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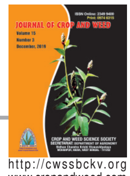

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Soil application of organic nano NPK on growth, yield and quality of sesame (*Sesamum indicum*) in the Onattukara sandy tracts of Kerala

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ABSTRACT

An experiment was undertaken with an objective of investigating the influence of soil application of organic nano NPK formulation on growth, yield and quality of sesame in Onattukara. The growth characters viz., plant height, primary branches plant^{-1} and leaf area was significantly improved by the application of organic nano NPK. Higher seed yield (712.50 kg ha^{-1}) was registered by soil application of organic nano NPK @ 50 kg ha^{-1} along with FYM @ 5 t ha^{-1}. Higher oil content in sesame (56 %) and grain protein content (18.40 %) was also registered by the application of organic nano NPK @ 50 kg ha^{-1} along with FYM @ 5 t ha^{-1}. Hence, it is concluded that the soil application of organic nano NPK @ 50 kg ha^{-1} along with FYM @ 5 t ha^{-1} enhances growth, yield and quality in sesame at Onattukara.

Keywords : Growth, oil content, organic nano NPK, protein, sesame.

The ever-increasing population and the decreasing land area for crop production is now a major concern while addressing the world food security. The truncated nutrient use efficiency of conventional inputs is one among the many factors that forces farmers to use more quantity of fertilizer to increase crop production. This higher application rate of chemicals poses a greater threat of polluting the soil and the environment. Nano fertilizers can reduce this pollution and boost crop production (Singh *et al.,* 2017). Since the particle comes under nano scale range (1 nm -100 nm), there is more absorption by the plants from applied surface thereby contributing much less to environmental pollution (Qureshi *et al.,* 2018). Onattukara sandy plain in Kerala, a special tract, located at 9.17713^0 N latitude and 76.51784^0 E longitude has a loamy sand texture which is inherently limited by organic matter and available nutrients. Sesame is one of the major crops grown during summer at Onattukara. Hence, an experiment was undertaken with the objective to investigate the effect of organic nano NPK formulation on growth, yield and quality of sesame at Onattukara.

The experiment was conducted from December 2020 to March 2021 at Onattukara Regional Agricultural Research Station, Kayamkulam. The experimental site was characterized by loamy sand texture with a higher acidity (pH-5.21). Initial analysis revealed that the soil was less fertile, having low organic carbon (0.21 %), low N (154.71 kg ha^{-1}), high P (44.60 kg ha^{-1}) and a low K content (125.84 kg ha^{-1}). The commercial formulation 'TAG NANO NPK' marketed by Tropical Agrosystem (P) Ltd was used as the granular organic nano NPK formulation. The field experiment was fit in RBD and were replicated thrice. The treatments were soil application of organic nano NPK formulation 25 kg ha^{-1} (T_1), soil application of organic nano NPK formulation 25 kg ha^{-1} + FYM 5 t ha^{-1} (T_2), soil application of organic nano NPK formulation 25 kg ha^{-1} +50 % recommended dose of NPK (T_3), soil application of organic nano NPK formulation 25 kg ha^{-1} + FYM 5 t ha^{-1} + 50 % of recommended dose of NPK (T_4), soil application of organic nano NPK formulation 50 kg ha^{-1} (T_5), soil application of organic nano NPK formulation 50 kg ha^{-1} + FYM 5 t ha^{-1} (T_6), soil application of organic nano NPK formulation 50 kg ha^{-1} + 50 % recommended dose of NPK (T_7), soil application of organic nano NPK formulation 50 kg ha^{-1} + FYM 5 t ha^{-1}+50 % recommended dose of NPK (T_8), soil test based recommendation of NPK + FYM 5 t ha^{-1} (T_9) and absolute control (T_{10}). All the treatments were applied basally for sesame (var. Thilak) and a nutrient management system of 30:15:30 kg NPK ha^{-1} (KAU, 2016) was followed.

The growth characters *viz*., plant height, primary branches plant^{-1} and leaf area were recorded at monthly intervals till harvest. Plant height was measured from

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the soil surface to the shoot apex and was expressed in cm. The branches from main stem were recorded and its average was worked out. The area of the leaf was found out using the formula $L2=\frac{L1}{W1}\times W2$ (Sreepriya, 2017) where, L1 is the single leaf area, L2 is the whole leaf area, W1 is the single leaf weight and W2 is the weight of all leaves. The seed yield and straw yield were recorded at harvest and are indicated in kg ha^{-1}. The sesame seeds were separated and the quality parameters like oil content and protein content from grains were analyzed and were expressed in percentage. The oil content of the seeds was estimated after oven drying by cold percolation (Kartha and Sethi, 1957). The protein content of the seeds was worked out by multiplying N per cent by 6.25 (Simpson *et al.,* 1965). Nitrogen was determined by Micro kjeldahl digestion and distillation (Jackson, 1973). The data obtained was statistically analysed using the two-way ANOVA for randomized block design.

Soil application of organic nano NPK formulation had significant effects on plant height of sesame (Table 1). The plant height was seen increasing upto harvest and the treatment T_6 (organic nano NPK 50 kg ha^{-1} and FYM 5 t ha^{-1}) produced tallest sesame plants throughout the study. Since the nano fertilizers are small in size, they are easily available to the plants. Slow and timely availability of nutrients from these nano fertilizer treatments during the entire crop growth period might have improved the plant uptake thereby increasing the plant height. Similar results of taller plants were obtained by Tarafdar *et al.* (2013) when pearl millet was applied with nano Zn fertilizer. Ajirloo *et al.* (2015) also recorded significantly taller tomato plants when they were applied with 400 kg ha^{-1} of potassium nano fertilizers. The control plot (T_{10}) recorded the lowest plant height throughout the study.

Significant number of branches plant^{-1} was obtained due to the use of organic nano NPK (Table 1). Similar to plant height, the primary branches per plant were also found to increase till harvest. The treatment T_5 (organic nano NPK 50 kg ha^{-1}) significantly produced more number of primary branches plant^{-1} throughout the plant growth. Eventhough the treatment T_2 (organic nano NPK 25 kg ha^{-1} + FYM 5 t ha^{-1}) recorded highest primary branches of 2.86 at 30 DAS, the results were found to be on par with the treatments T_7 (2.53), T_6 (2.26) and T_5 (2.20). The increase in primary branches might have been due to the increase in meristematic activity and accumulation of carbohydrates by the application of organic nano NPK. Similar findings were obtained by Salem *et al.* (2016) in *Cucurbita pepo,* where the application of green synthesized nano particles significantly improved the number of branches plant^{-1}. Drostkar *et al.* (2016) observed an increase in number of branches of chickpea with foliar nutrition through nano formulation of NPK.

Leaf area plant^{-1} was significantly increased throughout the crop period by the application of organic nano NPK (Table 1). At 30th DAS, highest leaf area per plant (200.11 cm^2) was registered in plots given the treatment T_5 (organic nano NPK 50 kg ha^{-1}) whereas, the treatment T_6 (organic nano NPK 50 kg ha^{-1} and FYM 5 t ha^{-1}) recorded the maximum leaf area at 60th DAS and at harvest with 414.42 cm^2 and 529.61 cm^2 respectively. This increase in leaf area might have been due to the increased uptake and translocation of nutrients due to the treatments. Higher leaf area exposes the leaf to intercept more light thereby improving the photosynthetic efficiency and yield of sesame. Ashfaq *et al.* (2016) also stated that the application of copper nano particle grown carbon nano fiber had resulted in significantly higher chlorophyll content in *Cicer arietinum.*

Organic nano NPK produced significant influence in the yield of sesame (Table 2). In general, soil application of organic nano NPK along with FYM registered higher seed yield. Among the treatments, significantly higher yield was registered by soil application of organic nano NPK @ 50 kg ha^{-1} along with FYM @ 5 t ha^{-1} (T_6) with 712.50 kg ha^{-1} followed by the treatment T_8 with 670.50 kg ha^{-1}. An overall increase of 42 per cent was recorded due to the treatment T_6 over control which might have been due to the increased leaf area, enhanced uptake and translocation of nano fertilizers leading to an increase in photosynthesis and biomass accumulation. Similar findings were also reported by Zheng *et al.* (2005) in spinach, Prasad *et al.* (2012) in groundnut and Liu and Lal (2014) in soybean. Kumar *et al.* (2020) had also reported that the foliar application of nano nitrogen produced an additional seed yield of 129 kg ha^{-1} over farmer's fertilizer practice in mustard. Meena *et al.* (2021) got similar results by the foliar application of zinc nano fertilizer on wheat.

The treatments had significant results on straw yield (Table 2) when compared with absolute control. The treatment T_5 (application of organic nano NPK @ 50 kg ha^{-1}) yielded highest straw with 9287.01 kg ha^{-1} and was closely followed by the treatment T_6 (application of 50 kg ha^{-1}organic nano NPK and 5 t ha^{-1} FYM) with

Table 1: Effect of organic nano NPK on the growth of sesame

Treatments	Plant height (cm)			Primary branches plant^{-1}			Leaf area plant^{-1} (cm^2)		
	30 DAS	**60 DAS**	**Harvest**	**30 DAS**	**60 DAS**	**Harvest**	**30 DAS**	**60 DAS**	**Harvest**
T_1: Organic nano NPK (25 kg ha^{-1})	35.80	60.53	85.00	2.13	2.56	3.83	130.54	149.00	216.60
T_2: Organic nano NPK (25 kg ha^{-1}) + FYM (5 t ha^{-1})	35.63	63.36	85.17	2.86	2.78	4.67	155.54	223.50	327.54
T_3: Organic nano NPK (25 kg ha^{-1}) + 50 % recommended dose of NPK	30.20	60.55	71.83	1.40	2.67	3.50	134.72	180.22	212.92
T_4: Organic nano NPK (25 kg ha^{-1}) + FYM (5 t ha^{-1}) + 50 % recommended dose of NPK	34.28	73.50	90.83	2.03	2.89	4.67	147.04	226.67	466.76
T_5: Organic nano NPK (50 kg ha^{-1})	34.98	77.17	79.94	2.20	3.17	5.17	200.11	206.20	239.41
T_6: Organic nano NPK (50 kg ha^{-1})+ FYM (5 t ha^{-1})	43.53	90.61	103.00	2.26	2.28	4.50	174.55	414.42	529.61
T_7: Organic nano NPK (50 kg ha^{-1})+ 50 % recommended dose of NPK	38.93	69.28	89.67	2.53	2.11	3.83	167.19	292.57	249.18
T_8: Organic nano NPK (50 kg ha^{-1})+ FYM (5 t ha^{-1}) + 50 % recommended dose of NPK	32.60	78.33	92.00	2.06	2.33	4.75	181.21	327.86	320.52
T_9: Soil test based recommendation of NPK + FYM (5 t ha^{-1})	37.45	73.50	79.67	1.40	2.06	4.50	137.89	167.42	273.39
T_{10}: Absolute control	27.86	55.46	68.12	1.33	1.55	3.50	104.82	126.20	205.98
SEm (±)	**2.77**	**2.40**	**2.28**	**0.24**	**0.08**	**0.07**	**3.27**	**7.13**	**8.06**
LSD (0.05)	**8.49**	**7.13**	**6.78**	**0.71**	**0.23**	**0.22**	**9.17**	**21.18**	**23.95**

Table 2: Effect of organic nano NPK on the yield of sesame (kg ha^{-1})

Treatments	Seed yield	Straw yield
T_1: Organic nano NPK (25 kg ha^{-1})	559.05	7016.65
T_2: Organic nano NPK (25 kg ha^{-1}) + FYM (5 t ha^{-1})	601.15	7383.31
T_3: Organic nano NPK (25 kg ha^{-1}) + 50 % recommended dose of NPK	588.20	5749.98
T_4: Organic nano NPK (25 kg ha^{-1}) + FYM (5 t ha^{-1}) + 50 % recommended dose of NPK	604.84	7447.20
T_5: Organic nano NPK (50 kg ha^{-1})	573.33	9287.01
T_6: Organic nano NPK (50 kg ha^{-1}) + FYM (5 t ha^{-1})	712.50	9055.52
T_7: Organic nano NPK (50 kg ha^{-1}) + 50 % recommended dose of NPK	619.50	6249.98
T_8: Organic nano NPK (50 kg ha^{-1}) + FYM (5 t ha^{-1}) + 50 % recommended dose of NPK	670.50	7671.28
T_9: Soil test based recommendation of NPK + FYM(5 t ha^{-1})	595.50	6254.60
T_{10}: Absolute control	499.00	4412.02
SEm (±)	**1.95**	**183.48**
LSD (0.05)	**5.79**	**545.34**

Table 3: Effect of organic nano NPK on the quality of sesame (%)

Treatments	Oil content	Grain protein content
T_1: Organic nano NPK (25 kg ha^{-1})	42.00	14.20
T_2: Organic nano NPK (25 kg ha^{-1}) + FYM (5 t ha^{-1})	51.00	14.55
T_3: Organic nano NPK (25 kg ha^{-1}) + 50 % recommended dose of NPK	43.00	15.95
T_4: Organic nano NPK (25 kg ha^{-1}) + FYM (5 t ha^{-1}) + 50 % recommended dose of NPK	49.00	16.30
T_5: Organic nano NPK (50 kg ha^{-1})	48.00	15.60
T_6: Organic nano NPK (50 kg ha^{-1}) + FYM (5 t ha^{-1})	56.00	18.40
T_7: Organic nano NPK (50kg ha^{-1}) + 50 % recommended dose of NPK	47.00	17.70
T_8: Organic nano NPK (50 kg ha^{-1}) + FYM (5 t ha^{-1}) + 50 % recommended dose of NPK	53.00	18.05
T_9: Soil test based recommendation of NPK + FYM (5 t ha^{-1})	48.00	14.90
T_{10}: Absolute control	40.00	13.85
SEm (±)	**1.19**	**0.51**
LSD (0.05)	**3.53**	**1.56**

9055.52 kg ha^{-1}. This increased straw yield due to the treatments might be due to the increased photosynthesis and increased metabolic activities by the plants. Similar reports of increased straw yield in barley was obtained by Janmohammadi *et al.* (2016) due to nano fertilizer application.

Generally, application of organic nano NPK had significant influence on the oil content of sesame (Table 3). Soil application of the treatment T_6 (organic nano NPK @ 50 kg ha^{-1} and FYM @ 5 t ha^{-1}) recorded the maximum oil content with 56 % and was found to be on a par with T_8 (53%), which suggests that a higher dose of organic nano NPK along with the recommended dose of FYM is required to improve the oil content in sesame. Boghra *et al.* (2015) observed that nano fertilizer application improved the oil content in sesame. The accumulation of oil in sesame seeds is significantly influenced by the availability of essential nutrients at critical stage of crop growth (Kaluzewicz *et al*., 2017). Al-Shumari *et al.* (2019) also repored an increase in duration of fertilizer effect by the application of nano fertilizers. The application of a higher dose of organic nano NPK along with FYM might have increased the duration of the fertilizer effect thereby improving the availability of essential nutrients at critical stage of the crop growth leading to a significantly higher oil content for the treatments. The lowest oil content was obtained from absolute control (T_{10}) with only 40%.

Sesame plants responded well to the organic nano NPK application by enhancing its seed protein content (Table 3). The protein content (18.40%) was found to be the highest in the treatment T_6 (organic nano NPK 50 kg ha^{-1} and FYM 5 t ha^{-1}) and was on a par with T_8 (18.05 %) and T_7 (17.70 %). The slow availability of nutrients throughout the study might be the reason behind the enhanced seed protein content. The extended availability of nutrients especially nitrogen by the treatment application might have increased the formation of various metabolites like protein in sesame. Liu *et al.* (2005) got similar result in peanut. Delfani *et al*. (2014) had reported an enhancement in the protein content of black eyed peas by 2% with nano iron. The plants which received no treatments (T_{10}) yielded the lowest grain protein content (13.85%).

The application of organic nano NPK fertilizers enhances growth, yield and quality in sesame at Onattukara. The growth characters like plant height, primary branches $plant^{-1}$ and leaf area increased with the soil application of either organic nano NPK (50 Kg ha^{-1}) alone or when combined with 5 t ha^{-1} of FYM. The seed and straw yield was significantly influenced by organic nano NPK. There was an overall increase of 42% in seed yield with the application of organic nano NPK @ 50 kg ha^{-1} together with 5 t ha^{-1} of FYM over control. The straw yield was also positively influenced by organic nano NPK fertilizers. The quality characters of sesame seed *viz*. oil content and grain protein content were also improved by application of organic nano NPK @ 50 kg ha^{-1} together with FYM @ 5 t ha^{-1}. To conclude, for enhanced growth, yield and quality in sesame at Onattukara region, the application of organic nano NPK @ 50 kg ha^{-1} with FYM @ 5 t ha^{-1} as basal dose is recommended.

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