

Original Research Article

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Effect of Tillage and Nutrient Management Practices to Pole Bean (*Phaseolus vulgaris* L.) on Nutrient Uptake, Soil Fertility Status and Microbial Population

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ABSTRACT

A Field experiment was conducted at Agricultural Research Station, Dhadesugur on deep black soil during *rabi*-2017. The experiment was replicated thrice in split plot design. There were ten treatment combinations consisted of tillage practices in main plot and nutrient management practices in sub plot. Among the main plot treatments, conventional tillage recorded significantly higher uptake of nitrogen, phosphorus and potassium (40.11, 17.15 and 38.38 kg ha⁻¹, respectively), and bacterial, fungal and actinomycetes (65.5 CFU × 10⁻⁶ g⁻¹, 21.9 CFU×10⁻⁴ g⁻¹ and 37.5 CFU×10⁻³ g⁻¹, respectively) population over reduced tillage. Among sub plot treatments, application of recommended dose of fertilizer with FYM recorded significantly higher uptake of nitrogen, phosphorus and potassium (47.31, 22.14 and 44.96 kg ha⁻¹, respectively) and bacterial, fungal and actinomycetes (82.7 CFU × 10⁻⁶ g⁻¹, 28.3 CFU×10⁻⁴ g⁻¹ and 47.5 CFU×10⁻³ g⁻¹, respectively) population over all other treatments. Interaction of main and sub plot treatments, significantly higher uptake of nitrogen, phosphorus and potassium (50.38, 22.64 and 46.96 kg ha⁻¹, respectively) and bacterial, fungal and actinomycetes (83 CFU × 10⁻⁶ g⁻¹, 28.7 CFU×10⁻⁴ g⁻¹ and 49.0 CFU×10⁻³ g⁻¹, respectively) population were observed in conventional tillage along with recommended dose of fertilizer and FYM compared to all other treatments. Whereas, significantly higher available of nitrogen, phosphorous and potassium content in soil (155.3, 54.3 and 290.6 kg ha⁻¹, respectively) was observed in reduced tillage with organic nutrient management practices. Conventional tillage with unfertilized control recorded significantly lower available of nitrogen, phosphorous and potassium content in soil (115.1, 46.5 and 271.5 kg ha⁻¹, respectively).

Keywords

Polebean, Tillage, Nutrient uptake and microbial population

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Introduction

Polebean (*Phaseolus vulgaris* L.) is an important vegetable crop belongs to the family

Fabaceae. It is also known as kidney bean, snap bean, French bean and wax bean. It is cultivated for the vegetable, shelled green beans and dry beans (Rajmah). Being a

leguminous crop French bean is rich in protein and minerals. Production of Polebean can be increased either by increasing the area of cultivation or by improving the cultivation practices. It is not possible to increase the area of cultivation in the present situation and on the other hand productivity in India is less as compared to world average.

Among several factors responsible for lower productivity, improper nutrient management and tillage practices are the major factor. Tillage is a practice, which changes the physical properties of soil and enables the plants to attain their full potential.

Tillage techniques are used in order to provide a good seedbed, root development, weed control, and manage crop residues, leveling the surface for uniform irrigation and incorporation of fertilizers (Cabeda, 1984) and combined application of organic manures and inorganic fertilizers that improves physical and chemical conditions of soil and soil productivity but the use of inorganic fertilizer alone for a long period deteriorates the physical properties, organic matter status and reduces crop yield. Therefore, considering the above facts, the present study was planned and executed accordingly.

Materials and Methods

The field experiment was carried out at Agricultural Research Station, Dhadesugur, during *rabi*-2017 to study “effect of tillage and nutrient management practices to pole bean (*Phaseolus vulgaris* L.) on nutrient uptake, soil fertility status and microbial population”.

The experiment was replicated thrice in split plot Design. There were ten treatment combinations consisted of tillage practices in main plot (conventional and reduced tillage) and nutrient management practices in sub plot

(Recommended dose of fertilizer (RDF + FYM), recommended dose of inorganic fertilizer (RDF), integrated nutrient management (INM), organic nutrient management (ONM), Control). The composite soil samples from 0 to 15 cm depth were collected before planting and at harvest. Soils were air dried in shade, powdered and passed through 2 mm sieve and analysed for pH, EC, OC, available N, P₂O₅ and K₂O₅ by following the methods described by Jackson (1973) and microbial population as outlined by (Primer and Schmidt, 1964). The soil was deep black soils with pH 8.23. The available N, P₂O₅ and K₂O contents were 165(low), 55.2 (high) and 300.4 (high) kg ha⁻¹, respectively. The gross plot size was 9.6 m x 3.6 m and net plot size was 7.2 m x 3.0 and spacing of 120 cm x 30 cm and the recommended package of practices were adopted for crop production. The crop was harvested at its physiological maturity. The data was statistically analysed as per the procedure given by Panse and Sukhatme (1967).

Results and Discussion

Nutrient uptake

Among the tillage practices, conventional tillage recorded significantly higher uptake of nitrogen, phosphorus and potassium (40.11, 17.15 and 38.38 kg ha⁻¹, respectively) over reduced tillage (37.27, 16.19 and 35.16kg ha⁻¹, respectively).

Among nutrient management practices, application of recommended dose of fertilizer with FYM recorded significantly higher uptake of nitrogen, phosphorus and potassium (47.31, 22.14 and 44.96 kg ha⁻¹, respectively) over all other treatments. Unfertilized control recorded significantly lower uptake of nitrogen, phosphorus and potassium (25.33, 9.57 and 23.48 kg ha⁻¹, respectively). Interaction of main and sub plot treatments on

uptake of nitrogen, phosphorus and potassium at harvest of poblebean differed significantly. Significantly higher uptake of nitrogen, phosphorus and potassium (50.38, 22.64 and 46.96 kg ha⁻¹ respectively) were observed in conventional tillage along with recommended dose of fertilizer and FYM compared to all other treatments (Table 1). Reduced tillage with unfertilized control recorded significantly lower uptake of nitrogen, phosphorus and potassium (24.24, 9.23 and 21.87 kg ha⁻¹ respectively) followed by conventional tillage with unfertilized control (26.45, 9.91 and 25.13 kg ha⁻¹ respectively).

Nitrogen being a structural component of proteins at either as storage protein or proteins involved in various biological functions. Increase in uptake due of N was also attributed to increase in dry matter production and content Jakhar *et al.*, (2005), Veeresh (2003). Increased phosphorus uptake mainly due to conversion of fixed phosphorus into readily available form by organic acids released during decomposition of composts Muthuramalingam *et al.*, (2002). Adequate supply of water throughout crop growth due to favourable condition of soil under conventional tillage and this in turn improved potassium content and uptake as it is mainly absorbed through diffusion Prasad *et al.*, (1998) and Veeresh (2003).

Soil fertility status

Significantly higher available of nitrogen, phosphorous and potassium content in soil (155.3, 54.3 and 290.6 kg ha⁻¹, respectively) was observed in reduced tillage with organic nutrient management practices. Conventional tillage with unfertilized control recorded significantly lower available of nitrogen, phosphorous and potassium content in soil (115.1, 46.5 and 271.5 kg ha⁻¹, respectively) followed by reduced tillage with unfertilized control (117.2, 47.5 and 273.7 kg ha⁻¹,

respectively). This may be due to lower uptake of nutrients and lower green pod yield and stalk yield, which leads to lower utilization of nutrients present in soil and makes more availability to the next subsequent crop. The soil application with recommended chemical fertilizer and FYM may increases the utilization of nutrients mainly due to its beneficial effect in mobilizing the native nutrients to increases their uptake and ultimately leads to lower availability in soil after the harvest. These results are conformity with Dhawan *et al.*, (1992) and Prasad (1994).

Further, available nitrogen content in soil increased with the application of organics alone or in combination with fertilizers under different tillage practices. This may be attributed to addition of nitrogen to soil through organics and its slow release pattern throughout the growth period, which might have minimized nitrogen loss. These results are in line with Reddy and Reddy (1998) and Abdulkadir (2000). Maximum available phosphorus content in soil with the application of organic nutrient management practices under reduced and conventional tillage practices may be attributed to more phosphorus added to soil. In addition to this, organic acids and carbon dioxide released during decomposition might have acted on native insoluble iron and aluminium phosphates resulting in release of insoluble phosphorus or might have chelated active Fe³⁺ and Al³⁺ reducing fixation or formation of insoluble iron and aluminium phosphates (Sharma and Saxena, 1985). Potassium content of soil increased with the application of with the application of organic nutrient management practices under reduced and conventional tillage practices (Table 2) which may be due to addition of more potassium to the soil through composts alone or in combination with chemical fertilizers. Reddy and Reddy (1998) also obtained similar results.

Table.1 Uptake of Nitrogen, phosphorous and potassium (kg ha⁻¹), as influenced by tillage and nutrient Management practices in pole bean

Nutrient management practices (S)	Tillage practices (M)								
	Nitrogen			Phosphorous			Potassium		
	M ₁	M ₂	Mean	M ₁	M ₂	Mean	M ₁	M ₂	Mean
S ₁	44.27	50.38	47.31	21.65	22.64	22.14	43.24	46.69	44.96
S ₂	41.28	43.92	42.59	18.71	20.00	19.35	40.25	43.70	41.97
S ₃	39.60	42.53	41.05	16.93	18.22	17.57	37.18	40.82	38.98
S ₄	38.35	38.92	38.63	15.68	16.29	15.98	35.01	37.12	36.07
S ₅	24.24	26.45	25.33	9.23	9.91	9.57	21.87	25.13	23.48
Mean	37.27	40.11		16.19	17.15		35.16	38.38	
	S.Em±		C.D at 5%	S.Em±		C.D at 5%	S.Em±		C.D at 5%
Main plot (M)	0.67		2.01	0.28		0.82	1.10		3.30
Subplot (S)	1.20		3.54	0.87		2.50	1.01		3.00
M at same level of S	1.65		4.78	0.29		0.84	1.15		3.42
S at same or different level of M	1.70		4.81	0.30		0.88	1.09		3.27

Main plot treatments: Tillage practices (M)	Sub plot treatments: Nutrient management practices (S)
M ₁ : Reduced tillage	S ₁ : Recommended dose of fertilizer + FYM(63:100:75 N:P ₂ O ₅ :K ₂ O + FYM @ 25 t ha ⁻¹)
M ₂ : Conventional tillage	S ₂ : Recommended dose of inorganic fertilizer(63:100:75 N:P ₂ O ₅ :K ₂ O kg ha ⁻¹)
DAS : Days after sowing	S ₃ : Integrated nutrient management (50% Rec. N through inorganic fertilizer + 50% Rec. N through FYM)
NS : Non significant	S ₄ : Organic nutrient management (75% Rec. N through FYM + 25% Rec. N through poultry manure)
	S ₅ : Control

Table.2 Available nitrogen, phosphorous and potassium (kg ha⁻¹) content in soil after the harvest of Pole bean as influenced by tillage and nutrient management practices

Nutrient management practices (S)	Tillage practices (M)								
	Nitrogen(kg/ha)			Phosphorous (Kg/ha)			Potassium (Kg/ha)		
	M ₁	M ₂	Mean	M ₁	M ₂	Mean	M ₁	M ₂	Mean
S ₁	144.6	142.0	143.3	49.8	49.3	49.6	283.1	280.5	281.8
S ₂	136.3	132.3	134.3	48.5	47.6	48.1	278.0	275.6	276.8
S ₃	152.0	148.9	150.4	52.1	51.5	51.8	286.8	284.6	285.7
S ₄	155.3	154.3	155.1	54.3	52.6	53.4	290.6	289.1	289.8
S ₅	117.2	115.1	116.6	47.5	46.5	46.9	273.7	271.5	272.6
Mean	141.9	138.6		50.4	49.5		282.4	280.2	
	S.Em±		C.D at 5%	S.Em±		C.D at 5%	S.Em±		C.D at 5%
Main plot (M)	0.037		0.228	0.028		0.080	0.218		0.651
Sub plot (S)	0.218		0.653	0.038		0.113	0.090		0.273
M at same level of S	0.081		0.949	0.030		0.174	0.222		0.579
S at same or different level of M	0.278		0.857	0.049		0.162	0.151		0.687

Main plot treatments: Tillage practices (M)	Sub plot treatments: Nutrient management practices (S)
M ₁ : Reduced tillage	S ₁ : Recommended dose of fertilizer + FYM(63:100:75 N:P ₂ O ₅ :K ₂ O + FYM @ 25 t ha ⁻¹)
M ₂ : Conventional tillage	S ₂ : Recommended dose of inorganic fertilizer(63:100:75 N:P ₂ O ₅ :K ₂ O kg ha ⁻¹)
DAS : Days after sowing	S ₃ : Integrated nutrient management(50% Rec. N through inorganic fertilizer + 50% Rec. N through FYM)
	S ₄ : Organic nutrient management(75% Rec. N through FYM + 25% Rec. N through poultry manure)
	S ₅ : Control

Table.3 Enumeration of microflora (Bacteria, fungi and actinomycetes) of Polebean as influenced by tillage and Nutrient management practices

Nutrient management practices (S)	Tillage practices (M)								
	Bacteria (CFU × 10 ⁻⁶ g ⁻¹ soil)			Fungi (CFU X 10 ⁻⁴ g ⁻¹ soil)			Actinomycetes (CFU X 10 ⁻³ g ⁻¹ soil)		
	M ₁	M ₂	Mean	M ₁	M ₂	Mean	M ₁	M ₂	Mean
S ₁	82.3	83.0	82.7	28.0	28.7	28.3	46.0	49.0	47.5
S ₂	60.7	74.0	67.3	19.7	26.0	22.8	36.0	42.0	39.0
S ₃	59.0	62.0	60.5	19.0	24.3	21.7	33.0	41.3	37.2
S ₄	52.7	58.7	55.7	14.0	18.3	16.2	28.7	29.0	28.8
S ₅	47.0	49.7	48.3	12.0	13.7	12.8	24.0	26.0	25.0
Mean	60.3	65.5		18.9	21.9		33.5	37.5	
	S.Em±		C.D at 5%	S.Em±		C.D at 5%	S.Em±		C.D at 5%
Main plot (M)	0.253		0.759	0.416		1.314	0.740		2.227
Sub plot (S)	0.554		1.661	0.247		0.741	0.363		1.089
M at same level of S	0.279		2.454	0.483		0.174	0.760		2.194
S at same or different level of M	0.712		2.229	0.380		0.162	0.572		2.441

Main plot treatments: Tillage practices (M)	Sub plot treatments: Nutrient management practices (S)
M ₁ : Reduced tillage	S ₁ : Recommended dose of fertilizer + FYM(63:100:75 N:P ₂ O ₅ :K ₂ O + FYM @ 25 t ha ⁻¹)
M ₂ : Conventional tillage	S ₂ : Recommended dose of inorganic fertilizer(63:100:75 N:P ₂ O ₅ :K ₂ O kg ha ⁻¹)
DAS : Days after sowing	S ₃ : Integrated nutrient management(50% Rec. N through inorganic fertilizer + 50% Rec. N through FYM)
	S ₄ : Organic nutrient management(75% Rec. N through FYM + 25% Rec. N through poultry manure)
	S ₅ : Control

Microbial population

Among the tillage practices, conventional tillage recorded significantly higher number of soil bacterial ($65.5 \text{ CFU} \times 10^{-6} \text{ g}^{-1}$ soil), fungi ($21.5 \text{ CFU} \times 10^{-4} \text{ g}^{-1}$ soil) and actinomycetes ($37.5 \text{ CFU} \times 10^{-3} \text{ g}^{-1}$ soil) population over reduced tillage ($60.3 \text{ CFU} \times 10^{-6} \text{ g}^{-1}$ soil, $18.9 \text{ CFU} \times 10^{-4} \text{ g}^{-1}$ soil and $33.5 \text{ CFU} \times 10^{-3} \text{ g}^{-1}$ soil, respectively).

Among nutrient management practices, application of recommended dose of fertilizer and FYM recorded significantly higher number of soil bacterial ($82.7 \text{ CFU} \times 10^{-6} \text{ g}^{-1}$ soil), fungi ($28.3 \text{ CFU} \times 10^{-4} \text{ g}^{-1}$ soil) and actinomycetes ($47.5 \text{ CFU} \times 10^{-3} \text{ g}^{-1}$ soil) over all other treatments. Unfertilized control recorded significantly lower number of soil bacterial ($48.3 \text{ CFU} \times 10^{-6} \text{ g}^{-1}$ soil), fungi ($12.8 \text{ CFU} \times 10^{-4} \text{ g}^{-1}$ soil) and actinomycetes ($25.0 \text{ CFU} \times 10^{-3} \text{ g}^{-1}$ soil). Interaction of main and sub plot treatments, significantly higher number of soil bacterial ($83.0 \text{ CFU} \times 10^{-6} \text{ g}^{-1}$ soil), fungi ($28.7 \text{ CFU} \times 10^{-4} \text{ g}^{-1}$ soil) and actinomycetes ($49.0 \text{ CFU} \times 10^{-3} \text{ g}^{-1}$ soil) were observed in conventional tillage with recommended dose of fertilizer and FYM compared to all other treatments. Reduced tillage (Table 3) with unfertilized control recorded significantly lower number of soil bacterial ($47.0 \text{ CFU} \times 10^{-6} \text{ g}^{-1}$ soil), fungi ($12.0 \text{ CFU} \times 10^{-4} \text{ g}^{-1}$ soil) and actinomycetes ($24.0 \text{ CFU} \times 10^{-3} \text{ g}^{-1}$ soil) followed by conventional tillage with unfertilized control (49.7, 13.7 and 26.0, respectively). These results are in line with the findings of Sharada (2013) who reported higher soil microbial population with combined application of organics and inorganics.

The results of the investigation revealed that significantly higher uptake of nutrients by pole bean, available nitrogen, phosphorus and potassium in soil and higher number of soil bacterial, soil fungi and soil actinomycetes

population were recorded with reduced tillage and conventional tillage.

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