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Integrated nitrogen management in summer sesamum (*Sesamum indicum* L.)

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Abstract
A field experiment entitled, "Integrated nitrogen management in summer sesamum (*Sesamum indicum* L.)" was conducted at Post Graduate Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur during summer 2018 on sandy loam soil. The nine treatments consisting of GRDF (T_1), no fertilizer (T_9), 100% RDN (50 kg N ha^{-1}) through inorganic fertilizer (T_2), combination of 75% RDN through inorganic fertilizer + 25% N through organic sources *viz.*, FYM (T_3), vermicompost (T_4), neem cake (T_5). Similarly, 75% RDN through inorganic fertilizer + 25% N were equally applied (12.5% + 12.5%) through combination of organic sources *viz.*, FYM + vermicompost (T_6), FYM + neem cake (T_7) and vermicompost + neem cake (T_8) in randomized block design replicated thrice. INM levels show discernible influence on growth characters, yield attributes and yield of sesamum. Among the integrated nitrogen management treatments, an application of 75% RDN through inorganic fertilizer + 25% N through vermicompost (T_4) and 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through vermicompost (T_6) were comparable and found beneficial in increasing growth attributes viz., plant height (101 cm), number of leaves $plant^{-1}$ (32.80), number of branches $plant^{-1}$ (7.57), leaf area $plant^{-1}$ (10.16 dm^2) and dry matter production $plant^{-1}$ (32.00 g) at harvest while, yield attributes viz., capsules $plant^{-1}$ (42.93), capsule length (3.53 cm), seeds $capsule^{-1}$ (76.51), weight of seeds $plant^{-1}$ (4.84 g), test weight (3.27 g), grain yield (12.15 q ha^{-1}) and straw yield (21.87 q ha^{-1}) except GRDF. Based on economics, an application of 75% RDN through inorganic fertilizer + 25% N through vermicompost (T_4) secured the maximum net realization of Rs. 57,965 ha^{-1} with BCR of 2.53.

Keywords: Growth attributes, yield attributes, yield, economics, INM and sesamum

Introduction
Sesamum (Sesamum indicum L.) is one of the most important oilseed crops next to groundnut. It is ancient crop which is locally known as til, gingely, sim-sim or gergelim. It is really the poor man's substitute for 'Ghee', as 100 g of seeds provides 592 calories energy. India rank first in area (45%), production (36%) and export (45%) of the sesame in the world. In India, sesamum was cultivated on an area of 18 lakh ha with annual production of 7.5 lakh tons and average productivity of 448 kg ha-1, which is below than that of the world average productivity 535 kg ha-1, whereas, the Maharashtra produced 0.80 lakh tons sesamum from an area of 0.33 lakh ha with the average productivity of 233 kg ha-1 during 2016-17 (Anonymous, 2017) [1]. The productivity of sesamum in Maharashtra is low as compared to India, due to its cultivation on marginal soils having poor soil fertility, use of local varieties and the poor agronomic management practices such as inadequate plant stand, inadequate nutrient management and lack of control against major pests and diseases. Among the nutrient management, the inadequate supply of N, is another factor of low productivity of sesame. The nitrogen is a universally deficient plant nutrient in most of Indian soils particularly, the light textured ones where most of the sesamum growing area is confined (Chhonkar and Rattan, 2000) [3].

The continuous and an inappropriate use of only chemical fertilizers in intensive cropping system, results into imbalance of nutrients in the soil had deleterious effect, leading to decline in productivity due to limitation of one or more of micro-nutrients (Nambiar and Abrol, 1989). The application of inorganic fertilizer no doubt increased the production but is becoming costlier day by day (Shaikh *et al*., 2011) [15]. The need for integrated nutrient management which embraces a combination of organic manure with inorganic fertilizers for providing better nutrients to the crop plants (Shaikh *et al*., 2010) [4].

The concept of integrated nitrogen management is developed to minimize the unfavourable exploitation of soil fertility and plant nutrient and thus to maintain the soil health and plant

nutrient at optimum level. However, the appropriate combination of chemical fertilizers, organic manure, inorganic sources and biofertilizers play an important role and varies according to the cropping pattern, ecological, social and economical situations (Singh and Dixit, 1993) [16]. In view of the above considerations, the present field experiment entitled "The Integrated Nitrogen Management in Summer Sesamum (sesamum indicum L.)" was carried out at Kolhapur, during summer season of 2018.

Materials and Methods

The field experiment was laid out in survey No 358 A of plot number 7C during summer season of 2018 at the Post Graduate Research Farm, RCSM College of Agriculture, Kolhapur. The experimental field was fairly uniform and levelled. The soil of the experimental plot was black with 90 cm depth, low in available N (236.40 kg ha-1), medium in available P2O5 (22.60 kg ha-1) and medium in available K2O (250.80 kg ha-1). The pH and electrical conductivity values were 7.7 and 0.23 dS m-1, respectively. The status of organic carbon content (0.18%) which was very low.

The field experiment was carried out in a randomized block design with nine treatments. Each experimental unit was replicated thrice having the gross plot size of 5.4 m x 3.6 m and net plot of 4.8m x 2.7 m. The sesamum crop was sown by using 3 kg ha-1 seed of variety AKT-101 on 15th February, 2018 by keeping 30 cm × 10 cm spacing and harvested on 1st June, 2018. In general, the summer season was good for crop growth and development. All the growth and yield attributes observations are recorded from five plants selected from net plot, while net plot yield was converted into hectare basis. The net realization was calculated by deducting the total cost of cultivation from the gross realization for each treatment. Statistical analysis was worked out as per the method described by Panse and Sukhatme (1967) [13].

Results and Discussion

Effect of INM on growth parameters of sesamum

The growth characters of sesamum significantly differed due to different integrated nitrogen management treatments (Table 1). All the growth characters viz., plant height (cm), number of branches, number of leaves, leaf area (dm2) and dry matter production (g) plant-1 were found significantly higher with an application of GRDF (T1) as compared to remaining treatments and it was on par with75% RDN through inorganic fertilizer + 25% N through vermicompost (T4) and 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through vermicompost (T6) during all the crop growth stages. The higher plant height (cm), number of branches, number of leaves, leaf area (dm2) and dry matter production (g) plant-1 under different integrated nitrogen management treatments may be due to enhanced activities of meristematic tissues of the plant, increase in number and size of the cell, assimilation rate, cell division, cell elongation and higher level of nitrogen. Similar, results were reported by Mondal *et al*., (1992), Jaishankar and Wahab (2005) and Chaurasia *et al*., (2009) [9, 7, 2].

Effect on yield attributes and yields of sesamum

The yield attributes of sesamum were significantly differed due to different integrated nitrogen management treatments (Table 2). The application of 75% RDN through inorganic fertilizer + 25% N through vermicompost (T4) and 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through vermicompost (T6) were at par and recorded significantly the higher yield contributing characters viz., number of capsules plant-1 (42.93), length of capsules (3.53), number of seeds capsule-1 (76.51), weight of seeds plant-1 (4.84) and test weight (3.27) which resulted into significant increase in grain and straw yields of sesamum as compared to rest of the treatments except GRDF (T1). The combination of inorganic and organic fertilizer showed positive influence on growth and yield of sesamum. As it has stimulatory effect on the synthesis of chloroplast and protein, which promoted accelerated photosynthesis which enhances the growth of sesamum crop and thereby increasing yield attributes. These results are corroborated with those reported by Imayavaramban *et al*., (2002) and Ghosh *et al*., (2013) [6, 5].

Table 1: Growth Parameters of sesamum as influenced by different integrated nitrogen management treatments

Treatments	Plant height (cm)	Number of leaves plant^{-1}	Number of branches plant^{-1}	Leaf area plant^{-1} (dm^2)	Dry matter production plant^{-1}
T_1 GRDF (50:00:00 kg NPK ha^{-1} + 5 t FYM ha^{-1})	101.00	32.80	7.57	10.16	32.00
T_2 100% RDN (through inorganic fertilizer)	89.70	25.70	5.00	7.37	24.10
T_3 75% RDN through inorganic fertilizer + 25% N through FYM	95.50	28.20	6.21	8.60	29.20
T_4 75% RDN through inorganic fertilizer + 25% N through vermicompost	100.60	30.67	7.50	10.00	30.60
T_5 75% RDN through inorganic fertilizer + 25% N through neem cake	91.80	26.56	5.33	7.87	26.22
T_6 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through vermicompost	99.80	29.43	7.38	9.65	30.00
T_7 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through neem cake	93.50	27.89	6.00	8.27	27.53
T_8 75% RDN through inorganic fertilizer + 12.5% N through vermicompost + 12.5% N through neem cake	95.20	27.93	6.15	8.56	27.55
T_9 No fertilizer	78.66	19.47	3.28	5.53	19.73
S.E. ±	1.80	1.47	0.36	0.49	0.92
C.D.at 5%	5.38	4.42	1.10	1.47	2.76
General mean	93.97	27.63	6.05	8.45	27.44

Effect of INM on grain yield and straw yield of sesamum

a) Grain yield

The mean grain yield of sesamum was significantly differentiated due to different treatments. The significantly higher grain yield (12.15 q ha^{-1}) was recorded under application of GRDF (T_1) over rest of the treatments, except 75% RDN through inorganic fertilizer + 25% N through vermicompost (11.69 q ha^{-1}) and 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through vermicompost (11.38 q ha^{-1}) which was statistically at par

with each other. The magnitude of increase in seed yield with application of 50:00:00 kg NPK ha^{-1} + 5 t FYM ha^{-1} (GRDF, T_1) was 3.93 and 6.77 per cent over T_4 and T_6 treatments, respectively. These indicate the role of an integrated nitrogen management in increasing the grain yield of sesamum. The higher grain yield of sesamum under integrated nitrogen management was mainly be due to significant improvement in growth and yield attributes resulting into higher grain yield of sesamum. These results are corroborated with those reported by Narkhede *et al.*, (2001), Jaishankar and Wahab (2005) and Nayek *et al*., (2014) [11, 7, 12].

b) Straw yield

There was a significant increase in straw yield of sesamum due to different integrated nitrogen management treatments. It is clear from the data that crop receiving GRDF (T_1) recorded significantly the highest straw yield (21.87 q ha^{-1}) over rest of treatments, except integration of 75% RDN through inorganic fertilizer + 25% N through vermicompost (T_4) and 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through vermicompost (T_6). Both later treatments were at par with each other.

The higher production of dry matter in plants might have improved the values of straw yield due to combination of inorganic and organic fertilizers. It indicates the role of integrated nitrogen management for improving straw yield. These results corroborated with those reported by Deshmukh *et al*., (2010) and Takar *et al*., (2017) [4, 17].

Table 2: Yield contributing characters and yield of sesamum as affected by different treatments

Treatments	Capsules plant^{-1}	Capsule Length (cm)	Seeds capsule^{-1}	Weight of seeds plant^{-1} (g)	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1GRDF (50:00:00 kg NPK ha^{-1} + 5 t FYM ha^{-1})	42.93	3.53	76.51	4.84	3.27	12.15	21.87
T_2 100% RDN (through inorganic fertilizer)	33.35	2.43	65.77	4.37	2.8	8.24	14.40
T_3 75% RDN through inorganic fertilizer + 25% N through FYM	38.57	3.06	70.20	4.7	2.83	9.39	16.62
T_4 75% RDN through inorganic fertilizer + 25% N through vermicompost	41.66	3.36	76.19	4.73	3.24	11.69	20.70
T_5 75% RDN through inorganic fertilizer + 25% N through neem cake	33.65	2.53	68.9	4.4	2.95	8.27	15.00
T_6 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through vermicompost	39.58	3.23	74.83	4.72	3.19	11.38	20.22
T_7 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through neem cake	36.13	2.63	69.91	4.63	2.95	8.44	15.02
T_8 75% RDN through inorganic fertilizer + 12.5% N through vermicompost + 12.5% N through neem cake	38.33	2.76	70.00	4.67	2.96	8.79	15.73
T_9 No fertilizer	28.92	1.91	56	3.33	2.61	5.40	9.18
S.E. ±	1.14	0.11	2.03	0.39	0.14	0.46	0.87
C.D.at 5%	3.43	0.35	6.09	0.13	NS	1.41	2.62
General mean	37.02	2.83	69.81	4.49	2.99	9.31	16.53

Effect of INM on Economics

The mean gross and net monetary returns were Rs. 73,154 ha^{-1} and Rs. 39,035 ha^{-1}, respectively. The total cost of cultivation was maximum (Rs. 39,504ha^{-1}) under treatment of GRDF (T_1). The lowest total cost of cultivation (Rs. 28,800 ha^{-1}) was obtained under control.

The gross monetary returns (Rs. 97,200 ha^{-1}) were significantly higher with an application of GRDF (T_1) over rest of the treatments, except 75% RDN through inorganic fertilizer + 25% N through vermicompost (Rs. 95,858 ha^{-1}).

Among the integrated nitrogen management treatments, an application of 75% RDN through inorganic fertilizer + 25% N through vermicompost (T_4) recorded significantly the higher net returns of Rs.57,965 ha^{-1} as well as higher B:C ratio of 2.53 as compared to rest of treatments, except GRDF which indicate the substitution of 25%N through organic fertilizer. Similar results were also reported by Mishra *et al*., (2006) and Takar *et al.*, (2017) [8, 17].

Table 3: Cost of cultivation, gross and net returns and benefit cost ratio as influenced by different treatments

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
T_1 GRDF (50:00:00 kg NPK ha^{-1}+ 5 t FYM ha^{-1})	39504	97200	57696	2.46
T_2 100% RDN (through inorganic fertilizer)	29504	61800	32296	2.09
T_3 75% RDN through inorganic fertilizer + 25% N through FYM	34465	75120	40655	2.18
T_4 75% RDN through inorganic fertilizer + 25% N through vermicompost	37893	95858	57965	2.53
T_5 75% RDN through inorganic fertilizer + 25% N through neem cake	32537	62025	29488	1.90
T_6 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through vermicompost	36179	85350	49171	2.36
T_7 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through neem cake	33501	67520	34019	2.01
T_8 75% RDN through inorganic fertilizer + 12.5% N through vermicompost + 12.5% N through neem cake	34694	70320	35626	2.02
T_9 No fertilizer	28800	43200	14400	1.50
S.E. ±	1141	1475	1605	-
C.D.at 5%	3421	4421	4811	-
General mean	34119	73154	39035	2.11

Conclusion

Among the integrated nitrogen management treatments, an application of 75% RDN through inorganic fertilizer + 25% N through vermicompost (T_4) and 75% RDN through inorganic fertilizer + 12.5% N through FYM + 12.5% N through vermicompost (T_6) were comparable and found beneficial in increasing growth and yield attributes resulting into higher grain and straw yields of sesamum.

Based on economics, an application of 75% RDN through inorganic fertilizer + 25% N through vermicompost (T_4) recorded higher net monetary returns and also B:C ratio, which indicates 25% N substitution through organic manure. Hence, it is advisable to apply 75% RDN through inorganic fertilizer + 25% N through vermicompost to sesamum under Kolhapur conditions.

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