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EFFECTS OF ORGANIC FERTILIZERS AND NEEM-COATED UREA ON GROWTH, YIELD, SOIL NUTRIENT STATUS AND COST ECONOMICS OF SESAME

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Keywords: Organic fertilizer, Neem-coated urea, Growth, Yield, Economics, Soil nutrient status, Sesame, *Sesamum indicum*

Abstract

An experiment was conducted to evaluate the effect of organic fertilizers and neem-coated urea on growth, yield, soil nutrient status and cost economics of sesame. Farmyard manure (FYM) @ 10 t ha^{-1} (M_2) significantly increased growth, with the highest test weight (2.87 g) and seed yield (349.4 kg/ha), followed by press mud cake @ 12.5 t/ha (M_3). Among nitrogen treatments, 150% (S_5) and 125% (S_4) recommended dose of nitrogen (RDN) with neem-coated urea resulted in the highest seed yields (368.2 kg/ha and 353.4 kg/ha, respectively). The soil nutrient status showed increased nitrogen, phosphorus, potassium and organic carbon with organic amendments. Economic analysis revealed that M_2S_5 provided the highest net returns (₹20,258) and M_3S_5 exhibited the highest benefit-cost ratio (1.97). Thus, combining organic manures with neem-coated urea improves yield, soil health and economic returns in sesame.

Introduction

Sesame (*Sesamum indicum* L.) is a significant oilseed crop grown globally, valued for its high-quality oil, rich in unsaturated fatty acids, antioxidants and essential vitamins. India is the largest producer and consumer of sesame contributing to nearly 40% of global production. In 2022-2023, India ranked first in both area (21 lakh ha) and production (8.5 lakh tonnes) of sesame with a productivity of around 400 kg/ha (Directorate of Economics and Statistics 2023). Despite its economic importance, the productivity of sesame in India and Andhra Pradesh remains relatively low, primarily due to factors such as soil fertility depletion, inadequate nutrient management and sub optimal use of fertilizers. To address these challenges and improve productivity, sustainable agricultural practices including the use of organic fertilizers and integrated nutrient management are gaining importance.

Organic fertilizers, such as farmyard manure (FYM) and press mud cake offer a promising solution by improving soil health, enhancing nutrient availability and promoting microbial activity (Takar *et al.* 2017, Sujatha *et al*. 2023). Additionally, neem-coated urea (NCU), a slow-release nitrogen fertilizeris gaining popularity due to its ability to improve nitrogen use efficiency (NUE) and reduce environmental nitrogen losses(Shivay *et al.* 2001, Suganya *et al*. 2009, Jat *et al*. 2011).

The combination of organic fertilizers and neem-coated urea could potentially offer a synergistic effect, improving soil fertility while enhancing nitrogen use efficiency. However, the effectiveness of such an integrated approach in optimizing the growth and yield of sesame is still under investigation.This research evaluates the effects of organic fertilizers and neem-coated urea on the growth, yield, soil nutrient status and economics of sesame, providing insights into integrated nutrient management strategies that can enhance productivity and sustainability in sesame farming.

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Materials and Methods

A field study was conducted at Agricultural Research Station, Yellamanchili, Visakhapatnam District, Andhra Pradesh, India during *kharif*, 2016 and 2017 in a split plot design replicated thrice. The soil was sandy loam in texture, slightly alkaline (pH 7.6) with 0.20% organic carbon and 158, 17 and 100 kg/ha of N, P and K, respectively. The treatments consisted of organic sources as main plots and nitrogen levels as sub-plots. The main plots included three organic treatments: M_1- Control (without organic manure), M_2- Farmyard manure @ 10 t/ha and M_3- Press mud cake @ 12.5 t/ha. The sub-plots included five nitrogen treatments: S_1 -100% RDN with normal urea, S_2-75% RDN with Neem-coated urea, S_3-100% RDN with Neem-coated urea, S_4-125% RDN with Neem-coated urea and S_5-150% RDN with Neem-coated urea.

Sesamum cv. YLM-66 was sown @ 5 kg seeds ha^{-1} with a row spacing of 30 cm and plant spacing of 10 cm. Thinning and gap filling were done 7 days after sowing. The Farmyard manure and Press mud cake were applied at their respective rates (10 t ha^{-1} and 12.5 t/ha) and incorporated into the soil 15 days before sowing to ensure proper nutrient release and improve soil health.The recommended dose of 40 kg N, 20 kg P_2O_5 and 20 kg K_2O per hectare was applied using urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O). Half of the total nitrogen was applied at sowing and the remaining half of nitrogen was topdressed 30 days after sowing. Similarly, Neem-coated urea (NCU) was applied in two splits, as per the treatments: 75, 100, 125 and 150% RDN. The full dose of P_2O_5 and K_2O was applied at the time of sowing. Recommended agronomic practices and plant protection measures were followed to maintain a healthy crop. Growth and yield parameters such as plant height, number of branches, and number of capsules per plant were recorded from ten randomly selected plants in each plot before harvesting. Seed yield was recorded at harvest and the data on seed yield from the net plot were converted to per hectare values.

Soil samples were collected after the harvest from each treatment and analyzed organic carbon and available major nutrients (N, P and K) using standard methods (Table 1).

Table 1. Methods for analysis of soil samples for different soil parameters.

Soil property	Method
pH	Glass electrode method (Jackson 1973)
Organic C (%)	Walkley and Black modified Method (Walkley and Black 1934)
Available N (kg/ha)	Alkaline permanganate method (Subbiah and Asija 1956)
Available P (kg/ha)	Olsen's method (Olsen *et al*.1954)
Available K (kg/ha)	Neutral normal ammonium acetate method (Muhr *et al.* 1965)

The economics of the treatments were evaluated based on the pooled mean seed yield. The cost of cultivation, gross return, net return and benefit-cost ratio were calculated for each treatment using the prevailing market prices of inputs and outputs. The data were subjected to statistical analysis as per Gomez and Gomez (1984).

Results and Discussion

The pooled data of sesame showed significant increase in growth, yield attributes and seed yield under the influence of organic manures and neem-coated urea (Table 2). The application of FYM @ 10 t/ha (M_2) resulted in the highest plant height (141.1 cm), number of branches $plant^{-1}$ (4.77), number of capsules per plant (102.1) and test weight (2.87 g) which were closely followed by pressmud cake @ 12.5 t/ha (M_3) (138.5 cm, 4.68, 98.6, 2.47, respectively). The improvement might be attributed to the fact that organic manures provide a slow release of nutrients, which improve soil health, structure and water retention (Lokhande *et al.* 2020).

Among nitrogen treatments, S_5 and S_4 resulted in statistically similar plant height (146.3 cm and 144.3 cm, respectively, number of capsules plant^{-1}(108.2 and 105.9), respectively and test weight (2.78 and 2.67 g), respectively in sesame. This can be attributed to the role of nitrogen in sesame growth (Lakhran *et al*. 2015). The application of neem-coated urea in S_5 is particularly beneficial because it provides a slow-release form of nitrogen, reducing nitrogen losses through volatilization and leaching. Higher nitrogen levels, as provided by 150 and 125% RDN with neem-coated urea are expected to support better plant growth especially in crops like sesame, which require adequate nitrogen for their development (Jat *et al.* 2011). The seed yield results indicated that M_3 and M_2 produced statistically similar yields, 349.4 and 337.9 kg/ha, respectively. The present findings were found consistent with Parmar *et al.* (2020) and Kiruthika *et al.* (2022) who found that organic sources like farmyard manure significantly enhanced the yield of sesame.

For nitrogen treatments, the highest seed yield was observed with S_5 yielding 368.2kg/ha followed by S_4 which yielded 353.4 kg/ha. These results are in agreement with findings of Ojonugwa *et al.* (2022), Issahaku *et al.* (2023), Sireesha *et al.* (2023).

The post-harvest soil nutrient status of experimental field as influenced by different organic fertilizers and neem coated urea is presented in Table 3. The available nitrogen content of soil was obtained notably higher in treatments involving organic manures in M_2 showed an increase in soil nitrogen content to 183.0 kg/ha, while in M_3 it was 177.7 kg/ha, which were significantly higher compared to the control (M_1) with 128.5 kg/ha. This could be attributed to the slow release of nutrients from organic sources (Elayaraja and Sathiyamurthi 2020). The highest nitrogen content was observed in S_5 treatment, followed by S_4 which were 188.9 kg/ha and 182.9 kg/ha of available nitrogen, respectively.

Available phosphorus and potassium content in the soil was obtained higher in M_2 and M_3. Both showed increased phosphorus availability (25.2 and 23.3 kg/ha) and available potassium (113.4 and 116.9 kg/ha, respectively). These organic amendments likely promoted better phosphorus and potassium availability through enhanced microbial activity. In contrast, the control treatment (M_1) had the lowest available phosphorus (13.7 kg/ha) and potassium content (92.6 kg/ha).

Among the nitrogen treatments, higher phosphorus and potassium availability was found at S_5 and S_4 which resulted in 22.6 and 21.7 kg/ha of available phosphorus and 123.9 and 121.1 kg/ha of available potassium, respectively. This can be attributed to the synergistic effect of organic and inorganic fertilizers and the slow release of nitrogen from neem-coated urea.

In terms of organic carbon, the organic treatments also showed significant improvements. In M_2 and M_3 the organic carbon increased to 0.40 and 0.38%, respectively compared to the control (0.20%). This indicated that organic manures not only enhance nutrient availability but also improve soil structure, which contribute to the long-term sustainability of soil fertility (Jalilian *et al.* 2022, Ojonugwa *et al.* 2022).

The economics of sesame under the influence of different organic fertilizers and neem coated urea are presented in Table 4. The highest values for gross returns and net returns were recorded for M_2S_5 with ₹31,648 ha^{-1} and ₹20,258 ha^{-1}, respectively. These results suggested that organic manures combined with higher nitrogen doses led to an increase in crop productivity and net returns (Choudhary *et al.* 2017, Sujatha *et al*. 2023). With regard to cost economics, the treatment M_3S_5 was found most remunerative with benefit cost ratio (BCR) of 1.97, followed by M_3S_4 recording BCR of 1.89. These treatments provided the most favourable economic returns per unit of investment, indicating their cost-effectiveness in sesame production which corroborates with Sukanta *et al.* (2020).

Table 2. Growth, yield attributes and yield of sesame as influenced by organic fertilizers and neem coated urea.

Treatments	Plant height (cm)			No. of branches/Plant			No. of capsules/Plant			Test weight (g)			Seed yield (kg/ha)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Main Plot: Organic Sources															
M_1: Control (without organic manure)	135.4	133.2	134.3	4.57	4.58	4.58	92.2	90.8	91.5	2.13	2.14	2.14	280.2	294.2	287.2
M_2: Farm yard manure @ 10 t ha^{-1}	142.0	140.1	141.1	4.77	4.76	4.77	102.9	101.2	102.1	2.87	2.86	2.87	342.4	356.4	349.4
M_3: Press mud cake @ 12.5 t ha^{-1}	139.5	137.4	138.5	4.68	4.67	4.68	100.0	98.6	99.3	2.47	2.47	2.47	330.9	344.9	337.9
SEm ±	1.97	2.30	2.10	0.07	0.07	0.07	1.49	1.94	1.72	0.13	0.07	0.10	9.55	12.36	10.96
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	5.87	7.64	6.76	NS	NS	NS	37.52	48.44	42.98
CV%	6.5	6.5	6.5	6.6	6.4	6.5	6.9	7.8	7.3	20.3	11.9	16.1	15.6	14.4	14.9
Sub Plots - Nitrogen Levels															
S_1:100 % RDN with normal urea	135.1	132.7	133.9	4.50	4.52	4.51	93.0	91.2	92.1	2.33	2.33	2.33	300.3	314.5	307.4
S_2 : 75 % RDN with neem coated urea	130.3	127.6	129.0	4.44	4.44	4.44	86.7	84.6	85.7	2.22	2.22	2.22	273.2	287.2	280.2
S_3 : 100 % RDN with neem coated urea	137.4	135.3	136.4	4.52	4.55	4.54	97.3	95.3	96.3	2.44	2.44	2.44	308.1	322.3	315.2
S_4 : 125 % RDN with neem coated urea	145.0	143.5	144.3	4.81	4.85	4.83	106.3	105.5	105.9	2.67	2.67	2.67	346.4	360.4	353.4
S_5 : 150 % RDN with neem coated urea	147.1	145.4	146.3	5.09	4.98	5.04	108.7	107.7	108.2	2.78	2.78	2.78	361.1	375.2	368.2
SEm ±	2.33	2.69	2.50	0.08	0.08	0.08	2.76	2.63	2.70	0.24	0.24	0.24	10.73	11.27	11.0
CD (P = 0.05)	6.81	7.85	7.30	0.24	0.25	0.25	8.07	7.68	7.90	NS	NS	NS	31.34	32.89	32.12
CV%	6.0	6.0	6.0	6.3	6.5	6.4	8.4	8.2	8.3	30.1	29.2	29.6	13.5	10.2	11.9
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Available nutrient status of sesamum as influenced by organic fertilizers and neem coated urea.

Treatments	Available N			Available P			Available K			Organic carbon (%)		
	kg/ha			kg ha			kg/ha					
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Main Plot- Organic Sources												
M_1-Control (Without organic manure)	130.6	126.4	128.5	14.4	13.0	13.7	93.4	91.7	92.6	0.21	0.20	0.20
M_2- Farm yard manure @ 10 t ha^{-1}	180.6	185.4	183.0	24.0	26.3	25.2	115.2	118.6	116.9	0.38	0.43	0.40
M_3- Press mud cake @ 12.5 t ha^{-1}	175.3	180.2	177.7	22.2	24.5	23.3	110.3	116.4	113.4	0.35	0.40	0.38
SEm ±	3.45	3.86	3.66	0.88	0.80	0.85	3.76	4.88	4.32	0.01	0.02	0.02
CD (P = 0.05)	10.35	11.58	10.97	2.63	2.40	2.52	10.85	14.86	12.86	0.03	0.06	0.05
CV%	7.1	8.2	7.6	7.2	6.8	7.1	7.3	8.0	7.6	7.2	7.8	7.7
Sub Plots - Nitrogen Levels												
S_1- 100 % RDN with normal urea	168.7	172.4	170.6	19.5	20.8	20.1	108.5	112.1	110.3	0.24	0.26	0.21
S_2-75 % RDN with Neem coated Urea	159.8	163.8	162.3	18.6	18.4	18.5	102.4	104.3	103.4	0.22	0.23	0.23
S_3- 100 % RDN with Neem coated Urea	170.5	174.5	173	19.8	21.5	20.6	110.2	117.2	113.7	0.25	0.27	0.25
S_4-125 % RDN with Neem coated Urea	180.4	184.4	182.9	20.6	22.8	21.7	118.6	123.4	121.1	0.26	0.28	0.26
S_5-150 % RDN with Neem coated Urea	186.4	190.4	188.9	22.1	23.2	22.6	121.5	126.3	123.9	0.25	0.27	0.25
SEm ±	3.80	4.40	4.10	0.92	1.10	1.01	4.60	4.87	4.74	0.02	0.03	0.03
CD (P = 0.05)	11.4	13.2	12.3	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	8.0	9.2	8.5	8.1	7.2	7.6	8.2	9.0	8.7	8.6	8.4	8.5
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4. Economics of sesamum as influenced by organic fertilizers and neem-coated urea.

*Treatments	Gross returns (₹/ha)			Cost of cultivation	Net returns (₹/ha)			BC Ratio		
	2016	2017	Pooled	(₹/ha)	2016	2017	Pooled	2016	2017	Pooled
M_1S_1	21456	23056	22256	9010	12446	14046	13246	1.38	1.56	1.47
M_1S_2	19376	20976	20176	8961	10415	12015	11215	1.16	1.34	1.25
M_1S_3	22272	21928	22100	9020	13252	12908	13080	1.47	1.43	1.45
M_1S_4	23832	24152	23992	9080	14752	15072	14912	1.62	1.66	1.64
M_1S_5	25136	25216	25176	9140	15996	16076	16036	1.75	1.76	1.76
M_2S_1	25848	26648	26248	11260	14588	15388	14988	1.30	1.37	1.34
M_2S_2	23208	24808	24008	11211	11997	13597	12797	1.07	1.21	1.14
M_2S_3	25872	28176	27024	11270	14602	16906	15754	1.30	1.50	1.4
M_2S_4	30416	31376	30896	11330	19086	20046	19566	1.68	1.77	1.73
M_2S_5	31608	31688	31648	11390	20218	20298	20258	1.78	1.78	1.78
M_3S_1	24760	25776	25268	10260	14500	15516	15008	1.41	1.51	1.46
M_3S_2	22984	23144	23064	10211	12773	12933	12853	1.25	1.27	1.26
M_3S_3	25800	27240	26520	10270	15530	16970	16250	1.51	1.65	1.58
M_3S_4	28888	30832	29860	10330	18558	20467	19513	1.80	1.97	1.89
M_3S_5	29928	31768	30848	10390	19538	21358	20448	1.88	2.05	1.97

*M_1- Control (Without organic manure): M_2 - Farm yard manure @ 10 t/ha: M_3 - Press mud cake @ 12.5 t/ha: S_1-100% RDN with normal urea, S_2-75% RDN with Neem-coated urea, S_3-100% RDN with Neem-coated urea, S_4-125% RDN with Neem-coated urea and S_5-150% RDN with Neem-coated urea.

The study concludes that the use of organic fertilizers, particularly farmyard manure and press mud cake, in combination with neem-coated urea significantly increased the growth, yield, soil nutrient status and profitability of sesame cultivation.

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