the basis of experimental results with the application of 75% RDF + FYM 5 t ha^{-1} + Vermicompost (VC) 1 t ha^{-1} + *Rhizobium trifolii* + PSB (seed inoculation) obtained significantly higher growth and fodder yield respectively than other treatments. Above conclusion are however, based on a only single season research and may it needs further more confirmations by repetition of research trial to draw valid and definite conclusion.

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