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Effect of graded levels of phosphorus and bio fertilizers on growth and yield of green gram (*Vigna radiata* L.)

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Abstract
The field experiment was conducted on plot No.68 of 'C' block of Agronomy Department Farm, College of Agriculture, Dapoli Dist. Ratnagiri during *Rabi* season 2017 to study the "Effect of graded levels of phosphorus and bio fertilizers on growth, yield and quality of green gram (*Vigna radiata* L.) in *Rabi* season under lateritic soils of *Konkan*". The experiment was laid out in split plot design with three replications. The main plot treatments comprised four phosphorus levels, viz., P_1 (control), P_2 (25Kg P_2O_5 ha^{-1}), P_3 (25Kg P_2O_5 ha^{-1}) and P_4 (75Kg P_2O_5 ha^{-1}). The sub plot treatments comprised four bio fertilizer treatments *viz.*, control (B_1), Seed inoculation with *Rhizobium* and PSB bio fertilizers each @ 25 g kg^{-1} seeds (B_2) PSB, (B_3) *Rhizobium* and (B_4) *Rhizobium* + PSB thus, there were in all sixteen treatment combinations. Application of 50Kg P_2O_5 ha^{-1} with *Rhizobium* + PSB green gram seeds produced maximum and significantly higher grain and stover yield over rest of the treatments.

Keywords: green gram, phosphorus, bio fertilizers and rabi

Introduction
Pulses play an important role in Indian agriculture. The grain legumes are of high value and low input requiring crops and play vital role in crop diversification. The pulse crops occupy a unique position in Indian agriculture by virtue of their higher protein content than cereals and their capacity to fix atmospheric nitrogen. In the developed countries, grain legumes are important indirect source of animal protein feeds of good biological value. However, for many developing countries pulses constitute the cheap and readily available source of dietary protein. India is the world's largest producer as well as consumer of green gram. It produces about 1.5 to 2.0million tons of mung annually from about 3 to 4 million ha of area with an average productivity of 500kgha^{-1}. Green gram output accounts for about 10 to12 % of total pulse production in the country. Mung production in the country is largely concentrated in five states *viz*. Rajasthan, Maharashtra, Andhra Pradesh, Gujarat and Bihar. These five states together contribute for about 70% of total mung production in the country. Among these five states Rajasthan (26%), Maharashtra (20%) occupies the first two positions contributing over 46%. Andhra Pradesh contributes about 10 % while together Gujarat and Bihar account for about 13% of total production in the country. (Anonymous 2016a) [1]

Green gram commonly known as 'Moong bean' or 'moong'. It contains 24.3 per cent protein fairly rich in carbohydrates and also contains small amount of riboflavin and thiamine, also rich in phosphorus and iron. It generally grown as intercrop, mixed crop and sole crop in *kharif* as well as in summer season where adequate irrigation facilities are available. The area in Maharashtra under mung bean is 3.39 lakh ha while production is 1.75lakh tones and average yield 550kgha^{-1}, during 2015-16 (Anonymous, 2016b) [2]. In *Konkan* region it is cultivated mainly districts in Thane, Raigad and parts of Ratnagiri district in *rabi* season. It is short duration leguminaceae crop in rotation with rice. Similar to the leguminaceae pulses, green gram enriches soil nitrogen concentration. The seed inoculation with proper strain of phosphorus solubilize bacteria is also a low cost input for enhancing yield, as it solubilize the unavailable phosphorus in to the available form, which reduce the high cost of inorganic phosphorus fertilizer (Parveen *et al*, 2002) [4]. Therefore, studies were undertaken to determine the effect of sulphur, phosphorus and inoculation of phosphorus solubilizing bacteria and its combination on green gram.

Materials and Methods

The field experiment was conducted on plot No.68 of Agronomy Department Farm, College of Agriculture, Dapoli. Dist. Ratnagiri during *Rabi* season of 2017. The selection of the site was considered on the basis of suitability of the land for the cultivation of green gram. The soil analysis indicated that the experimental plot was sandy clay loam in texture, medium in available nitrogen and phosphorus, high in available potassium, very high in organic carbon and slightly acidic in reaction. The quantity of fertilizer dose was calculated as per the treatments and applied in the plots as per the treatments and mixed thoroughly in to the soil after layout. Nitrogen and phosphorus were applied in the form of urea and single superphosphate as per the treatments. The whole quantity of fertilizers was applied as a basal dose before sowing.

Required quantity of healthy, bold, unbroken and fully developed seeds of green gram was inoculated with *Rhizobium* and PSB bio fertilizers @ 25gkg^{-1} seeds before sowing of the crop. Rows were marked on the field with the help of marker and bio fertilizers treated and untreated seeds were sown at the spacing of 30cm × 10cm as per the treatments. Two seeds were dibbled at each hill at about 3 cm depth. Seeds were properly covered with the soil to obtain uniform germination and plant stand. The experimental crop was harvested when pods were fully matured. Harvesting was carried out manually by cutting the crop at ground level with sharp sickle. Five observational plants were harvested separately for recording the yield contributing characters and yield were recorded.

Results and Discussions

Effect of phosphorus levels on growth and yield of *rabi* green gram

In the green gram crop, the growth contributing characters *viz.*, number of functional leaves plant^{-1} and number of branches plant^{-1}, dry matter production, functional leaves plant^{-1}, was increased at phosphorus level of 50 kg P2O5 ha-1, at all the stages of crop growth followed by remaining treatments. Application of phosphorus level 50 kg P2O5 ha^{-1} recorded significantly more, yield contributing characters namely number of pods plant^{-1}, number of grains pod^{-1}, test weight of grain, length of pod, grain yield plant^{-1} and stover yield plant^{-1} were significantly more under phosphorus level (50 kg P_2O_5 ha^{-1}) and found at par with treatment (75 kg P_2O_5 ha^{-1}) than rest of the treatments. Application of phosphorus levels significantly influenced on grain and straw yield of green gram crop. Phosphorus level P_3 (50 kg P_2O_5 ha^{-1}) recorded significantly more grain and stover yield than rest of the treatment. Data further revealed that the magnitude of increase in grain yield recorded were 13.51 %, 3.40 % and 01.50 % respectively.

Effect of bio fertilizers on growth and yield of *rabi* green gram

Application of bio fertilizers (*Rhizobium* + PSB) recorded highest growth contributing characters *viz.*, maximum height of the plant, functional leaves plant^{-1}, branchesplant^{-1}, and dry matter production throughout the growth period of the crop as compared to all rest of the treatments. Yield contributing characters namely number of pods plant^{-1}, number of grains pod^{-1}, test weight of grain, length of pod, grain and stover yield plant^{-1} were significantly more under treatment (*Rhizobium* + PSB) and which is greater than the single inoculation of *Rhizobium* and PSB. It showed significant improvement due to application of bio fertilizers. The treatment (*Rhizobium* + PSB) was reported significantly more grain and stover yield than rest of the treatment.

Table 1: Mean plant height (cm), number of functional leaves plant^{-1}, branches plant^{-1} and dry matter production plant^{-1} (g) of green gram as influenced periodically by different treatments

Treatments	Plant height (cm)	Number of functional leaves plant^{-1}	Branches plant^{-1}	Dry matter production plant^{-1} (g)
Phosphorous levels				
P_1: 00 Kg P_2O_5 ha^{-1}	35.37	7.70	3.09	10.86
P_2: 25 Kg P_2O_5 ha^{-1}	37.91	8.08	3.40	12.96
P_3: 50 Kg P_2O_5 ha^{-1}	41.96	9.44	3.63	15.08
P_4: 75 Kg P_2O_5 ha^{-1}	39.27	8.79	3.44	13.82
S. EM ±	0.77	0.13	0.10	0.56
C.D. at 5 %	2.65	0.46	0.34	1.95
Bio fertilizers				
B_1:No Bio fertilizer	36.96	7.99	3.07	11.70
B_2: PSB	38.26	8.26	3.41	12.20
B_3: Rhizobium	38.83	8.54	3.51	13.34
B_4: PSB +Rhizobium	40.46	9.23	3.58	15.50
S. EM ±	0.75	0.25	0.13	0.53
C.D. at 5 %	2.18	0.72	0.38	1.55
Interaction effect				
S. EM ±	1.49	0.49	0.26	1.06
C.D. at 5 %	NS	NS	NS	NS
General mean	38.62	8.50	3.39	13.18

Table 2: Mean yield contributing characters of green gram as influenced by different treatments

Treatments	Total number of pods plant^{-1}	Length of pod (cm) plant^{-1}	Number of grains pod^{-1}	Test Weight (g)	Grain yield (g) plant^{-1}	Grain yield (q ha^{-1})	Stover yield (g) plant^{-1}	Stover yield (q ha^{-1})
Phosphorous levels								
P_1 : 00 Kg P_2O_5 ha^{-1}	9.97	7.10	9.21	46.33	2.77	9.22	4.38	14.61
P_2 : 25 Kg P_2O_5 ha^{-1}	11.70	7.26	10.71	47.66	3.08	10.28	4.51	15.04
P_3 : 50 Kg P_2O_5 ha^{-1}	13.35	8.13	11.33	51.12	3.88	12.68	4.93	16.44
P_4 : 75 Kg P_2O_5 ha^{-1}	12.80	8.07	11.05	48.23	3.61	12.08	4.83	16.09
S. EM ±	0.61	0.11	0.55	0.91	0.05	0.13	0.06	0.17
C.D. at 5 %	2.10	0.38	0.98	3.14	0.17	0.44	0.19	0.58
Bio fertilizers								
B_1: No Bio fertilizer	9.31	7.27	9.89	46.98	2.37	7.92	3.44	8.35
B_2: PSB	12.35	7.47	10.06	47.22	2.42	8.07	3.42	8.55
B_3: Rhizobium	12.75	7.60	10.77	49.08	2.46	8.19	3.51	8.77
B_4: PSB + Rhizobium	13.41	8.22	11.54	50.06	2.76	8.99	3.73	9.32
S. EM ±	0.59	0.23	0.52	0.82	0.09	0.27	0.08	0.25
C.D. at 5 %	1.71	0.66	1.51	2.40	0.25	0.78	0.22	0.75
Interaction effect								
S. EM ±	1.17	0.46	1.04	1.64	0.17	0.53	0.15	0.51
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
General mean	11.95	7.64	10.43	48.34	2.50	8.29	3.60	11.66

Conclusion

On the basis of present investigation it can be concluded that for obtaining higher growth, yield and economics returns in the green gram crop be grown during the *Rabi* season with application of 50kgP_2O_5 ha^{-1} along with seed inoculation of *Rhizobium* and PSB bio fertilizers each @ 25gKg^{-1} seeds.

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