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JP Bhutadiya
Department of Agronomy, C.P. College of Agriculture, S.D.A.U., Sardar Krushinagar, Gujarat, India

MG Chaudhary
Department of Agronomy, C.P. College of Agriculture, S.D.A.U., Sardar Krushinagar, Gujarat, India

RP Damor
Department of Agronomy, C.P. College of Agriculture, S.D.A.U., Sardar Krushinagar, Gujarat, India

AJ Patel
Department of Agronomy, C.P. College of Agriculture, S.D.A.U., Sardar Krushinagar, Gujarat, India

Correspondence
JP Bhutadiya
Department of Agronomy, C.P. College of Agriculture, S.D.A.U., Sardar Krushinagar, Gujarat, India

Effect of different organic sources on growth, yield, yield attributes and economics of summer groundnut (*Arachis hypogaea* L.) under organic farming

JP Bhutadiya, MG Chaudhary, RP Damor and AJ Patel

Abstract
An experiment was conducted during summer-2017 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of different organic sources on growth, yield, yield attributes and economics of summer groundnut (*Arachis hypogaea* L.) under organic farming. The soil of experimental field was loamy sand in texture, low in organic carbon (0.30 %) and available nitrogen (142.5 kg/ha), medium in available phosphorus (43.41 kg/ha) and available potash (253.02 kg/ha) with soil pH of 7.7. Different twelve treatments comprising of application of nutrients through different organic sources viz., FYM, castor cake, NPK consortium, *Rhizobium* and PSB. The experiment was laid out in randomized block design and replicated three times. Groundnut variety TG 37 was used as test crop. The application of 1.0 t/ha castor cake + *Rhizobium* + PSB recorded significantly higher plant height at 30 DAS (7.56 cm), 60 DAS (21.47 cm) and at harvest (48.02 cm), number of branches per plant 60 DAS (9.00) and at harvest (10.40), number of effective pegs per plant at harvest (19.66), more numbers of pods per plant at harvest (13.00), pod yield per plant (8.90 g), higher pod yield (2861 kg/ha) and haulm yield (4876 kg/ha) over rest of the treatments. The maximum net realization (Rs. 1,14,348/ha) was obtained with treatment 1.0 t/ha castor cake + *Rhizobium* + PSB, while maximum benefit : cost ratio (3.57) was recorded with the treatment of 5.0 t/ha FYM +*Rhizobium* + PSB as compare to other treatments.

Keywords: Castor cake, FYM, groundnut, NPK consortium, PSB and *Rhizobium*

Introduction
Groundnut (*Arachis hypogaea* L.) is one of the most important edible oil seed crop in the world. It was belongs to the *Leguminosae* family. Groundnut is also known as "peanut," "monkey nut," "manila nut," "pinda" and "gobber nut." The groundnut originated in South America from where it spread to Asia, Africa, Sudan, Nigeria, U.S.A. and other parts of the worlds. In India, groundnut is known as poor man's almond. Groundnut has a useful role in offsetting deficiencies as a rich source of edible oil and protein which play important position in Indian diet. Groundnut is an important food, fodder and cash crop for the farmers of India.

In India, groundnut is grown on 4.56 million hectare and production of 6.77 million tonnes with an average productivity of 1486 kg/ha (DAC and FW, 2016) [4]. In India, 80 percent of the groundnut area and 84 percent of the production is confined to the states of Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra. Among these, Gujarat rank first both in area and production. In Gujarat, the area under *kharif* and summer groundnut was 1.599 million ha. and 0.063 million ha. With the production of 3.77 and 0.13 M.T., respectively, during the year 2017-18. The average productivity of groundnut was 2360 kg/ha in *kharif* and 2140 kg/ha in summer of groundnut (DOA, 2018) [5]. In Gujarat, largely cultivated districts are Junagadh, Jamnagar, Rajkot, Amreli, Bhavnagar, Sabarkantha and Banaskantha. The hand-picked selected (HPS) groundnut is mainly exported from Saurashtra region of Gujarat state, looking to the demand of the edible oil seed, groundnut cultivation has extended to *rabi* and summer season depending upon the exiting temperature regimes.

The yield potentially of summer groundnut as observed under North Gujarat Agro-climatic Condition is more than 2 t/ha (Dodia, 1998) [6]. The productivity of summer groundnut is considerably higher than the *kharif* groundnut due to favourable condition such as high temperature, more sunshine hours, assured irrigation under control condition and comparatively low incidence of disease and pests (Sabale and Khuspe, 1986) [11].

The application of organic manure viz., FYM and castor cake may serve the source of macro and micro nutrient and complexing agent.

Organic manure addition in the soil is not only acts as a source of nutrient, but also influences their availability. Inoculation of seed with *Rhizobium* recorded higher protein content and increase yield due to more nitrogen fixation and better utilization by plants. The PSB like Pseudomonas and Bacillus also enhances the availability of phosphorus to the plant by converting inherent insoluble phosphorus into soluble form. Keeping this in view, a field experiment was conducted to study the Response of summer groundnut (*Arachis hypogaea* L.) to different organic sources under organic farming.

Materials and methods

A field experiment was conducted during summer season of 2017 in loamy sand soil of Agronomical Farm, C.P.C.A., S.D.A.U., Sardarkrusdhinagar. Twelve treatments comprising of application of nutrients through different sources viz., T_1 : 2.5 t/ha FYM, T_2 : 5.0 t/ha FYM, T_3 : 0.5 t/ha castor cake, T_4 : 1.0 t/ha castor cake, T_5 : 2.5 t/ha FYM + NPK consortium, T_6 : 5.0 t/ha FYM + NPK consortium, T_7:0.5 t/ha castor cake + NPK consortium, T_8 : 1.0 t/ha castor cake + NPK consortium, T_9 : 2.5 t/ha FYM + *Rhizobium* + PSB, T_{10} : 5.0 t/ha FYM + *Rhizobium* + PSB, T_{11} : 0.5 t/ha castor cake + *Rhizobium* + PSB, T_{12} : 1.0 t/ha castor cake + *Rhizobium* + PSB. The experiment was laid out in randomized block design and replicated three times. Groundnut variety TG 37 was used as test crop. The soil of experimental field was loamy sand in texture, low in organic carbon (0.30 %) and available nitrogen (142.5 kg/ha), medium in available phosphorus (43.41 kg/ha) and available potash (253.02 kg/ha) with soil pH of 7.7. Groundnut seeds (120 kg ha^{-1}) were sown at a row distance of 30 cm and 10 cm plant to plant distance. Various growth and yield attributing characters of the crop were measured and studied during the course of investigations. Other management practices were followed as recommended.

Results and discussion

Plant height (cm)

The data indicated that significantly higher plant height of 7.56 cm, 21.47 cm and 48.02 cm at 30, 60 DAS and at harvest, respectively were recorded with treatment T_{12} (1.0 t/ha castor cake + *Rhizobium* + PSB) over the other treatments, but it was at par with treatment T_4 (1.0 t/ha castor cake), T_8 (1.0 t/ha castor cake + NPK consortium), T_9 (2.5 t/ha FYM + *Rhizobium* + PSB), T_{10} (5.0 t/ha FYM + *Rhizobium* + PSB) and T11 (0.5 t/ha castor cake + *Rhizobium* + PSB).

It might be attributed to multifarious role of castor cake in terms of nutrients supply as well as improvement in physical, chemical and biological properties of soil which finally reflected on growth of plant. The PSB like Pseudomonas and Bacillus also enhances the availability of phosphorus to the plant by converting inherent insoluble phosphorus into soluble form. The better growth of plant results in increased plant height. The findings are in agreement with those reported by Konthoujam *et al.* (2013) [8], Chaudhary (2014) [3] and Alsamowal *et al.* (2016) [2] in groundnut.

Number of branches per plant at harvest

Significantly the more number of branches per plant at 60 DAS (9.0) and at harvest (10.40) were found with treatment T_{12} (1.0 t/ha castor cake + *Rhizobium* + PSB) over the treatments, but it was at par with T_4, T_6, T_8, T_9, T_{10} and T_{11} at 60 DAS and with T_4, T_8, T_9, T_{10} and T_{11} at harvest. Significantly the lowest number of branches per plant at 60 DAS (6.46) and at harvest (7.60) were observed with treatment T_1 (2.5 t/ha FYM).

This might due to increase availability of N and P_2O_5 at the early stages of crop growth to fast mineralization of the castor cake provide adequate nitrogen for nitrogen fixation after 30 DAS and castor cake improves the soil physical conditions that resulted in better crop growth manifested by higher number of branches per plant. This was confirmed with the findings of the findings are in agreement with those reported by Konthoujam *et al.* (2013) [8], Chaudhary (2014) [3] and Alsamowal *et al.* (2016) [2] in groundnut.

Number of effective pegs per plant at harvest of groundnut

Data revealed that significantly higher number of effective pegs per plant at harvest (19.66) was achieved with treatment T_{12} (1.0 t/ha castor cake + *Rhizobium* + PSB), which was remained at par with treatments T_4 (17.40), T_8 (17.86), T_9 (18.80), T_{10} (19.26) and T_{11} (19.00). Significantly lower number of effective pegs per plant at harvest (13.86) was noted with treatment T_1 (2.5 t/h FYM) over all other treatments, but it was at par with treatments T_2 (15.53) and T_3 (14.00).

Further, the magnitude of increase in number of effective pegs per plant at harvest under treatment T_{12} (1.0 t/ha castor cake + *Rhizobium* + PSB) was to the tune of 41.84, 26.59, 40.42, 19.44, 14.30 and 17.51 percent, respectively over treatments T_1, T_2, T_3, T_5, T_6 and T_7, respectively. This might be due to adequate supply of organic manure along with *Rhizobium* and PSB helpful in the peg penetration into soil. These results are in close vicinity with the findings of Walpola and Yoon (2013) [14], Sharma *et al.* (2013) [12], Chaudhary (2014) [3] and Alsamowal *et al.* (2016) [2] in groundnut.

Effect on yield attributes and yield

Number of pods per plant at harvest

The significantly higher number of filled pods per plant at harvest (13.00) was noted with treatment T_{12} (1.0 t/ha castor cake + *Rhizobium* + PSB) and it was at par with the treatment T_8 (11.93), T_9 (12.06), T_{10} (12.53) and T_{11} (12.26). While treatment T_1 (2.5 t/ha FYM) registered significantly lower number of filled pods per plant (9.53), but it was at par with treatment T_2 (10.00), T_3 (9.60), T_5 (10.33), T_6 (10.86) and T_7 (10.66). Further, the magnitude of increase in number of filled pod per plant at harvest under treatment T_{12} was to the tune of 36.41, 30.00, 35.41, 25.84, 19.70 and 21.95 percent, respectively over treatment T_1, T_2, T_3, T_5, T_6 and T_7, respectively.

The higher value of filled pod per plant under the high dose of castor cake might be due to favorable effect of castor cake on growth in term of dry matter accumulation in plant due to better translocation of photosynthesis toward sink. *Rhizobium* and PSB increase the availability of nitrogen and phosphorus. The present findings are closely associated with Guar and Neelkantan (1984) [7], Walpola and Yoon (2013) [14], Chaudhary (2014) [3], Patil *et al.* (2014) [9] and Alsamowal *et al.* (2016) [2] in groundnut.

Pod yield per plant (g)

A perusal of data indicated that pod yield per plant was significantly higher (8.90 g) with treatment T_{12} (1.0 t/ha castor cake + *Rhizobium* + PSB) and it was at par with the treatment T_4 (8.06 g), T_6 (7.76 g), T_8 (8.26 g), T_9 (8.46 g), T_{10} (8.73 g) and T_{11} (8.60 g). An application of 2.5 t/ha FYM (T_1)

registered lower pod yield per plant (6.40 g). But it was at par with T_2 (7.06 g), T_3 (6.60 g), T_5 (7.16 g) and T_7 (7.30 g).
Increase in pod yield per plant was mainly due to effect of castor cake, *Rhizobium* and PSB that provided balanced nutrition and favourable soil environment, better plant growth and ultimately photosynthesis increase which leads to maximum pod yield per plant. These results are agreements earlier work by Chaudhary (2014) [3], Patil *et al.* (2014) [9] and Alsamowal *et al.* (2016) [2] in groundnut.

Pod yield (kg/ha)
Significantly higher pod yield (2861 kg/ha) was produced with treatment T_{12} (1.0 t/ha castor cake + *Rhizobium* + PSB) as compared to all other treatments, but it was found at par with treatments T_4 (2517 kg/ha), T_6 (2450 kg/ha), T_8 (2620 kg/ha), T_9 (2706 kg/ha), T_{10} (2798 kg/ha) and T_{11} (2757 kg/ha). An application of 2.5 t FYM/ha (T_1) registered significantly lower pod yield (2014 kg/ha). The percent increase in pod yield by treatment T8 was to the tune of 42.05, 28.81, 37.74, 26.64 and 23.90 percent over treatment T_1, T_2, T_3, T_5 and T_7, respectively.

Haulm yield (kg/ha)
The application of 1.0 t/ha castor cake + *Rhizobium* + PSB (T12) registered significantly higher haulm yield (4876 kg/ha) over all other treatments, but it was found at par with treatment T_4 (4027 kg/ha), T_8 (4264 kg/ha), T_9 (4497 kg/ha), T_{10} (4731 kg/ha) and T_{11} (4876 kg/ha). Significantly minimum haulm yield (2986 kg/ha) was noted with 2.5 t/ha FYM (T_1). The percent increase in haulm yield by treatment T_{12} was to the tune of 63.29, 47.53, 58.72, 43.79 and 38.60 percent over treatments T_1, T_2, T_3, T_5 and T_7 respectively.

Table 1: Plant height and number of branches per plant of groundnut as influenced by different organic sources

Treatments		Plant height (cm)			Number of branches/plant	
		30 DAS	60 DAS	At harvest	60 DAS	At harvest
T_1	2.5 t/ha FYM	4.75	16.34	34.58	6.46	7.60
T_2	5.0 t/ha FYM	5.24	17.21	36.46	7.13	8.00
T_3	0.5 t/ha castor cake	4.99	16.35	35.86	6.66	7.06
T_4	1.0 t/ha castor cake	6.68	18.28	41.11	7.93	9.06
T_5	2.5 t/ha FYM + NPK consortium	5.87	17.61	37.89	7.26	8.06
T_6	5.0 t/ha FYM + NPK consortium	6.32	17.71	40.85	7.66	8.80
T_7	0.5 t/ha castor cake + NPK consortium	5.99	17.62	38.78	7.40	8.33
T_8	1.0 t/ha castor cake + NPK consortium	6.94	18.88	42.79	8.13	9.26
T_9	2.5 t/ha FYM + *Rhizobium* + PSB	7.13	19.25	44.44	8.26	9.80
T_{10}	5.0 t/ha FYM + *Rhizobium* + PSB	7.37	20.39	47.50	8.66	10.20
T_{11}	0.5 t/ha castor cake + *Rhizobium* + PSB	7.32	20.13	45.69	8.40	10.13
T_{12}	1.0 t/ha castor cake + *Rhizobium* + PSB	7.56	21.47	48.02	9.00	10.40
S.Em.±		0.31	0.92	2.38	0.48	0.46
C.D. at 5 %		0.92	2.71	6.97	1.41	1.35
C.V. %		8.58	8.68	10.00	10.78	8.93

Table 2: Number of effective pegs per plant at harvest, Number of filled pods/plant, 100 kernel weight (g), Pod yield per plant (g) of groundnut as influenced by different organic sources

Treatments		Number of effective pegs per plant at harvest	Number of filled pods/plant	100 kernel weight (g)	Pod yield per plant (g)
T_1	2.5 t/ha FYM	13.86	9.53	47.23	6.40
T_2	5.0 t/ha FYM	15.53	10.00	48.84	7.06
T_3	0.5 t/ha castor cake	14.00	9.60	47.45	6.60
T_4	1.0 t/ha castor cake	17.40	11.40	52.84	8.06
T_5	2.5 t/ha FYM + NPK consortium	16.46	10.33	50.11	7.16
T_6	5.0 t/ha FYM + NPK consortium	17.20	10.86	52.92	7.76
T_7	0.5 t/ha castor cake + NPK consortium	16.73	10.66	51.28	7.30
T_8	1.0 t/ha castor cake + NPK consortium	17.86	11.93	53.13	8.26
T_9	2.5 t/ha FYM + *Rhizobium* + PSB	18.80	12.06	53.58	8.46
T_{10}	5.0 t/ha FYM + *Rhizobium* + PSB	19.26	12.53	53.91	8.73
T_{11}	0.5 t/ha castor cake + *Rhizobium* + PSB	19.00	12.26	53.65	8.60
T_{12}	1.0 t/ha castor cake + *Rhizobium* + PSB	19.66	13.00	54.19	8.90
S.Em.±		0.80	0.50	3.17	0.46
C.D. at 5 %		2.35	1.50	NS	1.35
C.V. %		8.09	7.88	10.65	10.23

Table 3: Pod yield, haulm yield, net realization and BCR of groundnut as influenced by different organic sources

Treatments		Pod yield (kg/ha)	Haulm yield (kg/ha)	Net realization (Rs/ha)	BCR
T_1	2.5 t/ha FYM	2014	2986	70208	2.64
T_2	5.0 t/ha FYM	2221	3305	79806	2.80
T_3	0.5 t/ha castor cake	2077	3072	72002	2.62
T_4	1.0 t/ha castor cake	2517	4027	94890	3.01
T_5	2.5 t/ha FYM + NPK consortium	2259	3391	83238	2.93
T_6	5.0 t/ha FYM + NPK consortium	2450	3838	93192	3.08
T_7	0.5 t/ha castor cake + NPK consortium	2309	3518	84926	2.90
T_8	1.0 t/ha castor cake + NPK consortium	2620	4264	100344	3.10

T_9	2.5 t/ha FYM + *Rhizobium* + PSB	2706	4497	110172	3.56
T_{10}	5.0 t/ha FYM + *Rhizobium* + PSB	2798	4731	114204	3.57
T_{11}	0.5 t/ha castor cake + *Rhizobium* + PSB	2757	4623	111810	3.51
T_{12}	1.0 t/ha castor cake + *Rhizobium* + PSB	2861	4876	114348	3.41
S.Em.±		180	300	-	-
C.D. at 5 %		527	880	-	-
C.V. %		12.6	13.2	-	-

Increase in pod and haulm yields was mainly because of increase in plant height, number of branches per plant at harvest, number of effective pegs per plant at harvest and number of pods per plant (filled) at harvest which resulted from of castor cake and *Rhizobium* and PSB that provided balanced nutrition, favourable soil environment and ultimately leads to maximum pod and haulm yields. *Rhizobium* bacteria fix atmospheric nitrogen to soil and make it available to plant. PSB make insoluble phosphorus to soluble phosphorus and also synthesize growth promoting substance which augment plant growth. These results are in close vicinity with the findings of Guar and Neelkantan (1984) [7], Zalate and Padmani (2009) [15], Akbari *et al.* (2011) [1], Chaudhary (2014) [3], Patil *et al.* (2014) [9] and Solanki *et al.* (2015) [13] in groundnut.

Economics

Net realization (Rs./ha)

The higher net realization of Rs.1,14,348/ha was accrued with treatment T_{12} (1.0 t/ha castor cake + *Rhizobium* + PSB) followed by treatment T_{10} (Rs. 1,14,204/ha). The lowest net realization (Rs. 70,208/ha) was noticed under treatment T_1 (2.5 t/ha FYM).

Benefit: cost ratio

Examination of data on benefit: cost ratio as influenced due to organic sources are furnished in Table indicated that higher benefit: cost ratio of 3.57 was observed with treatment T10 (5.0 t/ha + *Rhizobium* + PSB) followed by treatment T_9 (3.56). The lowest benefit: cost ratio of 2.64 was noted with treatment T_1 (2.5 t/ha FYM). This could be attributed to higher pod and haulm yield received in these treatments. The results are well supported with those reported by Chaudhary (2014) [3] and Poonia *et al.* (2014) [10] in groundnut.

Conclusion

Based on the experimental results it can be concluded that the growth, yield and net profit (Rs./ha) in summer groundnut can be secured by applying 1.0 t/ha castor cake or 1.0 t/ha castor cake along with NPK consortium or *Rhizobium* + PSB and 2.5 or 5.0 t/ha FYM or 0.5 t/ha castor cake along with *Rhizobium* + PSB under loamy sand soil of North Gujarat Agro-climatic Zone.

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