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Organic Cultivation of Summer Groundnut using Cow-based Bio-enhancers and Botanicals

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ABSTRACT

Background: Recognizing the adverse impact of excessive use of chemicals on soil health, human health and environment, Government is promoting production of organic crops, fruits and vegetables *etc*. through various schemes. Demand for organic food items is also on the rise during the last few years. Number of cow-based bio-enhancers and botanicals have been developed by innovative organic growers/ associations and NGOs. But very meagre scientific information is available regarding such formulations. Hence, to incorporate these products in organic farming module, the present experiment was conducted.

Methods: A field experiment was conducted in summer season of 2017 to 2019 at Junagadh, Gujarat, India with cow-based bio-enhancers (*Panchagavya, Bijamrut, Jivamrut, Amrutpani, Sanjivak* and cow urine) and botanicals (Seaweed extract and Banana pseudo stem sap) in randomized block design with three replications. The cow-based formulations were prepared on farm as per the procedure given by National Centre for Organic Farming, Ghaziabad and botanicals *viz*., banana pseudo stem extract and seaweed extract (*Kappaphycus alvarezii*) were obtained from Navsari Agricultural University, Navsari and Junagadh Agricultural University, Okha.

Result: The results revealed that application of FYM @ 5 t/ha significantly enhanced growth and yield attributes *viz*., plant height, number of branches/plant, number and dry weight of nodules/plant, number of mature pods/plant, pod weight/plant and shelling percentage and ultimately produced significantly higher pod (1823 kg/ha) and haulm (3270 kg/ha) yields, followed by *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS (1582 and 2846 kg/ha) and seaweed extract as foliar spray @ 3.5% at 30, 45 and 60 DAS (1423 and 2570 kg/ha). Application of FYM, *Panchagavya* and seaweed extract also increased uptake of NPK by pod and haulm over the control, while different treatments failed to affect the post-harvest soil fertility except available P which is higher under FYM, *Jivamrut*, *Amrutpani* and *Sanjivak* over the control. Overall, application of FYM and *Panchagavya* accrued higher net return of `55285 and 46229/ha with B:C of 2.21 and 2.12, respectively.

Key words: *Amrutpani,* Banana pseudo stem sap, *Bijamrut,* Cow urine, *Jivamrut, Panchagavya*, *Sanjivak,* Seaweed extract.

INTRODUCTION

India is one of the largest producers of oilseeds in the world and occupies an important position in the Indian agricultural economy. Groundnut is called as the 'King' of oilseeds. Groundnut is grown on 26.4 million ha worldwide with a total production of 37.1 million tonnes and an average productivity of 1.4 t/ha. India is the second largest producer of groundnut after China in the world. In India, it occupies about 4.88 million ha with production of 9.25 million tonnes and an average productivity of 1893 kg/ha (Anonymous, 2018a). In Gujarat, groundnut is premier oilseed crop and ranks first with an area of 1.67 million ha and a production of 4.59 million tonnes with productivity of 2758 kg/ha including summer groundnut area of 33920 ha with production of 84140 tonnes with productivity of 2480 kg/ha (Anonymous, 2018b).

Recognizing the adverse impact of excessive use of chemicals on soil health, human health and environment, Government of India promoting organic farming through various projects and schemes. Organic farming has been included as special category of farming in the National Agriculture Policy approved by the Government of India during 2000. Recently the Government of Gujarat declared "Gujarat Organic Farming Policy-2015" to support scientifically evolved organic farming practices for sustainable farming system along with the trustworthy marketing and supply chain of the produce (OFAI, 2015). It is aimed to promote technically sound, economically viable, environmentally non-degrading and socially acceptable use of natural resources in favour of organic agriculture. The policy seeks to actualize the area and crop potential for organic farming, sustaining soil fertility, conserving bio-resources, strengthening rural economy, promoting value addition, accelerating the growth of agro-business and securing a fair standard of living for the farmers and agricultural workers and their families. For effective implementation of the policy, there is an urgent need to

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develop a composite package of practices for major crops of the region. Number of cow-based bio-enhancers like '*Bijamrut*', '*Jivamrut*', '*Panchagavya*', '*Amrutpani*', '*Sanjivak*' *etc*. have been developed in different organic farming systems by innovative organic growers/associations and NGOs (Gupta *et al.,* 2017). But very meagre scientific information is available regarding such formulations. National Centre for Organic Farming and National Horticulture Mission included such cow-based bio-enhancers in package of practices for organic cultivation of different crops. Banana pseudo stem sap and seaweed extract have been recommended by agricultural universities. These products can be prepared on farm and incorporated in organic farming module, which can reduce the cost of cultivation and thereby increase the income of farmers. Considering these points in view, the present experiment was conducted to test the efficacy of some cow-based bio-enhancers and botanicals for organic cultivation of summer groundnut.

MATERIALS AND METHODS

A field experiment was conducted at Organic Farming Research Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) in summer season of 2017 to 2019. Geographically, Junagadh is situated at 21.5° N latitude and 70.5° E longitude with an altitude of 60 m above the mean sea level. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction (pH 7.9 and EC 0.35 dS/m) having bulk density of 1.40 Mg/m^3 as well as low in organic carbon (0.41%), available nitrogen (242 kg/ha), available phosphorus (27.3 kg/ha) and medium in available potash (299 kg/ha). The weather parameters *viz*., maximum temperature (29.2-42.2°C), minimum temperature (12.1-27.4 °C), relative humidity (morning 52-82% and evening 17-46%), wind speed (4.0-9.5 km/h), bright sunshine (7.4-11.0 h) and evaporation (5.5-11.7 mm/day) remained favourable for the crop. The experiment comprised of 10 treatments *viz*., T_1: *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS, T_2: *Bijamrut* as seed treatment @ 300 mL/kg seed, T_3: *Jivamrut* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS, T_4: *Amrutpani* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS, T_5: *Sanjivak* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS, T_6: Seaweed extract as foliar spray @ 3.5% at 30, 45 and 60 DAS, T_7: Banana sap as foliar spray @ 1% at 30, 45 and 60 DAS, T_8: Cow urine @ 500 L/ha with irrigation at sowing, 30 and 45 DAS, T_9: FYM @ 5 t/ha and T_{10}: Control was laid out in randomized block design with three replications. The gross and net plot size were 5.0 m × 2.4 m and 4.0 m × 1.8 m, respectively. The groundnut variety "GJG-31" was sown during February at 30 cm × 10 cm using seed rate of 120 kg/ha. The cow-based formulations were prepared on farm by following the procedure given by National Centre for Organic Farming, Ghaziabad (NCOF, 2006).

Panchagavya

Fresh cow dung (5 kg) was mixed with ghee (1 L) and kept in a plastic barrel separately for three days. On the same day, other ingredients, namely cow urine (3 L), cow's milk (2 L), curd (2 L), yellow banana (400 g, without skin), coconut water (3 L), jaggery (1 kg dissolved in 3 L water) were mixed in a plastic barrel separately. Filtered jaggery solution was added to the other ingredients. On the third day, the contents of both the barrels were mixed and left aside for seven days. The content was stirred with a wooden stick twice a day. After seven days, the product was filtered with a *khada* or terracot (TC) cloth and stored in closed containers (Pierce small holes in the cap of the containers to prevent bursting). This is diluted @ 300 mL/10 L water and sprayed.

Bijamrut

Cow dung 5 kg, cow urine 5 L, cow milk 1 L, lime 50 g, water 20 L and handful soil from rhizosphere area of banyan tree were mixed and kept overnight. The formulation was sprinkled on seeds to be sown, then dried in the shade before sowing.

Jivamrut

100 L water was taken in barrel and 10 kg cow dung + 10 L cow urine were added, mixed well with the help of a wooden stick and 2 kg old jaggery and 2 kg pulse flour (gram, pigeonpea, greengram, cowpea or blackgram) and handful soil from rhizosphere area of banyan tree were added. This solution was mixed up well with a wooden stick. The solution was kept aside for fermentation for two to seven days. The solution was regularly shaked three times a day.

Amrutpani

10 kg cow dung and 500 g honey were thoroughly mixed to form a creamy paste. 250 g of ghee was added and mixed at high speed. The content was diluted with 200 L water. This suspension was sprinkled in one acre over soil or with irrigation water.

Sanjivak

100 kg cow dung, 100 L cow urine and 500 g jaggary were mixed in 300 L water in a 500-L closed drum and fermented for 10 days. It was used as soil application either by sprinkling or by applying through irrigation water. Three applications were given; one day before sowing, 30 days of sowing and 45 days of sowing.

The banana pseudo stem extract was obtained from Soil and Water Management Unit, Navsari Agricultural University, Navsari (Gujarat) and seaweed extract (*Kappaphycus alvarezii*) from Fisheries Research Station, Junagadh Agricultural University, Okha (Gujarat). Foliar spraying was done using knapsack sprayer with spray volume of 500 L/ha. The crop was raised as per organic standards in organically converted plot. Pest and disease protection measures were taken using organic/bio-pesticides. The experiment was laid out in the organic plot (maintained since 10 years) and the treatment of chemical

fertilizers was kept outside the organic plot. Eight irrigations each of 5 cm depth were applied at 1.0 IW:CPE and plant protection measures were taken as per need using bio-pesticides. The growth and yield attributes were recorded from the five tagged plants in each plot. Seed and stalk yield were recorded from the net plot area and converted into quintal per hectare base. Soil and plant analysis was carried out adopting standard methods. The gross realization in terms of rupees per hectare was worked out taking into consideration the pod and haulm yields from each treatment and local market prices. The expenses incurred for all the cultivation operations from preparatory tillage to harvesting including the cost of inputs *viz*., seeds, fertilizers, pesticides, *etc*. applied to each treatments along with the treatment cost were calculated on the basis of prevailing local charges. Net return of each treatment was calculated by deducting the total cost of cultivation from the gross returns. The benefit : cost (B:C) ratio was calculated by dividing gross returns by total cost of cultivation.

The data were subjected to statistical analysis by adopting appropriate analysis of variance (Gomez and Gomez, 1984). Wherever the F values found significant at 5 per cent level of probability, the critical difference (CD) values were computed for making comparison among the treatment means.

RESULTS AND DISCUSSION

Growth and yield attributes

Data presented in Table 1 showed that various treatments comprising of based bio-enhancers and botanicals did exert their significant influence on growth and yield attributes of groundnut. However, oil content remained unaffected under various treatments. Significantly the highest plant height, number of branches/plant, number and dry weight of nodules/plant, number of mature pods/plant, pod weight/plant and shelling percentage were recorded with application of FYM @ 5 t/ha (T_9), which mostly remained statistically at par with *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS (T_1) and seaweed extract as foliar spray @ 3.5% at 30, 45 and 60 DAS (T_6). FYM might have improved physical, chemical and biological properties of soil and ultimately enhanced growth and yield attributes of groundnut. The *Panchagavya* is considered to be the most effective bio-enhancer, which might have enhanced photosynthesis and partitioning of photosynthates to various metabolic sinks and resultantly promoted growth and yield components. The seaweed composed of various plant hormones, which might have been responsible for improved growth and development of groundnut. These results are in conformity with findings of Rao *et al.* (2015) and Gayathri *et al.* (2015) for *Panchagavya* in vegetables, Kavipriya *et al.* (2011) and Jadhao *et al.* (2015) for seaweed extract in green gram and black gram and Abraham and Thenua (2010) for FYM in groundnut.

Yield

The data furnished in Table 2 showed that significantly the highest pod (1823 kg/ha) and haulm (3270 kg/ha) yields of groundnut were registered with application of FYM @ 5 t/ha (T_9), however it was closely followed by *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS (T_1) and seaweed extract as foliar spray @ 3.5% at 30, 45 and 60 DAS (T_6). These treatments increased 210, 169 and 142% pod yield and 121, 93 and 74% haulm yield over the control, respectively. Improved growth and yield attributes under these treatments might have been responsible for increased yield. The results corroborate the findings of Patel *et al.* (2013) and Panchal *et al.* (2017) in respect of *Panchagavya* in cowpea and chickpea, Rathore *et al.* (2009) and Dogra and Mandradia (2012) in case of seaweed extract in soybean and onion and Malsawmkimi and Hazarika (2018) in case of manures and biodynamic preparations in mandarin.

Economics

An appraisal of data furnished in Table 2 further revealed that application of FYM @ 5 t/ha (T_9) had the highest cost of

Table 1: Effect of different treatments on growth attributes of groundnut (Pooled over three years).

Treatment	Plant height (cm)	No. of branches/ plant	No. of nodules/ plant	Dry weight of nodules/ plant (mg)	No. of mature pods/ plant	Pod weight/ plant (g)	Shelling (%)	Oil content (%)
T_1: *Panchagavya*	31.52	8.94	58.63	88.44	16.12	148.2	72.86	46.18
T_2: *Bijamrut*	23.13	5.64	53.86	86.33	8.91	99.8	67.63	45.16
T_3: *Jivamrut*	28.26	8.05	63.87	100.48	13.46	129.2	70.73	45.13
T_4: *Amrutpani*	27.40	7.13	60.36	96.98	12.32	116.2	70.16	44.28
T_5: *Sanjivak*	26.73	6.25	61.01	98.14	11.98	111.1	69.35	45.66
T_6: Seaweed extract	30.65	8.31	52.30	82.00	15.51	132.3	71.26	46.54
T_7: Banana sap	29.06	7.47	51.01	83.12	14.11	120.2	71.04	46.28
T_8: Cow urine	24.27	6.12	49.33	77.10	10.34	100.4	68.88	45.32
T_9: FYM	32.16	9.48	65.28	105.36	17.28	172.3	73.41	46.66
T_{10}: Control	20.58	5.28	45.34	70.26	5.29	68.9	65.65	45.08
S.Em.±	1.09	0.25	1.73	2.14	0.45	3.06	1.21	1.43
CD (P≤0.05)	3.09	0.71	NS	1.79	1.28	8.68	3.44	NS

Table 2: Effect of different treatments on yield and economics of groundnut (Pooled over three years).

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Gross returns (`/ha)	Cost of cultivation (`/ha)	Net returns (`/ha)	B:C
T_1: *Panchagavya*	1582	2846	87629	41400	46229	2.12
T_2: *Bijamrut*	828	1746	46628	38964	7664	1.20
T_3: *Jivamrut*	1192	2236	66307	45366	20941	1.46
T_4: *Amrutpani*	1132	2166	63080	41571	21509	1.52
T_5: *Sanjivak*	1011	2045	56674	39906	16768	1.42
T_6: Seaweed extract	1423	2570	78883	48411	30472	1.63
T_7: Banana sap	1302	2360	72156	41016	31140	1.76
T_8: Cow urine	904	1882	50871	41316	9555	1.23
T_9: FYM	1823	3270	100953	45668	55285	2.21
T_{10}: Control	589	1477	33890	38532	-4642	0.88
S.Em.±	43	85				
CD (P≤0.05)	121	240				

Table 3: Effect of different treatments on nutrients uptake and post-harvest soil fertility.

Treatment	Nutrients uptake by pod (kg/ha)			Nutrients uptake by haulm (kg/ha)			Available nutrients (kg/ha)			Organic carbon	Bulk density
	N	P	K	N	P	K	N	P	K	(%)	(Mg/m^3)
T_1: *Panchagavya*	74.14	7.30	10.37	66.06	9.02	24.12	259	31.0	253	0.67	1.38
T_2: *Bijamrut*	35.53	3.62	5.24	36.99	5.23	14.15	257	30.7	251	0.67	1.39
T_3: *Jivamrut*	53.71	5.30	7.64	49.52	6.86	18.50	278	35.3	265	0.75	1.39
T_4: *Amrutpani*	50.21	5.03	7.25	47.49	6.62	17.93	271	34.2	262	0.73	1.37
T_5: *Sanjivak*	44.42	4.50	6.45	44.32	6.22	16.83	275	35.1	264	0.75	1.38
T_6: Seaweed extract	65.66	6.49	9.26	58.84	8.02	21.47	258	30.8	253	0.74	1.37
T_7: Banana sap	59.50	5.89	8.36	53.28	7.29	19.61	262	31.6	257	0.73	1.38
T_8: Cow urine	39.17	3.97	5.74	40.33	5.69	15.45	272	31.3	253	0.74	1.37
T_9: FYM	86.80	8.55	12.14	77.02	10.83	28.24	284	37.3	273	0.82	1.36
T_{10}: Control	22.01	2.09	3.03	26.88	3.66	9.83	252	28.1	242	0.65	1.40
S.Em.±	2.49	0.19	0.27	2.03	0.41	0.73	11	1.7	11	0.03	0.02
CD (P≤0.05)	7.08	0.55	0.75	5.77	1.21	2.08	NS	5.0	NS	NS	NS

cultivation, but gave the highest net returns of `55285/ha with B:C ratio of 2.21, followed by foliar application of *Panchagavya* @ 3% at 30, 45 and 60 DAS ($T_1$) having net returns of `46229/ha with B:C ratio of 2.12. Panchal *et al.* (2017) and Jegoda *et al.* (2019) also found *Panchagavya* as an economical treatment in organic cultivation of chickpea and green gram, respectively.

Nutrients uptake

Significantly the highest nutrients (NPK) uptake by pod and haulm of groundnut were registered with application of FYM @ 5 t/ha (T_9), followed by *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS (T_1) and seaweed extract as foliar spray @ 3.5% at 30, 45 and 60 DAS (T_6) (Table 3). The FYM is known to improve physical, chemical and biological properties of soil, which might be reflected in higher uptake of nutrients. Similarly, *Panchagavya* and seaweed extracts contain several enzymes and beneficial microorganisms, which might have helped in increased the nutrients uptake. Beaulah (2001) and Raverkar *et al.* (2016) reported similar results.

Post-harvest soil properties

Whereas, post-harvest soil properties like available N, available K, organic carbon and bulk density remained unaffected under different treatments. However, significantly higher available P was observed with application of FYM @ 5 t/ha (T_9), followed by *Jivamrut* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS (T_3), *Amrutpani* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS (T_4) and *Sanjivak* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS (T_5). This could be ascribed to role of FYM and the cow-based formulations in improving P solubilization. Rana *et al.* (2015) also reported favourable effect of *Panchagavya* on soil health.

CONCLUSION

Higher yield of summer groundnut grown under organic condition could be achieved by application of FYM @ 5 t/ha on medium black clayey soil under South Saurashtra Agro-climatic Zone. Alternatively, under paucity of FYM, foliar spray of *Panchagavya* @ 3% or seaweed extract @ 3.5% at 30, 45 and 60 DAS could be done.

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