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Effect of integrated nutrient management on soil properties after harvest of lablab bean (*Lablab purpureus*) in Alfisols of Konkan region of Maharashtra

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Abstract
A field experiment was conducted during *Rabi*, 2019-20 entitled, "Effect of Integrated Nutrient Management on growth and yield of Lablab bean (*Lablab purpureus*) and soil properties in Alfisols" at Dapoli. The experiment was laid out in Randomized Block Design (RBD) comprising sixteen treatment combinations and replicated thrice. The effect of different inorganic fertilizers alone (Urea and SSP) or in combination with organic manures (Farm yard manure, vermicompost and poultry manure) and Biofertilizers (Rhizobium and PSB) on chemical properties of the soil, growth, yield, quality and nutrient content of lablab bean (var. *Dapoli-2*) were studied. The chemical properties *viz.*, Soil reaction, Electrical conductivity and Organic carbon content of soil did not show a significant change in their status. However, available macronutrients (N, P, K,) and micronutrient (Fe, Mn, Zn, Cu) status showed significant improvement as a consequence of various treatment combinations. In general, chemical properties of experimental plot represented a typical lateritic soil of Konkan (M.S.). The application of equal integration of RDN through inorganics and through organics, either through poultry manure or vermicompost with or without bio-inoculations proved its significance and enhanced macro (N, P, K) as well as micro nutrients (Fe, Mn, Zn and Cu) status of soil.

Keywords: Integrated, nutrient, properties, harvest, lablab, *Lablab purpureus*

Introduction
Pulses are nature's precious gift to mankind. They provide not only nutritious food and feed but also improve soil health and crop productivity. India is major pulse growing country in the world sharing about 25% of total production and 32% of global acreage in the world. In India pulses are grown on area of 297.77 lakh ha and production of 224.01 MT of grains with average yield of 765 kg ha^{-1} Maharashtra ranks first in acreage and production of pulses followed by Madhya Pradesh, Uttar Pradesh, Rajasthan, Orissa, Haryana, Gujrat, Karnataka, Tamil Nadu, Andhra Pradesh. In Maharashtra, pulses are grown on an area of 37.56 lakh ha and production of 25.48 lakh tonnes of grains with average yield of 679 kg ha^{-1}, while in Konkan region, total pulse area was 27.2 thousand ha; production of 16.70 lakh tonnes of grains with average yield of 537 kg ha^{-1}. Lablab bean has 227.78 '000-hectare area under cultivation with 2,276.95 '000 metric tonnes vegetable bean production and 10 metric tonnes per hectare productivity (Anonymous, 2018) [2].

In general, Indian soils have low productivity (FAI, 2001) which may be due to poor fertility of Indian soils, accompanied with adoption of high yielding varieties without adequate fertilization. Inadequate and imbalanced fertilizer use has created imbalance in nutrient supply by the soil leading to soil degradation. There has been a growing emergence of nutrient deficiencies in areas, particularly those, following highly intensive cropping. Imbalance fertilizer use has widened NPK nutrient use ratio from 1991-92 onwards. Research data of number of long-term trials have also revealed the importance of balance use of nutrients. For achieving high level of production, crop should be supplied with adequate quantities of manures and fertilizers.

Now-a-days chemical fertilizers are quite expensive input and their usage over a long period may deplete the soil fertility. It is also considered that their indiscriminate usage may also cause environmental pollution problems, soil sickness, reduce the microbial activities and availability of essential nutrients and deteriorate the quality of crops. Use of chemical fertilizers in combination with organic manure is essentially required to improve the soil health (Prasad *et al*., 2010) [12].

Chemical fertilizers, organic manures alone cannot encourage the desired levels of crop production under continuous farming.

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.

Integrated nutrient management is very essential which is not only encourages high crop production over the years but also improves soil health and ensures safer environment (Verma *et al*. 2010) [16]. The nutrient supplied to crops through IPNM not only restoring the soil fertility but also supports desired level of production over the years. Majority of soils in India are deficient in N and organic matter. The high fertility of the soil is essential to the sustainability of both natural and managed ecosystems because it is the medium from which terrestrial production emanates. Long term fertilizer trials have clearly shown the positive role of organic fertilizer in conjunction with chemical fertilizer in maintaining the productivity of soil by improving the soil fertility (Bharadwaj *et al*., 1994) [3]. Use of biofertilizers not only supplements the nutrient but also improves the efficiency of applied nutrients (Somani *et al*., 1990) [14]. Several long trial research studies revealed that integrated use of chemical fertilizers, organic residues and manures such as FYM, composts, etc. and biofertilizers resulted in reduced losses of nutrients and environmental pollution (Ange, 1993) [1].

In Konkan region, lablab bean is widely grown during *rabi* season mainly for grain purpose in small pockets especially on residual moisture. After harvest of paddy immediately it is probably the highest price pulse crop is cultivated by farmers. Therefore, as an initial step towards this goal, studied the Effect of Integrated Nutrient Management on yield and quality of Lablab Bean (*Lablab purpureus*) and soil properties of Alfisols of Konkan (MS) was carried out.

Materials and Methods

The present investigation was conducted at Department of Agronomy, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.) during the month of December to April, 2019-20, to study the Effect of integrated nutrient management on growth and yield of Lablab bean (*Lablab purpureus*) and soil properties in Alfisols. The analytical work was carried out in the research laboratory of the Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dapoli.

The field experiment was conducted on Alfisols which is a typical lateritic soils of order, under the heavy rainfall zone of the Konkan region of the Ratnagiri district. A representative surface soil sample (0-30 cm depth) was collected, processed and analysed for different chemical properties for initial soil fertility status. The experiment was laid out in randomized block design with sixteen treatments and replicated thrice.

Experimental soil was sandy loam in texture, moderately acidic in reaction, and having very low electrical conductivity, very high in organic carbon, while low in available nitrogen, very low in available phosphorus, high in available potassium, low in exchangeable calcium and magnesium and sulphur while experimental soil showed an adequate status of DTPA extractable micronutrients (Fe, Mn, Zn and Cu). In general, physico-chemical properties of experimental plot represented a typical lateritic soil of the Konkan region.

Entire quantity of manures were applied to each plots 30 days before sowing of the crop and incorporated in the soil. Lablab bean seeds were sown in the main field at a spacing 15 x 30 cm. Care was taken for optimum moisture supply during entire growing period lifesaving irrigations were provided at critical stages of the crop. Two inter-cultural operations and two to three hand weeding were carried out for controlling the weeds.

Soil samples were collected from each plot before sowing and after harvest of the crop at 0-22.5 cm depth. The soil samples were dried in shade, sieved through 2 mm sieve processed and analysed for soil reaction (pH), electrical conductivity, organic carbon, available nitrogen, available phosphorus and available potassium content by following standard analytical methods.

Data was statistically processed by using analysis of variance (ANOVA) procedure given by Panse and Sukhatme, 1967 [9].

Results and Discussion

Different nutrient management practices did not show significant influence on the soil pH, EC and OC status. Soil organic carbon is one of the major components of soil organic matter. It is extremely important in all soil processes *viz*., nutrient availability and soil structure. The OC content showed slight improvement in its status as compared to its initial status (12 g kg^{-1}). Significantly higher organic carbon content in the soil was recorded as a result of equal integration of inorganics and organic with a blend of PSB and Rhizobium inoculations (T_{11}).(14.07 g kg^{-1}) and lower organic carbon (12.14 g kg^{-1}) was recorded in the control treatment (T_1).

In the present investigation, after harvest of the crop the soil nitrogen status was found significantly higher in the T_5 (280.06 kg ha^{-1}) receiving application of 100 per cent RDN through poultry manure. When compared to initial status of N (237.4 kg ha^{-1}) a gradual build-up (280.06 kg ha^{-1}) in nitrogen status was noticed as a consequence of application of 100% RDN through poultry manure (T_5) after harvest. Soil nitrogen availability depends on N mineralization and which in turn results in increased root biomass this leads to increased uptake of the nutrients by the plants.

Nutrient status of the soil gets influenced by soil physico-chemical and biological properties. Organic manure application will improve the soil fertility and availability of nutrients through slow mineralization and slow release of nutrients which in turn results in availability of nutrients throughout the growing period of the crop (Dudhat *et al*., 1997) [4].

Table 1: Effect of Integrated Nutrient Management (INM) on Chemical properties [Soil Reaction (pH), Electrical conductivity (EC) and Organic Carbon (OC)] of soil after harvest of lablab bean

Tr. No	Treatments	pH (1:2.5)	EC (dS m-1)	OC (g kg-1)
T_1	Absolute control	5.73	0.064	12.14
T_2	100% RDF through Inorganic Fertilizes	5.83	0.066	12.38
T_3	100% RDN through FYM	5.79	0.073	12.56
T_4	100% RDN through VC	5.93	0.072	13.07
T_5	100% RDN through PM	5.92	0.097	13.18
T_6	50% RDN through Inorganics + 50% RDN through FYM	5.98	0.079	13.21
T_7	50% RDN through Inorganics + 50% RDN through VC	5.88	0.069	12.16
T_8	50% RDN through Inorganics + 50% RDN through PM	6.07	0.067	13.19
T_9	T2+ *Rhizobium* + PSB Inoculation	5.78	0.061	12.56
T_{10}	T6+ *Rhizobium* + PSB Inoculation	5.94	0.065	13.85
T_{11}	T7 + *Rhizobium* + PSB Inoculation	5.94	0.072	14.07
T_{12}	T8 + *Rhizobium* + PSB Inoculation	6.10	0.071	13.63
T_{13}	75% RDN through Inorganics + *Rhizobium* + PSB Inoculation	5.99	0.063	12.17
T_{14}	T13 + 25% RDN through Farm Yard Manure	6.08	0.066	13.88
T_{15}	T13 + 25% RDN through Vermicompost	5.90	0.068	13.84
T_{16}	T13 + 25% RDN through Poultry Manure	5.85	0.067	13.16
	Initial	5.64	0.062	12.00
	Mean	5.92	0.070	13.07
	S.E.±	0.31	0.15	1.54
	C.D. (P=0.05)	NS	NS	NS

Note: RDF- Recommended Dose of Fertilizers, RDN- Recommended Dose of Nutrients, FYM- Farm Yard Manure, VC- Vermicompost, PM- Poultry manure, PSB- Phosphate Solubilizing Bacteria

In addition to this lateritic soils are well drain soils due to It's coarse texture. Further, the farm yard manure, vermicompost, poultry manure and chemical fertilizers alone or in combination were showed it's superiority in increasing available nitrogen over control (Sharma *et al.* 2009) [13].

Table 2: Effect of Integrated Nutrient Management (INM) on available macronutrients status [N, P_2O_5, K_2O (kg ha-1)] of soil after harvest of lablab bean

Tr. No	Treatments	N	P_2O_5	K_2O
T_1	Absolute control	226.75	8.37	232.78
T_2	100% RDF through Inorganic Fertilizes	242.43	10.30	274.14
T_3	100% RDF through FYM	258.36	11.65	251.26
T_4	100% RDN through VC	261.24	12.94	265.89
T_5	100% RDN through PM	280.06	15.74	322.03
T_6	50% RDN through Inorganics + 50% RDN through FYM	248.79	13.27	263.68
T_7	50% RDN through Inorganics + 50% RDN through VC	249.74	14.64	286.16
T_8	50% RDN through Inorganics + 50% RDN through PM	252.88	15.54	425.00
T_9	T2+ *Rhizobium* + PSB Inoculation	241.68	10.60	274.02
T_{10}	T6+ *Rhizobium* + PSB Inoculation	249.96	12.82	263.03
T_{11}	T7 + *Rhizobium* + PSB Inoculation	251.64	15.29	287.12
T_{12}	T8 + *Rhizobium* + PSB Inoculation	254.91	14.86	428.19
T_{13}	75% RDF through Inorganics + *Rhizobium* + PSB Inoculation	250.36	11.61	262.22
T_{14}	T13 + 25% Farm Yard Manure	235.36	12.56	312.10
T_{15}	T13 + 25% Vermicompost	237.2	12.83	316.95
T_{16}	T13 + 25% Poultry Manure	260.22	12.79	328.73
	Initial	237.4	12.00	260.04
	Mean	250.09	12.86	299.58
	S.E.±	1.44	0.52	2.89
	C.D. (P=0.05)	4.18	1.51	8.35

Note: RDF- Recommended Dose of Fertilizers, RDN- Recommended Dose of Nutrients, FYM- Farm Yard Manure, VC- Vermicompost, PM- Poultry manure, PSB- Phosphate Solubilizing Bacteria

The increase may be attributed to higher microbial activity in the integrated nutrient management treatments which might have favoured the conversion of the organically bound nitrogen into inorganic form (Panwar, 2008) [10].

The available phosphorus was found significantly higher in the treatment T_5 (15.74 kg ha^{-1}) receiving 100% RDN through poultry manure. Gradual increase in available P content was also observed as compared to initial status (12 kg ha^{-1}). This is attributed to release of organic acid during microbial decomposition of organic matter which might encompass in the solubility of native phosphates thus increasing available phosphorus pool in the soil. Further, the organic anions compete with phosphate ions for the binding sites on the soil particles (Patra *et al*., 2011) [11]. The data indicated that available status of potassium in all treated plots was found to be high to very high representing a typical lateritic soil of experimental plot. The highest available potassium (428.19 kg ha^{-1}) was recorded in the treatment (T_{12}) receiving equal integration of inorganics and poultry manure along with rhizobium and PSB inoculations. There was a definite and significant build up in available potassium status was seen in all treatment combinations as compared to the initial status (260.04 kg ha^{-1}). The available Micronutrient status after harvest of lablab bean crop found to be above than the sufficiency level (Gajbhiye, 1985) [5] of the experimental plot and showed variation from 33.75 to 67.74 mg kg^{-1}, 35.62 to 64.29 mg kg^{-1}, 2.75 to 3.25 mg kg^{-1} and 7.62 to 8.38 mg kg^{-1} with an average value of 56.42 mg kg^{-1}, 51.83 mg kg^{-1}, 3.07 mg kg^{-1} and 8.03 mg kg^{-1} in case of Fe Mn Zn and Cu, respectively. Micronutrient status showed higher Fe, Mn, Zn and Cu status in the treatment T_5 receiving application of 100 per cent RDN through poultry manure.

Table 3: Effect of Integrated Nutrient Management (INM) on available Micronutrients [Fe, Mn, Zn, Cu (mg kg-1)] status of soil after harvest of lablab bean

Tr. No.	Treatments	Fe	Mn	Zn	Cu
T_1	Absolute control	33.75	35.62	2.75	7.62
T_2	100% RDF through Inorganic Fertilizes	53.72	50.05	2.82	7.68
T_3	100% RDN through FYM	63.61	56.88	3.15	8.19
T_4	100% RDN through VC	64.12	58.09	3.22	8.29
T_5	100% RDN through PM	67.74	64.29	3.25	8.38
T_6	50% RDN through Inorganics + 50% RDN through FYM	54.72	42.09	3.00	8.16
T_7	50% RDN through Inorganics + 50% RDN through VC	55.35	43.92	3.07	8.19
T_8	50% RDN through Inorganics + 50% RDN through PM	61.54	58.26	3.15	8.24
T_9	T2+ *Rhizobium* + PSB Inoculation	54.39	51.21	2.93	7.71
T_{10}	T6+ *Rhizobium* + PSB Inoculation	58.44	52.86	3.06	7.82
T_{11}	T7 + *Rhizobium* + PSB Inoculation	55.88	53.19	3.12	7.93
T_{12}	T8 + *Rhizobium* + PSB Inoculation	61.62	54.81	3.18	8.18
T_{13}	75% RDN through Inorganics + *Rhizobium* + PSB Inoculation	55.33	52.93	2.94	7.86
T_{14}	T13 + 25% RDN through Farm Yard Manure	54.91	51.17	3.12	8.1
T_{15}	T13 + 25% RDN through Vermicompost	53.49	51.62	3.14	7.98
T_{16}	T13 + 25% RDN through Poultry Manure	54.11	52.23	3.21	8.16
	Initial	56.34	68.28	1.36	5.76
	Mean	56.42	51.83	3.07	8.03
	S.E.±	0.89	0.41	0.09	0.11
	C.D. (P=0.05)	2.58	1.19	0.26	0.32

Note: RDF- Recommended Dose of Fertilizers, RDN- Recommended Dose of Nutrients, FYM- Farm Yard Manure, VC- Vermicompost, PM- Poultry manure, PSB- Phosphate Solubilizing Bacteria

The higher availability of micronutrients in soil with the application of organic manures might be due to complexing properties of organic manures with the metal ions which prevents precipitation and fixation and also due to production of chelating agents during the decay of organic manures which have the ability to transform solid phase of micronutrient cations into the soluble metal complexes. Among manures, poultry manure recorded higher available micronutrients as compared to other organics which might be due to the application of poultry manure, a potential source of micronutrient cations and as a complexing agent preventing precipitation, fixation and keep them in soluble form (Madhavi and Reddy, 1996) [8].

Application of equal integration of RDN through inorganics and through organics, either through poultry manure or vermicompost with or without bio-inoculations proved it's significance by enhancing nutrient status of soil and thereby improving the fertility status of the soil. Since data of the present investigation is of one *Rabi* season only and needs further confirmation.

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