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Effect of Different Organic Nutrient Sources on the Growth and Yield of Summer Sesamum (*Sesamum indicum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *Zaid* season of 2023 at the Agricultural Research Station, Binjhagiri, Chhatabar, Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha. The experiment was laid out in Randomized Block Design with ten treatments and each treatment replicated thrice. Soil of the experiment field was sandy loam in texture, slightly acidic (pH-6.4), low in organic carbon (0.45%), low in available nitrogen (179 kg ha^{-1}), medium in available phosphorous (20.0 kg ha^{-1}) and potassium (142 kg ha^{-1}).The results showed that the application of various organic sources like FYM, jeevamrutha, beejamrutha,

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panchagyavya, vermicompost and rock phosphate significantly affected the growth parameters, yield parameters, yield and economic attributes of summer sesamum net return and return per rupee.

Keywords: Summer sesame; organic nutrients; rock phosphate; seed yield.

1. INTRODUCTION

"Oil seed crops play a vital role in the Indian agriculture, industry and export trade. In India, oil seed crops occupy an area of about 26.53 million hectares with the production of 31.01 million tonnes and average productivity of 1169 kg/ha" [1]. "Sesame (*Sesamum indicum* L.) is commonly known as 'til' and has been known to be one of the earliest domesticated edible oil seed used by the mankind. The cultivated type, *Sesamum indicum* originated in India. It has an important advantage as it can be grown under fairly high temperature, low water supply and low levels of other inputs" [2]. "It is known as "the sovereign of oil seeds" since it is valued for its nutritive incentive as well as for the quality and amount of its oil which is plentiful in nutrient E and has a lot of linoleic corrosive that can control blood cholesterol levels" [3,4]. The oil content and protein content in sesame generally varies from 46-52% and between 18-20%, respectively. Sesame is one of the most important oil seed crops in India that grown next to groundnut, rapeseed and mustard. It is cultivated in an area of 19.53 lakh hectares in India with an annual production of 7.84 lakh tonnes and productivity of 463 kg/ha. It is mostly cultivated in Maharashtra, Uttar Pradesh, Rajasthan, Odisha, Andhra Pradesh, Madhya Pradesh, Tamil Nadu and Karnataka. These six states account about 64 percent of an area and 78 percent of the production of sesame in the country. India ranks first in area, production and export of sesame in the world [5,6]. Sesame ranks third in terms of total oil seed area and fourth in terms of total oil seed production in India. Lower productivity of summer sesame is due to use of sub-optimal rate of fertilizer, poor management and cultivation of summer sesame in marginal and sub-marginal lands where deficiency of macro nutrients such as nitrogen, phosphorus, potassium and micro nutrients is predominant. Increased usages of chemical fertilizers without adequate organic recycling has not only aggravated multi-nutrient deficiencies in soil and plant system, but also deteriorated soil health and created environmental pollution. Therefore, it is right time to evaluate the feasibility and efficiency of organic agriculture not only for improving building up soil fertility, but also for increasing the efficiency of chemical fertilizers. Now-a-days there is a huge demand for organic sesame in the global market. India has greater scope to produce sesame as it is traditionally grown without much chemical fertilizer and plant protection.

Organic agriculture is a production system, which avoids or largely excludes the use of chemical fertilizers, pesticides and growth regulators [7-9]. To the extent feasible, organic farming relies on crop rotations, crop residues, animal manures, green manures, off farm organic wastes and aspects of biological pest management to maintain soil productivity and to manage insects and pests. The concept of soil as a living system that promotes the activities of beneficial organisms is central to this definition. For successful organic farming in any crops depends upon the availability of nutrients at right time and in right amount, particularly in short duration crops [7-9]

"Organic manures like FYM add much needed organic and mineral matter to the soil. The organic matter added is an indispensable component of soil and plays an important role in maintenance and improvement of soil fertility and productivity. Farm yard manure is known to play an important role in improving the fertility and productivity of soils through its positive effects on soil physical, chemical and biological properties and balanced plant nutrition. Vermicomposting is one of the biological process in which the organic wastes has been converted into nutrient rich manure by the action of earthworms. The characteristic feature of vermicompost such as high porosity and moisture holding capacity increases the growth of pathogen free plants" [10]. "The major factor contributing to plant growth is the occurrence of plant growth hormones and humic acid content in the vermicompost. The high yield and growth of the plants due to usage of vermicompost increases the commercial value and agricultural sustainability" [11, 1].

Panchagavya is a mixed culture of naturally occurring beneficial microbes mostly lactic and bacteria (Lactobacillus), yeast (Sacahromyces), actinomyces (Streptomyces), photosynthetic bacteria (Rhodopsuedomonas) and certain fungi (Aspergillus) which promotes the growth and yield of different crops. Panchagavya helps to preserve the quality of crops, soil and environment as well.it has also been reveal ed that as compared to chemical fertilizers, panchagavya is less expensive and more eco-friendly with no side effects [12].

Jeevamruth is one of those organic fertilizer which have large number of nutrients like nitrogen, phosphrous, calcium and other micronutrients. This will ensure higher yield by enhancing the availability of nutrients through faster decomposition of bulky organic manures by boosting the microbial activity in the soil. Use of beejamrutha, a mix of cow dung, cow urine, water, lime and a handful of soil has been given importance in sustainable agriculture since age old days. It is also one such organic product helpful for the plant growth. The beneficial microorganisms present in beejamrutha are known to protect the crop from harmful soil-borne and seed-borne pathogens. In this context, it is worth noting that nutrient management through organics play a major role in maintaining soil health due to build up of soil organic matter, beneficial microbes and enzymes, besides improving soil physical and chemical properties.

Thus, the objective of present study to evaluate the effect of different organic manuring schedule on growth and yield of sesame, to determine the nutrient uptake under different sets of treatment, and to work out the economics for different organic manuring practices.

2. MATERIALS AND METHODS

The experiment was carried out at Agricultural Research Station, Binjhagiri, Chhatabar ($20^0$26 North and 85^0 67 East,45 meters above mean sea level) in the Faculty of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha. The experiment was conducted on sandy loam soil was slightly acidic (pH-6.4), low in organic carbon (0.45%) and low in available nitrogen (179 kg ha^{-1}), medium in available phosphorous (20.0 kg ha^{-1}) and potassium (142 kg ha^{-1}). The experiment was laid out in a Randomized Block Design with ten treatments and each treatment was replicated three times. The gross plot size was 5m x 3m and net plot size was 4m x 2.6m. The treatment combinations are T_1- Control, T_2 - 100 % RDN through 50% of FYM and 50% of vermicompost + remaining RDP through rock phosphate, T_3- 50 % RDN through 50% of FYM and 50 % of vermicompost + remaining RDP through rock phosphate, T_4- Seed treatment with beejamrutha 10 % solution @ 20 ml kg^{-1} seed + application of panchagavya @ 3 % as one soil application and two foliar application (branching and flowering), T_5- Seed treatment with beejamrutha 10 % solution @ 20 ml kg^{-1} seed + application of jeevamrutha @ 10 % as one soil application and two foliar application (branching and flowering), T_6- Seed treatment with beejamrutha 10 % solution @ 20 ml kg^{-1} seed + application of panchagavya @ 3 % and jeevamrutha @ 10 % as soil application, T_7-Seed treatment with beejamrutha 10 % solution @ 20 ml kg^{-1} seed + application of panchagavya @ 3 % and jeevamrutha @ 10 % as one soil application and two spray of panchagavya @ 3 % and jeevamrutha @ 10 % as foliar application (branching and flowering), T_8- T_3 + T_4, T_9-T_3+ T_5 , T_{10}- T_3+T_4+T_5.

3. RESULTS AND DISCUSSION

Plant height, number of branches $plant^{-1}$ and leaf area index (LAI) of summer sesamum at 45 and 60 DAS showed significant variation due to application of various organic sources (Table 1).The tallest plant height and maximum number of branches $plant^{-1}$ were found in combined use of organic sources of nutrient i.e. 100% RDN through 50% of FYM and 50% of vermicompost + remaining RDP through rock phosphate (T_2) and 50% of RDN through FYM and vermicompost + remaining RDP through rock phosphate + seed treatment with beejamrutha + application of panchagavya @3% as one soil application and two foliar application + application of jeevamrutha @10% as one soil application and two foliar application (T_{10}) over other treatments. The findings are in close conformity with the results of Chaubey et al. [13], Naugraiya and Singh [14]. “The increase in plant height also influenced by vermicompost and FYM due to the availability of plant growth regulation and humic acid, which is produced by increasing the activity of microbes in vermicompost” [15]. “Nitrogen is associated with increase in protoplasm, cell division and cell enlargement resulting in taller plants” [16]. “Presence of naturally occurring, beneficial, effective microorganisms in panchagavya predominantly, lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi besides beneficial and proven the beneficial effect especially in improving soil quality, growth and yield of crops” [17].

Table 1. Effect of organic nutrient management practices on growth behaviour of summer sesamum

Treatments	Plant Height (cm)		Number of Branches Plant^{-1}		Leaf Area Index (LAI)	
	45 DAS	**60 DAS**	**45 DAS**	**60 DAS**	**45 DAS**	**60DAS**
T_1: Control	24.06	56.14	2.28	2.48	1.05	1.18
T_2: 100% RDN (50% FYM& 50 % VC) + remaining RP	41.32	72.9	2.87	3.64	1.25	1.39
T_3: 50% RDN (50% FYM& 50% VC) + remaining RP	36.74	67.60	2.71	3.41	1.19	1.32
T_4: Seed treatment with BM+ PG application (one soil & two foliar spray)	26.62	60.9	2.34	3.05	1.09	1.2
T_5: Seed treatment with BM+ JM application (one soil & two foliar spray)	29.56	59.55	2.43	3.09	1.13	1.21
T_6: Seed treatment with BM+ soil application of PG & JM	30.25	61.03	2.51	3.11	1.15	1.23
T_7: Seed treatment with BM+ soil application & foliar spray of PG & JM	33.18	63.87	2.57	3.26	1.17	1.26
T_8: T_3 + T_4	34.11	64.85	2.65	3.32	1.18	1.29
T_9: T_3 + T_5	37.65	68.77	2.75	3.48	1.21	1.34
T_{10}: T_3 + T_4 + T_5	40.30	71.3	2.81	3.53	1.23	1.36
S.Em (±)	0.91	0.97	0.06	0.11	0.02	0.02
CD (*P* =0.05)	2.55	2.73	0.15	0.30	0.05	0.06

**RDN- Recommended Dose of Nitrogen, BM- Beeja Mrutha, VC- Vermi Compost, PG- Pancha Gavya, JM- Jeeva Mrutha, RP- Rock Phosphate*

Table 2. Effect of organic nutrient management practices on yield attributes and yield of summer sesamum

Treatments	**Number of Capsules plant^{-1}**	**Number of Seeds Capsules^{-1}**	**Seed Yield (kg ha^{-1})**	**Net Return (Rs ha^{-1})**	**Return Per Rupee Investment**
	18.35	29.97	415	13263	0.60
T_1: Control	22.87	40.77	808	36701	1.14
T_2: 100% RDN (50% FYM& 50 % VC) + remaining RP	21.81	35.98	680	31031	1.12
T_3: 50% RDN (50% FYM& 50% VC) + remaining RP	19.21	31.28	477	15325	0.60
T_4: Seed treatment with BM+ PG application (one soil & two foliar spray)	20.60	32.43	549	21113	0.83
T_5: Seed treatment with BM+ JM application (one soil & two foliar spray)	20.78	33.84	563	22767	0.90
T_6: Seed treatment with BM+ soil application of PG & JM	21.31	35.65	643	27509	1.00
T_7: Seed treatment with BM+ soil application & foliar spray of PG & JM	21.22	36.80	646	24929	0.81
T_8: T_3 + T_4	22.06	38.96	711	30163	0.97
T_9: T_3 + T_5	22.59	40.21	803	34575	1.01
T_{10}: T_3 + T_4 + T_5	0.93	1.44	26.58	-	-
S.Em (±)	18.35	29.97	415	13263	0.60
CD (*P* =0.05)	22.87	40.77	808	36701	1.14

***RDN- Recommended Dose of Nitrogen, BM- Beeja Mrutha, VC- Vermi Compost, PG- Pancha Gavya, JM- Jeeva Mrutha, RP- Rock Phosphate**

Maximum leaf area index (1.25, 1.39 and 1.24 at 30, 45 and 60 DAS at harvest) was obtained with application of 100% RDN through 50% of vermicompost + remaining RDP through rock phosphate(T_2), which was found statistically at par with treatment i.e. 50 % RDN through 50% of FYM and 50 % of vermicompost + remaining RDP through rock phosphate + seed treatment with beejamrutha + application of panchagavya @ 3 % as one soil application and two foliar application+ application of jeevamrutha @ 10 % as one soil application and two foliar application (T_{10}) and significantly found superior over rest of the treatments.

The data relating to number of capsules plant^{-1} as influenced by different organic sources are presented in Table 2. It is clear from table that application of 100 % RDN through 50% of FYM and 50 % of vermicompost + remaining RDP through rock phosphate (T_2) registered significantly higher in the number of capsules per plant (22.87) which was found statistically at par with application of 50 % RDN through 50% of FYM and 50 % of vermicompost + remaining RDP through rock phosphate + seed treatment with beejamrutha + application of panchagavya @ 3 % as one soil application and two foliar application + jeevamrutha @ 10 % as one soil application and two foliar application (22.59) (T_{10}) and was superior over the other treatments. The effect of organic sources on the number of seeds capsule^{-1} shown in Table 2 and appraisal of the data revealed that the highest seeds capsule^{-1} (40.77) was recorded with the treatment T_2 (100 % RDN through 50% of FYM and 50 % of vermicompost + remaining RDP through rock phosphate) and the minimum value (29.97) was found in control treatment (T_1) respectively during the experimentation. Among other treatments, application of 50 % RDN through FYM and vermicompost + remaining RDP through rock phosphate + seed treatment with beejamrutha + application of jeevamrutha @ 10 % as one soil application and two foliar application (T_9) was found statistically similar to T_3.

The seed yield of summer sesame was significantly influenced by different organic nutrient management practices (Table 2). Among all the treatments, significantly highest seed yield (808 kg ha^{-1}) was recorded by application of 100 % RDN through 50% of FYM and 50 % of vermicompost + remaining RDP through rock phosphate (T_2) which was statistically at par with the application of 50% of RDN through FYM and vermicompost + remaining RDP through rock phosphate + seed treatment with beejamrutha + application of panchagavya @ 3 % as one soil application and two foliar application + jeevamrutha @ 10 % as one soil application and two foliar application (T_{10}) followed by 50 % RDN through FYM and vermicompost + remaining RDP through rock phosphate + seed treatment with beejamrutha + application of jeevamrutha @ 10 % as one soil application and two foliar application (T_9) and 50 % RDN through FYM and vermicompost + remaining RDP through rock phosphate (T_3). These treatments are superior over T_8, T_7, T_6, T_5 and T_4. The lowest seed yield was observed in control treatment T_1. The combined application of FYM, vermicompost, rock phosphate and jeevamrutha results in better growth and yield attributes resulting in increased seed yield over FYM at 100 per cent N equivalent and without application of jeevamrutha thus, FYM and jeevamrutha can effectively and efficiently be used to get higher seed yield. Better seed yield due to balanced and timely supply of nutrients from diversified sources of nutrients (FYM, vermicompost, microbial consortia) that resulted in prolonged availability of nutrients to crop [18].

Among the different treatments, higher net returns (36,701 Rs. ha^{-1} & 34,575 Rs. ha^{-1}) and returns per rupee investment were obtained maximum (1.14 and 1.01) with application of 100 % RDN through 50% of FYM and 50 % of vermicompost + remaining RDP through rock phosphate (T_2) and 50 % RDN through FYM and vermicompost + remaining RDP through rock phosphate + seed treatment with beejamrutha + application of panchagavya @ 3 % + jeevamrutha @ 10 % (T_{10}), respectively. The lowest net returns (15,225 Rs ha^{-1}) and returns per rupee investment (₹0.60) were obtained with application of beejamrutha 10 % solution + application of panchagavya @ 3 % (T_4) which might be due to the higher cost of cultivation and lesser yields. Similar views were found by Quddus et al. [19], Jamkhogin [20] and Sipai et al. [21].

4. CONCLUSION

Based on the findings of the present investigation, the following conclusions could be drawn: Application of organic source of nutrients i.e. 100 % RDN through 50% of FYM and 50% of vermicompost + remaining RDP through rock phosphate (T_2) resulted in maximum growth parameters, yield attributes and yield of summer sesamum, but, it was found to be statistically at par with combined application of 50% of RDN through FYM & vermicompost + remaining RDP through rock phosphate+ seed treatment with beejamrutha + application of panchagavya @ 3 % as one soil application & two foliar application + application of jeevamrutha @ 10 % as one soil application & two foliar application (T_{10}). In the organic nutrient treatments, application of 100 % RDN through 50% of FYM and 50 % of vermicompost + remaining RDP through rock phosphate resulted in maximum uptake of nutrients by seeds and stover and this was found to be the best combination for increasing the productivity of summer sesamum and also resulted in increased residual fertility levels of the soil compared to different source of organic nutrient combinations. Highest gross returns, net returns and return per rupee investment were obtained with application of 100 % RDN through 50% of FYM and 50 % of vermicompost + remaining RDP through rock phosphate.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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