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Effect of integrated nutrient management on growth and quality parameters of lablab bean (*Lablab purpureus* L.) in alfisols of Konkan region of Maharashtra

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Abstract
A field experiment was conducted at Department of Agronomy, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri during *Rabi* 2020-21 and 2021-22 in Split Plot Design (SPD) comprising fifteen treatment combinations replicated thrice with an absolute control which was laid out of experimental plot to study the effect of integrated nutrient management on growth and quality parameters of lablab bean. The results reveals that the equal integration of RDN through fertilizers and RDN through poultry manure (F_5) and seed inoculations of phosphorus solubilizing bacteria @ 5 mL kg^{-1} and vesicular arbuscular mycorrhiza @ 10 g kg^{-1} seed (B_3) to lablab bean recorded the better dry matter accumulation per plant and quality parameters such as protein and total chlorophyll content in lablab bean. The data on nodulation indicated that the F_5 treatment receiving the application of 50% RDN through fertilizers and 50% RDN through poultry manure recorded the highest and statistically significant nodule count while, among the biofertilizers, seed inoculation of phosphorus solubilizing bacteria @ 10 mL kg^{-1} seed (B_1) recorded the significantly highest nodule count during both the years of investigation.

Keywords: Integrated nutrient management, biofertilizers, chlorophyll content, protein, nodulation, dry matter accumulation

Introduction
Lablab bean (*Lablab purpureus* L.) also known as field bean or dolichos bean, is grown throughout tropical regions of Asia, Africa and America. In India, it is grown as a field crop in Tamil Nadu, Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra. The Indian bean belongs to the family Leguminosae and considered as nutritious vegetables as they contain high amount of vegetable protein, besides carbohydrates and vitamins. Lablab bean is grown in all the districts of Konkan region of Maharashtra *viz*., Thane, Palghar, Raigad, Ratnagiri and Sindhudurg with gram, lentil, horse gram with an average productivity of 537 kg ha^{-1} (Anonymous 2016) [2]. The proximate and mineral composition of lablab bean shows that the protein content ranged from 20.46 to 25.47 percent, crude lipid 2.69 to 4.17 percent, ash 3.97 to 4.48 percent and carbohydrates 60.63 to 66.32 percent (Davari *et al.* 2018) [5].
Now days, use of chemical fertilizer is increasing to boost up crop production. Simultaneously, cost of chemical fertilizer is increased constantly, besides these, only use of inorganic fertilizer is injurious to soil health and soil productivity. Integration of inorganic, organic and bio-fertilizer play vital role for enhancing crop productivity and sustaining soil fertility, this proves great promise for farmer. Thus the basic concept underlying the principles of integrated nutrient management is the maintenance and possible improvement in soil fertility for sustained crop productivity on long term basis (Harisudan *et al.* 2009) [11]. The concept of Integrated Nutrient Management (INM) is aimed to continuous improvement of soil productivity on long term basis through appropriate use of inorganic fertilizers, organic manures, biofertilizers, green manures, crop residues and legume inter-cropping and their scientific management for optimum growth, yield and quality of different crops and cropping systems in specific agro-ecological situations and ensuring environmental safety.

Materials and Methods

Details of experimental site and treatment combinations

A field experiment was conducted at Department of Agronomy, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra to study the effect of integrated nutrient management (INM) on yield and economics of lablab bean as a test crop in lateritic soil of Konkan region of Maharashtra during *Rabi* season of 2020-21 and 2021-22. The experiment was laid out in in Split Plot Design (SPD) comprising fifteen treatment combinations replicated thrice with an absolute control which was laid out of experimental plot. The main plot treatment was manures and fertilizers consisted of 100% RDF through Fertilizers (F_1), 100% RDN through Vermicompost (F_2), 100% RDN through Poultry manure (F_3), 50% RDN through Fertilizers + 50% RDN through Vermicompost (F_4) and 50% RDN through Fertilizers + 50% RDN through Poultry manure (F_5). While the sub plot treatments were three biofertilizers combinations, consisted of Phosphorus solubilizing bacteria (B_1), Vesicular arbuscular mycorrhiza (B_2) and Phosphorus solubilizing bacteria + Vesicular arbuscular mycorrhiza (B_3)

Growth attributing characters

i) Dry matter (g)

Five representative plants were randomly sampled from each treatment plot. The plants were uprooted and their roots were removed. Plant were washed with water and were preserved in labeled paper bags which were dried in over at 60º±20 ºC till constant weight was obtained. Dry weight was recorded separately at each stage for calculating dry matter and it was expressed in gram per plant.

ii) Nodulation

Five plants were sampled randomly from each plot at flowering (50% flowering). The whole plant was carefully uprooted using a spade so as to obtain intact roots and nodules for nodule count were recorded by exposing the whole-root system to avoid loss of nodules. The adhering soil was removed by washing the roots with intact nodules gently with water over a metal sieve.

Quality analysis

i) Chlorophyll content (mg g^{-1})

Analytical determination of total chlorophyll (a + b) was performed with spectrophotometer at 662nm and 644nm, respectively as per procedure given by Ranganna (1986) [25].

ii) Protein content in lablab bean seed (%)

The protein content was calculated by multiplying percent nitrogen content (seed) by 6.25.

Statistical analysis

The experimental data was analyzed statistically by the technique of Analysis of Variance as applicable to Factorial Randomized block design. The significance of treatment difference was tested by 'F' (Variance ratio) test. Critical difference (CD) at 5 percent level of probability was worked out for comparison and statistical interpretation of the treatment means (Panse and Sukhatme 1967) [16].

Results and Discussion

Effect of Integrated Nutrient Management (INM) on growth attributing characters of lablab bean

Dry matter (g) at different growth stages of lablab bean

The data on dry matter of lablab bean as influenced by the application of manures and fertilizers in conjunction with biofertilizers is presented in Table 1.

Effect of Manures and Fertilizers

During *Rabi* 2020-21, the dry matter varied from 6.55 to 6.96 g at 30 DAS, 14.47 to 15.31 g at 60 DAS and 23.74 to 24.75 g at harvest stage. While during the year 2021-22, the dry matter varied from 7.02 to 7.40 g at 30 DAS, 14.66 to 15.44 g at 60 DAS and 24.31 to 25.32 g at harvest (Table 1). The highest and statistically significant dry matter was observed in the treatment F_5 receiving the equal integration of RDN through fertilizers and RDN through poultry manure over almost all the treatments at all the growth stages of lablab bean during both the years of investigation. However, the treatment F_2 receiving the application of 100% RDN through vermicompost and the treatment F_3 receiving the application of 100% RDN through poultry manure were found to be statistically at par with treatment F_5 during both the years of investigation.

Effect of biofertilizers

The statistically significant effect on dry matter accumulation per plant was observed due to the seed inoculation of biofertilizers and it showed variations from 6.59 to 6.90 g at 30 DAS, 14.38 to 15.23 g at 60 DAS and 23.61 to 24.54 g at harvest stage during *Rabi* 2020-21. During the year 2021-22, the dry matter ranged from 7.03 to 7.36 g at 30 DAS, 14.64 to 15.29 g at 60 DAS and 24.18 to 25.11 g at harvest (Table 1). The statistically significant and the highest values of dry matter were observed in the treatment B_3 receiving the seed inoculation of phosphorus solubilizing bacteria @ 5 mL kg^{-1} and the vesicular arbuscular mycorrhiza @10 g kg^{-1} seed at all the growth stages of lablab bean and it showed it's superiority over rest of the treatments with exception of the treatment B_1 receiving seed inoculation of phosphorus solubilizing bacteria @ 10 mL kg^{-1} during both the years of investigation.

Interaction effect

The interaction effect of manures and fertilizers with a blend of biofertilizers significantly influenced the dry matter at 30 and 60 DAS and it is presented in Table 2 and 3. The dry matter ranged from 6.44 to 7.28 and 6.84 to 7.74 g at 30 DAS and 14.19 to 15.75 g and 14.33 to 15.89 g at 60 DAS during the years 2020-21 and 2021-22, respectively. The interaction effect of F_5B_3 receiving the equal integration of fertilizers and poultry manure (PM) along with the seed inoculation of phosphorus solubilizing bacteria @ 5 mL kg^{-1} and vesicular arbuscular mycorrhiza @ 10 g kg^{-1} seed recorded significantly superior dry matter with exception of interactions F_3B_1, F_3B_3 and F_5B_1 which remained statistically at par with treatment F_5B_3, however at 60 DAS, the interactions F_2B_1, F_2B_3, F_3B_1, F_3B_3 and F_5B_1 remained statistically at par with the interaction F_5B_3 during both the years of investigation.

Table 1: Effect of Integrated Nutrient Management (INM) on growth attributing characters of lablab bean

Treat. No.	Dry matter (g)						Nodulation	
	2020- 2021			2021-2022			2020- 2021	2021-2022
	30 DAS	60 DAS	At Harvest	30 DAS	60 DAS	At Harvest	At Flowering	At Flowering
Effect of manures and fertilizers								
F_1	6.55	14.47	23.79	7.02	14.82	24.35	10.00	10.74
F_2	6.84	15.00	24.14	7.30	15.13	24.71	12.22	13.03
F_3	6.93	15.16	24.24	7.39	15.29	24.81	14.56	15.30
F_4	6.58	14.64	23.74	7.04	14.66	24.31	14.89	15.72
F_5	6.96	15.31	24.75	7.40	15.44	25.32	15.33	16.41
S.E. ±	0.05	0.12	0.20	0.06	0.13	0.20	0.38	0.37
C.D. at 5%	0.17	0.38	0.65	0.20	0.43	0.65	1.23	1.21
Effect of biofertilizers								
B_1	6.83	15.14	24.25	7.29	15.28	24.82	14.27	15.14
B_2	6.59	14.38	23.61	7.03	14.64	24.18	12.73	13.57
B_3	6.90	15.23	24.54	7.36	15.29	25.11	13.20	14.01
S.E. ±	0.04	0.09	0.23	0.05	0.10	0.23	0.27	0.26
C.D. at 5%	0.13	0.26	0.67	0.15	0.30	0.67	0.79	0.77
Interaction Effect (F X B)								
S.E. ±	0.10	0.20	0.51	0.11	0.23	0.51	0.60	0.58
C.D. at 5%	0.29	0.59	N.S	0.33	0.67	N.S	N.S	N.S
General mean	6.77	14.92	24.13	7.23	15.07	24.70	13.40	14.24
Absolute control	6.43	14.28	23.62	7.29	14.52	24.16	11.00	10.00

Table 2: Interaction effect of manures and fertilizers and biofertilizers on dry matter (g) at 30 DAS of lablab bean

Treat. No.	2020- 2021					2021-2022				
	F_1	F_2	F_3	F_4	F_5	F_1	F_2	F_3	F_4	F_5
B_1	6.44	6.93	7.01	6.61	7.15	6.93	7.39	7.47	7.07	7.61
B_2	6.58	6.69	6.69	6.53	6.44	7.04	7.15	7.15	6.99	6.84
B_3	6.62	6.90	7.10	6.61	7.28	7.08	7.36	7.56	7.07	7.74
S.E. ±	0.10					0.11				
C.D. at 5%	0.29					0.33				

Interaction effect of biofertilizers along with manures and fertilizers did not show significant influence on the dry matter at harvest stage of lablab bean during both the years of investigation. The different biofertilizers treatments in combination with manures and fertilizers performed better than manures and fertilizers alone in terms of dry matter at different growth stages of lablab bean. This could be attributed to the supply of additional N and P nutrients through N fixation and P solubilization activities of the inoculated biofertilizers. The variation in dry matter weight may be due to the synergetic effect of biofertilizers. Among the biofertilizers inoculation, the dual inoculation of phosphorus solubilizing bacteria and vesicular arbuscular mycorrhiza recorded the highest and statistically significant dry matter in interaction with chemical fertilizers as compared to control treatments. The reason for increase in dry matter with inoculation of PSB could be attributed to proliferation of roots resulting into effective nutrient absorption and thereby higher dry matter accumulation (Vaidya, 2005, Gaidhani, 2008 and Karmegan, 2008) [24, 8, 13].

Table 3: Interaction effect of manures and fertilizers and biofertilizers on dry matter (g) at 60 DAS of lablab bean

Treat. No.	2020- 2021					2021-2022				
	F_1	F_2	F_3	F_4	F_5	F_1	F_2	F_3	F_4	F_5
B_1	14.48	15.46	15.60	14.72	15.46	14.61	15.59	15.74	14.85	15.59
B_2	14.33	14.19	14.22	14.41	14.72	15.13	14.33	14.36	14.55	14.85
B_3	14.58	15.35	15.66	14.79	15.75	14.72	15.49	15.79	14.58	15.89
S.E. ±	0.20					0.23				
C.D. at 5%	0.59					0.67				

Hiraguli and Alloli (2011) [12] observed the significant difference among the treatments in dry matter accumulation (118.5 g plant^{-1}) when chilli supplemented with FYM @ 25t/ha + 100 percent RDF followed by chilli which was nourished with FYM @ 75 t/ha + Azospirillum + PSB + 25 percent RDF (113.7 g plant^{-1}) dry matter accumulation.

Effect of Integrated Nutrient Management (INM) on nodulation at flowering stage of lablab bean

The nodule count as influenced by the application of manures and fertilizers with a blend of inoculation of biofertilizers at flowering stage during the year 2020-21 and 2021-22 is presented in Table 1.

Effect of manures and fertilizers

The nodule count of lablab bean ranged from 10.00 to 15.33 and 10.74 to 16.41 as a result of the application of manures and fertilizers during the years 2020-21 and 2021-22, respectively. The application of 50% RDN through fertilizers and 50% RDN through poultry manure (F_5) recorded the highest and statistically significant nodule count (15.33 and 16.41) of lablab bean, however, it was found to be statistically at par with the treatments F_3 and F_4 during the years 2020-21 and 2021-22, respectively.

Manure application caused slight but definite increase as compared to the absolute control treatment. This was probably due to the slow mineralization of manure hence slow nitrogen release. In addition, the additional phosphorus present in the manure perhaps resulted in the positive effect of manure on nodulation. Phosphorus and poultry manure have been reported to improve both the total and active nodules dry

weight. (Floor 1985; Ganeshmurthy and Swami-Reddy 2000) [7, 9].

Effect of biofertilizers

The variation in nodule count of lablab bean due to the seed inoculation of biofertilizers in different treatments was observed from 12.73 to 14.27 and 13.57 to 15.14 during the years 2020-21 and 2021-22, respectively. The significantly highest nodule count (14.27 and 15.14) of lablab bean was observed due to seed inoculation of phosphorus solubilizing bacteria @ 10 mL kg^{-1} (B_1) seed during both the years of investigation.

From the above data, it was observed that the application of the biofertilizers increased the nodule count as compared to absolute control; this might be due to the application of phosphorus solubilizers and mobilizers. The phosphorus solubilizing bacteria have increased the availability of phosphorus in root zone, which resulted in better growth and development of roots as well as shoots and also helped in better nodulation.

Amruta *et al.* (2015) [26] observed that the combined application of inorganic nutrients and biofertilizers increased the nutrient use efficiency and continuous supply of nutrients to the plants throughout the crop growth period and promoted various physiological activities in black gram which are consider being indispensable for proper growth and development. The highest number of nodules might be due to phosphorus solubilizing bacteria which produce growth hormones, *i.e.* IAA, auxins, gibberellins and vitamins which are conductive to better nodulation. Similar findings were also reported by Vadgave (2010) [23] in green gram, Dusica *et al.* (2011) [30] in mung bean and Tagore *et al.* (2013) [21] in chickpea.

Interaction effect

The interaction effect of manures and fertilizers in conjunction with biofertilizers on nodule count of lablab bean failed to reach to the level of significance during both the years of investigation.

Effect of Integrated Nutrient Management (INM) on quality parameters of lablab bean

Effect of Integrated Nutrient Management (INM) on protein (%) content of lablab bean seed

The data regarding quality parameter *i.e.* protein content in lablab bean seed as affected by manures and fertilizers along with the seed inoculation of biofertilizers is presented in Table 4.

Effect of manures and fertilizers

The protein content in lablab bean seed increased significantly from 19.31 to 21.31 and 19.69 to 21.69 percent due to the application of manures and fertilizers during the years 2020-21 and 2021-22, respectively. The highest protein (21.31 and 21.69%) content in lablab bean seed was recorded as a result of the application of 50% RDN through fertilizers and 50% RDN through poultry manure (F_5) and it was found to be significantly superior over rest of the treatments with exception of the treatments F_2, F_3 and F_4 which were remained at par with treatment F_5 during both the years of investigation.

Effect of Biofertilizers

The protein content in lablab bean seed increased significantly due to various biofertilizers inoculation and varied from 19.63 to 21.31 and 20.13 to 21.69 percent during the years 2020-21 and 2021-22, respectively. Among the different biofertilizers, the seed inoculation of phosphorus solubilizing bacteria @ 5 mL kg^{-1} and vesicular arbuscular mycorrhiza @10 g kg^{-1} seed (B_3) recorded significant and the highest protein (21.31 and 21.69%) content in lablab bean seed and it was found to be statistically at par with the seed inoculation of phosphorus solubilizing bacteria @ 10 mL kg^{-1} seed (B_1) during the years 2020-21 and 2021-22, respectively. Imade *et al.* (2010) [27] also reported that the seed inoculation of *Rhizobium* + phosphorus solubilizing bacteria proved to be beneficial for soybean crop, which recorded significantly highest protein content (39.40%) over no inoculation.

Interaction Effect

The data pertaining to the interaction effect of manures and fertilizers along with biofertilizers was found to be significant in protein content in lablab bean seed during the year 2020-21 and2021-22 as presented in Table 5. Protein content in lablab bean seed varied from 16.50 to 21.94 and 17.13 to 22.31 percent in the years 2020-21 and 2021-22, respectively. During the year 2020-21, the highest and statistically significant value of protein content (21.94%) was recorded as a result of interaction effect of F_5B_3 receiving the equal integration of RDN through fertilizers and RDN through poultry manure (PM) in conjunction with the seed inoculation of phosphorus solubilizing bacteria @ 5 mL kg^{-1} and vesicular arbuscular mycorrhiza @10 g kg^{-1} seed and it was found to be statistically significant over the interactions of F_1B_1, F_1B_2 and F_4B_2. However, it was found to be statistically at par with the remaining interactions. However, during the year 2021-22, the significant and the highest protein content (22.31%) was recorded due to the same interaction (F_5B_3) and it was found to be statistically significant over the interactions F_1B_2 and F_2B_2. Protein content in seed of lablab bean (Table 5) was influenced significantly due to the various interactions of manures and fertilizers in conjunction with biofertilizers. Protein content of seed of lablab bean followed the similar trend as observed in the nitrogen content of seed, because protein content was computed by multiplying N content with the factor of 6.25. Since protein content is a function of nitrogen accumulation, higher nitrogen content resulting in the higher protein content. These results are in close conformity with the results reported by Dhangada (2015) [14], Tapkeer *et al.* (2017) [22], Davari *et al.* (2018) [5]. Ahire (2020) [1] and Raut (2021) [17]. Sodavadiya *et al.* (2017) [20] reported that the application of 50% RDF + 5 t BC ha^{-1} + biofertiliser (PSB + *Rhizobium*) recorded significantly highest protein content in seed of Indian bean this might be due to an increase in the N uptake which might have proportional increase in the protein content.

Table 4: Effect of Integrated Nutrient Management (INM) on quality parameters of lablab bean

Treat. No.	Protein (%)		Total chlorophyll (mg kg^{-1})					
	2020- 2021	2021-2022	2020- 2021			2021- 2022		
			30 DAS	60 DAS	At Harvest	30 DAS	60 DAS	At Harvest
Effect of manures and fertilizers								
F_1	19.31	19.69	0.65	1.61	0.82	0.77	1.81	0.76
F_2	20.50	20.75	0.82	1.82	1.06	1.08	2.09	1.04
F_3	20.81	21.63	0.97	1.96	1.16	1.09	2.14	1.18
F_4	20.56	21.19	0.73	1.66	0.92	0.91	1.85	0.88
F_5	21.31	21.69	1.04	2.05	1.34	1.17	2.22	1.30
S.E. ±	0.34	0.42	0.03	0.03	0.07	0.03	0.05	0.08
C.D. at 5%	1.12	1.36	0.09	0.10	0.23	0.10	0.15	0.25
Effect of biofertilizers								
B_1	20.63	21.13	0.89	1.85	1.09	0.99	2.04	1.04
B_2	19.63	20.13	0.69	1.69	0.89	0.84	1.88	0.91
B_3	21.31	21.69	0.94	1.92	1.20	1.18	2.15	1.14
S.E. ±	0.27	0.27	0.02	0.03	0.04	0.03	0.03	0.05
C.D. at 5%	0.81	0.80	0.05	0.08	0.13	0.10	0.08	0.15
Interaction Effect (F X B)								
S.E. ±	0.61	0.61	0.04	0.06	0.10	0.07	0.06	0.11
C.D. at 5%	1.81	1.80	N.S	N.S	N.S	N.S	N.S	N.S
G. mean	20.51	20.98	0.84	1.82	1.06	1.00	2.02	1.03
Absolute control	18.81	19.50	0.92	1.94	1.17	0.92	2.12	1.24

Table 5: Interaction effect of manures and fertilizers and biofertilizers on [quality parameter protein (%)] of lablab bean seed

Treat. No.	2020- 2021					2021-2022				
	F_1	**F_2**	**F_3**	**F_4**	**F_5**	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**
B_1	20.13	20.31	20.56	20.50	21.44	20.88	21.19	21.44	20.94	21.00
B_2	16.50	20.56	20.50	20.00	20.63	17.13	19.44	21.38	20.88	21.81
B_3	21.31	20.69	21.31	21.25	21.94	21.00	21.50	22.00	21.69	22.31
S.E. ±	0.61					0.61				
C.D. at 5%	1.81					1.80				

Effect of Integrated Nutrient Management (INM) on total chlorophyll (mg g^{-1}) content at different growth stages of lablab bean

The total chlorophyll content in lablab bean as influenced by the inoculation of biofertilizers with a blend of manures and fertilizers are presented in Table 4.

Effect of Manures and Fertilizers

The data on total chlorophyll content when studied revealed that there was a significant enhancement in total chlorophyll content due to the application of manures and fertilizers and it showed variations from 0.65 to 1.04 mg g^{-1} at 30 DAS, 1.61 to 2.05 mg g^{-1} at 60 DAS and 0.82 to 1.34 mg g^{-1} at harvest during the year 2020-21. While during the year 2021-22, the total chlorophyll content ranged from 0.77 to 1.17 mg g^{-1} at 30 DAS, 1.81 to 2.22 mg g^{-1} at 60 DAS and 0.76 to 1.30 mg g^{-1} at harvest (Table 4). During the years 2020-21 and 2021-22, the treatment receiving application of 50% RDN through fertilizers and 50% RDN through poultry manure (F_5) recorded the maximum total chlorophyll content at all growth stages of lablab bean. The application of 100% RDN through poultry manure (F_3) was found to be statistically at par with the F_5 treatment at all the growth stages of lablab bean during the year 2020-21. The treatments F_2 and F_3 were found to be statistically at par with the treatment F_5 at 30 and 60 DAS however treatment F_3 was found to be statistically at par with the treatment F_5 at harvest stage of lablab bean during the year 2021-22.

Effect of biofertilizers

The data on total chlorophyll content was significantly influenced by the application of biofertilizers and it showed variations from 0.69 to 0.94 mg g^{-1} at 30 DAS, 1.69 to 1.92 mg g^{-1} at 60 DAS and 0.89 to 1.20 mg g^{-1} at harvest during the year 2020-21. While during the year 2021-22, the total chlorophyll content showed variation from 0.84 to 1.18 mg g^{-1} at 30 DAS, 1.88 to 2.15 mg g^{-1} at 60 DAS and 0.91 to 1.14 mg g^{-1} at harvest (Table 4). The seed inoculation of phosphorus solubilizing bacteria @ 5 mL kg^{-1} and vesicular arbuscular mycorrhiza @10 g kg^{-1} seed (B_3) recorded the highest and statistically significant total chlorophyll content over rest of the treatments with exception of seed inoculation of phosphorus solubilizing bacteria @10 mL kg^{-1} seed (B_1) which was found to be statistically at par with B_3 at all the growth stages of lablab bean during the year of 2020-21. During the year 2021-22, the treatment B_3 recorded the statistically significant and highest value of total chlorophyll content at all the growth stages of lablab bean, however, it remained statistically at par with the seed inoculation of phosphorus solubilizing bacteria @ 5 mL kg^{-1} (B_1) at harvest stage of lablab bean.

Berova and Karanatsidis (2009) [3] observed increased photosynthetic pigments and leaf gas exchange in red chilli due to application of vermicompost. Sandhya *et al.* (2013) [18] reported maximum chlorophyll a, b in seeds inoculated with PSB and VAM T_4 (1.34, 1.77) and least in control T_1 (0.85, 1.15). There was a significant difference in total chlorophyll content among the treatments and different days. This may be due to the increase in stomatal conductance and carbon assimilation (Levy and Krikun, 1980) [28]. Krishna and Bagyaraj (1981) also observed that bundle sheath chloroplasts were larger and numerous in mycorrhizal plant. Increased

chlorophyll 'a', chlorophyll 'b' and total chlorophyll content were also reported by Mathur and Vyas (2000) [15], Giri *et al.* (2003) [29], Kate *et al.* (2005) [14] and Senthilkumar and Sivagurunathan (2012) [19].

Interaction effect

The interaction effect of manures and fertilizers in conjunction with biofertilizers was found to be non-significant in respect of the total chlorophyll content at all the growth stages of lablab bean during both the years of investigation.

Conclusions

All manures, fertilizers and biofertilizers treatments showed significant influence on lablab bean crop. The equal integration of RDN through fertilizers and RDN through poultry manure (PM) with a blend of seed inoculations of phosphorus solubilizing bacteria (PSB) @ 5 mL kg^{-1} and vesicular arbuscular mycorrhiza (VAM) @10 g kg^{-1} seed (F_5B_3) was found to be beneficial for growth attributing characters such as dry matter accumulation and quality parameters like protein and chlorophyll content of lablab bean while in case of nodulation, the seed inoculation with phosphorus solubilizing bacteria was found to show better results in lateritic soils of Konkan during *Rabi* season.

References

1. Ahire PG. Integrated nutrient management for rice - lablab bean cropping sequence in *Konkan* region of Maharashtra. Ph.D. (Agri.) Thesis submitted to Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan (Unpublished); c2020.
2. Anonymous Agricultural Statistical Information. Maharashtra State; c2016.
3. Berova M, Karanatsidis G. Influence of biofertilzer, produced by *Lumbricus rubellus* on growth, leaf gas-exchange and photosynthetic Pigment content of pepper plants (*Capsicum annum* L.). Acta Horticulturae. 2009;830:447-452.
4. Dhangada JB. Effects of tillage and levels of fertilizer on growth, yield and quality of lablab bean (*Lablab purpureus* L.). M. Sc. (Agri.). Thesis submitted to Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra (Unpublished); c2015.
5. Davari SA, Gokhale NB, Palsande VN, Kasture MC. Wal (*Lablab purpureus* L.): An unexploited potential food legumes. International Journal of Chemical Studies. 2018;6(2):946-949.
6. Delic D, Stajkovic-Srbonovic O, Kuzmanovic D, Rasulic N, Mrvic V, Jelovic S, *et al.* Effect of bradyrhizobium inoculation on growth and seed yield of mung bean. African Journal of Microbiology Research. 2011;5(23):3946-3957.
7. Floor J. Effect of soil fertility status, moisture and application of fertilizer on inoculum and nodulation and growth of dry beans in Kenya. Biological Nitrogen Fixation in Africa, Ssali, H. and S.O. Keya (Eds.) Matianum press, consultants, Nairobi; c1985. p. 253-261.
8. Gaidhani SM. Effect of integrated nutrient management on yield, partitioning and uptake by rice and on fertility status of lateritic soils of Konkan. M.Sc. (Agri.) Thesis submitted to Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra (Unpublished); c2008.
9. Ganeshmurthy AN, Swami-Reddy K. Effect of integrated use of farm yard maure and sulphur in soybean and wheat cropping system on nodulation, dry matter production and chlorophyll content of soybean on swell-shrink soils in Central India. Journal of Agronomy and Crop Science. 2000;185:91-97.
10. Bhoopander G, Kapoor R, Mukerji KG. Influence of arbuscular mycorrhizal fungi and salinity on growth, biomass and mineral nutrition of *Acacia auriculiformis*. Biology and Fertility of Soils. 2003;38:170-175.
11. Harisudan C, Latha KR, Subbian P, Vaidyanathan R, Manivannan V. Nutrient management for rainfed pulses. Agricultural Review. 2009;30(3):224-228.
12. Hiraguli PS, Allolli TB. Response of organic, inorganic and bio fertilizers on growth and yield of Byadagi Chilli. Asian Journal of Horticulture. 2011;6(2):352-354.
13. Karmegam N, Daniel T. Effect of vermicompost and chemical fertilizer on growth and yield of Hyacinth Bean (*Lablab purpureus* L.) Sweet. Dynamic Soil, Dynamic Plant. 2008;2:77-81.
14. Kate DM, Solanke AM, Tiwari TK, Nemade SM. Growth and yield of potato cultivars as affected by integrated nutrient management system. Journal of Maharashtra Agricultural Universities. 2005;30:236-237.
15. Mathur N, Vyas A. Influence of arbuscular mycorrrhizae on biomass production, nutrient uptake and physiological changes in Ziziphus mauritiana Lam. Under water stress. Journal of Arid Environment. 2000;45:191-195.
16. Panse VG, Sukhatme PV. Statistical method for Agricultural Workers., I.C.A.R., New Delhi; c1967.
17. Raut BV. Effect of Integrated Nutrient Management on growth and yield of Lablab bean (*Lablab purpureus*) and soil properties in Alfisols. M.Sc. (Agri.) Thesis submitted to Dr. B. S. K. K. V., Dapoli. India (M.S.) (unpublished); c2021.
18. Sandhya A, Vijaya T, Sridevi A, Narasimha G. Influence of vesicular arbuscular mycorrhiza (VAM) and phosphate solubilizing bacteria (PSB) on growth and biochemical constituents of *Marsdenia volubilis*. African Journal of Biotechnology. 2013;12(38):5648-5654.
19. Senthilkumar PK, Sivagurunathan P. Comparative effect on bacterial biofertilizers on growth and yield of green gram (*Phaseolus radiata* L.) and cow pea (*Vigna sinensis* Edhl.) International Journal of Current Microbiology and Applied Scences. 2012;1(1):34-39.
20. Sodavadiya HB, Naik VR, Chaudhari SD. Effect of land configuration, irrigation and INM on quality, nutrient content and uptake of Indian Bean (var. GNIB-21). International Journal of Current Microbiology and Applied Sciences. 2017;6(8):527-537.
21. Tagore GS, Namdeo SL, Sharma SK, Kumar N. Effect of Rhizobium and phosphate solubilizing bacterial inoculants on symbiotic traits, nodule leghemoglobin and yield of chickpea genotypes. International Journal of Agronomy; c2013. p. 1-8.
22. Tapkeer PB, Kasture MC, Kadu JB. Effect of different fertilizer briquettes on yield, nutrient uptake and soil fertility status of Dolichos bean (*Dolichos lablab* L.) in lateritic soils of Konkan. International Journal of Chemical Studies. 2017;5(4):367-371.
23. Vadgave S. Studies on integrated nutrient management on seed yield, quality and stability of green gram. M.Sc.

(Agri.) Thesis submitted to Konkan Krishi Vidyapeeth, Dapoli (Maharashtra); c2010.
24. Vaidya KP. Integrated nutrient management in rice-cowpea cropping sequence on Alfisols of Maharashtra. Ph. D. (Agri) Thesis submitted to Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan (Unpublished); c2005.
25. Ranganna S. Handbook of analysis and quality control for fruits and vegetables. Tata Mc. Graw Hill Publishing Company Limited. New Delhi-110. 1986;7:9-10.
26. Amruta N, Maruthi JB, Sarika G, Deepika C. Effect of integrated nutrient management and spacing on growth and yield parameters of black gram cv. LBG-625 (Rashmi). The Bioscan. 2015 Mar 10;10(1):193-8.
27. Imade PE, Izekor PE, Eghafona NO, Enabulele OI, Ophori E. Asymptomatic bacteriuria among pregnant women. North American journal of medical sciences. 2010 Jun;2(6):263.
28. Levy Y, Krikun J. Effect of vesicular-arbuscular mycorrhiza on *Citrus jambhiri* water relations. New Phytologist. 1980 May;85(1):25-31.
29. Giri B, Kapoor R, Mukerji KG. Influence of arbuscular mycorrhizal fungi and salinity on growth, biomass, and mineral nutrition of *Acacia auriculiformis*. Biology and Fertility of Soils. 2003 Aug;38:170-175.
30. Slavča H, Zvonko Z, Branislav S, Dušica OA, Vesna D, Mirjana JT, *et al*. Welfare assessment for dairy cows in loose stalls. Veterinarski Glasnik; c2011.