



## Yield, nutrient uptake and quality of groundnut (*Arachis hypogaea*) kernels as affected by organic sources of nutrient

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### ABSTRACT

A field experiment was conducted during pre-kharif seasons of 2008-09 to study the effect of organics on yield and quality of groundnut (*Arachis hypogaea* L.) under *terai* region of West Bengal. The experiment was laid out in randomized block design with 12 treatments and replicated thrice. Results revealed that poultry manure 2.5 t/ha + neem cake 2.5 t/ha + vermicompost 2.5 t/ha + phosphocompost 2.5 t/ha gave 2.08 tonne pod yield/ha, which was 9.47% higher over recommended dose of chemical fertilizer. Combined application of vermicompost 2.5 t/ha + phosphocompost 2.5 t/ha + poultry manure 2.5 t/ha + neem cake 2.5 t/ha brought about significant improvement in N, P and K uptake by groundnut. Application of organic manures resulted in the improvement of soil organic carbon, available soil N, P and K compared to either recommended dose of fertilizers or control. Among the organic treatments, phosphocompost 5 t/ha recorded highest values of oil (46.7%), crude protein (22.4%), soluble protein (10.5%), total sugar (13.1%), starch (14.8 %), calcium (143.92 mg/100g) and phosphorus (836.6 mg/100g) during both the years.

**Key words:** Groundnut, Nutrient uptake, Organics, Quality and Yield

In the wake of serious pollution problems and bio-magnification of toxic chemicals in the various biological systems, 'Organic Farming' is the right approach in the present day agriculture. Organic farming in recent years is gaining impetus due to realization of inherent advantages it confers in sustaining crop production and also in maintaining dynamic soil nutrient status and safe environment. Use of farmyard manure with other organic amendments, like vermicompost, neem cake, phosphocompost and poultry manure, etc., has become imperative to go for rational use of organic inputs for sustainable crop production. Organic farming is one among the broad spectrum of production methods that are supportive to the environment. Organic production systems are based on specific standards precisely formulated for food production and aim at achieving agro ecosystems which are socially and economically sustainable. Groundnut is an important oil-seed crop in India. Though groundnut is primarily used for oil extraction it is also consumed directly because of its high food value which is again due to higher content of protein (22 %), carbohydrates (10 %), minerals (3%), niacin (17 mg/100g) and vitamin B especially thiamin content of 1 mg/100g (Rajagopal *et al.*, 2000). Considering all these aspects, the field experiment was conducted to see

the effect of organics on yield attributes, pod yield, nutrient uptake and quality of groundnut kernels under *terai* region of West Bengal.

### MATERIALS AND METHODS

The experiment was carried out at the instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, during pre-kharif seasons of 2008 and 2009. The farm is situated at 26°19'86" N latitude and 89°23'53" E longitude at an elevation of 43 meters above mean sea level. The soil was sandy loam, (63.27% sand, 20.19% silt and 16.54% clay) acidic with a pH of 5.45, low in available nitrogen (158.7 kg/ha), available phosphorus (26.3 kg/ha) and available potash (112.2 kg/ha).

The experiment was laid out in randomized block design with 12 treatments and replicated thrice. Treatments comprised of farmyard manure (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 + NC 2.5 t/ha, VC 2.5 t/ha + NC 2.5 t/ha, PC 2.5 t/ha + NC 2.5 t/ha, PM 2.5 t/ha + NC 2.5 t/ha, VC 2.5 t/ha + PC 2.5 t/ha + PM 2.5 t/ha + NC 2.5 t/ha, recommended dose of fertilizer (N:P:K=20:60:60) and control. All the organics were applied 20 days before sowing of

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groundnut. 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. Groundnut ‘TAG 24’ was sown in the second fortnight of February with a spacing of 30cm x 10cm. The plot size of 6m x 4m was maintained. The sowing and harvesting were 21 February and 5 June in 2008 and 22 February and 6 June in 2009 respectively.

Pod yield was recorded from individual plots at harvest and converted to tonne/ha. Composite soil sample were used to assess soil fertility and nutrient uptake. The concentration of iron, calcium and phosphorus in the groundnut kernels was determined by atomic absorption spectrophotometer (Perkin Elmer Model 2380). Carbohydrate, starch and total sugar was determined by anthrone method as described by Hedge and Hofreiter (1962) and expressed in percentage. Protein percentage was estimated by Lowry’s method (Lowry *et al.*, 1951). Oil percentage was estimated by Soxhlet method. Standard statistical methods were used for comparing the treatment means.

## RESULTS AND DISCUSSION

### *Yield attributes and pod yield*

Mature pods/plant, 100 pods weight, 100 kernels weight and shelling out-turn were significantly influenced by different organic sources of nutrients (Table 1). It was revealed from the Table 1 that all the yield attributing characters were found to be higher in the treatments receiving combination of organic manures than 100% RDF in both the years of investigation. Except phosphocompost 5 t/ha all the organically amended plot recoded lower yield attributing characters than the treatment with 100% RDF.

Organic manures alone may meet the lower nutrient demand, but combination of organic manures has become imperative to sustain high nutrient supply for higher productivity. Application of PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha recorded significantly higher number of mature pods/plant (42.00 and 48.08), 100 pod weight (86.77 & 90.25 g), 100 kernels weight (62.11 & 63.98 g) and shelling out turn (71.71 & 72.89) percentage, followed by PC 2.5 t/ha + NC 2.5 t/ha and PM 2.5 t/ha + NC 2.5 t/ha in both the years of investigation. This might be due to higher availability, higher uptake and greater conversion efficiency of applied nutrients by groundnut. Higher yield contributing characters in PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha ultimately resulted in highest pod yield (2.08 t/ha). The positive response to combine application of organic manures might be attributed to the better nutrient availability and its favorable effect on soil physical and biological properties resulting in increased yield attributes and finally higher yields. The results are in close agreement with the observations of Singaravel *et al.* (2006) and Elayaraja and Singaravel (2007).

Among the sole application of organic manures, phosphocompost 5 t/ha proved superior in producing pod yield, followed by neem cake 5 t/ha, poultry manure 5 t/ha, vermicompost 5 t/ha and FYM 10 t/ha. Except phosphocompost all the organically amended plot recorded lower pod yield than chemically fertilized plot in both the years (Table 1) and the pod yield was found to be higher in the second year irrespective of treatments except control, where pod yield was lower in second year. Lower pod yield might be due to comparatively lower crop growth rate at initial stages of growth. Application of

**Table 1.** Effect of organic sources of nutrient on yield attributes, pod yield and nutrient uptake of groundnut (Pooled data of 2 years)

Treatment	Mature pods/plant	100 pods weight (g)	100 kernels weight (g)	Shelling out-turn (%)	Pod yield (t/ha)	Nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)
FYM 10 t/ha	25.72	70.84	45.29	64.06	1.47	70.3	17.7	51.7
Vermicompost 5 t/ha	27.42	72.70	47.17	64.93	1.74	73.2	20.2	55.9
Phosphocompost 5 t/ha	29.74	77.52	49.52	63.86	1.91	88.5	21.8	63.4
Poultry manure 5 t/ha	27.65	73.89	48.31	65.43	1.76	79.4	20.5	59.5
Neem cake 5 t/ha	29.28	75.52	49.06	64.89	1.81	80.2	20.7	62.2
FYM 5 t/ha + NC 2.5 t/ha	31.82	80.03	51.93	64.86	1.95	93.0	22.9	68.8
VC 2.5 t/ha + NC 2.5 t/ha	32.60	80.50	53.34	66.49	1.96	96.7	24.2	68.9
PC 2.5 t/ha + NC 2.5 t/ha	37.36	85.60	57.24	67.50	2.00	103.0	26.2	75.0
PM 2.5 t/ha + NC 2.5 t/ha	34.81	82.20	55.76	67.96	1.99	98.7	25.8	71.2
PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha	45.04	88.51	63.05	72.30	2.08	134.1	30.7	80.5
RDF (20 : 60 : 60)	29.53	77.88	51.27	66.15	1.90	88.6	22.2	67.4
Control	12.25	60.60	39.74	64.81	0.62	52.4	11.9	32.4
SEm±	0.885	2.241	0.905	2.454	0.115	2.15	0.62	3.23
CD (P=0.05)	2.521	6.352	2.580	NS	0.327	6.13	1.77	9.15

phosphocompost 5 t/ha produced 1.91 tonne pod yield/ha which was 5.52%, 8.52%, 9.77 and 29.93% higher over neem cake 5 t/ha, poultry manure 5 t/ha, vermicompost 5 t/ha and FYM 10 t/ha.

#### Nutrient uptake and soil nutrient status

The nutrient uptake studies revealed that application of different sources of plant nutrients increased the uptake of major nutrients by groundnut (Table 1). The treatment receiving VC 2.5 t/ha + PC 2.5 t/ha + PM 2.5 t/ha + NC 2.5 t/ha recorded higher uptake of nutrients (N, P and K) by groundnut as compared to other treatments (Table 1). Combined application of VC 2.5 t/ha + PC 2.5 t/ha + PM 2.5 t/ha + NC 2.5 t/ha brought about significant improvement in N, P and K uptake by groundnut to the extent of 56.66 and 46.44, 34.02 and 41.38 and 23.46 and 15.74% during 2008 and 2009, respectively over the 100% RDF. Increased nutrient uptake with combined application of organic manures might be due to consistent supply of nutrients and reduced rate of loss of releasing nutrients during the process of decomposition of organic manure and also due to improved root growth and its functional activity which helped in greater extraction of nutrient.

Available nitrogen was found to be highest under PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha followed by neem cake 5 t/ha and PM 2.5 t/ha + NC 2.5 t/ha. It was revealed from the Table 2 that phosphocompost when applied, either solely or combined with other organic manures, recorded higher available phosphorus, the probable reason might be because of favourable soil pH achieved due to neutralisation of acidic soil pH by  $\text{CaCO}_3$

present in phosphocompost and holed the available soil phosphorus in organic form for a longer period of crop growth and also due to higher rate of mineralization of native soil phosphorus (Akbari *et al.* 2002). On the other hand, solely chemically treated plot recorded lower value of available phosphorus might be because of fixation of mono-calcium phosphate in acid soil of North Bengal. Treatments receiving poultry manure either solely or combined with other organic manures recorded maximum available potassium in both the years, might be due to higher potassium content in poultry manure (0.98 and 1.01% in 2008 and 2009, respectively). The higher available potassium can be attributed to higher mineralization potential of soils owing to organic matter application in the form of PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha and improved nutrient holding capacity of soils amended with organics. Soil pH increased from the initial value with the application of organic manures. Pooled data revealed that soil pH was found highest in phosphocompost 5 t/ha (6.05), followed by PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha (5.98) and PC 2.5 t/ha + NC 2.5 t/ha (5.93) however, lowest in control (5.27) plot. Phosphocompost application was found to increase the soil pH significantly. This was due to the increase in percentage of  $\text{CaCO}_3$  through the addition of phosphocompost, which raised the soil pH. There was significant variation in percent organic carbon of soil after harvesting of groundnut due to various treatments (Table 2). FYM 10 t/ha recorded significantly higher soil organic carbon, followed by PM 2.5 t/ha + NC 2.5 t ha + VC 2.5 t/ha + PC 2.5 t/ha. This was due to higher amount of organic matter

**Table 2.** Effect of organic sources of nutrients on soil nutrient status, soil pH and organic carbon after groundnut harvest (Pooled data of 2 years)

Treatment	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)	pH	Organic carbon (%)
FYM 10 t/ha	212.06	23.04	131.88	5.88	0.92
Vermicompost 5 t/ha	217.77	23.42	138.21	5.85	0.83
Phosphocompost 5 t/ha	215.30	32.99	118.95	6.05	0.80
Poultry manure 5 t/ha	218.62	24.48	154.77	5.91	0.84
Neem cake 5 t/ha	246.77	25.98	141.07	5.79	0.82
FYM 5 t/ha + NC 2.5 t/ha	227.90	24.20	134.74	5.77	0.85
VC 2.5 t/ha + NC 2.5 t/ha	236.20	25.43	143.97	5.76	0.81
PC 2.5 t/ha + NC 2.5 t/ha	235.11	26.55	133.15	5.93	0.80
PM 2.5 t/ha + NC 2.5 t/ha	238.18	25.21	144.88	5.82	0.82
PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha	254.15	28.72	151.41	5.98	0.90
RDF (20 : 60 : 60)	207.17	20.63	111.74	5.33	0.69
Control	107.25	11.35	62.46	5.28	0.55
SEM±	4.262	1.148	1.588	0.022	0.02
CD (P=0.05)	12.148	3.252	4.526	0.064	0.04

**Table 3.** Effect of organic sources of nutrients on quality parameters of groundnut kernels (Pooled data of 2 years)

Treatment	Oil content (%)	Crude protein (%)	Soluble protein (%)	Carbohydrate (%)	Total sugar (%)	Starch (%)	Calcium (mg/100g)	Phosphorus (mg/100g)	Iron (mg/100g)
FYM 10 t/ha	46.1	21.3	10.2	24.4	12.2	14.1	131.9	815.1	3.8
Vermicompost 5 t/ha	45.8	21.1	10.1	23.9	11.7	12.9	128.1	813.1	3.4
Phosphocompost 5 t/ha	46.7	22.4	10.6	25.3	13.1	14.8	143.9	836.7	2.7
Poultry manure 5 t/ha	45.4	21.0	9.6	23.5	11.4	12.7	126.1	811.7	3.2
Neem cake 5 t/ha	43.9	20.2	9.1	22.4	10.6	11.9	119.7	799.7	3.1
FYM 5 t/ha + NC 2.5 t/ha	45.9	21.2	10.1	24.0	11.7	13.6	130.3	814.3	3.4
VC 2.5 t/ha + NC 2.5 t/ha	44.1	20.8	9.2	22.7	10.9	12.0	123.7	808.6	3.0
PC 2.5 t/ha + NC 2.5 t/ha	44.8	20.9	9.3	22.8	11.4	12.2	125.8	810.5	2.9
PM 2.5 t/ha + NC 2.5 t/ha	43.4	19.8	8.2	22.2	9.6	11.5	117.8	796.0	3.0
PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha	45.9	21.6	10.3	24.6	12.8	14.6	133.8	824.1	3.4
RDF (20 : 60 : 60)	42.6	19.2	7.9	20.7	9.2	10.6	113.8	789.3	2.6
Control	39.5	16.0	6.8	17.9	7.9	9.1	96.8	728.5	2.4
SEm±	0.35	0.23	0.17	0.35	0.18	0.18	2.29	7.64	0.06
CD (P=0.05)	0.90	0.64	0.49	0.98	0.51	0.53	6.50	21.65	0.17

and greater activity of micro-organisms. pH and organic carbon decreased continuously in 100% RDF and control plot.

#### Quality parameters

Oil percentage did not differ significantly among the organic treatments. Pooled data of 2 years (Table 3) showed that application of phosphocompost 5 t/ha recorded highest (46.7%) oil percentage, followed by FYM 5 t/ha (46.1), FYM 5 t/ha + NC 2.5 t/ha (45.9) and PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha (45.9). Solely chemically treated plot and control plot recorded 9.80 and 18.50% lower oil content over the treatment recording highest oil percent *i.e.* phosphocompost 5 t/ha. According to Miller (1938), formation of lecithin, an important form in which the fats occur in plants, does not take place in absence of phosphorus. It was noticed that all organically treated plots proved superiority in terms of quality of groundnut than chemically treated plots. The higher carbohydrate might be due to synthesis of more glucose, due to application of organic manures. Based on pooled data (Table 3) it was observed that treatment receiving phosphocompost 5 t/ha recorded highest percentage of crude protein (22.4%), soluble protein (10.6%), carbohydrate (25.3%), total sugar (13.1%), starch (14.8%), calcium (143.9 mg/100g) and phosphorus content (836.7 mg/100g) which was followed by PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha, FYM 10 t/ha, FYM 5 t/ha + NC 2.5 t/ha, vermicompost 5 t/ha and poultry manure 5 t/ha. The probable reason might be due to more amounts of added phosphorus and sulfur through phosphocompost; both play an important role for the synthesis of proteins.

Besides supplying phosphorus and sulfur phosphocompost also add considerable amount of calcium in the soil which ultimately resulting into highest calcium content in groundnut kernels.

Iron content was found to be significantly highest (3.98 and 3.77 mg/100g) under sole FYM treated plot, followed by FYM 5 t/ha + NC 2.5 t/ha, PM 2.5 t/ha + NC 2.5 t/ha + VC 2.5 t/ha + PC 2.5 t/ha, vermicompost 5 t/ha and poultry manure 5 t/ha during both the years of investigation. The highest iron content of groundnut kernels in FYM treated plot might be due to higher supply and increased uptake of iron through enhanced availability from the soil than other organic manures. This was in line of harmony with the findings of Panwar and Munda (2007).

Based on the study, it is concluded that in *terai* region of West Bengal during pre-*kharif* season application of phosphocompost 5t/ha is superior to either recommended dose of fertilizers or sole application of vermicompost, neem cake, poultry manure and FYM, both in terms of production and quality of kernels.

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