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Effect of organic sources and seaweed extract on soil nutrients status after harvest and N content and uptake in kernels of summer groundnut

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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 to study 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, various treatments of organic sources and seaweed extract had no significant effect on EC (dS/m), pH and organic carbon (%) of soil after harvest of groundnut. Treatment T_1 (100% RDN through FYM) recorded significantly higher available nitrogen content in soil (235 kg/ha) after harvest of groundnut, while treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) recorded significantly higher available phosphorus content in soil (38.23 kg/ha) after harvest of groundnut. However, available potassium content in soil after harvest of groundnut was not significantly affected by application of various organic sources and seaweed extract. Significantly higher nitrogen content (4.15%) and uptake (95.28 kg/ha) in kernel was obtained underapplication of 75% RDN through Vermicompost + seaweed extract 3% (T_6) The treatments had no significant impact on EC, pH, organic carbon, or potassium content.

Keywords: FYM, Bio NPK consortium, summer groundnut, 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) [1], (Fageria *et al.*, 1997) [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) [3], Lal *et al.*, 2017) [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, BA 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, and Gujarat. Groundnut variety GG 34 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 @ 5ml/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

Effect on soil nutrient status after harvest

Available nitrogen (kg/ha)

The data revealed that available nitrogen content in the soil after harvest was significantly influenced by the application of various organic sources and seaweed extract. Treatment T_1 (100% RDN through FYM) recorded the highest available nitrogen content (235 kg/ha), statistically at par with treatments T_2 (100% RDN through Vermicompost), T_5 (75% RDN through FYM + seaweed extract 3%), T_6 (75% RDN through Vermicompost + seaweed extract 3%), T_3 (75% RDN through FYM + seed treatment and soil application of Bio NPK), T_4 (75% RDN through Vermicompost + seed treatment and soil application of Bio NPK), and T_8 (50% RDN through Vermicompost + seed treatment and soil application of Bio NPK). The lowest nitrogen content (206 kg/ha) was recorded under treatment T_7 (50% RDN through FYM + seed treatment and soil application of Bio NPK).

The significant improvement in soil nitrogen content under treatments with FYM can be attributed to enhanced mineralization of nitrogen. High enzymatic activity in FYM-amended soil likely facilitated the transformation of nutrients into their available forms. Additionally, the residual nitrogen accumulation and increased C:N ratio in the soil played a vital role. These results corroborate findings by Patel *et al.* (2022) [10], Maurya *et al.* (2017) [11], and Amipara and Jadav (2017) [12].

Similarly, treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) resulted in significantly higher nitrogen content (4.15%) and nitrogen uptake (95.28 kg/ha) in groundnut kernels. The synergistic effects of vermicompost and seaweed extract likely enhanced nutrient availability and crop uptake, emphasizing their efficacy in sustainable groundnut cultivation.

Available phosphorus (kg/ha)

Available phosphorus content in soil after harvest of groundnut crop as influenced by different treatments of organic sources and seaweed extract.

The treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) recorded significantly higher available phosphorus content in soil (38.23 kg/ha) after harvest of groundnut, however 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). Significantly lower phosphorus content (32.20 kg/ha) was recorded with treatment T_7 (50% RDN through FYM + Seed treatment and soil application of Bio NPK).

Increase in available phosphorus content in soil under treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) might be due to the beneficial role of vermicompost in mineralization of native as well as its own nutrient content by creating favourable conditions for microbial as well as chemical activities which enhanced the available nutrient pool of the soil. As a matter of fact, all the available nutrients are not taken up by the plant and the rest remains in the soil which improves the available nutrient status of soil after harvest of crop. Vermicompost being rich in P might have added appreciable quantity of P besides addition through PROM and also solubilized the native P in the soil through release of various organic acids. These findings are in close agreement with Rajkhowa *et al.* (2017) [13], Donga and Mathukia (2021) [14] and Sharma *et al.* (2017) [15].

Available potassium (kg/ha)

The data on available potassium content in soil after harvest of groundnut crop as influenced by different organic sources and seaweed extract. The results revealed that available potassium content in soil after harvest of groundnut crop was not significantly affected by application of various organic sources and seaweed extract.

Effect on N content and uptake in kernels

N content (%) and uptake (kg/ha) in kernels

N content (%) in kernel

The data tabulated that significantly higher nitrogen content in

kernel (4.15%) of groundnut were obtained with application of 75% RDN through Vermicompost + seaweed extract 3% (T_6) 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). The lower nitrogen content (3.47%) in kernel was recorded under treatment T_7 (50% RDN through FYM + Seed treatment and soil application of Bio NPK).

Increase in nutrient content in kernel under treatment T_6 (75% RDN through Vermicompost + seaweed extract 3%) might be due to the presence of all these nutrients as constituent of seaweed extract which enhances the content of mineral nutrients in plants. These results are in close agreement with findings of Zodape *et al*. (2010) [16] and Nofal *et al*. (2016) [17].

Application of vermicompost increased the root enlargement; microbial activities resulted in more availability and uptake of nitrogen and thereby N content noted by Sharma *et al*. (2017) [15].

N uptake (kg/ha) in kernel

The data indicated that significantly higher nitrogen uptake in kernel (95.28 kg/ha) of groundnut were obtained with application of 75% RDN through Vermicompost + seaweed extract 3% (T_6) 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). While, lower value (55.36 kg/ha) of nitrogen uptake in kernel was recorded under treatment T_7 (50% RDN through FYM + Seed treatment and soil application of Bio NPK). Increased in nitrogen uptake in kernel under treatment T_6 (of 75% RDN through Vermicompost + seaweed extract 3%) might be due to presence of marine bioactive substances in seaweed extract which improves stomata uptake efficiency of plants. These results are in close agreement with finding of Pramanick *et al*. (2013) [18].

Vermicompost plays significant role in increasing root enlargement and microbial activities which resulted in more availability and uptake of nitrogen. These results are in close agreement with finding of Sharma *et al*. (2017) [15].

Table 1: Effect of organic sources and seaweed extract on soil nutrients status after harvest and N content and uptake in kernels of summer groundnut

Treatments	Available Nutrients (Kg/Ha)			N Content (%)	N Uptake (Kg/Ha)
	N	P_2O_5	K_2O		
Intitial	204	30.05	275		
T_1	235	34.69	284	3.74	68.04
T_2	233	35.34	286	3.93	76.83
T_3	226	35.88	286	3.99	82.08
T_4	218	36.18	289	4.07	87.07
T_5	230	37.04	290	4.13	92.05
T_6	229	38.23	294	4.15	95.28
T_7	206	32.20	277	3.47	55.36
T_8	218	34.53	281	3.65	65.25
T_9	208	32.79	279	3.55	60.02
T_{10}	213	33.13	280	3.62	63.47
LSD (p=0.05)	19.60	3.49	NS	0.43	15.79

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 significantly improves available nitrogen and phosphorus content in the soil. These practices provide a sustainable approach to enhance soil fertility and groundnut quality. Further research is warranted to explore long-term effects and optimize the use of organic inputs in groundnut cultivation.

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