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Influence of various cow-based bio-enhancers and botanicals on growth parameters, yield attributes and economics of summer groundnut (*Arachis hypogaea* L.)

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Abstract

An experiment was conducted during summer-2019 at certified organic plot, Agronomy Instructional Farm, Department of Agronomy, Junagadh Agricultural University, Junagadh to study the "Influence of various cow-based bio-enhancers (*Panchagavya*, *Jeevamrut*) and botanicals (Banana *Pseudostem* sap, Seaweed extract) on growth parameters, yield attributes and economics of summer groundnut (*Arachis hypogaea* L.)" (Cv. TG-37A). The soil of experimental field was medium black calcareous in texture, low in organic carbon (0.59%) available nitrogen (257.00 kg/ha) and medium in available phosphorus (29.63 kg/ha), medium in available potash (254.60 kg/ha) with soil pH of 8.19. The experiment results revealed that next to 100% RDF, application of *Panchagavya* as foliar spray @ 3% at 30 and 45 DAS + 5 t/ha FYM were found superior in respect of the plant height and number of branches per plant, highest number of mature pods and pod weight per plant. Application of *Jeevamrut* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS + FYM 5 t/ha enhanced number of root nodules per plant and dry weight of root nodules per plant. Economic analysis showed that maximum net returns and B: C ratio (₹ 46664/ha and 2.18) were obtained with *Panchagavya* as foliar spray @ 3% at 30 and 45 DAS + FYM 5 t/ha in respect with normal price. Whereas with premium price, maximum net return ₹ 74649/ha and B: C 2.76 followed by FYM 10 t/ha + Biofertilizers (*Rhizobium* + PSB + KSB) over control.

Keywords: *Arachis hypogaea* L., *Panchagavya*, *Jeevamrut*, banana *Pseudostem* sap, seaweed extract

Introduction

Groundnut is the 13th most important food crop and 4th most important oilseeds crop of the world. Multiple uses of groundnut make it an excellent cash crop for domestic markets as well as for foreign trade in several developing and developed countries. It is grown in about 24 M ha area with a total production of 35 M tonne under different agro-climatic zones between 40°S and 40°N (Anon., 2013) ^[1]. In India, it is cultivated on area of 5.33 M ha with production of 7.46 M tonne and productivity of 1398 kg/ha (Anon., 2017a) ^[2]. In India, about 75% of the groundnut area lies in a low to moderate rainfall zone (parts of peninsular region and western and central region) with a short period of distribution (90-120 days). Based on rainfall pattern, soil factors, diseases and pest situations, groundnut growing area in India has been divided into five zones.

Currently six states *viz.*, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra and Rajasthan account for more than 90% of the total groundnut area and 89.3% of total groundnut production. Madhya Pradesh, Uttar Pradesh, Odisha and West Bengal are the other states having substantial area under this crop. Among the major groundnut growing states, Gujarat ranks first in area (1.76 M ha) and production (2.94 M tonne) with productivity of 1673 kg/ha (Anon., 2017b) ^[3].

In the recent years, the area under summer groundnut (0.94 M ha) has increased due to assured higher profit and productivity as it is grown in area where assured irrigation water is available and less incidence of a biotic and abiotic stresses on the crop as compared to rainy season (Rana *et al.*, 2014) ^[4]. There is a keen awareness worldwide in recent years on the excess use of inorganic fertilizers and other chemicals leading to environmental pollution and pest outbreaks. Principle of organic farming is to allow Mother Nature to provide us food the nature intended. Organic farming is all about producing healthy food and fiber without the use of synthetic agrochemicals while ensuring animal welfare and environment sustainability. *Panchgavya* had reverence in the scripts of Vedas (divine scripts of Indian wisdom) and *Vrkshyurveda* (*Vrksha* means plants and *Ayurveda* means health system). (Naresh *et al.*, 2018) ^[12].

Cow is the backbone of Indian culture and rural economy and sustains our life represent cattle wealth and bio-diversity. It is known as “Kamdhenu” and “Gaumata” because of its nourishing nature like mother, the giver of all providing riches to humanity and is a store of medicines. The Ayurveda, the ancient Indian system of medicine, has detail mentions of importance. Cow-based bio-enhancers, botanicals, organic manure and bio-fertilizer play important role in crop production. It acts on the soil physical properties, organic matter promotes formation of soil crumb, thus makes the soil friable and thereby, facilitates the proper movement of air and water as well as absorption of rain water.

The *Panchagavya*, *Jeevamrut* and *Beejamrut* are cheaper ecofriendly organic preparations made by cow products namely dung, urine, milk, curd and ghee. The situation has been changed with depletion of fossil fuel, resulting in exorbitant cost of chemical fertilizers. The reduction in use of NPK fertilizers can be fulfilled by alternate options like bio-fertilizers. It is aimed to promote technically sound, economically viable, environmentally non-degrading and socially acceptable use of natural resources in favor of organic agriculture. In view of the above considerations and paucity of adequate research evidence, the present study was undertaken during summer season 2019 to determine the “Evaluation of some cow-based bio-enhancers and botanicals for organic cultivation of summer groundnut (*Arachis hypogaea* L.) Cv. TG- 37A at the Instructional Organic Farm, Department of Agronomy, Junagadh Agricultural University, Junagadh.

Materials and Methods

A field experiment was conducted at Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) in summer season of 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 with pH 8.19 and EC 0.34 ds/mand organic carbon 0.59%. The soil was low in available nitrogen (257.00 kg/ha), medium in available phosphorus (29.63 kg/ha), available potash (254.60 kg/ha) and available sulphur (17.5 mg/kg). The experiment comprising of 12 treatments viz., T₁-Absolute Control, T₂-100% RDF (25:50:50 NPK kg/ha), T₃-*Panchagavya* as foliar spray 3% at 30 and 45 DAS, T₄-*Panchagavya* as foliar spray 3% at 30 and 45 DAS + FYM 5 t/ha, T₅-*Jeevamrut* 500 L/ha with irrigation at sowing, 30 and 45 DAS, T₆-*Jeevamrut* 500 L/ha with irrigation at sowing, 30 and 45 DAS + FYM 5 t/ha, T₇- Banana pseudostem sap as foliar spray 1% at 30 and 45 DAS, T₈- Banana pseudostem sap as foliar spray 1% at 30 and 45 DAS + FYM 5 t/ha, T₉-Seaweed extract as foliar spray 3.5% at 30 and 45 DAS, T₁₀-Seaweed extract as foliar spray 3.5% at 30 and 45 DAS + FYM 5 t/ha, T₁₁-FYM 5 t/ha + Bio-fertilizers (*Rhizobium* + PSB + KSB), T₁₂-FYM 10 t/ha was laid out in randomized block design with three replications. The groundnut variety “TG-37A” was sown at 30 cm x 10 cm using seed rate of 120 kg/ha. The cow-based formulations were prepared on farm as per the modus operandi given by National Centre for Organic Farming, Ghaziabad (NCOF, 2006) [11]. Foliar spraying was done using knapsack sprayer with spray volume of 500 L/ha. The initially prepared and filtered solution of *Panchgavya* was sprayed on the crop foliage as per treatments. Similarly, *Jeevamrut* was applied on

the soil 500 L/ha. The crop was raised as per organic standards in organically converted plot. Pest and disease protection measures were taken using organic or bio-pesticides.

***Panchagavya*:** *Panchgavya* can be loosely translated as “Five products of cow”. As the name suggests it uses five products from cow and a few more natural ingredients for the fermentation process. Collect fresh cow dung (7 kg), mix it with ghee (1 kg) in the container using a wooden stick. Stirred it clockwise direction in a rhythmic motion. Left this mixture for three days. It was stirred twelve times in each direction once in the morning and once in the evening. After 3 days mix cow urine (10 litres) and water (10 litres) than kept it for 15 days with regular mixing both in morning and evening hours. After 15 days mix cow milk (3 litres), cow curd (2 litres), tender coconut water (3 litres), jaggery (3 kg) and well ripened banana (12 no. without skin). Stir the contents with a wooden stick twice a day. After seven days, filter the product with a khada or terracot (TC) cloth and store it in closed containers (Pierce small holes in the cap of the containers to prevent bursting). This was diluted 300 ml/ 10 L water and sprayed.

Precaution: All the above items can be added to a wide mouthed earthen pot, concrete tank or plastic can as per the above order. Do not use a metal container. The container should be kept open under shade and it should not mix vigorously otherwise it will kill the beneficial microbes in cow dung. Care should be taken not to mix buffalo products. The products of local breeds of cow is said to have potency than exotic breeds. It should be covered with a wire mesh or plastic mosquito net to prevent houseflies from laying eggs and the formation of maggots in the solution. Store it in a place away from direct sun and rain.

***Jeevamrut*:** Take 200 liters capacity plastic drum and mix 10 kg of desi cow dung, 10 litres of cow urine, Mix well with the help of a wooden stick, add 2 kg of jaggery, 2 kg of pulse flour (gram, pigeon pea, greengram, cowpea or blackgram) and hand full of soil collected from rhizosphere of Banyan tree. The mixture was stirred well in clock wise direction and kept in shade covered with wet jute bag. Keep the solution aside for fermentation for two to seven days. Shake the solution regularly three times a day. The solution was regularly stirred clockwise in the morning, afternoon and evening for continuously 9 days and it was used for soil application.

Banana Pseudostem sap: Banana *pseudostem* sap was obtained from Soil and Water Management Unit, Navsari Agricultural University, Navsari (Gujarat) (Fig.2)

Seaweed extract: Seaweed extract (*Kappaphycus alvarezii*) was acquired from Fisheries Research Station, Junagadh Agricultural University, Okha (Devbhumi Dwarka). Foliar spraying was done using knapsack sprayer with spray volume of 500 L/ha (Fig. 2).

Bio-fertilizers: *Rhizobium*, PSB and KSB were obtained from the Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh. KSB was obtained from Navsari Agricultural University, Navsari.

Results and Discussion

Effect on growth parameters

An inquisition of the data in Table 1 revealed that the maximum plant height at 45 DAS (7.67 cm) was observed in plants treated with 100% RDF (T₂) and it was statistically at par with FYM 10 t/ha (T₁₂), FYM 5 t/ha + Biofertilizers (*Rhizobium* + PSB + KSB) (T₁₁). While significantly the maximum plant height at 60 DAS and at harvest was recorded under treatment *Panchagavya* as foliar spray @ 3% at 30 and 45 DAS + FYM 5 t/ha it was statistically at par with FYM 5 t/ha + Biofertilizers (*Rhizobium* + PSB + KSB), FYM 10 t/ha, 100% RDF, and *Jeevamrut* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS + FYM 5 t/ha at all the stages. The lowest plant height was recorded in control (T₁).

Number of branches per plant at harvest was significant due to some cow-based bio-enhancers and botanicals at all the growth stages *Panchagavya* as foliar spray @ 3% at 30 and 45 DAS + FYM 5 t/ha and it was found statistically at par with 100% RDF, FYM 5 t/ha + Biofertilizers (*Rhizobium* + PSB + KSB), *Jeevamrut* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS + FYM 5 t/ha and Banana sap as foliar spray @ 1% at 30 and 45 DAS + FYM 5 t/ha.

Reason for improvement in growth parameters with application of 100% RDF might have resulted in better and timely availability of nitrogen and phosphorus for their utilization by plant. Increase in number of branches per plant in this treatment due to antagonizing action of auxin responsible for apical dominance and there by suppressing terminal bud growth and translocated towards the axillary buds and helps in stimulation of lateral branches since it contain favorable macro and micro nutrient, growth hormones and biofertilizers in liquid formulation. Beneficial effect of FYM in conjunction with recommended dose of fertilizers may be due to the effect of organic matter in improving physical, chemical and biological environment of soil conducive to better plant growth. The results were in the line of the result reported by Jat *et al.* (2006)^[5], Kumar *et al.* (2011)^[6], and Sutar *et al.* (2018)^[17].

The number of nodules per plant at 45 and 60 DAS and highest root nodules dry weight per plant at 45 and 60 DAS differed significantly due to some cow-based bio-enhancers and botanicals at all the growth stages. Application of *Jeevamrut* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS + FYM 5 t/ha. It was statistically at par with 100% RDF, FYM 5 t/ha + Biofertilizers (*Rhizobium* + PSB + KSB), Banana sap as foliar spray @ 1% at 30 and 45 DAS + FYM 5 t/ha, Seaweed extract as foliar spray @ 3.5% at 30 and 45 DAS + FYM 5 t/ha. Significantly the lowest number of root nodule was recorded under treatment control. The IAA and GA present in *Jeevamrut* when applied as soil application created stimuli in the plant system and increased the production of growth regulators in cell system and ultimately stimulated growth and development. Biofertilizer inoculations increase the numbers of such microorganisms in soil or rhizosphere and consequently improve the extent of microbiologically fixed nitrogen for plant growth. Similar findings were also reported by Gore and Sreenivasa (2011)^[4],

Safiullah *et al.* (2018)^[15].

Effect on yield attributes

Advantageous yield attributes such as number of mature pods per plant and pods weight per plant (Table 2) were improved by various treatments of some cow-based bio-enhancers and botanicals. Application of *Panchagavya* as foliar spray @ 3% at 30 and 45 DAS + FYM 5 t/ha (T₄) recorded significantly the highest values for number of mature pods per plant (13.02) and pods weight per plant (9.93 g) and it was found at par with treatment of FYM 10 t/ha + Biofertilizers (*Rhizobium* + PSB + KSB) (T₁₁), 100% RDF (T₂), *Jeevamrut* @ 500 L/ha with irrigation at sowing, 30 and 45 DAS + FYM 5 t/ha (T₆). This is might be due to accumulated metabolites which help in overall improvement in vegetative growth and nodulation, which favorably influenced the flowering and fruiting and ultimately resulted into increased number of matured pods and pod weight per plant. Lyngdoh *et al.* (2017)^[9], Panchal *et al.* (2017)^[13] and Shariff *et al.* (2017)^[16].

Effect on economics

An appraisal of data showed (Table: 2) that maximum cost of cultivation ₹ 42456/ha was realized with the treatment FYM 10 t/ha (T₁₂), followed by the treatments Banana sap as foliar spray @ 1% at 30 and 45 DAS + 5 t/ha (T₈), Seaweed extract as foliar spray @ 3.5% at 30 and 45 DAS + FYM 5 t/ha (T₁₀), by securing cost of cultivation of respectively. However, the lowest cost of cultivation ₹ 32860/ha was accrued under the treatment control (T₁). From the economics point of view, maximum gross returns, net return and benefit: cost ratio was obtained with the treatments of *Panchagavya* as foliar spray @ 3% at 30 and 45 DAS + FYM 5 t/ha which was closely followed by treatment FYM 10 t/ha + Biofertilizers (*Rhizobium* + PSB + KSB) and 100% RDF in respect of normal market price.

With premium price (Table: 3) of organic produce, maximum gross return, net return and benefit: cost ratio was secured with the treatment *Panchagavya* as foliar spray @ 3% at 30 and 45 DAS + FYM 5 t/ha which was closely followed by FYM 10 t/ha + Biofertilizers (*Rhizobium* + PSB + KSB) and Banana sap as foliar spray @ 1% at 30 and 45 DAS. The lowest net return and BCR was recorded under the treatment control. Increase in gross return, net return and benefit cost ratio in treatment of *Panchagavya* because it is rich with micro and macronutrients, and also have growth promoters which increases more number of pods which resulting in highest pod yield per hectare. When premium price is considered it result in low input cost and increases return than other treatments. From the point of economics, it was inferred that the use of of *Panchagavya* as foliar spray @ 3% at 30 and 45 DAS + FYM 5 t/ha could be recommended for increasing both unit productivity and also net returns. These findings are in vicinity with those reported by Matai (2012)^[10] in respect of *Panchagavya* and Khan *et al.* (2015)^[8] and Kalegore *et al.* (2018)^[7] in respect of Biofertilizer.

Table 1: Effect of different treatments on growth parameters in summer groundnut

Treatments	Plant height (cm)			Number of branches per plant			Number of nodules per plant		Root nodules dry weight (mg/plant)	
	45 DAS	60 DAS	At Harvest	45 DAS	60 DAS	At Harvest	45 DAS	60 DAS	45 DAS	60 DAS
T ₁ : Control	4.58	14.80	30.00	3.38	6.37	7.37	41.05	69.33	50.04	67.87
T ₂ : 100% RDF	7.67	20.37	36.27	4.79	8.70	10.30	50.51	82.96	65.73	91.14
T ₃ : <i>Panchagavya</i> as foliar spray 3% at 30 and 45 DAS	5.85	17.48	33.05	3.82	7.30	8.32	44.26	73.15	53.04	76.70
T ₄ : <i>Panchagavya</i> as foliar spray 3% at 30and 45 DAS + FYM 5 t/ha	7.09	21.32	37.47	4.58	9.00	10.48	45.00	80.79	64.66	87.37
T ₅ : <i>Jeevamrut</i> 500 L/ha with irrigation at sowing, 30 and 45 DAS	5.92	17.56	33.50	3.89	7.18	8.07	43.52	72.56	52.13	77.50
T ₆ : <i>Jeevamrut</i> 500 L/ha with irrigation at sowing, 30 and 45 DAS + FYM 5 t/ha	7.14	19.68	35.82	4.15	8.12	9.74	50.88	83.22	66.55	94.23
T ₇ : Banana sap as foliar spray 1% at 30and 45 DAS	5.15	17.21	32.42	3.64	6.67	8.07	43.06	72.07	51.56	72.60
T ₈ : Banana sap as foliar spray 1% at 30 and 45 DAS + FYM 5 t/ha	6.98	20.14	35.95	4.38	7.99	9.29	47.44	80.28	60.17	82.30
T ₉ : Seaweed extract as foliar spray 3.5% at30 and 45 DAS	4.81	16.34	31.90	3.60	6.55	7.65	42.86	69.96	50.36	70.64
T ₁₀ : Seaweed extract as foliar spray 3.5% at 30 and 45 DAS + FYM 5 t/ha	6.48	18.29	34.45	4.29	7.67	9.05	47.03	78.27	59.11	80.97
T ₁₁ : FYM 5 t/ha + Bio-fertilizers (<i>Rhizobium</i> + PSB + KSB)	7.34	20.37	35.95	4.54	8.47	10.10	50.47	81.93	64.94	89.91
T ₁₂ : FYM 10 t/ha	7.40	19.60	33.80	3.88	7.48	8.81	45.70	73.93	64.00	83.99
C.D. at 5%	0.73	2.23	4.06	0.49	1.02	1.21	4.90	8.92	7.90	11.45

Table 2: Effect of different treatments on yield attributes and economics (with normal price) in summer groundnut

Treatments	Number of mature and	Pods weight/plant	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net Return (₹/ha)	B:C ratio
T ₁ : Control	9.53	7.33	32860	60876	28016	1.85
T ₂ : 100% RDF	12.32	9.83	37591	81450	43859	2.17
T ₃ : <i>Panchagavya</i> as foliar spray 3% at 30 and 45 DAS	10.76	7.71	35866	75045	39179	2.09
T ₄ : <i>Panchagavya</i> as foliar spray 3% at 30and 45 DAS + FYM 5 t/ha	13.02	9.93	39643	86307	46664	2.18
T ₅ : <i>Jeevamrut</i> 500 L/ha with irrigation at sowing, 30 and 45 DAS	11.52	8.00	37063	77608	40545	2.09
T ₆ : <i>Jeevamrut</i> 500 L/ha with irrigation at sowing, 30 and 45 DAS + FYM 5 t/ha	12.12	9.35	40432	80386	39954	1.99
T ₇ : Banana sap as foliar spray 1% at 30and 45 DAS	10.62	7.54	35152	74200	39048	2.11
T ₈ : Banana sap as foliar spray 1% at 30 and 45 DAS + FYM 5 t/ha	11.96	9.15	40630	75678	35048	1.86
T ₉ : Seaweed extract as foliar spray 3.5% at30 and 45 DAS	10.34	7.40	36853	71601	34748	1.94
T ₁₀ : Seaweed extract as foliar spray 3.5% at 30 and 45 DAS + FYM 5 t/ha	11.57	8.42	40630	78211	37581	1.92
T ₁₁ : FYM 5 t/ha + Bio-fertilizers (<i>Rhizobium</i> + PSB + KSB)	12.70	9.35	39019	83212	44193	2.13
T ₁₂ : FYM 10 t/ha	11.89	7.82	42456	79372	36916	1.87
C.D. at 5%	1.38	0.89				

Market Price:

Organic pod	: 52.00 (₹/kg)
Inorganic pod	: 40.00 (₹/kg)
Haulm	: 3.00 (₹/kg)

Table 3: Effect of different treatments on economics (with premium price) in summer groundnut

Treatments	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net return (₹/ha)	B:C ratio
T ₁ : Control	32860	77292	44432	2.35
T ₂ : 100% RDF	37591	81450	43859	2.17
T ₃ : <i>Panchagavya</i> as foliar spray 3% at 30 and 45 DAS	35866	95277	59411	2.66
T ₄ : <i>Panchagavya</i> as foliar spray 3% at 30and 45 DAS + FYM 5 t/ha	39643	109599	69956	2.76
T ₅ : <i>Jeevamrut</i> 500 L/ha with irrigation at sowing, 30 and 45 DAS	37063	98500	61437	2.66
T ₆ : <i>Jeevamrut</i> 500 L/ha with irrigation at sowing, 30 and 45 DAS + FYM 5 t/ha	40432	101998	61566	2.52
T ₇ : Banana sap as foliar spray 1% at 30and 45 DAS	35152	94228	59076	2.68
T ₈ : Banana sap as foliar spray 1% at 30 and 45 DAS + FYM 5 t/ha	40630	96090	55460	2.36
T ₉ : Seaweed extract as foliar spray 3.5% at30 and 45 DAS	36853	90897	54044	2.47
T ₁₀ : Seaweed extract as foliar spray 3.5% at 30 and 45 DAS + FYM 5 t/ha	40630	99247	58617	2.44
T ₁₁ : FYM 5 t/ha + Bio-fertilizers (<i>Rhizobium</i> + PSB + KSB)	39019	105652	66633	2.71
T ₁₂ : FYM 10 t/ha	42456	100732	58276	2.37

Market Price:

Organic pod	: 52.00 (₹/kg)
Inorganic pod	: 40.00 (₹/kg)
Haulm	: 3.00 (₹/kg)

Conclusion

On the basis of the results obtained from the present one year field experimentation, it seems quite logical to conclude that growth, yield parameters and net realization with good soil health could be obtain with application of *Panchagavya* as foliar spray @ 3% at 30 and 45 DAS + FYM 5 t/ha or FYM 5 t/ha + Biofertilizers (*Rhizobium* + PSB + KSB) in summer groundnut (Cv. TG- 37A) under medium black calcareous clayey soil of South Saurashtra Agro-climatic Zone.

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