Agronomic Efficiency, Partial Factor Productivity and Seed Yield of Groundnut (*Arachis hypogeae* L.) as Influenced by Different Sources of Organic Manures

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Abstract

An experiment was conducted at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during the Pre-Kharif season of 2008-2009 in a randomized complete Block with twelve treatments to study the effect of organic sources of nutrients on Agronomic efficiency, Partial factor productivity and Seed yield of groundnut. Pooled data over two years revealed that application of PM @ 2.5 t ha^{-1} + NC @ 2.5 t ha^{-1} + VC@ 2.5t ha^{-1} + PC @ 2.5 t ha^{-1} produced 19.32 and 267.05 % more seed yield of groundnut over 100 % RDF and control, respectively. Among the sole application of organics phosphocompost @ 5 t ha^{-1} recorded higher seed yield, though all the sole applied organic treatment recoded lower seed yield than 100 % RDF. Maximum partial factor productivity (PPF_N) of 63.02 kg seed kg^{-1} N and agronomic efficiency (AE_N) of 42.53 kg seed kg^{-1} N of groundnut was observed with 100 % RDF. Partial factor productivity of phosphorus (PFP_p) was found to be maximum (27.33 kg seed kg^{-1} P) under neem cake @ 5 t ha^{-1}, where as phosphocompost @ 5 t ha^{-1} gave significantly maximum (161.80 kg seed kg^{-1} K) partial factor productivity of potassium (PFP_K). Highest internal efficiency (13.71 and 17.35 kg seed kg^{-1} N uptake) was obtained from vermicompost @ 5 t ha^{-1} during 2008 and 2009, respectively.

1. Introduction

Adoption of inefficient N management practices is responsible for low partial factor productivity and agronomic efficiency. Partial factor productivity (PFP) and agronomic efficiency is a useful measure of nutrient use efficiency as it provides an integrative index that quantifies total economic output relative to the utilization of all nutrient resources in the system (Yadav, 2003). Groundnut is a promising oil seed crop in the congenial light textured up and medium land soil in the Northern part of West Bengal. But few soil constraints prevent the farmers from taking positive outlook about cultivation of this crop. Soils of North Bengal is mostly acidic in nature which aggravates the problem of fixation of phosphorus and reduced the availability of micro-nutrients like zinc, boron and molybdenum which leads to improper nodulation, pod formation and ultimately poor yield of number of pulse and oilseed crops under the *fabaceae* family. The application of essential plant nutrients in optimum quantity and right proportion, through correct method and time of application, is the key to increased and sustained crop production (Cisse and Amar, 2000). The production of high groundnut yields is highly responsible on adequate nutrient supply and nutrient uptake. 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 the management of soil organic matter for sustainable crop production. Considering all the facts in mind, the experiment was conducted to study the effect of organic sources of nutrient on Agronomic efficiency, Partial factor productivity and Seed yield of groundnut.

2. 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^{0}19'86" N latitude and 89^{0}23'53" E longi-

tude at an elevation of 43 meters above mean sea level. The soil is sandy loam, (63.27 % sand, 20.19 % silt and 16.54% clay) acidic in nature with a pH of 5.45, low in available nitrogen (158.72 kg ha^{-1}), available phosphorus (26.35 kg ha^{-1}) and available potash (112.20 kg ha^{-1}). Groundnut cv. 'TAG-24' was sown in the second fortnight of February with a spacing of 30 x10 cm. The experiment was laid out in randomized block design with 12 treatments and replicated thrice. Treatments comprised of FYM @ 10 t ha^{-1}, Vermicompost @ 5 t ha^{-1}; Phosphocompost (PC) @ 5 t ha^{-1}; Poultry manure (PM) @ 5 t ha^{-1}; Neem cake (NC) @ 5 t ha^{-1}; FYM @5 t ha^{-1} + NC @ 2.5 t ha^{-1}; VC @ 2.5 t ha^{-1} + NC @ 2.5 t ha^{-1}; PC @ 2.5 t ha^{-1} + NC @ 2.5 t ha^{-1}; PM @ 2.5 t ha^{-1} + NC @ 2.5 t ha^{-1}; VC @ 2.5 t ha^{-1} + PC @ 2.5 t ha^{-1} + PM @2.5 t ha^{-1} + NC @ 2.5 t ha^{-1}; 100 % recommended dose of fertilizer (N:P:K=20:60:40) 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 (well decomposed) were incorporated 20 days before sowing of groundnut. Field preparation was done by tractor followed by power tiller 3-4 times. There after individual plot of equal size (24 m^{-2}) were prepared and separated by bunds. 20 days after application of organics as per treatment groundnut was sown during 21st February and 22nd February in 2008 and 2009, respectively. All the agronomic practices were adopted as per need for the crop. All data were statistically analyzed by using WINDOSTAT Software Version-7. Treatments differences were found significant based on results of F test, critical differences were calculated at 5% level of probability.

Partial Factor Productivity (PFP), Agronomic Efficiency (AE) and Internal efficiency (IE) was determined according to following formulas.

$$\text{PFP (kg seed kg}^{-1}\text{ nutrient)} = \frac{\text{Seed yield of respective treatment (kg ha}^{-1}\text{)}}{\text{Quantity of nutrient added in treatment (kg ha}^{-1}\text{)}}$$

$$\text{AE (kg seed kg-1 N)} = \frac{\text{Seed yield of fertilized plot-seed yield of unfertilized plot}}{\text{Quantity of fertilizer N applied}}$$

$$\text{IE (kg seed kg}^{-1}\text{ N)} = \frac{\text{Seed yield (kg ha}^{-1}\text{)}}{\text{Total N uptake (kg ha}^{-1}\text{)}}$$

3. Results and Discussion

3.1. Partial factor productivity

2 years pooled data showed that maximum partial factor productivity (PPF_N) of 63.02 kg seed kg^{-1} N was obtained with 100 % RDF (Table 1 and 2). This was statistically at par with phosphocompost @ 5 t ha^{-1} (T_3). Combined application of organics gave significantly lowest PPF_N (12.51 kg seed kg^{-1} N).

Decline in partial factor productivity for N may be attributed to nutrient imbalance, decline in indigenous soil N supply and subsoil compaction (Karim and Ramasamy 2000). Partial factor productivity of phosphorus (PFP_p) was found to be maximum (27.33 kg seed kg^{-1} P) under neem cake @ 5 t ha^{-1} which was at par with T_6, T_7 and T_9, while 100 % RDF gave lowest PFP_P (9.03 kg seed kg^{-1} P). Application of phosphocompost @ 5 t ha^{-1} gave significantly maximum (161.80 kg seed kg^{-1} K) partial factor productivity of potassium (PFP_K) which was followed by T_8, where as groundnut grown with poultry manure @ 5 t ha^{-1} recorded lowest PFP_K. Higher partial productivity might be due to higher uptake and more utilization of indigenous nutrients, and increased efficiency of applied nutrients which are taken up by the crop and utilized to produce seed. Individual years also gave similar trend of result. Irrespective of treatments second year of experiment showed superiority in respect of partial factor productivity and agronomic efficiency might be due to higher seed yield.

3.2. Agronomic efficiency (AE) and Internal efficiency

In case of agronomic efficiency (AE), application of phosphocompost @ 5.0 t ha^{-1} (28.99 & 36.03 kg pod yield kg^{-1} N) showed its superiority, which was statistically at par with 100 % RDF (28.77& 35.16 kg pod yield kg^{-1} N) during both the year of investigation, might be due to higher pod yield and lesser quantity (19.75 & 20.00 kg ha^{-1}, respectively) of added nitrogen. Higher agronomic efficiency also might be due to enhanced uptake and use of N and by decreased N losses from the soil-plant system. Interestingly, treatment with highest pod yield i.e. T_{10} had the lowest value (5.61 & 6.46 kg pod yield kg^{-1} N in 2008 and 2009, respectively) of Agronomic efficiency might be due to addition of huge amount (120.25 kg ha^{-1}) of nitrogen through this treatment which cannot give pod yield at that level (Table 2). It has been seen that whenever nitrogen was applied in huge quantity gave comparatively lower values of agronomic efficiency. Yogananda (2001) also reported higher agronomic efficiency with organic manure application. All the treatments except 100 % RDF and control were statistically at par in respect with internal efficiency, however highest internal efficiency was obtained from vermicompost @ 5 t ha^{-1} during both the year of investigations.

3.3. Seed yield

Pooled data over the years showed that combined application of PM @ 2.5 t ha^{-1} + NC @ 2.5 t ha^{-1} + VC@ 2.5 t ha^{-1} + PC @ 2.5 t ha^{-1} (T_{10}) produced highest seed yield of 1503.75 kg ha^{-1} which was statistically equal with T_8 (1361.91kg ha^{-1}), T_9 (1349.22 kg ha^{-1}), T_7 (1298.99 kg ha^{-1}) and T_6 (1259.33 kg ha^{-1}). Higher

Table 1: Effect of organics on Partial factor productivity (kg seed yield per kg of nutrient) in groundnut

Treatments	Nitrogen (kg seed kg^{-1} of N)			Phosphorus (kg seed kg^{-1} of P)			Potash (kg seed kg^{-1} of K)		
	2008	2009	Pooled	2008	2009	Pooled	2008	2009	Pooled
FYM @ 10 t ha^{-1}	17.31	19.78	18.54	17.65	20.18	18.92	36.63	41.87	39.25
Vermicompost @ 5 t ha^{-1}	17.42	22.56	19.99	17.53	22.71	20.12	23.95	31.03	27.49
Phosphocompost @ 5 t ha^{-1}	57.65	65.73	61.69	11.87	13.53	12.70	151.20	172.39	161.80
Poultry manure @ 5 t ha^{-1}	13.77	17.18	15.48	15.62	19.49	17.55	17.12	21.36	19.24
Neem cake @ 5 t ha^{-1}	11.70	14.57	13.14	24.34	30.31	27.33	53.49	66.60	60.05
FYM @5 t ha^{-1}+ NC @ 2.5 t ha^{-1}	16.04	19.81	17.93	24.22	29.93	27.08	51.59	63.73	57.66
VC @ 2.5 t ha-^{1}+ NC@ 2.5 t ha^{-1}	16.12	19.41	17.76	23.71	28.55	26.13	38.74	46.66	42.70
PC @ 2.5 t ha-1 + NC @ 2.5 t ha^{-1}	22.98	26.88	24.93	18.07	21.13	19.60	92.63	108.33	100.48
$^{\#}$PM @ 2.5 t ha^{-1} + NC @ 2.5 t ha^{-1}	15.74	17.16	16.45	23.75	25.89	24.82	32.47	35.40	33.93
$^{\#}$+VC@ 2.5t ha^{-1} + PC @ 2.5 t ha^{-1}	12.23	12.78	12.51	11.27	11.77	11.52	22.93	23.95	23.44
100 % RDF	57.21	68.82	18.54	8.20	9.86	9.03	36.63	41.87	39.25
Control	-	-	-	-	-	-	-	-	-
SEm±	3.69	2.72	3.06	1.77	1.52	1.59	8.48	6.27	7.47
CD (p=0.05)	10.87	8.04	8.70	5.23	4.49	4.51	25.02	18.50	21.35

Table 2: Effect of organics on internal efficiency, Agronomic efficiency and seed yield of groundnut

Treatments	Internal efficiency			Agronomic efficiency (kg seed kg^{-1} N)			Seed yield (kg ha^{-1})		
	2008	2009	Pooled	2008	2009	Pooled	2008	2009	Pooled
FYM @ 10 t ha^{-1}	13.95	13.13	13.54	8.26	12.76	10.51	882.74	1008.83	945.79
Vermicompost @ 5 t ha^{-1}	13.71	17.35	15.53	9.29	16.26	12.77	988.40	1280.55	1134.48
Phosphocompost @ 5 t ha^{-1}	13.41	14.46	13.93	34.29	47.60	40.94	1138.54	1298.15	1218.35
Poultry manure @ 5 t ha^{-1}	14.00	15.08	14.54	7.58	12.38	9.98	1026.14	1280.27	1153.21
Neem cake @ 5 t ha^{-1}	14.03	15.26	14.65	6.55	10.57	8.56	1047.30	1303.94	1175.62
FYM @5 t ha^{-1} + NC @ 2.5 t ha^{-1}	12.44	14.60	13.52	9.47	14.72	12.09	1126.69	1391.97	1259.33
VC @ 2.5 t ha^{-1} + NC@ 2.5 t ha^{-1}	12.26	14.57	13.42	9.81	14.51	12.16	1178.62	1419.38	1298.99
PC @ 2.5 t ha^{-1} + NC @ 2.5 t ha^{-1}	12.08	14.65	13.37	14.54	20.32	17.43	1255.51	1468.30	1361.91
$^{\#}$PM @ 2.5 t ha^{-1} + NC @ 2.5 t ha^{-1}	13.17	14.13	13.65	10.12	12.80	11.46	1290.99	1407.45	1349.22
$^{\#}$+VC@ 2.5 t ha^{-1} + PC @ 2.5 t ha^{-1}	11.25	11.19	11.22	8.39	9.80	9.10	1470.80	1536.71	1503.75
100 % RDF	13.68	14.81	14.25	34.14	50.92	42.53	1144.21	1376.40	1260.30
Control	8.28	7.35	7.82	-	-	-	461.37	358.00	409.68
SEm±	1.17	1.49	1.27	3.66	2.62	3.20	108.01	110.58	104.03
CD (p=0.05)	3.43	4.36	3.60	10.79	7.73	9.08	316.79	324.33	294.86

seed yield might be due higher growth attributes, enhanced rate of net photosynthesis and higher yield attributes. The results are in close agreement with the observation of Paramasivam et al. (2006), Elayaraja and Singaravel (2007), Chandrasekaran et al. (2007) and Panwar and Munda (2007). Among the sole application of organics phosphocompost @ 5 t ha^{-1} recorded higher seed yield (1218.35 kg ha^{-1}) of groundnut, followed by neem cake @ 5 t ha^{-1}, poultry manure 5 t ha^{-1}, vermicompost 5 t ha^{-1} and FYM 10 t ha^{-1} during both the years of investigation, though all the sole application of organics recorded lower seed yield than 100 % RDF. 100 % RDF and control plot produced 16.19 % and 72.76 % lower seed yield than T_{10}.

4. Conclusion

Application of poultry manure (PM) @ 2.5 t ha^{-1} + neem cake (NC) @ 2.5 t ha^{-1} + vermicompost (VC) @ 2.5 t ha^{-1} + phosphocompost (PC) @ 2.5 t ha^{-1} proved best in producing seed yield of groundnut. Maximum partial factor productivity

(PPF_N) of 63.02 kg seed kg^{-1} N and agronomic efficiency (AE_N) of 42.53 kg seed kg^{-1} N of groundnut was observed with 100 % RDF. Highest internal efficiency (13.71 and 17.35 kg seed kg^{-1} N uptake) was obtained from vermicompost @ 5 t ha^{-1} during 2008 and 2009, respectively.

5. References

Chandrasekaran, R., Somasundaram, E., Mohamed Amanullah, M., Nalini, K., Thirukkumaran, K., Sathyamoorthi, K., 2007. Response of confectionery groundnut (*Arachis hypogaea* L.) varieties to farm yard manure. Journal of Applied Sciences Research 3(10), 1097-1099.

Elayaraja, D., Singaravel, R., 2007. Study on the use of organic wastes in coastal sandy soil for groundnut production. *Plant Archives* 7(2), 545-548.

Panwar, A.S., Munda, G.C., 2007. Response of groundnut (*Arachis hypogaea*) to organic and inorganic sources of nutrient supply under mid-hill altitude conditions. Indian Journal of Agricultural Sciences 77(12), 814-818.

Paramasivam, V., Balamurugan, P., Mohandas , S., 2006. To study the effect of sources of nutrients viz. organic and inorganic and their method of application on groundnut. Madras Agricultural Journal 93, 7-12.

Cassman, K.G., G.C. Gines, M.A. Dizon, M.I. Samson and J.M. Alcantar. 1996. Nitrogen use efficiency in tropical lowland rice systems: contribution from indigenous and applied nitrogen. Field Crop Research 47, 1-12.

Cisse, L., Amar, B., 2000. The importance of Phosphatic fertilizer for increased crop production in developing countries. In: Proceedings of the AFA 6th International Annual conference held on 31 January-2 February, 2000, Cairo, Egypt.

Karim, A.A., Ramasamy, C., 2000. Expanding frontiers of agriculture: contemporary issues. Kalyani Publishers, Ludhiana, India.

Yadav, R.L., 2003. Assessing on-farm efficiency and economics of fertilizer N, P and K in rice wheat systems of India. Field Crops Research 18, 39-51.