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RESEARCH PAPER

Effect of integrated nutrient management on growth and yield attributes of yardlong bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) *Verdc.*)

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Abstract: The present experiment was conducted during *Kharif* 2020-21 and 2021-22 at Zonal Agricultural and Horticultural Research Station, Shivamogga, Karnataka, to evaluate the effect of Integrated Nutrient Management on growth and yield of underexploited vegetable crop yardlong bean cv. Arka Mangala under naturally ventilated polyhouse. The experiment was laid out in randomized complete block design (RCBD) with three replications and eight treatments *viz.* T_1 – 100 % Recommended Dose of Fertilizer (RDF-25:75:60 NPK, kg ha^{-1}), T_2 -100 % RDF + Effective Microbial Consortia (EMC)+ Vegetable Special (VS) , T_3 - 125 % RDF, T_4 - 150 % RDF, T_5 - 175 % RDF, T_6 - 125 % RDF + EMC+ VS , T_7 – 150 % RDF +EMC+VS , T_8 - 175% RDF+EMC+ VS. The integrated treatment combinations involve both organic and inorganic source of nutrients which significantly influenced the growth and yield attributes. The results from the pooled data of two year revealed that, all the growth and yield traits were markedly influenced by the integrated nutrient management practices. Among different treatments, significantly higher plant height (247.96 cm), number of primary branches (8.54), initiation of flowering (38.29 d), days to fifty percent flowering (43.48 d), days to first harvest (52.83 d), number of pods per plant (25.17), pod length (74.56 cm), pod girth (3.98 cm), average pod weight (35.54 g), yield per plant (664.17 g) and higher pod yield per 1000 m^2 (2171.96 kg) were recorded with treatment 150% RDF + EMC+ VS. Thus Integrated Nutrient Management practices increased the growth and yield attributes of Yardlong bean and among compared treatments, T_7 – 150% RDF + Effective Microbial Consortia (EMC)+ Vegetable Special (VS), found to achieve the maximum productivity of Yardlong bean. The evaluation of production economics revealed that growing of Yardlong bean with said treatment (T_7) could be the most remunerative option with a highest benefit: cost of 3.15.

Key words: Bio fertilizers, EMC, Integrated Nutrient Management, Rhizobium, Yardlong bean

Introduction

Yardlong bean (*Vigna unguiculata* subsp. *sesquipedalis L.Verdc*.) is a member of the Fabaceae family. It is an important leguminous vegetable and mostly cultivated in China, Southeast Asia, Central and West Africa (FAO 1993; Piluek 1994). The Yardlong bean is considered to be one of the popular vegetable crops in Indonesia, India Thailand, Philippines, Taiwan and China (Rachie 1985). It is one of the most nutritious leguminous vegetable crop. It is a rich and inexpensive source of vegetable protein. Fresh pods are used as a green vegetable. The pods are rich in calcium, phosphorus, sodium, and potassium and also fair amounts of vitamin A, thiamine and ascorbic acid are present (Piluek, 1994).

It enriches soil fertility by fixing atmospheric nitrogen. Because of its quick growth habit it has become an essential component of sustainable agriculture. The factors attributed for low yield of Yardlong bean is mainly growing of Yardlong beans under less fertile soil with low inputs or improper application of fertilizers. Nowadays Increasing cost of inorganic fertilizers and reduction in soil health with chemical fertilizers, it is essential to replace inorganic fertilizers through organic for sustainable agriculture. Organic sources of the plant nutrients have been reported to improve growth, yield and soil fertility status. Reliance on the increased use of chemical fertilizers and associated hazards put back attention on organic sources which are effective in promoting health and productivity of the soil. Integrated management of chemical fertilizers and organic wastes may be an important strategy for sustainable production of crops. This may not only improve the efficiency of chemical fertilizers along with their minimal use in crop production besides increasing crop yield and improving available major and minor nutrients (Rautaray *et al*., 2003).

Over the years inorganic fertilizers have been widely used worldwide to support and optimize the growth of vegetables. However, the use of organic fertilizer has gained more importance globally in the last few decades, due to efforts made for the conservation of agriculture. Organic fertilizers have been shown to help preserve natural resources and reduce degradation of ecosystem (Mader *et al.* 2002; Francis and Daniel, 2004).

In commercial agriculture, the use of chemical fertilizers cannot be ruled out completely. However, there is a need for integrated use of alternate sources of nutrients for sustaining the crop productivity. The integration of organic and inorganic sources of plant nutrients has proved superior to individual components with respect to growth, yield and quality of pulses. In this context the study will include integration of different levels of organic and inorganic fertilizers for getting high productivity in Yardlong bean which inturn helps the farmers to get higher returns.

Material and methods

The experiment was conducted to study the effect of integrated nutrient management on growth and yield attributes of Yardlong bean during *Kharif* 2021 and 2022 at ZAHRS,

Table 1. Details of experimental treatments

Notations	Treatment details
T_1	100 % Recommended Dose of Fertilizer - RDF (Control),
T_2	100 % RDF + Effective Microbial Consortia (EMC)+ Vegetable Special (VS)
T_3	125 % RDF
T_4	150 % RDF
T_5	175 % RDF
T_6	125 % RDF + EMC+ VS
T_7	150 % RDF + EMC+ VS
T_8	175 % RDF + EMC+ VS

Note. RDF- Recommended Dose of Fertilizer: 25:75:60 NPK kg ha^{-1} (Ref: POP Horticulture page no. 87, UHS, Bagalkot, Karnataka)
EMC- Effective Microbial Consortia : *Azospirillium* + PSB (*Bacillus megaterium*) + KSB (*Frateuria aurantia*)- 10 ml/kg of seed
VS- Vegetable Special - Micro nutrient formulation developed from IIHR, Bangalore, Karnataka. (5g/L)

Shivamogga, Karnataka, India. The location situated at *13^0 58 North latitude and 75^0 34 East latitude* with an altitude of 650 meters above mean sea level. It comes under agro-climatic region-4 and zone-VII (Southern Transition Zone) of Karnataka, India.

The experiment was laid out in randomised complete block design (RCBD) with eight treatments (Table 1) with three replications. The variety Arka Mangala which was released from ICAR- Indian Institute of Horticulture Research (ICAR-IIHR), Bangalore was taken for study. Seeds are treated with Effective Microbial Consortia *viz*., *Azospirillium, Bacillus megaterium* and *Frateuria aurania* for each 10 ml were taken. Farmyard manure (FYM) is applied at the rate of 25 t/ha. Foliar spray of vegetable special micronutrient formulation (5g/L) which is released from IIHR, Bangalore was sprayed uniformly on entire crop canopy at 30 and 60 days after sowing. As there is no standardized recommended dose of fertilizer (RDF) for yardlong bean in Karnataka, recommended dose of fertilizer of cowpea (25:75:60 NPK, kg ha-1) is considered for formulating treatments.(Since yardlong bean is sub species of cowpea).All the recommended package of practices except nutrient management was given uniformly to all the treatments. The required dose of fertilizers as per treatment schedule were calculated and supplied to plants through different sources like Urea, Single super phosphate, Muriate of potash. Cultural operations were performed as per the recommendations. Sowing of healthy treated seed was done with a spacing of 60 cm × 45 cm. Fifteen plants from each treatment were selected randomly for observation of data.

The data was collected and subjected to statistical analysis by adopting Fisher's method of analysis of variance as outlined by Gomez and Gomez (1984). The critical difference (CD) values are given at 5 per cent level of significance, wherever the 'F' test is significant.

Results and discussion

a) Effect of Integrated Nutrient Management on growth attributes of Yardlong bean:

Integrated nutrient management had significant effect on the growth and yield traits of Yardlong bean. Mean performance for growth attributing traits *viz*., plant height, number of branches, days to initiation of flowering, days taken to first harvest was higher in *Kharif* 2020 than *Kharif* 2021 (Table 2). It was observed that significantly higher plant height at 30 DAS (249.58 cm, 246.33 cm) was noticed with the $\mathbf{T_7}$ which is at par with T8 (246.42 cm, 242.08 cm) followed by T6 (243.90 cm, 239.82 cm) Whereas, the minimum plant height was noticed under control T1 (230.17 cm, 227.09 cm) in *Kharif* 2020 & 2021 respectively. This may be due to application of major nutrients through different levels of chemical fertilizers, increased the photosynthetic activity, nitrogen metabolism and auxin contents in the plants which ultimately improving the plant height. The results of the present investigation showed an increase in plant height might be due to the application of nitrogenous fertilizers applied through inorganic fertilizers supplied nutrients in the early stages, whereas in later stages, the mineralized N from organic manures and atmospheric N fixation by *Rhizobium* contributed to N availability to crop. Another reason for increase in vine length is result of PSB biofertilization. Hence, there was continuous supply of nutrients throughout the crop growth period. These results are in line with findings of SK, Dash et al (2019) who reported that, integrated use of fertilizers results in significant increase in growth parameters as compare to sole application of chemical fertilizer / organic fertilizer. Who stated that it might be due to more availability and uptake of nutrients, specifically nitogen which is important element for better cell enlargement and cell division which leads to increased plant growth, during trial for initial requirement of nitrogen would be met from inorganic sources as it would be available instantly to the plant. Later organic nitrogen will be mineralized slowly but steadily and supplied required quantity of available nitrogen during progressive crop growth period. This results also confirmed by Mohanty *et al* (2017) in French bean and Mandhata singh (2017) in Mungbean, G. Sindhuja, (2021) in Yardlongbean.

Number of primary branches: Data presented in (Table 2), revealed that the number of primary branches per plant were significantly maximum with T7 (8.67, 8.42) which was found to be at par with T8 (8.12, 7.92) followed by T6 (7.87, 7.75). While, minimum number of branches per plant was recorded under T1-control (6.17, 5.83) in 2020 & 2021 respectively. It might be due to the application of phosphorus through inorganic fertilizer and microbial inoculation of seed, which increased the availability of phosphorus in root zone, which in turn resulted in better growth and development of roots and shoots and also helped in better nodulation. Meera *et al.* (2010) opined that application of organic manure in two split doses along with inorganic fertilizers results in significant increase in plant height, dry matter production, number of branches per plant. Similar results were reported by Sajitha *et al*. (2016) in dolichus bean. Mohanty *et al* (2017) in French bean and Mandhata singh(2017) in Mungbean.

Number of days taken for initiation of flowering and 50 per cent flowering: It is evident from the data in Table 2 that, significantly minimum number of days to first flowering was

Table 2. Effect of Integrated Nutrient Management on growth attributes of Yardlong bean:

Treatment details	Plant height (cm)			Number of primary branches			Days to initiation of flowering (Days)			Days to 50 % flowering (Days)			Days taken to first harvest (Days)		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
T_1 RDF (100%)	230.17	227.09	228.63	6.17	5.83	6.00	41.17	40.92	41.04	44.90	44.37	44.63	55.17	54.83	55.00
T_2 RDF + EMC+ VS	239.40	235.83	237.62	7.25	6.96	7.10	39.87	39.53	39.70	44.58	44.10	44.34	54.47	54.00	54.23
T_3 125% RDF	232.52	230.33	231.43	6.33	6.25	6.29	40.60	40.08	40.34	44.72	44.38	44.55	54.95	54.50	54.73
T_4 150% RDF	235.08	233.58	234.33	6.75	6.58	6.67	40.47	39.93	40.20	44.60	44.52	44.56	54.67	54.32	54.49
T_5 175% RDF	240.50	236.92	238.71	7.25	7.08	7.17	39.82	39.65	39.73	44.33	43.65	43.99	54.28	53.75	54.02
T_6 125% RD +EMC+ VS	243.90	239.82	241.86	7.87	7.75	7.81	39.25	38.92	39.08	44.18	43.50	43.84	53.92	53.45	53.68
T_7 150% RDF+EMC+ VS	249.58	246.33	247.96	8.67	8.42	8.54	38.50	38.08	38.29	43.75	43.22	43.48	53.08	52.58	52.83
T_8 175% RDF+ EMC+VS	246.42	242.08	244.25	8.12	7.92	8.02	38.92	38.50	38.71	43.92	43.50	43.71	53.62	52.83	53.23
MEAN	239.70	236.50	238.10	7.30	7.10	7.20	39.82	39.45	39.64	44.37	43.90	44.14	54.27	53.78	54.03
SEM±	1.73	1.92	1.57	0.27	0.28	0.26	0.37	0.37	0.33	0.28	0.30	0.25	0.31	0.27	0.27
CD @5%	5.25	5.82	4.77	0.82	0.85	0.79	1.13	1.12	1.01	0.84	0.91	0.77	0.95	0.81	0.81

NOTE: RDF- Recommended Dose of Fertilizer, EMC-Effective Microbial Consortia, VS- Vegetable Special

Table 3. Effect of Integrated Nutrient Management on yield attributes of Yardlong bean

Treatment details	No. of pods per plant			Pod length (cm)			Pod girth (cm)			Yield per plant (g)			Yield per 1000 m^2 (kg)			B:C		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
T_1 RDF (100%)	19.00	18.33	18.67	68.33	67.92	68.13	3.30	3.23	3.26	383.50	358.58	371.04	1583.33	1506.67	1545.00	2.27	2.37	2.32
T_2 RDF + EMC+ VS	21.92	20.75	21.33	71.33	70.50	70.92	3.43	3.39	3.41	495.00	466.75	480.88	1858.75	1777.83	1818.29	2.62	2.74	2.68
T_3 125% RDF	20.25	19.67	19.96	69.42	68.75	69.08	3.39	3.26	3.33	407.83	383.42	395.63	1662.60	1598.00	1630.30	2.37	2.49	2.43
T_4 150% RDF	21.50	20.33	20.92	70.50	69.83	70.17	3.48	3.40	3.44	448.42	408.33	428.38	1760.08	1657.64	1708.86	2.49	2.56	2.53
T_5 175% RDF	22.08	21.33	21.71	72.17	71.17	71.67	3.52	3.44	3.48	528.33	493.33	510.83	1976.08	1898.00	1937.04	2.76	2.90	2.83
T_6 125% RDF +EMC+ VS	23.12	22.79	22.96	73.12	72.12	72.62	3.64	3.57	3.60	573.33	536.67	555.00	2093.08	1989.67	2041.38	2.92	3.03	2.98
T_7 150% RDF+EMC+ VS	25.50	24.83	25.17	75.11	74.00	74.56	4.08	3.88	3.98	685.00	643.33	664.17	2208.50	2135.42	2171.96	3.07	3.23	3.15
T_8 175% RDF+ EMC+VS	24.21	23.75	23.98	73.58	73.33	73.46	3.85	3.62	3.74	635.00	598.33	616.67	2151.92	2065.67	2108.79	2.96	3.09	3.02
MEAN	22.20	21.47	21.84	71.70	70.95	71.32	3.59	3.47	3.53	519.55	486.09	502.82	1911.79	1828.61	1870.20	2.68	2.80	2.74
SEM±	0.40	0.36	0.33	0.36	0.37	0.33	0.07	0.10	0.08	11.44	13.18	11.87	24.51	28.72	18.47	0.03	0.04	0.03
CD @5%	1.21	1.09	1.00	1.10	1.14	1.00	0.21	0.31	0.23	34.71	39.97	36.01	74.35	87.12	56.03	0.10	0.13	0.08

NOTE: RDF- Recommended Dose of Fertilizer, EMC-Effective Microbial Consortia, VS- Vegetable Special

recorded in treatment T7 (38.50 d, 38.08 d) followed by T8 (38.92 d, 38.50 d), while the maximum number of days to first flowering was recorded in control (41.17 d, 40.92 d) in 2020 & 2021 respectively. Application of organic and inorganic fertilizers as well as by Rhizobium and PSB treatment increased availability of nitrogen and phosphorus might have resulted in minimum number of days for first flowering. Similar results were observed by Jubin chauhan *et al*. (2016) in cowpea. The data shows that minimum number of days to 50% flowering was recorded in T7 (43.75 d, 43.22 d) and followed by T8 (43.92 d, 43.50 d), while the maximum number of days was recorded in control T1 (44.90 d, 44.37 d) in 2020 & 2021 respectively. This trend is due to the application of organic and inorganic fertilizers as well as by seed treatment with microbial consortia increased availability of nitrogen and phosphorus might have resulted in minimum number of days for 50% flowering. These findings are in accordance with work done by Sahu (2014) in French bean, Jubinchauhan *et al*. (2016) in cowpea.

Das *et al.* (2011) also reported that growth parameters viz., the plant height, number of leaves, branches per plant and days to flowering were significantly increased to a greater extent by the treatment 75 per cent RDF + Vermicompost + *Rhizobium* + PSB as compared to RDF alone in cowpea.

b) Effect of Integrated Nutrient Management on Yield attributes of Yardlong bean:

The data presenting in Table 3 revealed that maximum number of pods per plant was recorded in treatment T7 (25.50, 24.83) which is followed by T8 (24.21, 23.75), T6 (23.12, 22.79) and T5 (22.08, 21.33). However, the minimum number of pods per plant was recorded under control (19.00, 18.33) in 2020 & 2021 respectively. The results of the present investigation showed an increase in pods per plant. It might be due to the application of organic and inorganic fertilizers as well as by Microbial consortia treatment (Rhizobium and PSB). The treatment was responsible for more vegetative and reproductive growth of plant due to release of more nutrient and organic acids, from the soil and thereby utilizing more nutrient and moisture from the soil inturn leads to increased photosynthesis. Similar results were observed by Mishra. (2003) and Senthilkumar and Sivagurunathan (2012) observed higher number of pods in cowpea by combined inoculation of *Rhizobium*, Phosphobacteria and *Azospirillum*.

Pod length was highest in T7 (75.11 cm, 74.00 cm) which is statistically superior than control (68.33 cm , 67.92 cm), similar trend in Pod girth was noticed that highest pod girth observed in T7 (4.08 cm , 3.88 cm) followed by T8 (3.85 cm, 3.62 cm) which is statistically significant over control T1(3.30 cm, 3.23 cm) in 2020 and 2021, respectively.

Data presented in (Table 3), revealed that the treatment T7 gives highest yield per plant (685.00 g, 643.33 g) followed by T8 (635.00 g, 598.33 g). Whereas, the lowest yield per plant observed under control T1 (383.50 g, 358.58 g) The maximum pod yield per 1000 m^2 was observed in T7 (2208.50 kg, 2135.42 kg) it was at par with treatment T8 (2151.92 kg, 2065.67 kg) while, minimum pod yield per 1000 m^2 was observed in control T1 (1583.33 kg, 1506.67 kg) during 2020 & 2021 respectively. The results of present investigation proves that increased supply of N and P and their higher uptake by plants might have stimulated the rate of various physiological processes in plant and resulted in increased yield attributes (Pod length, Pod girth, Yield of plant). Another probable reason could be efficient and greater partitioning of metabolites and adequate transformation of nutrients.The results are in concurrence with the findings of Saikia et al. (2018) in French bean who reported that increase is due to the supply of N and P through organic manures and inorganic fertilizers along with Rhizobium and PSB and their higher uptake by plants might have stimulated the rate of various physiological processes in plant and led to increased pod yield. These findings are in accordance with Arulananth and Rameshkumar (2018) in Dolichus bean. There are many studies revealed that Microbial inoculation to seed increased the root nodulation through better root development and more nutrient availability, resulting in vigorous plant growth and dry matter production which resulted in better flowering, fruiting and pod formation and ultimately increased yield (Sardana *et al*., 2006). Das *et al.* (2011) in cowpea and Singh *et al.* (2006) in pea reported that for seed yield and its attributes combined use of inorganic, organic and Biofertilizers was found significant over control and RDF alone. This is due to integrated application of inorganic fertilizers along with vermicompost and biofertilizers which increased the availability and uptake of nutrients for a longer duration. Biofertilizers are involved in the various endogenous hormonal functions in the plant tissues and responsible for enhanced pollen germination and pollen tube growth and ultimately increased the podset as well as increased numbers of pods per plant (Mal *et al.* 2014).

Patil *et al.* (2012), Menon *et al*. (2010), Subbarayappa *et al.* (2009) in cowpea, Gorade *et al.* (2014) in green gram and Rajput *et al.* (2009) in French bean reported that combination of organic and inorganic nutrient sources gave significantly better results than when either was used alone with regard to the growth and yield attributes.

The findings of this investigation confirm the results of earlier work Sachan *et al*, (2021) who reported that, Organic and inorganic fertilizers combinations significantly increase the growth and pod yield attributes in French bean.

An appraisal of data presented in Table 3 revealed that T_7 accrued maximum B:C value (3.07, 3.23) and the lowest B:C was recorded under control T_1 (2.27. 2.37) during 2020 & 2021 respectively. This might be due to higher total green pod yield of Yardlong bean recorded in integrated treatment T_7 . These results are in agreement with the findings reported by Patel *et al*. (2010) who reported that, Application of FYM @ 10 t ha^{-1} + *Rhizobium* inoculation integrated with chemical fertilizer (100% RDF) fetched maximum net returns (Rs. 1,16,640 ha^{-1}) and BC (6.21) in clusterbean cv. Pusa Navbahar. This result in conformity with G Sindhuja *et al*.(2021)., Hemant Kumar *et al.* (2018).

Conclusion: Thus, Integrated Nutrient Management practices (Organic and inorganic combination) increased the growth and yield attributes of Yardlong bean. The evaluation of production

economics revealed that growing of Yardlong bean by following treatment T_7 – 150% RDF + Effective Microbial Consortia (EMC)+ Vegetable Special (VS)**,** could be the most remunerative option with a highest benefit: cost of 3.15. Hence, among compared treatments, T_7 – 150% RDF + Effective Microbial Consortia + Vegetable Special micronutrient spray, was found to achieve the maximum productivity of Yardlong bean which in turn gives high returns to the farmers.

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