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Ganvit DG
M.Sc. Student, Department of Organic Farming, GNFSU, Halol, Anand Camp., Gujarat, India

Suthar JV
Assistant Professor, Department of Agricultural Sciences, College of Agricultural Information Technology, Anand Agricultural University, Anand, Gujarat, India

Vala HD
M.Sc. Student, Department of Organic Farming, GNFSU, Anand Camp., Halol, Gujarat, India

Corresponding Author:
Ganvit DG
M.Sc. Student, Department of Organic Farming, GNFSU, Halol, Anand Camp., Gujarat, India

Effect of organic sources and seaweed extract on growth, yield and economics of summer groundnut

Ganvit DG, Suthar JV and Vala HD

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Abstract
A field experiment was carried out during summer season of 2022 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand tostudy the Response of organic sources and seaweed extract on summer groundnut. The experiment was conducted in Randomized Block Design with 3 replication and 10 treatments *viz.*,100% RDN through FYM (T_1), 100% RDN through Vermicompost (T_2), 75% RDN through FYM + Bio NPK (Seed treatment and soil application) (T_3), 75% RDN through Vermicompost + Bio NPK (Seed treatment and soil application) (T_4), 75% RDN through FYM + seaweed extract 3% (T_5), 75% RDN through Vermicompost + seaweed extract 3% (T_6), 50% RDN through FYM + Bio NPK (Seed treatment and soil application) (T_7), 50% RDN through Vermicompost + Bio NPK (Seed treatment and soil application) (T_8), 50% RDN through FYM + seaweed extract 3% (T_9), 50% RDN through Vermicompost + seaweed extract 3% (T_{10}). According to results, application of 75% RDN through vermicompost + seaweed extract 3% (T_6) at 60 DAS, recorded higher values of growth parameters, yield attributing parameters and yield of summer groundnut as compared to absolute control (T_1). The dry weight of nodules at 45 DAS recorded significantly higher (72.24 mg/plant) under treatment T_4 (75% RDN through Vermicompost + Seed treatment and soil application of Bio NPK).

Keywords: Summer groundnut, Bio NPK consortium, FYM, vermicompost, seaweed extract

Introduction
India is one of the largest producers of oilseeds globally, contributing significantly to its agricultural economy. Among nine major oilseed crops, groundnut *(Arachis hypogaea* L.) holds a vital place due to its dual role as a source of edible oil and protein. Groundnuts are grown extensively across India, with Gujarat leading in production, followed by Rajasthan and Tamil Nadu. Besides being a rich source of edible oil (45-50%) and digestible protein (25-30%), groundnuts also provide haulm for animal fodder and oilcakes used as manure and livestock feed (Chandrasekaran *et al.*, 2007); (Fageria*et al.*, 1997) [1, 2].

While chemical fertilizers have historically driven agricultural productivity, their overuse has led to environmental degradation and declining soil health. Consequently, there is a shift toward sustainable and organic agricultural practices. Organic manures such as farmyard manure (FYM), vermicompost, seaweed extracts, and biofertilizers are gaining traction as they enhance soil fertility, promote beneficial microorganisms, and ensure sustainable productivity (Adhikary, 2012); Lal *et al.*, 2017) [3, 4]. Farmyard manure, rich in essential nutrients like nitrogen, phosphorus, and potassium, has been traditionally used to maintain soil fertility (Zalate and Padmani, 2009) [5]. Vermicompost, derived from earthworm activity, further boosts soil health through its high nutrient content and long-lasting effects (Ullah *et al.*, 2021) [6]. Additionally, seaweed extracts such as *Sargassum wightii*, which contain growth-promoting hormones and micronutrients, offer an eco-friendly alternative to chemical inputs (Sivasankari*et al.*, 2006) [7]. Biofertilizers have emerged as a sustainable solution, promoting plant growth through nutrient acquisition, stress management, and disease suppression. Formulations like the Bio NPK Consortium, containing nitrogen-fixing, phosphate-solubilizing, and potassium-mobilizing microorganisms, play a critical role in sustainable crop production (Rathod *et al.*, 2022) [8].

This research focuses on the integrated use of organic and biofertilizers in enhancing groundnut productivity while maintaining soil health.

The study seeks to address the growing consumer demand for organic produce, driven by health consciousness and environmental concerns, while ensuring agricultural sustainability. Keeping in view the above facts, the present study was carried out on "Response of organic sources and seaweed extract on summer groundnut."

Materials and Methods

The field experiment was carried out during summer of 2022 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat (22°54′ North latitude, 72°98′ East longitude and 39 m above mean sea level). The soil at the trial location was loamy sand in texture, low in organic carbon (0.70%) and available nitrogen (204 kg/ha), medium in available phosphorus (30.05 kg/ha) and potassium (275 kg/ha) and slightly alkaline (pH:8.05) in reaction. Electrical conductivity of experimental field was (0.23 dS/m). There were ten treatments of organic sources and seaweed extract *viz*., 100% RDN through FYM (T_1), 100% RDN through Vermicompost (T_2), 75% RDN through FYM + Bio NPK (Seed treatment and soil application) (T_3), 75% RDN through Vermicompost + Bio NPK (Seed treatment and soil application) (T_4), 75% RDN through FYM + seaweed extract 3% (T_5), 75% RDN through Vermicompost + seaweed extract 3% (T_6), 50% RDN through FYM + Bio NPK (Seed treatment and soil application) (T_7), 50% RDN through Vermicompost + Bio NPK (Seed treatment and soil application) (T_8), 50% RDN through FYM + seaweed extract 3% (T_9), 50% RDN through Vermicompost + seaweed extract 3% (T_{10})were tested in Randomized Block Design with 3 replications. The Bio NPK consortium was sourced from the department of microbiology at Anand Agricultural University, Anand, Gujarat. Groundnut variety GG34 was shown on 27th January 2022. Sowing was done by drilling method of sowing at 45 cm apart. Data regarding growth parameters, yield attributes and yield were recorded as per the standard procedure and economics were calculated based on yield of crop and total cost of cultivation. The RDF of Summer Groundnut was 25:50:00 NPK kg/ha. All the organic manures were incorporated 15 days before sowing in respective treatment. For seed treatment, Bio NPK consortium was mixed with seeds @ 5 ml/kg of seeds and kept in shade for 20-25 min before sowing. All the parameters underwent statistical analysis and interpretation according to procedure described by Cochran and Cox (1967) [9].

Results and Discussion

Growth Parameters

Plant population *(*per meter row length)

Plant population (per meter row length) at 20 DAS of Summer Groundnut was found non-significant as different organic sources and seaweed extract did not exert any significant impact on plant population. Thus, uniformity in plant population was observed across all experimental plots throughout the growth period. It reveals that, variations observed in results were due to treatment effects only.

Plant height (cm)

The periodical plant height was recorded at 30, 60 DAS and at harvest. At 30 and 60 days after sowing, there was no any significant difference in plant height. The data showed that there was non-significant difference in plant height measured at 30 DAS by different organic sources and seaweed extract. While, plant height at 60 DAS and at harvest was significantly affected due to different organic sources and seaweed extract.

Treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) recorded significantly higher plant height at 60 DAS and at harvest (18.11 cm and 42.90 cm, respectively). However, plant height at 60 DAS was remained at par with treatments T_5 (75% RDN through FYM + seaweed extract 3%), T_4 (75% RDN through Vermicompost + Seed treatment and soil application of Bio NPK), T_3 (75% RDN through FYM + Seed treatment and soil application of Bio NPK), T_2 (100% RDN through Vermicompost) and T_1 (100% RDN through FYM) while, plant hight at harvest was remained at par with treatments T_5 (75% RDN through FYM + seaweed extract 3%), T_4 (75% RDN through Vermicompost + Seed treatment and soil application of Bio NPK) and T_3 (75% RDN through FYM + Seed treatment and soil application of Bio NPK). Significantly lower plant height (14.16 cm and 35.38 cm) was recorded under treatment T_7 (50% RDN through FYM + Seed treatment and soil application of Bio NPK) at 60 DAS and at harvest, respectively.

Better performance of treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) with respect to plant height might be due to combined application of vermicompost and seaweed extract.

Presence of relatively readily available plant nutrients, growth enhancing substances and number of beneficial organisms like nitrogen fixing, phosphate solubilizing, cellulose decomposing and other beneficial microbes as well as antibiotics, vitamins and hormones etc. in vermicompost produced larger cells with thinner cell wall and its contribution in cell division and cell elongation which improved vegetative growth and ultimately increased plant height. These findings are in agreement with Vala *et al.* (2017) [10], Chaudhary *et al.* (2015) [11] and Dadhich *et al.* (2021) [12].

Yield Attributes and Yield

Dry weight of nodules at 45 DAS (mg/plant)

The results summarized in Table 1 indicated that different treatments exhibited their significant effect on dry weight of nodules/plant at 45 DAS. Significantly higher dry weight of nodules (72.24 mg/plant) was recorded under treatment T_4 (75% RDN through Vermicompost + Seed treatment and soil application of Bio NPK) but it was at par with T_3 (75% RDN through FYM + Seed treatment and soil application of Bio NPK), T_8 (50% RDN through Vermicompost + Seed treatment and soil application of Bio NPK), T_7 (50% RDN through FYM + Seed treatment and soil application of Bio NPK) and T_6 (75% RDN through Vermicompost + seaweed extract 3%). Significantly lower dry weight of nodules (58.43 mg/plant) was recorded under treatment T_9 (50% RDN through FYM + seaweed extract 3%.) as compared to other treatments.

Increase in dry weight of nodules per plant of groundnut has been recorded under treatment T_4 (75% RDN through Vermicompost + Seed treatment and soil application of Bio NPK) might be due to combination of vermicompost and biofertilizers resulted in greater nodulation. Increase in dry weight of nodules per plant of groundnut might be due to combination of organic manure and biofertilizers inoculation resulted in greater nodulation. The additional supply of nitrogen and phosphorus helped in formation of new cell and thus, proliferation of growth. Phosphorus is an important constituent of co-enzymes involved in photosynthesis which might have been increased accumulation of photosynthesis. These are in conformity with the result of Patel *et al.* (2022) [13].

Number of branches/plant at harvest

The data presented in Table 1 revealed that treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) registered

significantly higher number of branches/plant (10.14) at harvest in groundnut which was remained at par with treatments T_5 (75% RDN through FYM + seaweed extract 3%), T_4 (75% RDN through Vermicompost + Seed treatment and soil application of Bio NPK) and T_3 (75% RDN through FYM + Seed treatment and soil application of Bio NPK). Significantly lower branches/plant (6.53) at harvest was recorded under treatment T_7 (50% RDN through FYM + Seed treatment and soil application of Bio NPK).

Increased in number of branches per plant of groundnut has been recorded under treatment T_6(75% RDN through Vermicompost + seaweed extract 3%) might be due to the presence of growth promoting hormones (IAA and IBA, Cytokinins) trace elements (Fe, Cu, Zn, Co, Mo, Mn and Ni), vitamins and amino acids. These findings match with Pramanick*et al*. (2013) [14] and Ghosh *et al*. (2020) [15].

Number of pods/plant

The results on effect of organic sources and seaweed extract on number of pods/plant at harvest in groundnut are given in Table 1.

The results summarized in Table 1 revealed that the application of 75% RDN through Vermicompost + seaweed extract 3% (T_6) registered significantly higher number of pods/plant (32.02) at harvest in groundnut and it was remained at par with treatments T_5(75% RDN through FYM + seaweed extract 3%), T_4 (75% RDN through Vermicompost + Seed treatment and soil application of Bio NPK), T_3 (75% RDN through FYM + Seed treatment and soil application of Bio NPK), T_2 (100% RDN through Vermicompost) and T_1 (100% RDN through FYM). Significantly lower number of pods/plant (25.11) was observed under treatment T_7 (50% RDN through FYM + Seed treatment and soil application of Bio NPK).

Increased in number of pods per plant of groundnut has been recorded under treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) might be due to increased values in yield attributes might have been on account of the 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. These are in conformity with the results of Patra *et al*. (2011) [16] and Chaudhary *et al*. (2015) [11].

Development of improved root system as influenced by endogenous auxins as well as other compounds present in the seaweed extract having higher root to shoot ratio thereby making the plants more able to mine adequate nutrients from the deeper layer of soil causing enhanced number of pods per plant and application of seaweed extract efficiently translocate of assimilates from leaf and stem to reproductive part and thereby increased pods per plant.These results are similar to the result of Nofal*et al*. (2016) [17] and Sridhar and Rengasamy (2010) [18].

Pod yield and haulm yield (kg/ha)

The results summarized in Table 1 revealed that application of 75% RDN through Vermicompost + seaweed extract 3% (T_6) registered significantly higher pod yield (3305 kg/ha) and haulm yield (5593 kg/ha) of groundnut, however it was at par with treatments T_5 (75% RDN through FYM + seaweed extract 3%), T_4 (75% RDN through Vermicompost + Seed treatment and soil application of Bio NPK), T_3 (75% RDN through FYM + Seed treatment and soil application of Bio NPK), T_2 (100% RDN through Vermicompost). The lower value of pod yield (2535 kg/ha) and haulm yield (4443 kg/ha) were obtained under treatment T_7(50% RDN through FYM + Seed treatment and soil application of Bio NPK).

The percent increase in pod yield by treatment T_6(75% RDN through Vermicompost + seaweed extract 3%) was to the tune of 22.54, 30.37, 23.09, 27.65 and 24.15 percent over treatments T_1, T_7, T_8, T_9 and T_{10}, respectively. The percent increase in haulm yield by treatment T_6(75% RDN through Vermicompost + seaweed extract 3%) was to the tune of 20.98, 25.88, 16.23, 22.84 and 15.86 percent over treatments T_1, T_7, T_8, T_9 and T_{10}, respectively.

Increased in pod yield under treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) might be due to increased and prolonged availability of nutrients, improvement in soil physical properties as well as biological activity due to use of vermicompost might have resulted in increased plant growth, yield components and yield.The similar kinds of results have been also recorded by Ramakrishna *et al*. (2016) [19], Dadhich *et al*. (2021) [12] and Chaudhary *et al*. (2015) [11].

Seaweed extractimprove the source - sinkrelationship and translocation of photo assimilates and there by photosynthetic ability of the plants increased and thus play significant role in realization of high productivity levels and higher crop yields. Similar results were obtained by Sridhar and Rengasamy (2010) [18] and Nofal*et al*. (2016) [17].

The increased haulm yield might be due to better vegetative growth and higher dry matter production due to availability of all plant nutrients and better physical properties of soil these finding confirms with Pramanick*et al*. (2013) [19].

Seed index (g)

The result in respect of seed index showed non-significant difference due to different organic sources and seaweed extract on seed index of groundnut.

Harvest Index (%)

The results summarized in Table 1 indicated that the different organic sources and seaweed extract did not exert their significant influenced on harvest index of groundnut.

Economics

An appraisal of data presented in Table 1 revealed that maximum net realization of ₹144211/ha was recorded under the application of 75% RDN through Vermicompost + seaweed extract 3% (T_6) which was followed by treatment T_5 (75% RDN through FYM + seaweed extract 3%), T_4 (75% RDN through Vermicompost + Seed treatment and soil application of Bio NPK) and T_3(75% RDN through FYM + Seed treatment and soil application of Bio NPK) with net realization of ₹142184/ha, ₹138535/ha and ₹135133/ha, respectively. The lowest net realization of ₹104593/ha was obtained under treatment T_7 (50% RDN through FYM + seaweed extract 3%).

In case of benefit: Cost ratio, the highest benefit: cost ratio of 3.40 was recorded under application of T_3 (75% RDN through FYM + Seed treatment and soil application of Bio NPK) which was followed by 75% RDN through FYM + seaweed extract 3% (T_5) with B: C ratio 3.31. The highest net realization under seaweed extract might be attributed to highest yield hence, increased the net income. These results corroborate with the findings of Dwivedi *et al*. (2014) [20].

Table 1: Effect of different organic sources and seaweed extract on growth, yield and economics of summer grounfnut

Treatments	Plant population/ meter row length	Plant height (cm)			Number of branches/plant at harvest	Number of pods/plant	Seed Index (g)	Pod yield (kg/ha)	Haulm yield (kg/ha)	HI (%)	Total Cost of cultivation (₹/ha)	Gross realization (₹/ha)	Net realization (₹/ha)	BCR
	At harvest	30 DAS	60 DAS	At harvest										
T_1	9.43	9.42	16.07	37.58	8.18	29.85	51.40	2697	4623	36.88	56146	171450	115304	3.05
T_2	9.90	9.59	16.25	38.31	8.59	30.34	52.13	2874	4959	36.64	61369	182865	121496	2.98
T_3	9.83	9.67	16.58	39.37	9.01	30.58	52.17	3025	5010	37.63	56292	191425	135133	3.40
T_4	10.30	9.85	17.18	40.46	9.33	31.73	52.23	3139	5219	37.57	60205	198740	138535	3.30
T_5	9.67	9.42	17.32	40.88	9.47	31.93	53.70	3220	5340	37.64	61616	203800	142184	3.31
T_6	10.37	10.12	18.11	42.90	10.14	32.02	53.73	3305	5593	37.16	65529	209740	144211	3.20
T_7	10.10	8.83	14.16	35.38	6.53	25.11	48.00	2535	4443	36.32	55243	161640	106397	2.93
T_8	10.17	9.34	15.99	37.42	7.60	26.64	50.87	2685	4812	35.73	57855	171735	113880	2.97
T_9	9.87	8.96	15.00	36.81	6.75	25.97	48.93	2589	4553	36.14	60567	165160	104593	2.73
T_{10}	10.33	8.99	15.31	36.95	7.87	26.26	49.30	2662	4827	35.52	63179	170545	107366	2.70
LSD (p=0.05)	NS	NS	2.22	4.28	1.28	5.17	NS	455	674	NS	-	-	-	-

Conclusion

Based on the results of an experiment on summer groundnut, should fertilized with 75% RDN through either FYM or vermicompost along with foliar spray of 3% seaweed extract at 30 and 45 DAS for getting higher yield and net realization under organic condition.

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