Original Research Article

Quantifying response of sesame (*Sesame indicum* L.) to dose and time of nitrogen application under irrigated condition

ABSTRACT

Aim: To determine the optimum dose and time of nitrogen application in sesame in YSR Kadapa district of Andhra Pradesh.
Study design: Split plot design
Place and duration of study: Department of Agronomy, Agricultural Research Station, Utukur, Kadapa, Andhra Pradesh, India and duration of study was three years (2020-21 to 2022-23).
Methodology: The treatments included four levels of nitrogen as main plot *viz*., N1: 40, N2: 60, N3: 80 and N4: 100 kg/ha and time of nitrogen application *viz*., T1: 50 kg as basal and 50 kg at 30 DAS, T2: 25 kg as basal and 75 kg at 30 DAS, T3: 25 kg as basal, 37.5 kg at 20 and 37.5 kg at 40 DAS and T4: No basal, 50 kg at 20 and 50 kg at 40 DAS as sub plot, which were laid out in split plot design with three replications.
Results: The results revealed that significantly the higher plant height at maturity, number of branches per plant, number of capsules per plant, number of seeds per capsule and seed yield were recorded with application of 100 kg N/ha which was at par with 80 kg N/ha. However, the application of 100 kg N/ha nitrogen as 25 kg in basal, 37.5 kg at 20 and 37.5 kg at 40 DAS (T3) recorded higher plant height at maturity, number of branches per plant, number of capsules per plant, number of seeds per capsule and seed yield and was at par with 50 kg as basal and 50 kg at 30 DAS (T1) in all three years of study. Whereas, test weight of sesame was not significantly influenced by levels of nitrogen and time of nitrogen application.
Conclusion: Application of 80 kg N/ha could be considered as an optimum dose of nitrogen in contrast to the present recommended dose of 40 kg N/ha which has a yield advantage of 11.5 % over 100 % RDF.

Key words : Nitrogen, Sesamum, Split application, Time of application

INTRODUCTION

Sesame (*Sesame indicum* L.) called as queen of oil seeds is one of the most ancient oilseed crops in the tropics. It is an important source of high-quality oil and protein. The oil has excellent stability due to the presence of natural antioxidants such as sesamolin and sesamin. The proteins in sesame are rich in essential sulphur containing amino acids such as methionine and tryptophan. In India average production of sesame was 657.50 Mt with area of 1622.6 Mha and productivity of 405 kg ha^{-1} compared to the world average (535 kg/ha). Inappropriate use of fertilizers is one of the major production constraints in sesame (Amin and Alireza, 2015, El-Sherif, 2016).

Sesame is grown in an area of 3279 ha in YSR Kadapa district of Andhra Pradesh during *rabi* season with average productivity of 406 kg/ha. Among the different agronomic management components that influences the productivity of sesame, nutrient management plays a key role out of which widely applied nitrogen management is little bit difficult due to its losses by ammonia volatilization during nitrification, denitrification, downward leaching and runoff with poor efficiency of 30–40 %. Nitrogen is considered as an essential element of bio-molecules such as amino acids, proteins, nucleic acids, phyto hormones and a number of enzymes and coenzymes. Nitrogen strongly stimulates growth, expansion of the crop canopy and interception of solar radiation. Nitrogen is the most dynamic and important nutrient required for survival of all living things (Rosolem *et al*., 2017). Significant positive correlation was observed between nitrogen application rate and yield in sesame. Patel *et al*. (2014) reported that varied responses of sesame to nitrogen from 60 kg/ha to 180 kg/ha were observed at different places. Kushawala *et al*. (2022) reported the response up to 75 kg N/ha, Damodar *et al*. (2015) observed increased sesame yield up to 90 kg N/ha. Zeb and Jan (2021) reported significant increase in sesame yield and yield attributes with increase in nitrogen levels up to 120 kg N/ha. Accordingly, methods have been recommended for improving the efficiency of fertilizer nitrogen *viz*., selection of plants with high nitrogen efficiency, adjusting the timing of fertilizer application and developing more efficient fertilizers. Out of this, time of fertilizer application with synchronization of crop nutrient demand is largely important as the maximum potential rate of N uptake is determined by plant growth stage and lower N uptake occurs during the seedling stage and pre-harvest periods, while the vegetative growth and flower initiation demand higher N supply. Gebremariam (2015) reported significant influence of timing of nitrogen application on yield of sesame. Hence the experiment was initiated to determine the optimum dose and best time of nitrogen application in sesame in YSR Kadapa district of Andhra Pradesh.

METHODOLOGY

The experiment was conducted in the farm of Agricultural Research Station, Utukur, Kadapa, Andhra Pradesh, India which is situated at 14.45^{0}N latitude and 78.81^{0}E longitude during *rabi* season (December II FN to January I FN) of three years 2020-21, 2021-22 and 2022-23 to study the performance of sesamum under different levels and time of nitrogen application. The soil of the experimental site was red clayey in texture, low in available nitrogen (160 kg ha^{-1}), medium in available phosphorus (30 kg ha^{-1}) and rich in available potash (320 kg ha^{-1}).). The treatments

included four levels of nitrogen as main plot *viz*., N1: 40, N2: 60, N3: 80 and N4: 100 kg/ha and time of nitrogen application *viz*., T1: 50 kg as basal and 50 kg at 30 DAS, T2: 25 kg as basal and 75 kg at 30 DAS, T3: 25 kg as basal, 37.5 kg at 20 and 37.5 kg at 40 DAS and T4: No basal, 50 kg at 20 and 50 kg at 40 DAS as sub plot, which were laid out in split plot design with three replications. The variety YLM-66 was sown with a spacing of 30 cm × 10 cm in plot size of 5.0 m × 4.0 m. Recommended dose of phosphorus and potassium (25–25 kg ha^{-1}) were applied through single super phosphate and muriate of potash respectively and nitrogen in the form of urea was applied as per the treatments. At present, the recommended dose of nitrogen for sesamum during *rabi* season was 40 kg ha^{-1}. Two hand weedings were carried out at 20 and 40 DAS. All other agronomic and protective practices were followed as per the recommendations prescribed by ANGRAU. The observations on growth and yield attributes were taken from randomly selected five plants and yield from net plot area and finally subjected to statistical analysis.

RESULTS AND DISCUSSION

Effect of nitrogen

Successive increase in nitrogen from 40 to 100 kg/ha influenced the growth parameters, yield attributes and yield of sesame under irrigated conditions during *rabi* (Table 1). Significantly maximum plant height (112.6 cm), number of branches per plant (4.2), number of capsules per plant (68.2) and seeds per capsule (67.4) were recorded with application of 100 kg N/ha which was at par with 80 kg N/ha. Test weight in sesame was not significantly influenced by the quantity of nitrogen. significantly the higher plant height at maturity, number of branches per plant, number of capsules per plant, number of seeds per capsule and seed yield were recorded with application of 100 kg N/ha which was at par with 80 kg N/ha (Table 2). Ahmad *et al*. (2018) and Vaghani *et al*. (2010) also reported that an optimum dose of 100 kg N/ha in sesame resulted in increase of seed yield. Increase in nitrogen supply within limits are associated with increase in leaf area, carboxylases and chlorophyll content which in turn determines the photosynthetic activities in leaves and ultimately dry matter production and allocation to various organs of plant improving source sink relation (Maqsood *et al*., 2016, Babajide and Oyeleke, 2014) which ultimately determines the yield.

Effect of time of application of nitrogen

The application of 100 kg N/ha nitrogen as 25 kg in basal, 37.5 kg at 20 and 37.5 kg at 40 DAS (T3) recorded higher plant height at maturity (109.5 cm), number of branches per plant (3.9), number of capsules per plant (66.5), number of seeds per capsule (69.7) and seed yield (1358 kg/ha) and was at par with 50 kg as basal and 50 kg at 30 DAS (T1) in all three years of study. Whereas, test weight of sesame was not significantly influenced by levels of nitrogen and time of nitrogen application (Table 1). Significantly higher seed yield of 1358 kg/ha was recorded with application of nitrogen in three splits of 25-37.5-37.5 ratio at basal, 20 and 40 DAS (Table 2). Interaction of nitrogen dose and time of application was found non- significant.

Economics

The application of 100 kg N/ha nitrogen as 25 kg in basal, 37.5 kg at 20 and 37.5 kg at 40 DAS (T3) recorded maximum net returns of Rs. 1,42,762/- per hectare and B:C ratio of 6.77 and followed by application of 100 kg N/ha nitrogen as 25 kg in basal, 37.5 kg at 20 and 37.5 kg at 40 DAS (T3) recorded net returns of Rs. 1,42,300/- per hectare and maximum B:C ratio of 6.81 in all three years of study (Table 3). With the above economic output it could be concluded that application of 80 kg N/ha in three splits as 25-37.5-37.5 at basal, 20 and 40 DAS in sesame might result in higher B:C ratio.

Conclusion

On the basis of three years of field experiment, higher growth, yield and net return archived by application of 100 kg N/ha as 25 kg in basal, 37.5 kg at 20 and 37.5 kg at 40 DAS in sesame under irrigated condition. Keeping in view of seed yield and economics there is no significant difference between application of 100 kg N/ha and 80 kg N/ha, hence, it is concluded that application of 80 kg N/ha as 25 kg in basal, 37.5 kg at 20 and 37.5 kg at 40 DAS results in maximum yield and economics in sesame under irrigated condition

Disclaimer (Artificial intelligence)

Option 1:

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 the writing or editing of this manuscript.

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Table 1. Growth and yield attributes of sesame as influenced by nitrogen management over three years (2021 to 2023)

Treatments	Plant height (cm)	No. of branches/ plant	No. of capsules/ plant	Capsule length (cm)	No. of seeds/ capsule	Test weight (g)
Nitrogen (N) - (kg/ha)						
N1: 40	92.1	3.2	46.5	2.09	56.1	0.31
N2: 60	98.2	3.6	53.6	2.17	60.7	0.32
N3: 80	103.8	3.9	58.9	2.41	65.2	0.32
N4: 100	112.6	4.2	68.2	2.67	67.4	0.32
S.Em±	2.69	1.68	3.53	1.41	4.27	0.008
CD (P= 0.05)	6.29	3.93	8.26	3.29	9.99	NS
Time of application						
T1: 50-50 (basal, 30 DAS)	97.7	3.5	62.6	2.42	65.3	0.32

T2: 25-75 (basal, 30 DAS)	92.3	3.4	55.4	2.26	53.2	0.32
T3: 25-37.5-37.5 (basal, 20, 40 DAS)	109.5	3.9	66.5	2.59	69.7	0.33
T4: 0-50-50 (basal, 20, 40 DAS)	89.6	3.1	46.0	2.14	45.1	0.31
S.Em±	2.22	1.94	3.64	1.92	5.23	0.006
CD (P= 0.05)	5.19	4.53	8.51	4.49	12.23	NS
Interaction of Nitrogen dose at Time of application						
S.Em±	1.89	1.23	2.13	1.06	3.76	0.002
Interaction of Time of application at Nitrogen dose						
S.Em±	1.20	1.37	2.27	1.26	4.27	0.004

Table 2. Seed yield (kg/ha) of sesamum as influenced by nitrogen management over three years (2021 to 2023)

Treatments	2020-21	2021-22	2022-23	Pooled mean
Nitrogen (N) - (kg/ha)				
N1: 40	1188	1158	1108	1151
N2: 60	1248	1288	1206	1247
N3: 80	1310	1300	1288	1299
N4: 100	1372	1392	1300	1355
S.Em±	26.8	20.6	62.0	42.6
CD (P= 0.05)	93.6	57.3	175.0	119.7
Time of application				
T1: 50-50 (basal, 30 DAS)	1295	1287	1232	1271
T2: 25-75 (basal, 30 DAS)	1223	1207	1101	1177
T3: 25-37.5-37.5	1399	1359	1317	1358

(basal, 20, 40 DAS)				
T4: 0-50-50 (basal, 20, 40 DAS)	1205	1078	1059	1114
S.Em±	26.1	22.7	67.0	37.8
CD (P= 0.05)	76.8	61.5	190.0	106.2
Interaction of Nitrogen dose at Time of application				
S.Em±	21.4	24.9	36.2	37.1
Interaction of Time of application at Nitrogen dose				
S.Em±	24.9	20.9	25.6	30.6

Table 3. Economics of sesamum as influenced by nitrogen management over three years (2021 to 2023)

Treatments	Cost of 'N' fertilizer (Rs./ha)	Cost of 'P' & 'K' fertilizers (Rs./ha)	Total cost of cultivation with fertilizers (Rs./ha)	Seed yield (kg/ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
T_1 : 40 kg N in 50-50	522	3456	23978	1205	144600	120622	6.03
T_2 : 40 kg N in 25-75	522	3456	23978	1049	125880	101902	5.25
T_3 : 40 kg N in 25-37.5-37.5	522	3456	23978	1250	150000	126022	6.26
T_4 : 40 kg N in 0-50-50	522	3456	23978	1100	132000	108022	5.51
T_1 : 60 kg N in	780	3456	24236	1196	143520	119284	5.92

50-50							
T_2 : 60 kg N in 25-75	780	3456	24236	1186	142320	118084	5.87
T_3 : 60 kg N in 25-37.5-37.5	780	3456	24236	1401	168120	143884	6.94
T_4 : 60 kg N in 0-50-50	780	3456	24236	1203	144360	120124	5.96
T_1 : 80 kg N in 50-50	1044	3456	24500	1326	159120	134620	6.49
T_2 : 80 kg N in 25-75	1044	3456	24500	1224	146880	122380	6.00
T_3 : 80 kg N in 25-37.5-37.5	1044	3456	**24500**	**1390**	**166800**	**142300**	**6.81**
T_4 : 80 kg N in 0-50-50	1044	3456	24500	1255	150600	126100	6.15
T_1 : 100 kg N in 50-50	1302	3456	24758	1375	165000	140242	6.66
T_2 : 100 kg N in 25-75	1302	3456	24758	1235	148200	123442	5.99
T_3 : 100 kg N in 25-37.5-37.5	1302	3456	**24758**	**1396**	**167520**	**142762**	**6.77**
T_4 : 100 kg N in 0-50-50	1302	3456	24758	1395	167400	142642	6.76