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## Effect of P<sub>2</sub>O<sub>5</sub>, FYM and bio-fertilizer on nutrient content in soil after harvest of summer greengram (*Vigna radiate* L.)

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**Abstract**

A field experiment was conducted during 2018-19 to study the effect of phosphorus, FYM and bio-fertilizer on nutrient content in soil before and after harvest of summer greengram. There were twelve treatments comprising of three phosphorus levels [Control (P<sub>0</sub>), 20 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (P<sub>1</sub>) and 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (P<sub>2</sub>)] combined with two FYM levels [control (F<sub>0</sub>) and 5 t FYM ha<sup>-1</sup>(F<sub>1</sub>)] along with two levels of bio-fertilizer [control (B<sub>0</sub>) and PSB inoculation (B<sub>1</sub>)]. Phosphorus applied in the form of SSP and PSB as seed inoculation. The experiment was laid out in factorial RBD with three replications. The recommended dose of N was applied uniformly to all the treatments. Residual availability of P increased due to phosphorus and PSB inoculation. Major and micro nutrients availability in soil was increased due to FYM treatment after harvesting. Organic carbon content was favourably influenced by FYM treatment. Interaction of P x F x B had synergistic effect on residual availability of P.

**Keywords:** Phosphorus, FYM, PSB, nutrient content

**1. Introduction**

Greengram (*Vigna radiata* L.) occupies prime position among pulses by virtue of its short growth period, high tonnage capacity and outstanding nutrient value as food, feed and forage. Among the pulses, greengram is one of the most important and extensively cultivated pulse crops. In India, greengram occupies an area of about 3.51 million hectares producing 1.80 million tonnes with the productivity of 511 kg ha<sup>-1</sup> (Anonymous, 2012) [1], whereas in Gujarat it is grown over 2.40 lakh hectares with production of 1.28 lakh tonnes and productivity of 525 kg ha<sup>-1</sup> (Anonymous, 2012a) [2].

Phosphorus (P) is one of the most needed elements for pulse production. Phosphorus, although not required in large quantities, is critical to green gram yield because of its multiple effects on nutrition. Phosphorus plays a key role in various physiological processes like root growth and dry matter production, nodulation and nitrogen fixation and also in metabolic activities especially in protein synthesis.

Farm yard manure (FYM) application to the crop is an age old practice. The yield and nutritional quality of green gram is greatly improved by application of FYM and nutrient elements. FYM is known to play an important role in improving the fertility and productivity of soils through its positive effects on soil physical, chemical and biological properties of soils and balanced plant nutrition.

Phosphorus solubilizing microorganisms (bacteria and fungi) enable P to become available for plant uptake after solubilization. Several soil bacteria, particularly those belonging to the genera *Bacillus* and *Pseudomonas* and fungi belonging to the genera *Aspergillus* and *Penicillium* possess the ability to bring insoluble phosphates in soil into soluble forms by secreting organic acids such as formic, acetic, propionic, lactic, glycolic, fumaric, and succinic acids. These acids lower the pH and bring about the dissolution of bound forms of phosphates.

Very high cost of phosphatic fertilizer also demand the need for recycling and exploitation of fixed phosphorus to improve crop production. The availability of phosphorus to the crop can be augmented by providing appropriate strains of microbes which are known to solubilise the fixed phosphorus and mobilize the deeply placed phosphorus to root zone by their activity. Besides increasing the availability of native P in the soil also help in enhancing the use

efficiency of applied phosphorus (Thenua and Sharma, 2007)<sup>[11]</sup>. FYM additions were also found to mobilize the fixed phosphates in the soil thus increasing the available P to crops (Venkateswarlu, 2000)<sup>[12]</sup>.

### 1. Materials and Methods

A field experiment was conducted during summer season of 2018 at the college farm, Navsari Agricultural University, Navsari to study the "Phosphorus Management in greengram (*Vigna radiate* L.) under south Gujarat condition.". The soil of the experimental field was clay in texture having medium to poor drainage, medium in available nitrogen, available phosphorus and potash. Total twelve treatment combinations comprising of all possible treatments of three levels of phosphorus *viz.*, P<sub>0</sub> (0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>), P<sub>1</sub> (20 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and P<sub>2</sub> (40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>), two levels of FYM *viz.*, F<sub>0</sub> (0 t ha<sup>-1</sup>) and F<sub>1</sub> (5 t ha<sup>-1</sup>) and two levels of bio-fertilizer *viz.*, B<sub>0</sub> (No inoculation) and B<sub>1</sub> (PSB inoculation) were tested in factorial randomized block design with three replications. Greengram variety Meha was sown by opening of furrow at a distance of 30 x 10 cm. The full dose of fertilizers was applied according to the treatments manually before sowing the seeds. PSB was applied as seed inoculation. The phosphorus was SSP. All the recommended cultural practices and plant protection measures were followed throughout the experimental periods.

### 3. Result and Discussion

#### 3.1 Effect of phosphorus

Post-harvest nutrient status of soil, in the case of available N and K<sub>2</sub>O in soil did not affect significantly by the effect of phosphorus application (table-2)

Available phosphorus status in soil (table-2) was significantly increase with phosphorus application and recorded significantly higher under the P<sub>2</sub> @ 40 kg P<sub>2</sub>O<sub>5</sub>ha<sup>-1</sup>(47.45 kg ha<sup>-1</sup>) over P<sub>0</sub>control. Treatment P<sub>1</sub>significantly higher than control P<sub>0</sub>. Significantly higher values of available phosphorus was recorded with the treatment P<sub>2</sub> (40 kg P<sub>2</sub>O<sub>5</sub>ha<sup>-1</sup>) as compared to P<sub>1</sub> (20 kg P<sub>2</sub>O<sub>5</sub>ha<sup>-1</sup>) and P<sub>0</sub> (0 kg P<sub>2</sub>O<sub>5</sub>ha<sup>-1</sup>). The available P status of the soil after harvest of greengram was also improved with the addition of phosphorus and this might be due to residual effect of phosphatic fertilizer. Similar findings were also reported by Kokani *et al.* (2015)<sup>[5]</sup> Nyekha *et al.* (2015)<sup>[7]</sup> and Mohammad *et al.* (2017)<sup>[6]</sup>.

Data showed in table 4 stated that, all other nutrient content (Ca, Mg, S, Fe, Mn, Zn and Cu) was not significantly influenced by the application of phosphorus.

#### 3.2 Effect of FYM

Data showed that the effect of FYM significantly influenced the available N in soil after harvest. Available N was recorded by treatment F<sub>1</sub>was significantly higher over control F<sub>0</sub>. (Table-2). The increase in available N under organics treatment was expected due to addition of N through mineralization of organic matter. The results were in accordance with the finding of Jat *et al.*(2012a)<sup>[4]</sup>, Ranpariya *et al.* (2017)<sup>[9]</sup> and Rekha *et al.* (2018)<sup>[10]</sup>.

Data in table 2, revealed that soil available P<sub>2</sub>O<sub>5</sub> was significantly influenced by effect of FYM. Treatment F<sub>1</sub> was recorded significantly highest available P<sub>2</sub>O<sub>5</sub> (44.66 kg ha<sup>-1</sup>) as compared to the control F<sub>0</sub> (38.89 kg ha<sup>-1</sup>).

The application of FYM had helped in maintaining P content in soil. Similar results were reported earlier by Jat *et al.*(2012a)<sup>[4]</sup>, Ranpariya *et al.* (2017)<sup>[9]</sup> and Rekha *et al.* (2018)<sup>[10]</sup>.

Data revealed that available K<sub>2</sub>O in soil after the harvest significantly influenced by effect of FYM. Significantly higher available K<sub>2</sub>O was recorded in treatment F<sub>1</sub>(306.5 kg ha<sup>-1</sup>) over control F<sub>0</sub>(289.0 kg ha<sup>-1</sup>). (table-2)

Data indicated that an application of farm yard manure significantly influence the availability of exchangeable Ca-Mg in soil after harvest of greengram. Significantly the higher exchangeable Ca-Mg (42.32 me100<sup>-1</sup> g soil & 13.60 me100<sup>-1</sup> g soil) was recorded under treatment F<sub>1</sub> over F<sub>0</sub> control, respectively. This is due to slow release of the Ca and Mg like secondary nutrient increase their availability after harvest of greengram crop.

Data revealed that available S in soil after the harvest significantly influenced by application of FYM. Significantly higher available S were recorded in treatment F<sub>1</sub>(15.82mg kg<sup>-1</sup>) over control F<sub>0</sub> (14.43mg kg<sup>-1</sup>).

Application of FYM helped in maintaining the available S status in soil while maximum S depletion was seen in control. Similar findings were reported by Ranpariya *et al.* (2017)<sup>[9]</sup> and Rekha *et al.* (2018)<sup>[10]</sup>.

The effects of FYM significantly influenced the available Fe in the soil after harvesting. F<sub>1</sub>recorded significantly higher available Fe content in soil (21.01 mg kg<sup>-1</sup>) over control (19.79 mg kg<sup>-1</sup>).

The effects of farm yard manure significantly influenced the available Zn in the soil after harvesting. F<sub>1</sub> recorded significantly higher available Zn content in soil (0.908 mg kg<sup>-1</sup>) over control (0.785 mg kg<sup>-1</sup>).

#### 3.3 Effect of bio-fertilizer

Data presented table-2 revealed that bio-fertilizer did not significantly influence on available N and K<sub>2</sub>O status of soil after harvest.

The effect of PSB inoculation significantly influenced the availableP<sub>2</sub>O<sub>5</sub> in soil after the harvest. Available P<sub>2</sub>O<sub>5</sub> was recorded by treatment B<sub>1</sub>(43.94 kg ha<sup>-1</sup>) was significant higher over control F<sub>0</sub>(39.60 kg ha<sup>-1</sup>). The increase in available P<sub>2</sub>O<sub>5</sub> under PSB inoculated treatment was expected due to solubilizing effect of phospho-bacteria, it convert unavailable phosphorus into available form. The results were in accordance with the finding of Dhakal *et al.* (2016).

A perusal of data indicated that the availability of all other nutrient content (K, Ca, Mg, S, Fe, Mn, Zn and Cu) was not significantly influenced by the inoculation of PSB.

#### 3.4 Interaction effect

Interaction effects between phosphorus, FYM and bio-fertilizer on available N and available K<sub>2</sub>O status in soil after harvest were found non-significant.

In the case of available P<sub>2</sub>O<sub>5</sub>in soil after harvest there were none of interaction effects between phosphorus, FYM and bio-fertilizer showed their significant differences on available P<sub>2</sub>O<sub>5</sub>in the soil after harvest of greengram except P x F x B combination.The combination of P<sub>2</sub>F<sub>1</sub>B<sub>1</sub> gave a significantly higheravailable P<sub>2</sub>O<sub>5</sub> (53.95kg ha<sup>-1</sup>) over rest of the treatment combination. This is due to synergetic effect of phosphorus fertilizer, farm yard manure and PSB which increase the available P<sub>2</sub>O<sub>5</sub>in soil. Similar result was reported earlier by Heisnam *et al.* (2017)<sup>[2]</sup>.

In the case of available S in soil after harvest there were none of interaction effects between phosphorus, FYM and bio-fertilizer showed their significant differences on available S in the soil after harvest of greengram

Data showed that the effect of different interactions effects between phosphorus, farm yard manure and bio-fertilizer on micronutrient (Fe, Mn, Cu and Zn) were also found non-significant.

### 3.5 Effect on pH, EC and OC

Data given in table 1 revealed that the effect of phosphorus, FYM and bio fertilizer on pH, EC and organic C content in soil after harvesting was found non-significant.

**Table 1:** Effect of various treatments on EC, pH and OC after harvest of greengram.

Treatments	EC (dSm <sup>-1</sup> )	pH	OC (%)
<b>Phosphorus (P)</b>			
P <sub>0</sub> – 0 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	0.47	7.22	0.77
P <sub>1</sub> – 20 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	0.48	7.25	0.77
P <sub>2</sub> – 40 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	0.48	7.26	0.77
S.Em ±	0.005	0.09	0.007
CD at 5%	NS	NS	NS
<b>FYM (F)</b>			
F <sub>0</sub> - 0 t ha <sup>-1</sup>	0.47	7.20	0.76
F <sub>1</sub> - 5 t ha <sup>-1</sup>	0.48	7.28	0.78
S.Em ±	0.004	0.07	0.005
CD at 5%	NS	NS	NS
<b>Bio fertilizer (B)</b>			
B <sub>0</sub> – No inoculation	0.48	7.25	0.77
B <sub>1</sub> – PSB inoculation	0.48	7.24	0.77
S.Em ±	0.004	0.07	0.006
CD at 5%	NS	NS	NS

**Table 2:** Effect of various treatments on available Macro-nutrients in soil after harvest of greengram

Treatments	Available Macro nutrients					
	N (kg/ha)	P <sub>2</sub> O <sub>5</sub> (kg/ha)	K <sub>2</sub> O (kg/ha)	Ex. Ca (me/100 g soil)	Ex. Ca (me/100 g soil)	Available S (mg/kg)
<b>Phosphorus (P)</b>						
P <sub>0</sub> – 0 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	267.7	37.72	292.8	38.08	12.24	14.77
P <sub>1</sub> – 20 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	272.1	40.14	297.9	39.56	12.72	15.02
P <sub>2</sub> – 40 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	275.2	47.45	302.6	40.44	13.00	15.59
S.Em ±	4.28	0.55	4.64	0.69	0.22	0.30
CD at 5%	NS	1.62	NS	NS	NS	NS
<b>FYM (F)</b>						
F <sub>0</sub> - 0 t ha <sup>-1</sup>	262.4	38.89	289.0	36.40	11.70	14.43
F <sub>1</sub> - 5 t ha <sup>-1</sup>	280.9	44.66	306.5	42.32	13.60	15.82
S.Em ±	3.49	0.45	3.78	0.57	0.18	0.24
CD at 5%	10.2	1.33	11.10	1.66	0.53	0.71
<b>Bio fertilizer (B)</b>						
B <sub>0</sub> – No inoculation	267.7	39.60	294.5	38.55	12.40	14.78
B <sub>1</sub> – PSB inoculation	275.6	43.94	301.1	40.17	12.91	15.48
S.Em ±	3.49	0.45	3.78	0.57	0.18	0.24
CD at 5%	NS	1.33	NS	NS	NS	NS
<b>Interaction</b>						
P×F S.Em ±	6.05	0.78	6.56	0.98	0.32	0.42
CD at 5%	NS	NS	NS	NS	NS	NS
P×B S.Em ±	6.05	0.78	6.56	0.98	0.32	0.42
CD at 5%	NS	NS	NS	NS	NS	NS
F×B S.Em ±	4.94	0.64	5.35	0.80	0.26	0.34
CD at 5%	NS	NS	NS	NS	NS	NS
P×F×B S.Em ±	8.55	1.11	9.27	1.39	0.46	0.59
CD at 5%	NS	3.25	NS	NS	NS	NS
<b>CV (%)</b>	5.45	4.59	5.39	6.10	6.10	6.81
<b>Initial status</b>	307.3	42.3	326.5	40.27	14.79	15.62

**Table 3:** Interaction effect (P x F x B) available P<sub>2</sub>O<sub>5</sub> in soil after harvest of greengram

Phosphorus	Available P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )			
	F <sub>0</sub>		F <sub>1</sub>	
	B <sub>0</sub>	B <sub>1</sub>	B <sub>0</sub>	B <sub>1</sub>
P <sub>0</sub> – 0 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	33.07	38.46	40.35	39.03
P <sub>1</sub> – 20 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	34.37	39.25	40.44	46.54
P <sub>2</sub> – 40 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	41.75	46.47	47.65	53.65
S.Em ±	1.11			
CD at 5%	3.25			

**Table 4:** Effect of various treatments on DTPA extractable available micronutrient (Fe, Mn, Zn and Cu) in soil after harvest of greengram.

Treatments	DTPA extractable			
	Fe	Mn	Zn	Cu
<b>Phosphorus (P)</b>				
P <sub>0</sub> – 0 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	19.99	21.92	0.826	2.353
P <sub>1</sub> – 20 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	20.27	22.23	0.839	2.361
P <sub>2</sub> – 40 P <sub>2</sub> O <sub>5</sub> kg ha <sup>-1</sup>	20.93	22.54	0.874	2.406
S.Em ±	0.38	0.42	0.013	0.034
CD at 5%	NS	NS	NS	NS
<b>FYM (F)</b>				
F <sub>0</sub> - 0 t ha <sup>-1</sup>	19.79	21.73	0.785	2.335
F <sub>1</sub> - 5 t ha <sup>-1</sup>	21.01	22.73	0.908	2.412
S.Em ±	0.31	0.34	0.011	0.028
CD at 5%	0.92	NS	0.032	NS
<b>Bio fertilizer (B)</b>				
B <sub>0</sub> – No inoculation	20.01	21.83	0.830	2.340
B <sub>1</sub> – PSB inoculation	20.79	22.63	0.861	2.404
S.Em ±	0.31	0.34	0.011	0.028
CD at 5%	NS	NS	NS	NS
<b>Interaction</b>				
P×F S.Em ±	0.54	0.59	0.019	0.048
CD at 5%	NS	NS	NS	NS
P×B S.Em ±	0.54	0.59	0.019	0.048
CD at 5%	NS	NS	NS	NS
F×B S.Em ±	0.44	0.48	0.015	0.039
CD at 5%	NS	NS	NS	NS
P×F×B S.Em ±	0.76	0.84	0.027	0.068
CD at 5%	NS	NS	NS	NS
CV (%)	6.49	6.52	5.58	5.02
Initial status	19.56	20.53	0.83	2.36

#### 4. Conclusion

From the result of experimentation, it can be concluded that greengram (Var. Meha) should be fertilized with application of P<sub>2</sub>O<sub>5</sub> @ 20 kg ha<sup>-1</sup> along with FYM @ 5 t ha<sup>-1</sup> and seed inoculation 10 ml kg<sup>-1</sup> seed with PSB in summer season under south Gujarat condition for getting higher yield, profit and maintenance the soil fertility.

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