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Research Paper

Studies on organic cultivation of groundnut (*Arachis hypogaea*) in Cooch Behar

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ABSTRACT

A field experiment was conducted at Cooch Behar, West Bengal during the Pre-*Kharif* seasons of 2008 and 2009 in a randomized complete block with twelve treatments to study the effect of organic sources of nutrients on physiological characters, yield attributes and pod yield of groundnut (*Arachis hypogaea* L.). The results showed that groundnut can be organically produced, provided adequate phosphorus is applied as phosphocompost. The highest yield of groundnut obtained with combination of phosphocompost, poultry manure, neem cake and vermicompost. FYM, vermicompost, neem cake and poultry manure applied alone was not able to adequately supply plant nutrients specially phosphorus and gave low yield of groundnut. Net photosynthesis rate recorded the highest correlation coefficient (0.948) with pod yield of groundnut.

Key words: FYM, Neem cake, Poultry manure, Phosphocompost, Photosynthesis, Stomatal conductance, Transpiration, Vermicompost

Groundnut is a promising oilseed crop grown on light textured up and medium land soils in the northern part of West Bengal. Soils of north West Bengal are mostly acidic there is a serious problem of fixation of phosphorus and lowered availability of micro-nutrients like zinc, boron and molybdenum, which leads to poor nodulation, reduced photosynthesis and low yield of groundnut and other leguminous crops. Organic manures have traditionally been the important input as sources of plant nutrients. They play a direct role in supplying macro and micronutrient and indirectly improve the physical, chemical and biological properties of soils (Palaniappan and Siddeswaran, 1994). Further organic farming in recent years is gaining impetus due to better price for the farm produce. Use of farmyard manure with other organic amendments like vermicompost, neem seed cake, phosphocompost and poultry manure, *etc*., provide a safer and environment friendly way of applying nutrients to groundnut (Prasad, 2005). Considering these facts in view an experiment was conducted to study the effect of organic manures and amendments on physiology, growth and yield of groundnut.

MATERIALS AND METHODS

The experiment was carried out at the instructional farm of Uttar Banga Krishi Viswavidyalaya during pre *Kharif* seasons of 2008 and 2009. The farm is situated at $26^0$19’86" N latitude and $89^0$23’53" E longitude at an elevation of 43 meters above mean sea level. The soil was a sandy loam, (63.27 % sand, 20.19 % silt and 16.54% clay) with a pH of 5.45. It was low in available nitrogen (158.72 kg/ha), available phosphorus (26.35 kg/ha) and available potash (112.20 kg/ha). Groundnut ‘TAG-24’ was sown in the second fortnight of February with a spacing of 30 cm × 10 cm. The experiment was laid out in a randomized block design with 12 treatments with three replications. Treatments comprised of FYM @ 10 t/ha, vermicompost (VC) @ 5 t/ha, phosphocompost (PC) @ 5 t/ha, poultry manure (PM) @ 5 t/ha, neem cake (NC) @ 5 t/ha, FYM @5 t/ha + neem cake @ 2.5 t/ha, vermicompost @ 2.5 t/ha + neem cake @ 2.5 t/ha, phosphocompost @ 2.5 t/ha + neem cake @ 2.5 t/ha, poultry manure @ 2.5 t/ha + neem cake @ 2.5 t/ha, VC @ 2.5 t/ha + PC @ 2.5 t/ha+ PM @2.5 t/ha + NC @ 2.5 t/ha, 100 % recommended dose of fertilizer (N:P:K=20:60:60) and control. The N-P-K content of FYM, poultry manure, vermicompost, neem cake and phosphocompost were 0.82-0.44-0.58, 2.25-0.73-1.50, 2.25-0.72-1.26, 4.93-1.03-1.32 and 1.20-6.93-0.28% respectively. All the organics were incorporated 20 days before sowing of groundnut. All the agronomic practices were adopted as per need for the crop.

Data on growth and yield attributes from randomly selected five plants from each net plot was recorded and the mean value was worked out. After harvesting the crop from net plot, the pods were separated from plants from

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each experimental plot; sun dried, cleaned thoroughly and weighed. Physiological parameters were measured on the flag leaves of five plants per plot using a CI-340 Ultra Light Portable Phototosynthesis system (CI-301PS CO2 Gas Analyzers, CID Inc., 1996, USA) at 60 DAS. The traits measured were net photosynthetic rate (Pn), stomatal conductance (gs) and transpiration rate (E) at 60 DAS. Agronomic efficiency (AE) was calculated using the following formulae suggested by Prasad (2009).

All data were statistically analyzed by using WINDOSTAT Software Version-7. Significance of the treatments was determined on the basis of F test. Critical differences were calculated at 5% level of probability. Linear correlation analyses were used to determine the association between kernel yield, net photosynthesis and yield attributes using SPSS statistical software version 17.0.

RESULTS AND DISCUSSION

Physiological parameters

Application of NPK through inorganic and organic fertilizers significantly increased net photosynthesis rate over control, there being no significant difference between various treatments (Table 1). Transpiration rate was not significantly influenced by manurial/ fertilizer treatments. Stomatal conductance was the highest (1804.8 mili/mol/m^2/s) with PM+NC+VC+PC; significantly more than all other treatments. Stomatal conductance rate with inorganic fertilizer (RDF) was no better than control. Thus organic manures increased stomatal conductance. In general, VC with PC+PM+NC and FYM/VC with NC recorded higher stomatal conductance.

Growth characters and yield attributes

Application of manures/ fertilizers significantly increased plant height, branches/plant and pod yield over control (Table 1). PM + NC + VC + PC gave significantly tallest plants (52.8 cm), more number of branches/plant (6.8) and pods/plant (54.2) than chemical fertilizer and several other organic manure treatments. As regards to pods/plant various treatments were with following order PM + NC + VC + PC > PC + NC > PM + NC > FYM + NC or VC + NC > RDF > PC or PM or NC > FYM or VC. Thus, in general a combined application of two organic manures was better than a single some application.

Single vs multiseeded pods

The largest numbers of pods were two seeded (Table 2). Control plot had the most single seeded pods, indicating the necessity of supply of plant nutrients for filling of pods. Even FYM and VC plots were at par with control. Two seeded and three seeded pods were the most with PM + NC + VC + PC, resulting in the highest pod yield (Table 2). Combined application of 2 or more than 2 sources of organic manure was better than their single application.

Pod and haulm yields

100% RDF were at par with all the treatments receiving 2 or more than 2 sources of organic manure in respect of pod yield and produced significantly more pods than control. FYM was inferior to all other manures and 100% RDF. Highest pod yield (2075 kg/ha) of groundnut was obtained from combine application of PM + NC + VC + PC (Table 2). This was mainly due to fact that apart from source of nutrient, combined application of organic manures improved the soil environment which encouraged proliferous root system resulting in better absorption of water and nutrients from lower layers and thus resulting in

Table 1. Effect of organics on physiology, growth and yield attributes of groundnut (data averaged over 2 years of study)

Treatment	Net photosynthesis rate (micro mol/m^2/s)	Transpiration rate (mili mol/m^2/s)	Stomatal conductance rate(mili mol/m^2/s)	Plant height at harvest (cm)	No. of branches/ plant	No. of pods/ plant
FYM @ 10 t/ha (T_1)	42.0	1.25	715.6	43.5	4.7	33.3
Vermicompost @ 5 t/ha (T_2)	46.5	1.21	941.5	44.4	4.9	34.4
Phosphocompost @ 5 t/ha (T_3)	53.5	1.39	913.1	46.8	5.8	38.9
Poultry manure @ 5 t/ha (T_4)	50.7	1.34	607.9	45.6	5.4	36.2
Neem cake @ 5 t/ha (T_5)	51.5	1.39	883.9	46.4	5.6	37.3
FYM @5 t/ha + NC @ 2.5 t/ha (T_6)	54.8	1.41	1427.4	47.9	6.3	40.5
VC @ 2.5 t/ha + NC@ 2.5 t/ha (T_7)	55.9	1.46	1033.1	48.1	6.3	41.0
PC @ 2.5 t/ha + NC @ 2.5 t/ha (T_8)	58.5	1.56	751.8	49.3	6.5	48.5
PM @ 2.5 t/ha + NC @ 2.5 t/ha (T_9)	57.5	1.50	532.5	48.3	6.5	44.3
PM + NC + VC + PC @ 2.5 t/ha each (T_{10})	64.2	1.72	1804.8	52.8	6.8	54.2
100% RDF (T_{11})	52.8	1.39	571.5	47.1	6.0	39.8
Control (T_{12})	30.2	1.21	421.5	38.7	4.3	21.7
SEm±	8.82	0.18	241.63	0.93	0.21	1.12
CD (P=0.05)	19.48	0.42	513.75	2.62	0.59	3.42

higher pod yield. Among the sole application of organics, phosphocompost @ 5 t/ha produced highest pod yield, which was followed by neem cake, poultry manure, vermicompost and FYM. The trend of results was similar with haulm yield of groundnut. These results are in accord with those reported by Singravel *et al*. (2006) Paramasivam *et al*. (2006), Elayaraja and Singaravel (2007), Chandrasekaran *et al*. (2007) and Panwar and Munda (2007).

Agronomic efficiency (AE)

Agronomic efficiency was the highest (32.51 kg pod/kg N) with PC, which was at par with 100% RDF and significantly superior to all other organic manures. The next in order is PC + NC. The results show that phosphate fertilizer, which was present in PC and RDF played a key role in increasing pod yield of groundnut. Organic manures released phosphorus too slowly to increase pod yield in groundnut. Importance of adequate phosphorus fertilization in groundnut is well established (Shelka *et al.,* 1997, Prasad 2008).

Correlation analysis

Pod yield exhibited positive and significant correlations with net photosynthesis rate (0.948) and transpiration rate (0.681) at 60 DAS, while stomatal conductance rate exhibited positive correlation with pod yield (0.491) but not significant (Fig. 1, 2 and 3). Coefficient of determinants indicated that highest variation of (89.90 %) pod yield was due to net photosynthesis rate, followed by transpiration rate (46.40%) and stomatal conductance rate (24.1%). Pod

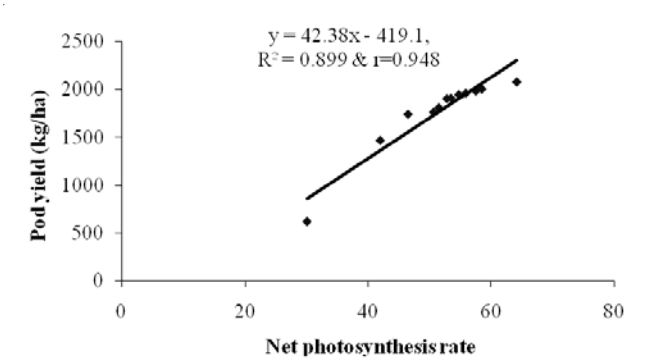

Fig. 1. Correlation coefficient between net photosynthesis & pod yield

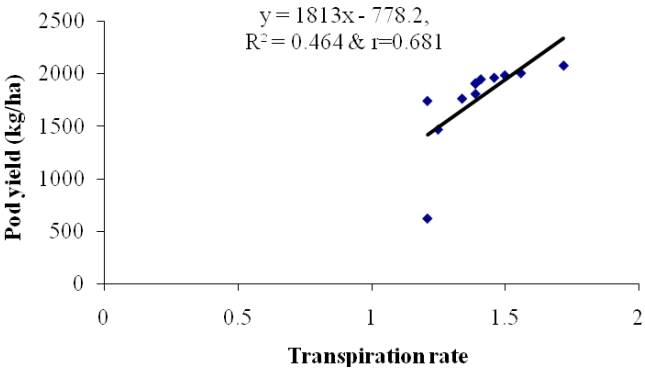

Fig. 2. Correlation coefficient between transpiration rate & pod yield

yield had highly significant and positive association with plant height, number of branches/plant, number of pods/plant, net photosynthesis rate, transpiration rate, two seeded and 3 seeded pods/plant (Table 3). Similar results

Table 2. Effects of organic sources of nutrients on yield attributes, yield and agronomic efficiency of groundnut (data averaged over 2 years of study)

Treatment	Number of 1 seeded pods	Number of 2 seeded pods	Number of 3 seeded pods	Pod yield (kg/ha)	Haulm yield (kg/ha)	Agronomic efficiency (kg pod/ kg N)
FYM @ 10 t/ha (T_1)	5.3	14.8	3.9	1468	1924	8.28
Vermicompost @ 5 t/ha (T_2)	5.2	15.6	4.1	1740	1961	9.83
Phosphocompost @ 5 t/ha (T_3)	4.3	17.3	4.8	1908	2056	32.51
Poultry manure @ 5 t/ha (T_4)	4.7	16.0	4.3	1761	1987	7.63
Neem cake @ 5 t/ha (T_5)	4.5	17.2	4.7	1806	2015	6.61
FYM @5 t/ha + NC @ 2.5 t/ha (T_6)	3.9	18.2	5.2	1945	2087	9.40
VC @ 2.5 t/ha + NC@ 2.5 t/ha (T_7)	3.4	18.8	5.5	1960	2122	9.13
PC @ 2.5 t/ha + NC @ 2.5 t/ha (T_8)	3.0	21.6	5.8	2003	2216	12.62
PM @ 2.5 t/ha + NC @ 2.5 t/ha (T_9)	3.1	20.6	5.7	1982	2148	8.29
PM + NC + VC + PC @ 2.5 t/haeach (T_{10})	2.3	24.3	6.1	2075	2271	6.03
100% RDF (T_{11})	4.6	17.8	5.1	1902	2077	31.97
Control (T_{12})	5.6	5.53	3.5	624	1357	-
SEm±	0.22	2.32	0.12	81.5	19.6	1.92
CD (P=0.05)	0.62	6.58	0.34	231.0	55.9	5.46

Table 3. Correlation between morphological characters, yield attributes and pod yield of groundnut

Growth, yield & morphological characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	Y
Plant height (X1)	1.00									
No. of branches/plant (X2)	.945**	1.00								
No. of pods/plant (X3)	.984**	.927**	1.00							
Net photosynthesis at 60 DAS (X4)	.987**	.946**	.963**	1.00						
Transpiration rate at 60 DAS (X5)	.915**	.925**	.930**	.874**	1.00					
Stomatal conductance DAS (X6)	.654*	.530	.603*	.576*	.581*	1.00				
1 seeded pod/plant (X7)	-.909**	-.948**	-925**	-.889**	-.967**	-.561	1.00			
2 seeded pod/plant (X8)	.979**	.902**	.979**	.977**	.856**	.572	-.868**	1.00		
3 seeded pod/plant (X9)	.931**	.990**	.932**	.925**	.935**	.498	-.964**	.897**	1.00	
Pod yield (Y)	.908**	.832**	0.868**	.948**	.681*	.491	-.717**	.940**	.798**	1.00

**and *Significant at 0.01 and 0.05 % level

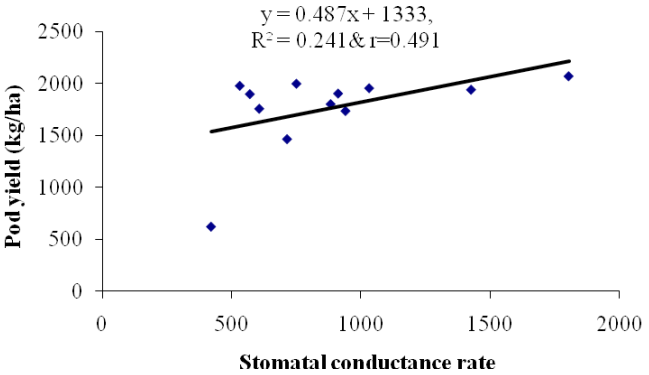

Fig. 3. Correlation coefficient between stomatal conductance & pod yield

were obtained by Ladole *et al.*, (2009). Plant height, number of branches/plant, number of pods/plant, net photosynthesis rate, transpiration rate, 2 seeded and 3 seeded pods/plant showed significant and positive inter correlations among themselves. Similar results were recorded by Reddy and Gupta (1992). One seeded pod/plant had significant negative association with the all yield attributing characters. Among the yield attributes and physiological parameters, the highest positive correlation was determined between net photosynthesis rate and pod yield (0.948) followed by 2 seeded pods/plant and pod yield (0.940).

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