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Effect of soil and foliar applied fertilizers on yield attributes and yield of *Rabi* sesame

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Abstract
A field experiment was conducted during *rabi*, 2016-17 on sandy loam soils of Agricultural College Farm, Naira, to study the effect of soil application of varied levels of NPK and foliar nutrition on yield and yield attributes of sesame. The experiment was laid out in split-plot design with four levels of NPK applied to soil and four levels foliar nutrition practices, each replicated thrice. Application of 125% RDF (M_3) along with foliar application 19:19:19 @ 1.0 % at early budding stage followed by 1.0 % KNO_3 at early capsule formation stage (F_4) recorded the highest number of capsules plant^{-1}, capsule length, number of seeds capsule^{-1}, test weight, seed yield (923 kg ha^{-1}) and stalk yield (2095 kg ha^{-1}). The lowest values for yield and yield attributes were found with the lowest level (75% RDF) of NPK supplied to soil and non supply of foliar nutrients (F_1).

Keywords: foliar nutrition, NPK levels, *rabi* sesame, yield attributes, yield

Introduction
Sesame (*Sesamum indicum* L.) is one of the important oilseed crop in Indian agriculture. Sesame seeds are rich source of food, nutrition, edible oil and bio-medicine. Sesame oil has excellent nutritional, medicinal, cosmetic and cooking qualities for which it is known as 'the queen of oilseeds'. Due to the presence of potent antioxidants, sesame seeds are called as 'the seeds of immortality'. Sesame cake or meal obtained as a byproduct of the oil milling industry is rich in protein, vitamin (Niacine) and minerals (Ca and P). Sesame has high oil content (46-55%) and a dietary energy of 6355 Kcal Kg^{-1}. The seeds serve as rich source of protein (20-28%), sugars (14-16%) and minerals (5-7%). Sesame oil has about 80 per cent of unsaturated fatty acids, mainly oleic and linolic acids.

In India, sesame is grown in 1784 lakh ha with an annual production of 850 M t and productivity of 486 kg ha^{-1} (*www.indiastatcom*, 2015-16). In Andhra Pradesh, it is grown in an area of 8.5 lakh ha with a production of 2.8 M tonnes and productivity of 329 kg ha^{-1} (Ministry of Agriculture, Government of India, 2014-15).

Despite of being such an important crop, the average productivity is very low in A.P comparison to global as well as national level. This may be due to cultivation of sesame on marginal and sub marginal lands of poor fertility under very poor agronomic practices and inadequate or even no use of fertilizers are the main reasons for low productivity of the crop. North coastal Andhra Pradesh is a traditional zone for sesame cultivation, especially during *rabi* in the pockets where meager water resources are available to provide a couple of irrigations. Farmers of this region usually pay little attention towards the nutritional needs of this crop due to its poor growing conditions and hence realizing very low yields. Since the crop receives one or two irrigations, soil application of all the required nutrients becomes a practical constraint, while application of nutrients at a right time is important in obtaining good yields.

Chemical fertilizers play a major role to meet nutrient needs of sesame, but continuous use of chemical fertilizers has adverse effects on soil physical and chemical conditions. Use of organics alone does not result in spectacular increase in crop yield, due to their low nutrient status. Therefore, integrated use of organic and chemical nutrients found to be promising not only in maintaining higher productivity and yield stability, but also contributes to sustenance of soil health (Sunita Verma *et al.*, 2013).

Fertilizer applied to the crop at the time of sowing is not fully available to the plants as the crop approaches maturity, so supplemental foliar application is one of the techniques to increase yield of the crop. Foliar fertilization is gaining more importance in recent years due to availability of soluble fertilizers and is of great significance in rainfed areas and under changing climatic conditions. Many research reports indicated positive effect in enhancing crop yield and quality of oilseed/pulse crops.

It constitutes one of the important milestones in the progress of agricultural production.

Material and Methods

A field experiment was conducted during *rabi* of 2016-17 at the Agricultural College Farm, Naira, Andhra Pradesh. The soil was sandy loam in texture with a pH of 7.04 and EC of 0.078 dSm^{-1}, low in organic carbon (0.61%), low in available nitrogen (252.5 kg ha^{-1}), medium in available phosphorus (29.5 kg ha^{-1}) and high in available potassium (352.5 kg ha^{-1}). Brown colored seed of sesame 'YLM-66' were line sown at a spacing of 30 cm x 10 cm at a seed rate of 4 kg ha^{-1} on 24th December, 2016. The plot size was 6 m × 5 m. The experiment was laid out in split-plot design, comprising of four NPK levels; 100% RDF (40:20:20 kg NPK ha^{-1}-M_1), 75% RDF (M_2), 125% RDF (M_3) and 75% RDF + 25% nitrogen through vermicompost (M_4) allotted to main plots and four foliar nutrition treatments *viz*., control (F_1), foliar application of 19:19:19 @ 1.0% at early budding stage (F_2), foliar application of KNO_3 @ 1.0% at early capsule formation stage (F_3) and 19:19:19 @ 1.0% at early budding stage followed by 1.0% KNO_3 at early capsule formation stage (F_4) allotted to subplots and each treatment replicated thrice. The crop was harvested on 4th April, 2017.

Results and Discussion

Yield attributes

Yield attributes of sesame *viz.*, number of capsules $plant^{-1}$, capsule length, number of seeds $capsule^{-1}$ and test weight were significantly varied with soil application of varied levels of NPK. The highest number of capsules $plant^{-1}$, capsule length, number of seeds $capsule^{-1}$ and test weight were recorded with application of 125% RDF (M_3). Significantly lower values for all the yield attributes were observed with the lowest level of (75% RDF) NPK applied to soil (M_2). Adequate and balanced nutrition might have produced large yield structure. These findings are in line with those reported by several earlier researchers (Javaid Akhtar *et al*., 2015) [3].

Among the foliar application treatments, significantly highest number of capsules $plant^{-1}$, capsule length, number of seeds $capsule^{-1}$ and test weight were obtained with foliar application of 19:19:19 @ 1.0% at early budding stage followed by 1.0% KNO_3 at early capsule formation stage (F_4) while, they were found to be the lowest with F_1 (control). Liberal supply of NPK through soil application together with foliar feeding of major nutrients at the peak physiological demand of sesame might be responsible for producing large yield structure. These findings are in conformity with those reported by Mahajan *et al*. (2016) [4].

Maximum seed yield (873 kg ha^{-1}) and stalk yield (2036 kg ha^{-1}) of sesame were realized with application of 125% RDF (M_3) and found significantly superior to rest of the nutrient levels. The seed yield (785 kg ha^{-1}) and stalk yield (1891 kg ha^{-1}) obtained with application of 100% RDF (M_1) were statistically comparable with M_4-75% RDF + 25% nitrogen through vermicompost (777, 1893 kg ha^{-1}). Seed yield (668 kg ha^{-1}) and stalk yield (1753 kg ha^{-1}) were found to be the lowest with application of 75% RDF (M_2) and found statistically inferior to rest of the treatments. The per cent gain in the seed yield due to application of the highest dose (M_3-125% RDF) over lowest dose (M_2-75 % RDF) was worked out to be 30.6% indicating the response of sesame to 66.6% hike in the recommended dose of NPK. While, the gain in seed yield due to 25% enhancement in fertilizer dose over the recommended dose of NPK applied to soil (100% RDF) was worked out to be 11.0%, clearly showing that the currently recommended dose of NPK (40:20:20 kg NPK ha^{-1}) was suboptimal. The results are in agreement with those reported by Gayatri Sahu *et al*. (2017) and Mahajan *et al*. (2016) [4].

As regards the response of sesame in terms of seed yield and stalk yield due to foliar feeding of nutrients, significantly highest values for seed yield (838 kg ha^{-1}) and stalk yield (1947 kg ha^{-1}) were noticed with F_4 (foliar application of 19:19:19 @ 1.0% at early budding stage followed by 1.0% KNO_3 at early capsule formation stage). While, non application of foliar nutrients to sesame (F_1) resulted in the lowest seed yield (697 kg ha^{-1}) and stalk yield (1841 kg ha^{-1}). There was an enhancement in the seed yield of sesame to the tune of 20.2% due to application of F_4 (foliar application of 19:19:19 @ 1.0% at early budding stage followed by 1.0% KNO_3 at early capsule formation stage) over non application of foliar nutrients (F_1- control). Similar views were also expressed by Bhosale *et al*. (2011) [1].

Harvest index, the ratio between seed yield to that of biological yield was not markedly altered either due to of varied levels of NPK to soil or due to foliar feeding of nutrients. The interaction effect between these two factors was also not statistically measurable.

It can be concluded that rabi sesame can be grown in North Coastal Zone of Andhra Pradesh with application of 50:25:25 kg NPK ha^{-1} (125% RDF) and supplemented with 19:19:19 @ 1.0% at early budding stage followed by 1.0% KNO_3 at early capsule formation stage (F_4) as it has resulted in maximum seed and stalk yield.

Table 1: Yield components of sesame as influenced by varied levels of NPK application to soil and foliar application of nutrients

Treatments	Number of capsules $plant^{-1}$	Capsule length (cm)	Number of seeds $capsule^{-1}$	1000 grain weight(g)
Varied levels of NPK application to soil				
M_1**:** 100% RDF (40:20:20 kg NPK ha^{-1})	32.3	2.43	55	2.48
M_2**:** 75% RDF	29.9	2.17	50	2.40
M_3**:** 125% RDF	35.7	2.62	59	2.64
M_4**:** 75% RDF + nitrogen through vermicompost	31.8	2.42	54	2.44
SEm (±)	1.02	0.09	2.04	0.04
C.D (P=0.05)	1.7	0.17	3	0.07
CV%	5.44	7.12	6.49	3.21
Foliar application of nutrients				
F_1**:** Control	30.4	2.23	50	2.35
F_2**:** Foliar application of 19:19:19 @ 1.0% at early budding stage	32.8	2.41	56	2.48
F_3**:** Foliar application of KNO_3 @ 1.0 % at early budding stage	31.9	2.37	54	2.47
F_4**:** Foliar application of 19:19:19 @ 1.0 % at early budding stage followed by 1.0 % KNO_3 at early capsule formation stage	34.7	2.63	59	2.65
SEm (±)	0.71	0.08	1.44	0.09

C.D (P=0.05)	1.0	0.12	2	0.14
CV%	3.84	6.07	4.60	6.75

Table 2: Seed and stalk yield (kg ha^{-1}) of sesame as influenced by varied levels of NPK application to soil and foliar application of nutrients

Treatments	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest Index (%)
Varied levels of NPK application to soil			
M_1**:** 100% RDF (40:20:20 kg NPK ha^{-1})	786	1891	29.32
M_2**:** 75% RDF	668	1753	27.55
M_3**:** 125% RDF	873	2036	30.03
M_4**:** 75% RDF + nitrogen through vermicompost	777	1893	29.07
SEm (±)	38.38	74.95	1.40
C.D (P=0.05)	66	130	NS
CV%	8.57	6.86	8.40
Foliar application of nutrients			
F_1**:** Control	697	1841	27.35
F_2**:** Foliar application of 19:19:19 @ 1.0 % at early budding stage	793	1908	29.24
F_3**:** Foliar application of KNO_3 @ 1.0 % at early budding stage	776	1878	29.28
F_4**:** Foliar application of 19:19:19 @ 1.0% at early budding stage followed by 1.0% KNO_3 at early capsule formation stage	838	1947	30.10
SEm (±)	13.07	23.99	1.46
C.D (P=0.05)	19	35	NS
CV%	2.92	2.20	8.78

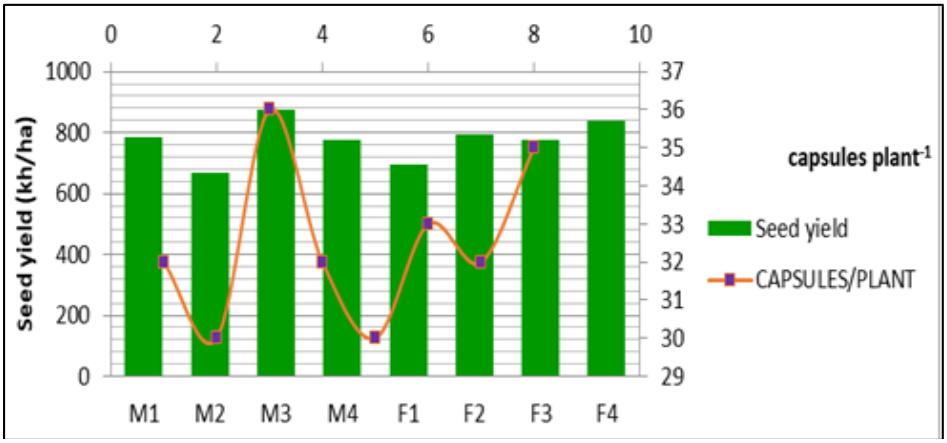

Fig 4.1: Seed yield vs. capsules plant^{-1} of sesame as influenced by varied levels of NPK application to soil and foliar nutrition

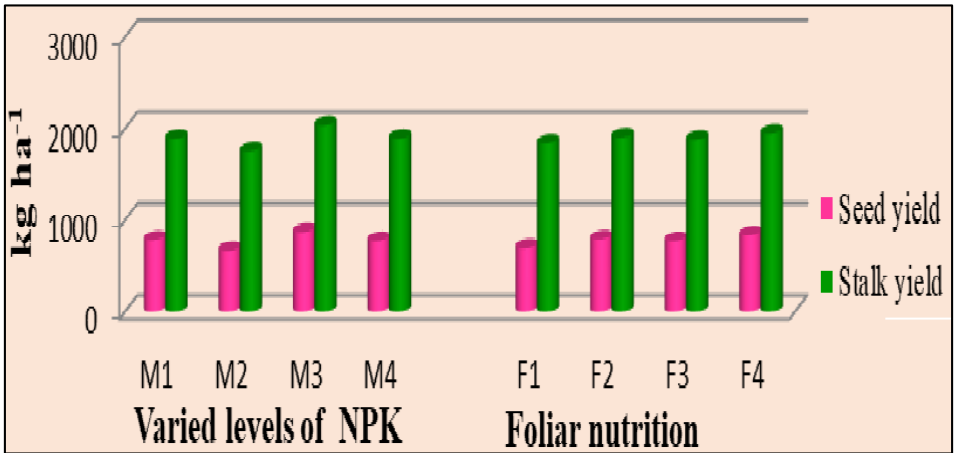

Fig. 4.2: Seed yield vs. stalk yield of sesame as influenced by varied levels of NPK application to soil and foliar nutrition

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