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Effect of Vermicompost, Rock Phosphate, PSB and Different Bio-products on Yield and Economics of Groundnut (*Arachis hypogea* L.)

Ashwini R. Chavan*, S. A. Chavan, Aparna M. Yadav and V. G. Chavan

Department of Agronomy, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli- 415712 Maharashtra, India
**Corresponding author*

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A B S T R A C T

A field experiment entitled "Effect of vermicompost, rock phosphate, PSB and different bio-products on yield and economics of groundnut (*Arachis hypogea* L.)" was conducted at Agronomy Department Farm, College of Agriculture, Dapoli. Dist. Ratnagiri, Maharashtra, India, during *rabi* seasons 2017-18 and 2018-19. The experiment consisted of eight different organic packages in main plot treatments and three bio-products in sub plot treatments. The experiment was laid out in split plot design with three replications. Data on yield and economics was recorded and statistically analyzed. The experimental results in pooled data revealed that, the groundnut crop grown under 50 kg N through vermicompost + 50 kg P_2O_5 through rock phosphate + phosphate solubilizing bacteria (PSB) (T_8) were recorded significantly higher dry pod yield (39.99 q ha^{-1}), kernel yield (29.22 q ha^{-1}), haulm yield (48.70 q ha^{-1})over all other organic packages. In case of economics, the highest net returns of ₹75894.94 ha^{-1} with B: C ratio of 1.44 were obtained under 25 kg N through vermicompost + 50 kg P_2O_5 through rock phosphate + phosphate solubilizing bacteria (PSB) (T_7) followed by 25 kg N through vermicompost + 50 kg P_2O_5 through rock phosphate (T_5). Application of cow urine (10%) (P_2) were recorded significantly higher dry pod yield (35.69 q ha^{-1}), kernel yield (25.93 q ha^{-1}), haulm yield (43.25 q ha^{-1}), net returns (58072.35₹ ha^{-1}) and B: C ratio (1.34) followed by vermi-wash (3%) (P_3) and control (P_1).

Introduction

Groundnut (*Arachis hypogaea* L.) is the important oilseed crop in the India. The crop has its own importance due to high edible oil and nutritional value of kernel as human food and haulm as rich feed for cattle. Its seed contain high quality of 45-50% edible oil, 25-30% digestible protein, 20% carbohydrates, and 5% fiber and ash which make a sustainable contribution to human nutrition (Fageria *et al.*, 1997). Groundnut is considered as poor man's almond and also called as "King of oilseeds". It is cultivated in India over 45.97 million ha area with the production of 67.33 million tonnes (both *kharif* and *rabi*) and average productivity of 1.47 t ha^{-1} (Indiastat, 2016). In Maharashtra, groundnut cultivated (both *kharif* and *rabi*) over an area of 3.09 million ha with production of 3.34 million tonnes having productivity of 1.08 t ha^{-1} (Indiastat, 2016). The area under

groundnut crop in konkan was about more than 15,000 ha with 1,550 kg ha^{-1} productivity during 2013-14 (Anonymous, 2013).

Vermicompost contain plant nutrients including N, P, K, Ca, Mn, Zn and Cu as well as other nutrients the uptake of which has a positive effect on plant nutrition, photosynthesis, the chlorophyll content of the leaves and improves the nutrient content of the different plant component. The soil properties such as P^H, Ec, available nitrogen, phosphorus, potassium, iron, zinc, copper and manganese were found to improve in the soils treated with vermicompost application (Mathivanan *et al.*, 2013). The nutrients present in vermicompost are readily available to crop plants and produce better plant growth and yield. Vermicompost also contains more number of N-fixing, P-solubilizing and other beneficial microbes, antibiotics, vitamins, hormones, enzymes etc. which have better effects on growth and yield of plants. To overcome the constraints of available phosphorus in acid soil it is imperative to explore all the possible sources of phosphorus nutrient in acid soil. Apart from super phosphate, according to Agarwal *et al.*, (1972), basic slag, rock phosphate and different organic sources are among the different possible sources of phosphorus nutrient in acid soil for plants that have the possibility to play vital role in the future agriculture scenario of our country, simply because, they are cheap, abundantly available in natural way and will be efficient if they are used in scientific way, which has been reviewed by a number of authors. The phosphate solubilizing microorganisms (Pseudomonas) play an important role in conversion of unavailable inorganic P (Ca-P, Fe-P and Al-P) into available inorganic P forms through secretion of organic acids and enzymes (Singh, 1999).

Cattle urine has a good manurial value and can be utilized as a bio fertilizer (Khanal *et al.*, 2011). Cattle urine is a good source of nitrogen, phosphate, potassium, calcium, magnesium, chlorite and sulphate. Application of cow urine has also been reported to correct the micronutrient deficiency, besides improving the soil texture and working as a plant hormone. Vermiwash obtained from dissolution of organic matter by earthworm is also found as a good liquid manure and affect significantly on the growth and productivity of crop during foliar spray, (Subasasri, 2003). It is coelomic fluid extraction contains several enzyme, plant growth stimulating hormones like cytokinins, gibberlines and vitamins along with micro and macro nutrients as nitrogen in the form of mucus, nitrogenous excretory substance, enzyme are present in vermiwash (Tripathi and Bhardwaj, 2004). It also increases the disease resistant power of crop (Yadav *et al.*, 2005). Therefore, keeping these facts in view, an attempt was made to study on the effect of vermicompost, rock phosphate, PSB and different bio-products on yield and economics of groundnut (*Arachis hypogea* L.).

Materials and Methods

The field experiment was conducted at Agronomy Farm, College of Agriculture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra State during *rabi* season of 2017-18 and 2018-19 is situated on 17.10º North latitude and 73.10º East longitude having elevation of 250 m above the mean sea level.

The soil of experimental plot was sandy clay loam in texture, moderately acidic in reaction with moderately high in organic carbon content. Soil was medium in available nitrogen (271.86 kg ha^{-1}), low in available phosphorus (10.55 kg ka^{-1}) and fairly high in available potassium (221.16 kg ha^{-1}). The main plot treatments comprised of eight organic packages *i.e.*, Control (T_1), RDF (25 kg N + 50 kg P_2O_5) (T_2), 25 kg N through Vermicompost (T_3), 50 kg N through

Vermicompost (T_4), 25 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate (T_5), 50 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate (T_6), 25 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate + Phosphate solubilizing bacteria (PSB) (T_7), 50 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate + Phosphate solubilizing bacteria (PSB) (T_8)along with sub plot treatments consisted of three bio-products *i.e.,* Control (P_1), Cow urine (10%) (P_2), Vermi-wash (3%) (P_3). The treatments were replicated thrice under split plot design.

The preparation of field by ploughing once with tractor drawn mould board plough, twice by cultivator which followed by planking. Each operation was followed by planking to have smooth clod free seed bed. After land preparation the layout of all the experiment was marked and sub-plots were demarcated within each main plot. Groundnut seed was sown at the rate of 120 kg ha^{-1} with spacing of 30 cm X 15 cm. Application of mannures and fertilizers were given as per the requirement of treatments.

The data on growth and yield attributes were recorded from randomly selected five plants in each plot and dry pod yield, kernel yield and haulm yield recorded from net plot and converted on hectare basis. The experimental data pertaining to each character were analysed statistically by using the technique of Analysis of variance for split plot design and significance was tested by 'F' test (Panse and Sukhatme, 1967).

Results and Discussion

Yield of groundnut

Effect of organic packages

Pooled data presented in Table 1 indicates that, dry pod yield (q ha^{-1}), kernel yield (q ha^{-1}) and haulm yield (q ha^{-1}) of groundnut were significantly influenced due to different organic packages. Treatment 50 kg N through vermicompost + 50 kg P_2O_5 through rock phosphate + phosphate solubilizing bacteria (PSB) (T_8) recorded significantly higher dry pod yield (39.65 q ha^{-1}, 40.34 q ha^{-1} and 39.99 q ha^{-1}), kernel yield (28.99 q ha^{-1}, 29.46 q ha^{-1} and 29.22 q ha^{-1}) and haulm yield (48.09 q ha^{-1}, 49.32 q ha^{-1} and 48.70 q ha^{-1}) over rest of the treatments during both the years and in the pooled data.

The increase in dry pod yield in the pooled data due to treatments T_8, T_6, T_7 and T_5 over treatment T_1, and were to the tune of 87.74, 82.25, 77.93 and 73.19 per cent, respectively. Similar trend was observed in the kernel yield and haulm yield during both the years of experimentation and in the pooled analysis. These results are in conformity with findings of Zalate *et al.,* (2009), Sarangi and Lama (2013), Chaudhary *et al.,* (2015) and Das *et al.,* (2015)

Effect of bio-products

Perusal of the data presented in Table 1 revealed that, the different bio-products significantly influenced the dry pod yield (q ha^{-1}), kernel yield (q ha^{-1}) and haulm yield (q ha^{-1}) of groundnut during both the years and in pooled data. Application of cow urine (10%) (P_2) were recorded significantly higher dry pod yield (35.52 q ha^{-1}, 35.85 q ha^{-1} and 35.69 q ha^{-1}), kernel yield (25.76 q ha^{-1}, 26.10 q ha^{-1} and 25.93 q ha^{-1}) and haulm yield (43.10 q ha^{-1}, 43.39 q ha^{-1} and 43.25 q ha^{-1}) followed by vermi-wash (3%) (P_3) and control (P_1) in the descending order during both the years of experimentation and in the pooled data. Results of the present investigation corroborate with the findings of Deotale *et al.,* (2008), Patil *et al.,* (2011), Kulkarni *et al.,* (2016) and Sadhukhan *et al.,* (2018).

Table.1 Effect of different treatments on the yield of groundnut

Treatments	Dry pod yield (q ha^{-1})			Kernel yield (q ha^{-1})			Haulm yield (q ha^{-1})		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Main plot: Organic package									
T_1: Control	22.28	20.33	21.30	14.56	13.25	13.91	29.25	27.01	**28.13**
T_2 : RDF (25 kg N + 50 kg P_2O_5)	32.37	33.15	32.76	22.89	23.50	23.19	38.94	39.43	**39.19**
T_3: 25 kg N through Vermicompost	31.25	30.56	30.91	21.95	21.38	21.67	37.36	36.75	**37.05**
T_4: 50 kg N through Vermicompost	32.88	32.98	32.93	23.36	23.32	23.34	39.31	39.37	**39.34**
T_5: 25 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate	36.43	37.36	36.89	26.19	26.57	26.38	43.71	44.18	**43.94**
T_6: 50 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate	38.73	38.90	38.82	27.86	28.22	28.04	46.79	46.94	**46.87**
T_7: 25 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate + Phosphate solubilizing bacteria (PSB)	37.39	38.41	37.90	26.94	27.79	27.36	44.74	45.74	**45.24**
T_8: 50 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate + Phosphate solubilizing bacteria (PSB)	39.65	40.34	39.99	28.99	29.46	29.22	48.09	49.32	**48.70**
S.Em.±	0.91	0.81	0.66	0.74	0.79	0.58	1.22	0.74	**0.78**
C.D. at 5%	2.76	2.45	1.99	2.25	2.40	1.77	3.70	2.25	**2.36**
Sub plot: Bio-product									
P_1: Control	32.50	32.11	32.30	22.62	22.25	22.43	39.22	38.85	**39.03**
P_2: Cow urine(10%)	35.52	35.85	35.69	25.76	26.10	25.93	43.10	43.39	**43.25**
P_3: Vermi-wash (3%)	33.60	34.05	33.83	23.90	24.21	24.06	40.75	41.04	**40.90**
S.Em.±	0.79	0.61	0.53	0.60	0.56	0.43	0.95	0.54	**0.54**
C.D. at 5%	2.28	1.76	1.52	1.73	1.61	1.23	2.72	1.57	**1.56**
Interaction effect									
S.Em.±	3.42	2.69	2.31	2.62	2.50	1.90	4.16	2.42	**2.43**
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	**NS**
General mean	**33.87**	**34.00**	**33.94**	**24.09**	**24.19**	**24.14**	**41.02**	**41.09**	**41.06**

Table.2 Effect of different treatments on cost of cultivation and gross returns of groundnut

Treatments	Cost of cultivation (₹ ha^{-1})			Gross returns (₹ ha^{-1})		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Main plot: Organic package						
T_1: Control	127657.20	125548.14	126602.67	145341.75	132687.38	**139014.56**
T_2 : RDF (25 kg N + 50 kg P_2O_5)	134980.89	135637.96	135309.43	168018.87	171961.28	**169990.07**
T_3: 25 kg N through Vermicompost	159417.60	158622.81	159020.20	202703.86	198268.45	**200486.16**
T_4: 50 kg N through Vermicompost	183380.00	183480.06	183430.03	213278.00	213878.41	**213578.20**
T_5: 25 kg N through Vermicompost + 50 kg P_2O_5 through Rock Phosphate	167795.25	168774.19	168284.72	236310.59	242175.35	**239242.97**
T_6: 50 kg N through Vermicompost + 50 kg P_2O_5 through Rock Phosphate	192504.32	192685.38	192594.85	251373.63	252459.97	**251916.80**
T_7: 25 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate + Phosphate solubilizing bacteria (PSB)	169345.96	170441.58	169893.77	242501.85	249075.57	**245788.71**
T_8: 50 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate + Phosphate solubilizing bacteria (PSB)	194029.19	194789.51	194409.35	257400.95	261962.89	**259681.92**
Sub plot: Bio-product						
P_1: Control	164599.27	164181.09	164390.18	205796.36	203283.97	**204540.17**
P_2: Cow urine(10%)	167920.76	168229.01	168074.89	225222.49	227071.99	**226147.24**
P_3: Vermi-wash (3%)	165896.37	166332.26	166114.31	212829.72	215570.03	**214199.87**
General mean	**166138.80**	**166247.45**	**166193.13**	**214616.19**	**215308.66**	**214962.42**

Table.3 Effect of different treatments on net returns and B: C ratio of groundnut

Treatments	Net returns (₹ ha^{-1})			B: C ratio		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Main plot: Organic package						
T_1: Control	17684.55	14180.81	15932.68	1.14	1.05	**1.10**
T_2 : RDF (25 kg N + 50 kg P_2O_5)	33037.97	36323.32	34680.65	1.24	1.27	**1.25**
T_3: 25 kg N through Vermicompost	43286.27	39645.64	41465.95	1.27	1.25	**1.26**
T_4: 50 kg N through Vermicompost	30104.91	30398.34	30251.62	1.16	1.17	**1.16**
T_5: 25 kg N through Vermicompost + 50 kg P_2O_5through Rock Phosphate	68515.33	73401.15	70958.24	1.40	1.43	**1.42**
T_6: 50 kg N through Vermicompost + 50 kg P_2O_5 through Rock Phosphate	58869.30	59774.59	59321.95	1.30	1.31	**1.31**
T_7: 25 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate + Phosphate solubilizing bacteria (PSB)	73155.89	78633.99	75894.94	1.43	1.46	**1.44**
T_8: 50 kg N through Vermicompost + 50 kg P_2O_5 through Rock phosphate + Phosphate solubilizing bacteria (PSB)	63371.75	67173.37	65272.56	1.33	1.34	**1.33**
Sub plot: Bio-product						
P_1: Control	41274.67	41743.46	41509.07	1.24	1.23	**1.23**
P_2: Cow urine(10%)	57301.72	58842.97	58072.35	1.33	1.34	**1.34**
P_3: Vermi-wash (3%)	46933.34	49237.77	48085.56	1.28	1.29	**1.28**
General mean	**48503.25**	**49941.40**	**49222.32**	**1.28**	**1.28**	**1.28**

Economics of groundnut

Effect of organic packages

The study on the economic feasibility of the different organic packages in groundnut revealed that, the maximum gross returns (₹257400.95 ha^{-1}, ₹261962.89 ha^{-1} and ₹259681.92 ha^{-1}) were recorded under 50 kg N through vermicompost + 50 kg P_2O_5 through rock phosphate + phosphate solubilizing bacteria (PSB) (T_8) followed by T_6, T_7, T_5, T_4, T_2, T_3 and T_1 during both the years as well as in the pooled data.

The highest net returns (₹73155.89 ha^{-1}, ₹78633.99 ha^{-1} and ₹75894.94 ha^{-1}) and benefit to cost ratio (1.43, 1.46 and 1.44) were obtained under 25 kg N through vermicompost + 50 kg P_2O_5 through rock phosphate + phosphate solubilizing bacteria (PSB) (T_7) than remaining treatments during both the years and in the pooled data. These findings are in close conformity with those of Sutaria *et al.,* (2010), Chaudhary *et al.,* (2014), Poonia *et al.,* (2014) and Choudhary *et al.,* (2017).

Effect of bio-products

In case of economics (Table 2 and 3) it was observed that higher cost of cultivation (₹167920.76 ha^{-1}, ₹168229.01 ha^{-1} and ₹168074.89 ha^{-1}), gross return (₹225222.49 ha^{-1}, ₹227071.99 ha^{-1} and ₹226147.24 ha^{-1}), net return (₹57301.72 ha^{-1}, ₹58842.97 ha^{-1} and ₹58072.35 ha_{-1}) and maximum B: C ratio (1.33, 1.34, 1.34) during 2017-18, 2018-19 and in the pooled data respectively, was recorded under cow urine (10%) (P_2) and it was followed by vermi-wash (3%) (P_3) and control (P_1), respectively. These findings are in close agreement with Jadhav and Kulkarni (2016), Kulkarni *et al.,* (2016), Shwetha *et al.,* (2018) and Verma *et al.,* (2018).

It may be concluded from the finding of the present study that, to get higher net returns and B: C ratio, groundnut should be grown with 25 kg N through vermicompost + 50 kg P_2O_5 through rock phosphate + PSB and provided with cow urine (10%) sprays at 45, 65 and 85 DAS.

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