Original Research Article   https://doi.org/10.20546/ijcmas.2017.605.301

Response of Integrated Nutrient Management on Soil Properties, Growth and Yield of Cluster Bean (*Cyamopsis tetragonoloba* L.) Cv. Pusa Sadabahar

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A B S T R A C T

An experiment was conducted during Kharif (july-october) season 2016-17 to study "Response of Integrated Nutrient Management on Soil Properties, Growth and Yield of Cluster bean (*Cyamopsis tetragonoloba* L.) Cv. Pusa Sadabahar" on central research farm of Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad. The soil of experimental area falls in order Inceptisol and soil texture was sandy loam (sand % 62.25, silt % 24.52 and clay % 13.23). The design applied for statistical analysis was carried out with 3×2×2 factorial randomized block design having three factors with three levels of NPK @ 0, 50, and 100 % ha^{-1}, two levels of FYM @ 0 and 100% ha-1and two level of rhizobium @ 0 and 100% respectively. The best treatment was T11 – [L2 F1 Z1] (@ 100% NPK ha^{-1} + 100% FYM ha^{-1} + 100% rhizobium) showed the significant increase on enrichment of soil fertility status. NPK, FYM and rhizobium in combination resulted in a slight decrease in pH 6.89, EC 0.225 dS m^{-1}. In post soil of NPK,FYM and rhizobium fertilizers observations were resulted in significant increase in organic carbon 0.88 %, particle density 2.66 Mg m^{-3}, bulk density 1.05 Mg m^{-3} and available N 334.12 kg ha^{-1}, available P 34.76 kg ha^{-1}, available K 214.74 kg ha^{-1}. Significant increase in case of nitrogen, phosphorus, potassium in treatment combination T11 –[L2F1 Z1] (@ 100% NPK ha^{-1} + @ 100% FYM ha^{-1} + @ 100% rhizobium). The maximum cost benefit ratio was recorded 1:2.85 in treatment combination [T11 – L2 F1 Z1] (@ 100% NPK ha^{-1} + 0% FYM ha^{-1} + 100% rhizobium) and maximum net return (100438 ha-1) and highest pod yield (77.22 q ha^{-1}) in treatment combination [T11 – L2 F1 Z1] (@ 100% NPK ha^{-1} + 100% FYM ha^{-1} + 100% rhizobium).

Introduction

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] popularly known as "Guar" is an important legume crop mainly grown under rainfed condition in arid and semi-regions of Rajasthan during kharif season. It is very hardy and drought tolerant crop. Its deep penetrating roots enable the plant to utilize available moisture more efficiently and thus offer better scope for rainfed cropping. The

crop also survives even at moderate salinity and alkalinity conditions. There is no other legume crop so hardy and drought tolerant as cluster bean (Kherawat *et al.,* 2013).

In India, cluster bean is mostly grown in Rajasthan, Haryana, Punjab, Uttar Pradesh and Madhya Pradesh. Rajasthan occupies first position in India both in area and production.

It accounts for almost 82.1% area and 70% production in India. Haryana and Gujarat has second and third position respectively. Rajasthan has an area of 30 lakh ha, production of 15.46 lakh tonnes with a productivity of 515 kg ha^{-1}. (Anonymous 2010-11). Rajasthan guar is mainly grown in Barmer, Churu, Sriganganagar, Nagaur, Jalore, Sikar, Jaisalmer, Bikaner, Jaipur, Jhunjhunu and Alwar districts.

Nitrogen

Nitrogen plays an important role in synthesis of chlorophyll and amino acid, which contributes to the building units of protein and thus the growth of plants. Insufficient nitrogen may reduce yield drastically and deteriorates the quality of produce. Cluster bean being a legume crop which has the capacity to fix atmospheric nitrogen by its effective root nodules the major part of nitrogen is met through rhizobium present in the root nodules hence, crop does not require additional nitrogen for its initial growth and development stage. The nitrogen application increased crude protein, crude fibre contents, ash percentage, carbohydrates, and leaf area per plant, dry matter and green fodder yield of cluster bean cultivars (Ayub *et al.,* 2010).

Phosphorus

Phosphorus is the second most important nutrient that must be added to the soil to maintain plant growth and sustain crop yield (Singh *et al.,* 2000).Phosphorus plays a vital role in photosynthesis, respiration, energy storage, cell elongation and improves the quality of crops. Deficient plants may have thin, erect and spindly stems and leaves turn into bluish-green colour. Phosphorus is an essential constituent of majority of enzymes, which are of great importance in the transformation of energy, in carbohydrate metabolism, in fat metabolism and also in

respiration of plants. It stimulates early root development and growth and there by helps to establish seedlings quickly. It enhances the activity of rhizobium and increased the formation of root nodules. Thus, it helps in fixing more of atmosphere nitrogen in root nodules.Hand book of Agriculture by ICAR, (2010).

Potassium

The potassium is the 3rd most important essential nutrient after nitrogen and phosphorus. The potassium activates more than 60 enzymes and enzymatically catalyzes the system involved in photosynthesis, metabolism and translocation of carbohydrates and proteins, membrane permeability, stomatal regulation and water utilization. Other benefits ascribed to K include resistance of plants against pests, disease and stresses caused by drought, frost, salinity, sodicity and in assuring improved crop quality characteristics (Kherawat *et al.,* 2013).

Farm yard manure

The organic manure like FYM is the oldest and cheapest source or nutrient being popular from the ancient times. Application of FYM on field enrich the soil fertility is an old practice unlike chemical fertilizers which contain only one, two or three plant nutrients. FYM seems to act directly for increasing the crop yields either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. FYM provides plants both macro and micronutrients. It supplies nitrogen, phosphorus, potassium and micronutrients like Fe, S, Mo, Zn etc. in available from to the plants through biological decomposition and improves physical-chemical properties of soil such as aggregation, aeration, permeability,

water holding capacity, slow release of nutrients, increasing in cation exchange capacity, stimulation of soil flora and fauna etc. A well decomposed FYM contains 0.5%N, 0.2%P2O5 and 0.5%K2O. Hand book of Agriculture by ICAR, (2010).

Rhizobium

The use of biofertilizers are more eco-friendly in nature. They can play a significant role in fixing atmospheric nitrogen biofertilizers enrich soil fertility and improves soil fertility. Of these biofertilizers, Rhizobium inoculants specific for different leguminous crop is the most important in India. The largest contribution of biological nitrogen fixation to agriculture is derived from the symbiosis between legumes and Rhizobium species.

Materials and Methods

A field experiment was conducted on research farm of department of Soil Science and, Agricultural Chemistry. SHUATS Allahabad, (U.P.) India. The soil of experimental area falls in order Inceptisol and alluvial in nature. The design applied for statistical analysis was carried out with 3x2x2 factorial randomized block design having three factors with three levels of NPK @ 0, 50, and 100% ha^{-1}, two levels of FYM 0 and 100% ha^{-1} and two level of rhizobium 0 and 100% ha^{-1} respectively.

Physical and chemical analysis

The soil samples were preserved in polythene bags for analysis of physical and chemical properties.

Physical analysis

The physical analysis was done with the help of Bouyoucous Hydrometer method for textural class and copper cylinder method for

bulk and particle density. The results of analysis are as under.

Chemical analysis

The chemical analysis of pre sowing was done for pH, EC, available nitrogen, phosphorus, potassium, and organic carbon (%). The results and various methods employed are represented under the following table.

Results and Discussion

The Table 3 shows the interaction effects of NPK and FYM are generally influenced physical and chemical properties of post-harvest soil.

Physical properties

The interaction effects of NPK, and FYM on bulk density (Mg m-3) and particle density (Mg m-3) was non- significant. The maximum particle density and bulk density after crop harvest soil was recorded as 2.66Mg m-3, 1.14 Mg m-3 respectively inT0-(L0+N0) @ 0%NPK ha^{-1} +@ 0%FYM ha^{-1}.

Chemical properties of post –harvest soil

During the course of study, it was observed that the highest pH was recorded in 7.35 (T0-(L0+N0) @ 0%NPK ha^{-1} +@ 0FYM ha^{-1}) and the lowest of 6.89 was recorded with the application of treatment T8-(L2+N2) @100%NPK ha^{-1} + @10 qFYM ha^{-1}. If we compare the pH of pre sowing soil sample which was 7.40 with that of after crop harvest soil, there was decrease in pH after crop harvest. Increasing dose of NPK and FYM slightly decrease pH of the post-harvest soil. The decrease in pH might be due to higher growth of crops as respiration is more. Respiration evolves carbon dioxide and reacts with water to form carbonic acid in soil.

The electric conductivity (dSm^{-1}), organic carbon (%), available nitrogen, phosphorus and potassium (kg ha^{-1}) was increase of soil after crop harvests. The chemical properties were significantly affected by different treatment combination of NPK and FYM.

Table.1 Treatment details

Treatment	Treatment Combination	Symbol
T_0	$N_0P_0K_0$ Kg ha^{-1} + FYM @ 0 t ha^{-1} + *Rhizobium* @ 0 g Kg^{-1} seed	$L_0F_0Z_0$
T_1	$N_0P_0K_0$ Kg ha^{-1} + FYM @ 0 t ha^{-1} + *Rhizobium* @ 20 g Kg^{-1} seed	$L_0F_0Z_1$
T_2	$N_0P_0K_0$ Kg ha^{-1} + FYM @ 10 t ha^{-1} + *Rhizobium* @ 0 g Kg^{-1} seed	$L_0F_1Z_0$
T_3	$N_0P_0K_0$ Kg ha^{-1} + FYM @ 10 t ha^{-1} + *Rhizobium* @ 20 g Kg^{-1} seed	$L_0F_1Z_1$
T_4	$N_{10}P_{20}K_0$ Kg ha^{-1} + FYM @ 0 t ha^{-1} + *Rhizobium* @ 0 g Kg^{-1} seed	$L_1F_0Z_0$
T_5	$N_{10}P_{20}K_0$ Kg ha^{-1} + FYM @ 0 t ha^{-1} + *Rhizobium* @ 20 g Kg^{-1} seed	$L_1F_0Z_1$
T_6	$N_{10}P_{20}K_0$ Kg ha^{-1} + FYM @ 10 t ha^{-1} + *Rhizobium* @ 0 g Kg^{-1} seed	$L_1F_1Z_0$
T_7	$N_{10}P_{20}K_0$ Kg ha^{-1} + FYM @ 10 t ha^{-1} + *Rhizobium* @ 20 g Kg^{-1} seed	$L_1F_1Z_1$
T_8	$N_{20}P_{40}K_0$ Kg ha^{-1} + FYM @ 0 t ha^{-1} + *Rhizobium* @ 0 g Kg^{-1} seed	$L_2F_0Z_0$
T_9	$N_{20}P_{40}K_0$ Kg ha^{-1} + FYM @ 0 t ha^{-1} + *Rhizobium* @ 20 g Kg^{-1} seed	$L_2F_0Z_1$
T_{10}	$N_{20}P_{40}K_0$ Kg ha^{-1} + FYM @ 10 t ha^{-1} + *Rhizobium* @ 0 g Kg^{-1} seed	$L_2F_1Z_0$
T_{11}	$N_{20}P_{40}K_0$ Kg ha^{-1} + FYM @ 10 t ha^{-1} + *Rhizobium* @ 20 g Kg^{-1} seed	$L_2F_1Z_1$

Table.2 Physical analysis of pre sowing soil samples

Particulars	Method employed	Result
Sand (%)	Bouyoucos Hydrometer method (1927)	62.25
Silt (%)		24.52
Clay (%)		13.23
Textural class	Bouyoucous Hydrometer method Bouyoucous (1927)	Sandy loam
Soil Colour	Munsell colour chart	
Dry Soil		Pale brown
Wet Soil		Olive brown
Bulk density(Mg m^{-3})	Black (1965)	1.41
Particle density (Mg m^{-3})	Black (1965)	2.50

Table.4 Response of effect of different levels of NPK, FYM **and** *Rhizobium* in post-harvest soil properties of cluster bean (*Cyamopsis tetragonoloba* L.) cv. Pusa Sadabahar

Treatment combination	Bd (Mg m^{-3})	Pd (Mg m^{-3})	pH (1:2w/v)	EC (dSm^{-1})	O.C. (%)	N (kg ha^{-1})	P$_2$O (kg ha^{-1})	K$_2$O (kg ha^{-1})
(I_0+F_0+R_0)	1.14	2.24	7.35	0.192	0.62	275.09	21.89	131.67
(I_0+F_0+R_1)	1.09	2.33	7.15	0.195	0.66	294.29	23.09	146.64
(I_0+F_1+R_0)	1.13	2.33	7.32	0.205	0.69	288.00	23.69	142.89
(I_0+F_1+R_1)	1.10	2.41	7.12	0.208	0.73	296.38	25.18	154.12
(I_1+F_0+R_0)	1.10	2.44	7.09	0.223	0.72	297.42	26.38	157.86
(I_I+F_0+R_1)	1.11	2.45	7.02	0.225	0.76	312.10	27.13	169.09
(I_1+F_1+R_0)	1.09	2.54	7.09	0.235	0.78	313.77	29.00	172.83
(I_1+F_1+R_1)	1.09	2.54	7.09	0.235	0.81	314.20	29.08	180.55
(I_2+F_0+R_0)	1.09	2.63	7.05	0.235	0.81	316.53	30.57	187.15
(I_2+F_0+R_1)	1.07	2.63	7.02	0.245	0.84	318.82	31.77	196.25
(I_2+F_1+R_0)	1.07	2.63	6.99	0.245	0.86	320.48	33.87	206.52
(I_2+F_1+R_1)	1.05	2.66	6.89	0.255	0.88	334.12	34.76	214.74
F- test	NS	NS	NS	NS	S	S	S	S
S. Em (±)	0.24	0.24	0.38	0.24	0.0004	1.71	0.13	0.55
C. D. at 5%	0.48	0.49	0.77	0.49	0.0008	3.47	0.27	1.11

Fig.1 Effect of different levels of NPK FYM and *Rhizobium* on
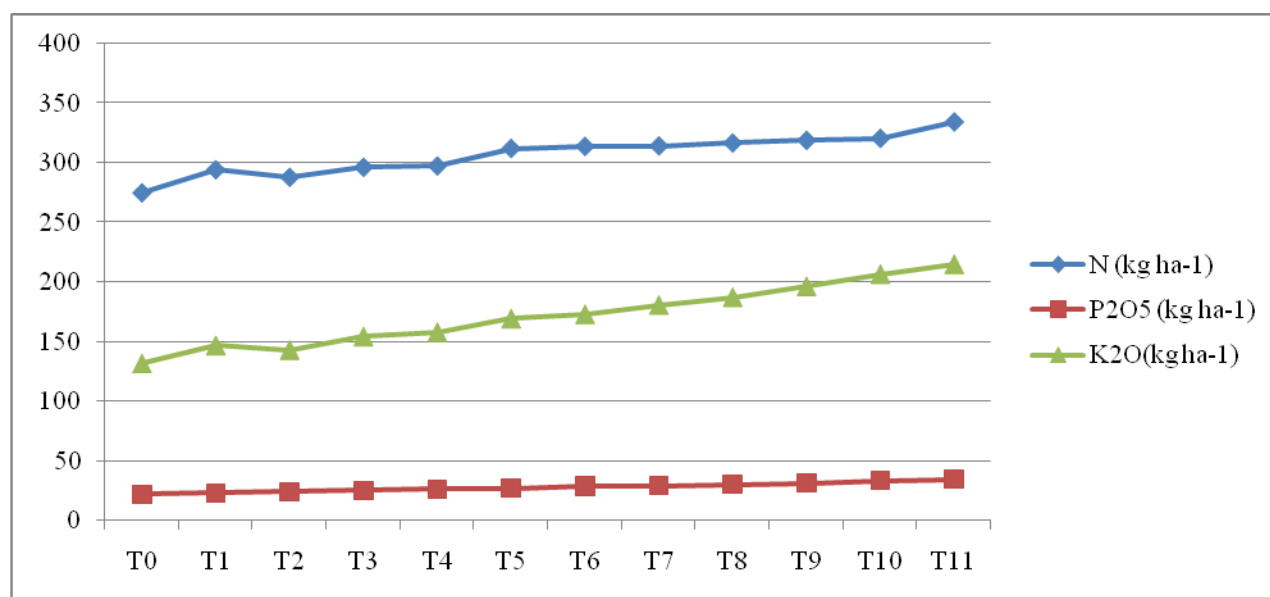Post-harvest soil chemical properties of cluster bean

Fig.2 Effect of different levels of NPK FYM and *Rhizobium* on
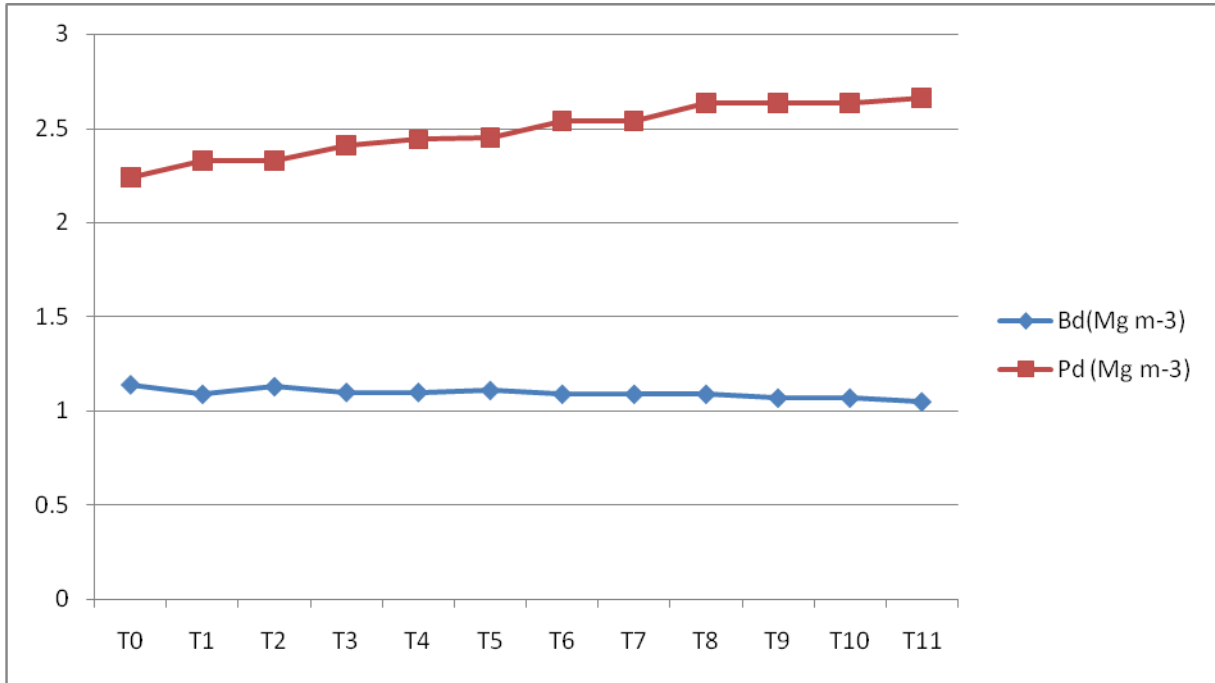Post-harvest soil physical properties of cluster bean

Fig.3 Effect of different levels of NPK FYM and *Rhizobium* on
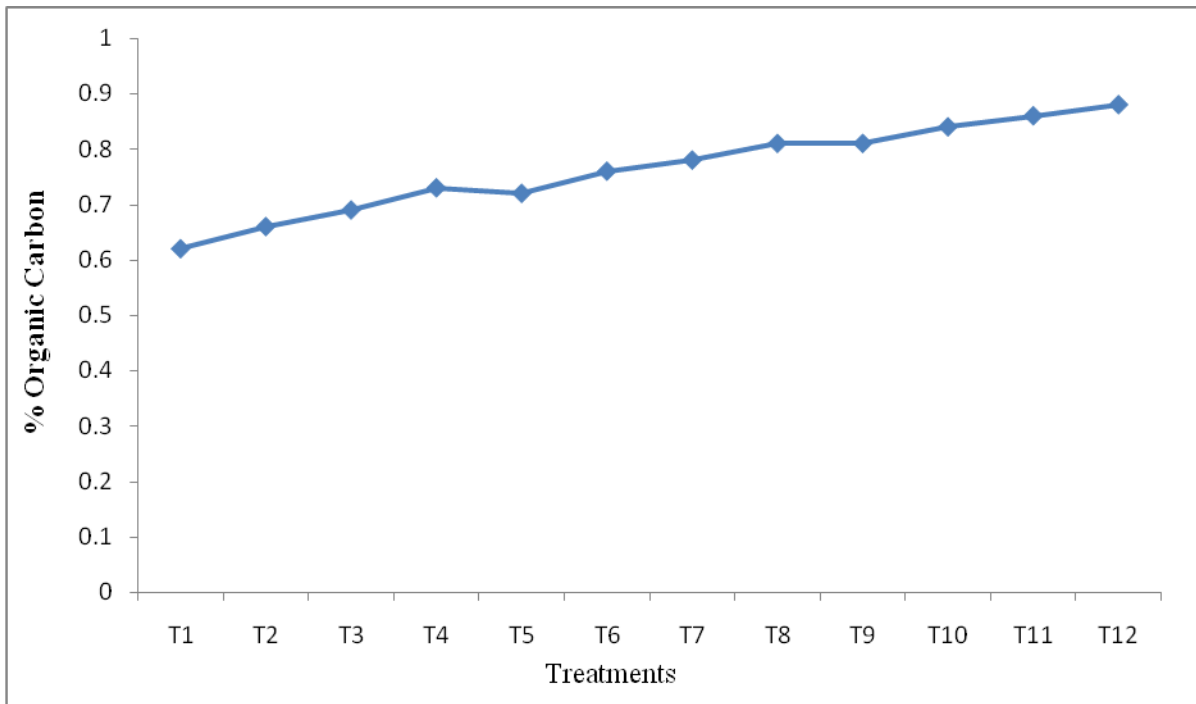Post-harvest soil chemical properties of cluster bean

Table.3 Chemical analysis of pre sowing soil samples

Parameters	Method employed	Result
Soil pH (1:2)	Digital pH meter (Jackson 1958)	7.40
Soil EC(dSm^{-1})	Digital EC meter(Wilcox 1950)	0.31
Organic carbon (%)	Walkley and Black (1947)	0.48
Available nitrogen (Kg ha^{-1})	Kjeldhal Method (Subbaih and Asija, 1956)	260.06
Available phosphorus (Kg ha^{-1})	Colorimetric method (Olsen *et al.,*1954)	23.30
Available potassium (Kg ha^{-1})	Flame photometric method (Toth and Prince, 1949)	135.60

The effect of NPK fertilizer on organic carbon (%), available nitrogen, phosphorus, potassium (kg ha^{-1}), electric conductivity (dSm^{-1}) significant the maximum chemical propertiesof after crop harvest soil was recorded electric conductivity (dSm^{-1}), organic carbon (%), available nitrogen, phosphorus, potassium (kg ha^{-1}) 0.255, 0.88, 334.12, 34.76, 214.74 respectively. available electric conductivity (dSm^{-1}) was found non-significant and available organic carbon (%), nitrogen, phosphorus, potassium (kg ha^{-1}) found to be significant.

It was concluded from trial that the various level of NPK + FYM and Rhizobium used in the experiment, the treatment combination T11-(I2+V2+R1) @100%NPK ha^{-1} + @ FYM 10 t ha^{-1} + Rhizobium @ 20 g/ Kg seed was found to be the best treatment gave highest benefit of 100438with highest cost benefit ratio 1:2.85 for cluster bean it could be recommended for profitable production of cluster bean (*Cyamopsis tetragonoloba* L.) Var. pusa Sadabahar and good for soil physical and chemical properties. Integrated nutrient management is better for soil health and cluster bean production.

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How to cite this article: