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Effect of conjunctive use of phosphorus and bio-organics on growth and yield of groundnut (*Arachis hypogaea*)

A.S. PANWAR AND N.P. SINGH

Division of Agronomy, ICAR Research Complex for NEH Region, Umiam, Meghalaya 793 103

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ABSTRACT

A field experiment was conducted during the rainy season of 2000 and 2001, to study the effect of conjunctive use of phosphorus and bio-organics on groundnut (*Arachis hypogaea* L.). Application of 60 kg P_2O_5/ha markedly influenced the growth and yield attributes resulting in significant increase of pod yield by 14.01% over the control. Seed inoculation with *Rhizobium* or phosphorus-solubilizing micro-organism (PSM) marginally improved yield, but their combined use increased pod yield significantly. Both the organics, i.e. FYM and need-cake, significantly increased the pod and haulm yields, but when half quantity of these organics were integrated with *Rhizobium* and PSM, the highest pod yield of 31.80 q/ha with FYM 5 tonnes/ha + *Rhizobium* + PSM was obtained. Neem-cake @ 1.5 tonnes/ha in the presence of same biofertilizers was next to it.

Key words : Rhizobium, PSM, Groundnut yield

Among the oilseed crops, groundnut stands first by contributing 29% area and 36% production of oilseed in India (DES, DAC, 1998). The decline in soil fertility and productivity are the matter of nutrient imbalance, which is recognized as one of the most important factors that limits the crop yield (Nambiar and Ghosh, 1984). Phosphorus is one of the nutrients, which is required in large quantity for optimum growth and yield in oilseeds. Groundnut responds well to higher levels of phosphorus fertilization, especially in acidic soil conditions of higher P-fixing capacity necessitating to lay emphasis on supplementing the use of chemical fertilizer with cheaper source of nutrient, viz. biofertilizer and organics. The biofertilizers are cost effective and eco-friendly, supplement the nutrients requirement of the plants and their use in association with inorganic and organic manures prove beneficial in improving yield and soil health. Therefore, integrated nutrient management is an important aspect in groundnut, as it does not only fetch promising yields but also maintain soil fertility. Keeping this in view, the present investigation was carried out to study the effect of bio-organics in the presence or absence of phosphorus under mid-hill altitude of Meghalaya.

MATERIALS AND METHODS

The field experiment was conducted during the rainy seasons of 2000 and 2001 at ICAR Research Complex for NEH Region, Umiam, Meghalaya. The soil was sandy loam having pH 4.6, organic carbon 1.53%, low in available nitrogen (255 kg/ha) and phosphorus (8.9 kg/ha) and medium in available K_2O (250 kg/ha). The experiment was laid out in randomized block design, replicated thrice with 16 treatment combinations of 2 phosphorus levels (0 and 60 kg P_2O_5/ha) and 8 biofertilizers and organics, viz. control, seed inoculation with *Rhizobium* (RB), seed inoculation with phosphorus-soliubilizing micro-organism (PSM), seed inoculation with RB + PSM, neem-cake 3 tonnes/ha, FYM 10 tonnes/ha, neem-cake 1.5 tonnes/ha + RB + PSM and FYM 5 tonnes/ha + RB + PSM. Groundnut cultivar 'ICGS 76' was sown on 22 and 28 May 2000 and 2001, respectively, with a spacing of 30 cm × 10 cm. A starter dose of 20 kg N/ha through urea and 40 kg K_2O/ha through muriate of potash as common dose to each plot and phosphorus through single superphosphate as well as organic manures were applied basal treatment-wise at the time of sowing. The seed was inoculated as per treatment with respective biofertilizer and sown the next day in the field. All the agronomic practices were followed throughout cropping period. The growth and yield attributes were recorded at harvest. The data of both years were pooled and analysed.

RESULTS AND DISCUSSION

Effect of phosphorus

Application of 60 kg P_2O_5/ha significantly improved plant height, branches, leaves and pods/plant over the

control (Table 1). This may be because of the fact that phosphorus encourages the cell division and cell elongation in the maristematic region of the plant, besides helping in nitrogen fixation, thereby results in improved growth and development of the plant. The increase in the vegetative growth owing to P application resulted in the production of more pods/plant and improved the kernel weight. Maximum pod yield up to 19.30 g/plant recorded with application of 60 kg P_2O_5/ha was 17.68% higher over the control (Table 2). These effects could be reflected in overall yield of crop, recording the highest pod and haulm yields of 28.40 and 48.41 q/ha with 60 kg P_2O_5/ha, being 14.01 and 21.32% higher over the control respectively. These results are in line with those of Majumdar *et al.* (2001). Harvest index was also significantly improved owing to 60 kg P_2O_5/ha during both the years.

Effect of bio-organics

Plant height, branches and leaves/plant were significantly improved with the application of biofertilizer combined with organics. The increase in height was possibly due to the elongation of internodes. The FYM @ 10 tonnes/ha and FYM @ 5 tonnes/ha + *Rhizobium* (RB) + phosphorus solubilizing micro-organisms (PSM) gave the maximum plant height of 51.34 cm and 51.15 cm respectively. Highest number of branches and leaves/plant were recorded with FYM @ 5 tonnes/ha + RM + PSM, followed by neem-cake 1.5 tonnes/ha + RB + PSM. This increase was attributed to the continuous supply of nutrients due to the action of biofertilizer and release of nutrients from organics. Maximum values of yield attributes, viz. pods/plant, 100-kernel weight and pod yield/plants, were recorded with FYM 5 tonnes/ha + RB + PSM. The better response in yield attributes significantly increased the pod yield of groundnut, as there is positive correlation of pod yield with growth and yield attributes (Manoharan *et al.*, 1988). Thus more branches and leaves/plant increased the number of pods and kernel weight. More pod yield/plant showed its additive effect on pod yield (q/ha) with the application of *Rhizobium* and PSM combined with FYM @ 5 tonnes/ha, recording pod yield of 31.80 q/ha, which was at par with the yield recorded due to neem-cake 1.5 tonnes/ha + RB+ PSM and significantly superior to rest of the treatments (Table 3). The increase in pod yield owing to these treatments may be due to the fact that N and P play an important role in the synthesis of chlorophyll and amino acids (Black, 1967) and *Rhizobium* and PSM ensured the continuous supply of these nutrients, while organics (FYM/neem-cake) besides supplying N, P and K also improved the soil condition, which enhanced the root proliferation and source– sink relationship (Bhattacharya and Ghosh, 2001).

It was also observed that single inoculation of *Rhizobium* of PSM marginally improved the pod and haulm yields but their combined use significantly improved pod yield 28.80% higher over that of the control (19.62 q/ha). It indicated that when both cultures applied together had synergistic effect on each other and gave more yield. Application of FYM or neem-cake also improved the yield by 41.84% and 41.43% over the control, respectively, but when half quantity of these organics was integrated with both the biofertilizers the

Table 1. Effect of phosphorus and bio-organic sources on growth and yield attributes in groundnut (average data of 2 years)

Treatment	Plant height (cm)	Branches/ plant	Leaves/ plant	Pods/ plant	Pod yield (g/plant)	100-kernel weight (g)
Phosphorus (kg/ha)						
P_0	46.55	9.75	12.10	14.55	16.40	62.32
P_{60}	49.80	11.80	14.30	18.57	19.30	67.29
CD (P=0.05)	2.26	1.15	1.08	1.24	1.16	1.17
Bio-organic sources						
Control	42.02	7.95	9.83	12.95	13.35	61.17
Rhizobium (RB)	46.96	9.75	11.58	14.85	15.40	64.39
PSM	47.20	10.78	11.51	15.15	15.76	63.72
RB + PSM	47.75	11.24	13.08	16.65	17.07	65.68
Neem-cake 3 tonnes/ha	48.55	10.50	13.90	17.09	19.08	66.71
FYM 10 tonnes/ha	51.34	10.60	14.75	18.05	20.05	67.30
Neem-cake 1.5 tonnes/ha + RB + PSM	50.45	11.95	15.42	19.65	20.38	68.26
FYM 5 tonnes/ha + RB + PSM	51.15	12.44	15.58	18.35	20.98	69.22
CD (P=0.05)	4.51	2.29	2.16	2.47	2.31	2.34

PSM, Phosphorus-solubilizing micro-organisms

Table 2. Effect of phosphorus and bio-organic sources on yield and harvest index of groundnut (average data of 2 years)

Treatment	Pod yield (q/ha)	Haulm yield (q/ha)	Harvest index
Phosphorus (kg/ha)			
P_0	24.91	39.90	35.18
P_{60}	28.40	48.41	36.59
CD (P=0.05)	1.08	1.89	0.62
Bio-organic sources			
Control	19.93	34.35	32.38
Rhizobium (RB)	24.44	41.65	35.48
PSM	24.72	42.56	35.56
RB + PSM	25.67	43.50	35.91
Neem-cake 3 tonnes/ha	27.75	45.60	36.32
Neem-cake 3 tonnes/ha	28.27	46.96	36.65
Neem cake tonnes/ha + RB + PSM	30.66	49.04	37.18
FYM 5 tonnes/ha+RB+PSM	31.80	49.70	37.56
CD (P=0.05)	2.15	3.78	1.24

PSM, Phosphorus-solubilizing micro-organisms

improvement in yield was 59.56 and 53.38% in the same order. These results are in the line of Agasimani and Hosmani (1989), who reported 64% improvement in pod yield with the application of 7.5 tonnes FYM/ha.

Thus the productivity of groundnut can be increased with the application of 60 kg P_2O_5/ha and seed inoculation with *Rhizobium* and PSM along with any of the organics (5.0 tonnes FYM or 1.5 tonnes neem-cake/ha) under mid-hill agro-climatic conditions of Meghalaya.

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