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Integrated Nutrient Management for Seed Production in French bean (*Phaseolus vulgaris* (L.))

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A B S T R A C T

An experiment on integrated nutrient management in French bean was conducted during 2016-17 with the treatments being T_1 (RDF), T_2 (RDF + lime), T_3 (75% RDF), T_4 (75% RDF + lime), T_5 (75% RDF +25% FYM), T_6 (75% RDF + 25% FYM + lime), T_7 (75% RDF + 25 % vermicompost), T_8 (75% RDF + 25% vermicompost + lime), T_9 (75 % RDF + 12.5 % vermicompost + 12.5 %FYM + lime), T_{10} (50% RDF +25% FYM + 2 foliar spray), T_{11} (50% RDF +25% vermicompost + 2 foliar spray). On the course of investigation, it was observed that the number of pods per plant was highest in T_8 (15.00) and T_9 (15.00) followed by T_7 (14.10), length of pod was highest with T_8 (13.80 cm) followed by T_9 (13.20 cm), dry weight of pod per plant was highest in T_8 (50.10 g) followed by (48.00 g) in T_9, number of seeds per plant was highest in T_5 (78.40) followed by T_8 (74.52) and dry weight of seeds per plot was highest in T_8 (1653.00 g) followed by T_9 (1587.00 g). However the seed yield per hectare was highest in T_8 (18.00 q/ha) followed by 16.65 q/ha in T_9 and 16.56 q/ha in T_6 and the lowest seed yield of 11.76 q/ha was obtained in T_{11}. It can be concluded that application of 75% RDF along with 25% vermicompost and lime application produced a good environment supporting very good growth of French bean to produce significantly higher marketable seed yield during rabi season under coastal agro climatic condition of Odisha.

Introduction

French bean (*Phaseolus vulgaris*) is one of the most important and popular legume vegetable cultivated in Rabi season in Odisha. There is good demand of this vegetable in Odisha. However sufficient good quality seed is not produced in Odisha. There is a worldwide consensus that sole dependence on chemical input based agriculture is not suitable in long run and only integrated plant nutrient systems (IPNS) involving a combination of fertilizer, organic manure and bio-fertilisers are essential to sustain crop production, preserve soil health and biodiversity. In addition to this, organic manures help in improving the use efficiency of inorganic fertilisers. The basic concept of integrated nutrient management system is the maintenance of Plant nutrients supply to achieve a given level of crop production by optimizing the benefits from all possible sources of plant nutrients in an integrated manner, appropriate to each cropping system and farming system. The advantage of combining organic and inorganic sources of

nutrients in integrated nutrient management has been proved superior to the use of each component separately.

The modern day intensive crop cultivation requires the use of chemical fertilizers. But, the price of inorganic fertilizers has gone up considerably which in turn has increased the cost of production. Use of inorganic fertilizers not only increased the cost of production but also decreased over all soil fertility causing environmental pollution (Ramana *et al.*, 2010).

Studies clearly indicated that, the combined use of organic and chemical fertilizer not only increase the yield of crop but improve the physical, chemical and biological properties of soil. Use of organic manure with optimum rate of fertilizer under intensive farming system increased the turnover of nutrients in the soil plant system (Metkari and Dhok, 2011). So, the experiment was designed to study the effect of different nutrient management on seed production and quality of seed under coastal agro climatic zones of Odisha.

Materials and Methods

This experiment was carried out during Rabi season of 2016-17 in the Horticultural Research Station of Department of Vegetable Science, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha. French bean variety Swarna Priya collected from ICAR research complex for eastern region (ICAR-RCER), Ranchi was taken for trial during the course of investigation. Swarna Priya is a promising French bean variety, developed through pure line selection at ICAR research complex Palandu, Ranchi. Pods are flat, green, fleshy having good cooking quality. Dried seeds are bold and maroon in colour, suitable for rajma preparation. The variety is high yielding and performed well for fresh pod production at Bhubaneswar climatic condition.

The trial was conducted in RBD with three replications and eleven treatments. The treatments are T_1 (RDF), T_2 (RDF + lime), T_3 (75% RDF), T_4 (75% RDF + lime), T_5 (75% RDF +25% FYM), T_6 (75% RDF + 25% FYM + lime), T_7 (75% RDF + 25 % vermicompost), T_8 (75% RDF + 25% vermicompost + lime), T_9 (75 % RDF + 12.5 % vermicompost + 12.5 %FYM + lime), T_{10} (50% RDF +25% FYM + 2 foliar spray), T_{11} (50% RDF +25% vermicompost + 2 foliar spray). [RDF: Recommended Dose of Fertilizer for French bean was 120:60:60 kg NPK ha^{-1}, Soluble fertilizer 19:19:19 was sprayed @7.5gm/liter, Lime @5q/ha was applied.]. Decomposed compost and vermicompost were purchased and applied in time as per treatment. FYM and vermicompost were applied before sowing of seeds along with lime wherever it was required.

The required amount of FYM and vermicompost were applied after calculation as per different treatments. The recommended dose of fertilizer is 120:60:60 kg NPK per ha^{-1} was applied through Urea, SSP (Single super phosphate), and MOP (Murate of potash). The total amount of phosphorous and half of nitrogen as well as half of potash were applied as basal dressing before sowing the seeds in the rows. Twenty five days after sowing, half of nitrogen and half of potash was applied as top dressing during hoeing as per the treatment schedule. The soluble fertilizer (19:19:19, N: P: K) was sprayed @ 7.5g/liter as per the treatment schedule.

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Other recommended package of practices was followed. Observations were taken on different growth and yield parameters like Growth Parameters, Leaf area, Leaf weight, Length of petiole, Number of leaves per plant, Number of branches per plant, Plant height, Number of pods per plant, Length of Pod, Number of seeds per pod, Average fresh weight of one pod, average weight of dry pod with seed, Average weight of total dry pods per plant, Number of seeds per plant, Weight of dry seeds per plant, Hundred seed weight, Weight of total dry seeds per plot, Weight of total dry seeds per hectare etc.

In the experiment the cost of input, field preparation and other cost were taken into consideration for each treatment and was divided by the gross return for each treatment and the B:C ratio was calculated to know the return for each rupee that is spent during the course of investigation. Analysis of variance (ANOVA) was carried out on mean values separately for each character adopting standard analysis of variance technique for RBD design (Panse and Sukhatme, 1954).

Results and Discussion

Average leaf area under various treatments ranged from 86.50cm^{2}to 105.20 cm^2 (Table 1). The average leaf area was comparatively more in T_4 with 75% RDF +lime but was slightly less with 100% RDF + Lime. Similarly with 75%RDF+25%FYM the leaf area was found to be the lowest. Due to different treatment combination even though T_5 and T_6 varied significantly as compared to T_8 with (75%RDF+25% vermicompost + lime) but, the trend of increasing in leaf area did not showed any uniform trend. Jagdale *et al.*, (2005) and Ramana *et al.*, (2011**)** also reported this type of information and trend in their earlier research work.

Average fresh weight of leaves did not vary significantly among the different treatments (Table 1). Even though, there was slight increase in leaf weight due to 75% inorganic and 25% organic combination with lime (T_5 and T_7) but, the increase was not significant. From the above result it can be concluded that application of different doses of RDF with organic manure either FYM or vermi along with lime or foliar spray did not produced any remarkable data indicating that in the present investigation the treatments had less influenced the above character.

The length of petiole was found to be maximum with T_5 (7.1), T_6 (7.1), T_9 (7.1) and T_{11} (7.1) followed by T_7 (7.0), T_4 (6.90) and T_8 (6.90). There was no significant difference in petiole length under different treatments (Table 1). More or less it was clear from the findings that only inorganic matters do not produce any significant change in length of petiole of leaf but varied to a great extent with inorganic and organic combination in suitable proportion.

The number of leaves and number of branches per plant produced uniform trend during the experiment (Table 1). The number of branches were more with T_9 (75%

RDF+12.5%Vermi compost +12.5%FYM+ Lime), T_6(75% RDF+25% FYM+ Lime) and T_8(75% RDF+25%Vermi compost + Lime). Likewise, more number of leave were also recorded with T_8(22.40), T_6(21.70), and T_9(21.60). It may be concluded that when number of branches increases mostly there was increase in number of leaves. However, there were significant difference among the treatments in producing number of branches per plant and number of leaves per plant indicating that these two characters respond well to integrated nutrient management and management practices, environment, edaphic, climatic and nutrition factors had profound influence on these two characters during the course of investigation. This types of investigation were done earlier by Banu *et al.,* (2009), Singh and Chauhan (2009), Sharma *et al.,* (2015) and Verma *et al.,* (2015).

The number of pod per plant, length of pod, number of seeds per pod along with weight of pod are most important character which contributes directly to yield. Other characters like plant height, number of leaves, number of primary branches, indirectly influence yield.It was observed that when RDF requirement of French bean was met through 75% RDF combined with 25% either one organic source or 12.5 and 12.5 organic sources from either through FYM or vermi the results were comparatively better (Table 2). This indicates that 100% RDF through produce some impact on growth but yield attributing characters were much influenced by supplemental organic source which changed the soil condition making it favorable for influencing the economic traits controlling yield. Increase in number of pods per plant, length of pod and number of seeds per pod were also reported by Das *et al.,* (2011), Ramana *et al.,* (2011), Sharma *et al.,* (2015) and Bhathal and Kumar (2016).

The fresh weight of pod did not varied significantly due to various combinations of different treatments (Table 2). However, a slight increase of fresh weight of pod was found with T_8(75% RDF+25%Vermi compost + Lime), T_9(75% RDF+12.5%Vermi compost +12.5%FYM+ Lime) and also in T_2(RDF + Lime). With this it can be concluded that the average fresh weight of pod did not show significant change and likewise when mature pods along with seeds were dried it was also observed that the average weight of dry pod with seed did not varied significantly indicating that with proper management different treatments could not produce significant changes for the above two characters. The present findings are in conformity with the findings of Jagdale *et al.,* (2005) and Chauhan *et al.,* (2010).

The average weight of total dry pod per plant (Table 2), number of seeds per plant and weight of dry seeds per plant (Table 3) as observed during the experiment showed a linear relation among themselves. In most of the cases when average weight of total dry pods per plant was increased there was also increase in number of seeds per plantand weight of dry seeds per plant, which were found to be inter relatedand produced a similar type of trend during the trial period. It was observed that application of 75%RDF along with 25% RDF met from either FYM or vermicompost along with or without lime application produced better result indicating that the growth and development has been influenced to produce the desirable changes in the above three traits in french bean. This type of findings were also reported by Jagdale *et al.,* (2005) and Meena *et al.,* (2014**).**

Total dry weight of seeds per plot was highest with T8 and also the highest yield of seed per quintal/ha was also found in T8 where 75% RDF and 25% vermicompost +lime was applied (Table 3).

Table.1 Average leaf area, fresh weight of leaves, length of petiole, number of leaves and number of branches at harvest, plant height at harvest of french bean crop as influenced by different treatments

Treatments		Average leaf area (cm^2)plant	Fresh weight of leaf (g)	Length of petiole (cm)	Number of leaves at harvest	Number of branches at harvest	Plant height at harvest
T1	RDF	96.20	2.80	19.60	6.00	38.20	6.70
T2	RDF+ Lime	98.40	2.60	20.10	6.00	36.50	6.80
T3	75% RDF	94.20	2.70	18.60	5.70	34.50	6.80
T4	75% RDF+ Lime	100.00	2.60	16.50	5.60	38.60	6.90
T5	75% RDF+25% FYM	86.50	3.10	18.50	7.40	37.60	7.10
T6	75% RDF+25% FYM+ Lime	89.20	2.90	21.70	8.00	41.30	7.10
T7	75% RDF+25% Vermicompost	100.30	3.10	19.60	7.80	40.10	7.00
T8	75% RDF+25%Vermicompost + Lime	105.20	3.20	22.40	8.00	44.20	6.90
T9	75% RDF+12.5%Vermicompost +12.5% FYM+ Lime	97.10	3.00	21.60	8.20	40.50	7.10
T10	50% RDF+25%FYM + 2 Foliar spray (19:19:19)	99.10	2.60	19.60	6.20	34.20	6.80
T11	50% RDF+25%Vermicompost + 2 Foliar spray (19:19:19)	102.60	2.70	18.00	7.00	35.20	7.10
SE (m) ±		2.88	0.23	0.24	1.13	0.33	2.35
CD5%		8.50	0.68	0.70	3.34	0.98	6.94
CV%		5.14	13.98	5.94	9.99	8.34	10.65

[RDF: Recommended Dose of Fertilizer for French bean was 120:60:60 kg NPK ha^{-1}, Soluble fertilizer 19:19:19 was sprayed @7.5gm/liter, Lime @5q/ha was applied.]

Table.2 Number of pods per plant, length of pod, Number of seeds/pod, fresh weight of one pod, average weight of dry pod with seed and average weight of total dry pod per plantof french bean crop as influenced by different treatments

Treatments		Number of pods per plant	Length of pod (cm)	Number of seeds per pod	Fresh weight of one pod (g)	Avgwt of dry pod+seed (g)	Avgwt of total dry pod per plant (g)
T1	RDF	13.10	5.30	9.45	3.02	39.56	10.60
T2	RDF+ Lime	13.20	5.20	10.32	3.10	40.92	13.00
T3	75% RDF	12.00	5.00	9.65	3.03	36.36	10.70
T4	75% RDF+ Lime	13.00	5.40	9.16	3.10	40.30	13.20
T5	75% RDF+25% FYM	14.00	5.60	9.20	3.10	43.40	13.00
T6	75% RDF+25% FYM+ Lime	13.30	5.50	9.40	3.00	43.20	13.20
T7	75% RDF+25% Vermicompost	14.10	5.00	8.90	3.20	42.30	12.30
T8	75% RDF+25%Vermicompost + Lime	15.00	5.40	10.50	3.34	50.10	13.80
T9	75% RDF+12.5%Vermicompost +12.5% FYM+ Lime	15.00	5.50	10.60	3.20	48.00	13.20
T10	50% RDF+25%FYM + 2 Foliar spray (19:19:19)	11.80	5.00	9.00	3.00	35.40	11.80
T11	50% RDF+25%Vermicompost + 2 Foliar spray (19:19:19)	12.20	4.80	9.40	3.10	37.82	11.90
SE (m) ±		0.89	0.60	0.41	0.59	0.20	2.53
CD5%		2.63	1.76	1.22	1.75	0.59	7.47
CV%		11.60	8.32	13.62	10.73	11.07	10.55

[RDF: Recommended Dose of Fertilizer for French bean was 120:60:60 kg NPK ha^{-1}, Soluble fertilizer 19:19:19 was sprayed @7.5gm/liter, Lime @5q/ha was applied.]

Table.3 Number of seeds per plant, weight of dry seeds per plant, 100-seed weight, weight of total dry seeds per plot and weight of dry seeds per hectare of French bean crop as influenced by different treatments

Treatments		Number of seeds/ plant	Weight of dry Seeds/ plant (g)	100 seed Weight(g)	Weight of total dry seeds/ plot (g)	Weight of dry seeds/ha(kg)
T1	RDF	69.43	48.00	1340.00	1524.00	28.04
T2	RDF+ Lime	68.64	47.10	1315.00	1551.00	27.67
T3	75% RDF	60.00	46.80	1222.00	1394.00	23.56
T4	75% RDF+ Lime	70.20	46.70	1319.00	1400.00	28.41
T5	75% RDF+25% FYM	78.40	47.00	1410.00	1601.00	32.31
T6	75% RDF+25% FYM+ Lime	73.15	47.90	1460.00	1656.00	29.82
T7	75% RDF+25% Vermicompost	66.50	46.50	1360.00	1456.00	26.65
T8	75% RDF+25%Vermicompost + Lime	74.52	49.60	1653.00	1800.00	30.47
T9	75% RDF+12.5%Vermicompost +12.5% FYM+ Lime	72.60	47.20	1587.00	1665.00	29.55
T10	50% RDF+25%FYM + 2 Foliar spray (19:19:19)	59.00	47.50	1176.00	1243.00	23.08
T11	50% RDF+25%Vermicompost + 2 Foliar spray (19:19:19)	57.12	46.40	1156.00	1176.00	20.18
SE (m) ±		3.30	2.02	1.95	117.86	130.18
CD5%		9.72	5.97	5.74	347.64	383.99
CV%		8.38	12.86	7.12	14.97	15.06

[RDF: Recommended Dose of Fertilizer for French bean was 120:60:60 kg NPK ha^{-1}, Soluble fertilizer 19:19:19 was sprayed @7.5gm/liter, Lime @5q/ha was applied.]

The second best treatment for the above two economic characters was in T9 where along with 75% RDF and 12.5% RDF was met from FYM +12.5%RDF was met from vermicompost along with lime application. The third best treatment was in T6 where 75% RDF + 25%FYM+lime was applied. By observing this type of trend particularly for this two most economic characters the result can be compared with T1 where only recommended dose of RDF was taken and by observing all this it can be explained that in a acidic soil application of lime along with suitable combination of inorganic and organic sources of nutrient helped for better growth, flowering, leaf number, yield per plot and also yield per hectare. This type of result earlier was reported by Singh *et al.,* (2005), Singh and Chauhan (2009)

The 100 seed weight of French bean were not much influenced by different treatments and was mostly a varietal character somewhat less influenced by different combination of treatments (Table 3). It was observed that the 100 seed weight was highest in T8 with 75%RDF +25%FYM+lime application. Ramana *et al.,* (2011), Singh *et al.,* (2011) and Haque *et al.,* (2015) also reported this type of information and trend in their earlier research work.

There were significant differences in plant height due to different treatments indicating that it is more influenced by environment and management practices (Table 1). Similar trends were observed in the experiment and the plant height were generally more with a proper combination of inorganic and organic sources of nutrients which have influenced the height of plant. Increase in plant height due to proper combination of RDF + organic sources of plant nutrients were also reported by other scientist like Prajapati *et al.,* (2003), Menon *et al.,* (2010)**,** Metkari and Dhok (2011), Jat *et al.,* (2013**)** earlier.

During the experiment application of foliar spraying of fertilizer did not produced any significant effect because in those treatments the amount of total nutrient requirement was not met from different combination. Application of lime in different treatments produced good result indicating that soil test based treatments were good for production of more quality yield in French bean.

It was observed that combination of organic and inorganic sources of fertilizer resulted in better growth, influenced yield attributing characters and also the yield. The application of lime in some treatments performed better with suitable nutrient combination. It can be concluded that application of 75%RDF +25% vermicompost along with lime application produced better yield (1800kg/ha.) as compared to other treatments. Foliar application of soluble fertilizer was not able to produce remarkable yield because 100% RDF was not supplemented in the treatment. So it can be concluded that application of and 5%RDF+ 25% vermicompost +lime was the best treatment producing around 1800 kg seed/ha. However the experiment may be conducted at various locations over season to get more authentic information related to seed production of French bean.

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