Madras Agric. J., 2018; doi:10.29321/MAJ 2018.000205

RESEARCH ARTICLE

Impact of Plant Density and Nutrient Management practices on Yield and Economics of Rainfed Sesame (*Sesamum indicum* L.)

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Received : 14th August, 2018
Revised : 03rd September, 2018
Accepted : 10th September, 2018

Abstract

Field experiment was conducted on black soil farm, Agricultural Research Station, Kovilpatti. Sesame variety SVPR 1 was sown during *rabi* season (October 2017 – January 2018) to find out suitable plant density, levels of fertilizers and foliar spray of mepiquat chloride at 30 DAS, $MnSO_4$ and DAP at flower initiation and capsule formation stage to maximize the yield and economics. Results revealed that, closer plant spacing of 30 × 20 cm coupled with 125 per cent RDF + foliar spray of 125 ppm mepiquat chloride at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at FIS & CF significantly improved the yield and economics. Significantly higher seed and stalk yield and also higher gross & net return, B: C ratio proved more remunerative over recommended practice of 30 × 30 cm spacing + 100 % RDF alone.

Keywords: *Sesame, Foliar nutrition, Seed yield, Stalk yield and economics*

Introduction

Sesame (*Sesamum indicum* L.) is the vintage oilseed crop cultivated in most of the states of India. This crop is cultivated almost throughout India for its high quality oil and it has magnificiant potential for export. It ranks first in terms of total oilseed area and production in the country, respectively. It is gaining abundant importance on account of its high economic value as edible oil, protein, calcium, iron and methionine (Gupta *et al*, 1998). The two important reasons for low yield in our country found to be low fertility status of soil and non- application or devoid of proper nutrient management in crop production practices (Teshhome, 2016). Hence this study was initiated with the objectives of determining the effects of plant geometry, recommended dose of fertilizers, foliar spray of growth retardant and nutrients on the performance of sesame under rainfed condition.

Material and Methods

The experiment was conducted at the Black soil farm of Agricultural Research Station, Kovilpatti during *Karthigaipattam* of October 2017 to January 2018 (09°10' N latitude and 77°52' E longitude and at an mean sea level of 130 m), where the mean annual rainfall is 703 mm and the maximum and minimum temperature ranges from 34.9˚C and 22.8˚C.The soil was clay loam, low in organic carbon (3.4g kg^{-1}), low in available nitrogen (N) (176 kg ha^{-1}), low in phosphorus (10 kg ha^{-1}), high in potassium (365 kg ha^{-1}) and available manganese is 2.22 ppm.

The experiment on sesame was laid out in Randomized block design with three replication, which comprised of twelve treatments. The treatment consists of two plant geometry, two different dose of fertilizer and foliar spray of MC,$MnSO_4$ and DAP *viz*., The treatment details are T_1- 30 × 30 cm + 100 % RDF alone, T_2- 30 × 30 cm + 100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF, T_3- 30 × 30 cm + 100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF, T_4- 30 × 30 cm + 125 % RDF alone, T_5- 30 × 30 cm + 125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF, T_6- 30 × 30 cm + 125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF, T_7- 30 × 20 cm + 100 % RDF alone, T_8- 30 × 20 cm + 100 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF, T_9- 30 × 20 cm + 100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF, T_{10}- 30 × 20 cm + 125 % RDF alone, T_{11}- 30 × 20 cm + 125 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF, T_{12}- 30 × 20 cm + 125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF. The foliar spray of MC at 30 DAS and $MnSO_4$ and DAP was given twice *i.e.* at flower initiation stage and capsule formation stage. The sesame variety SVPR 1 was chosen for the study. All agronomic operations *viz.*, weed control, hoeing, thinning, plant protection measure and harvesting as well as postharvest operation were made uniformly under all treatments.

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Various observation *viz.* plant height, number of branches plant^{-1}, number of capsules plant^{-1}, number of seeds capsule^{-1} and test weight of seeds, finally seed yield were recorded at final stage. The experimental data were analyzed as per method suggested by Gomez and Gomez (1984).

Results and Discussion

Effect on yield attributes of rainfed sesame

The yield components of grain crops including rainfed sesame would generally be in accordance with that of growth parameters since the size of source most often determines the size of sink. The greater availability of nutrients in soil due to increasing level of fertilizers application and by foliar nutrition might have enhanced the meristemtic activity leading to increased plant height and yield attributes. This present experimental result on yield attributes supporting the findings of Sharma (2014). Application of higher dose of NPK increases yield attributing characters like number of capsules plant^{-1}, number of seeds capsule^{-1}, capsule length and test weight of sesame crop. The maximum number of capsules plant^{-1} (54) was noticed with the spacing of 30 × 30 cm + 125% RDF + foliar spraying of 125 ppm mepiquat chloride +0.5 % $MnSO_4$ & 2 % DAP (Table 1).

Table 1. Yield attributing characters of rainfed sesame as influenced by different plant density and nutrient management

Treatments			Number of capsules plant^{-1}	Number of seeds capsule^{-1}	Test weight (g)
T_1	30 × 30 cm spacing	100 % RDF alone	44.8	33.2	2.80
T_2		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	45.5	35.7	2.89
T_3		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	53.0	39.2	3.32
T_4		125 % RDF alone	48.3	36.2	3.05
T_5		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	49.5	37.6	3.11
T_6		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	54.0	40.4	3.40
Mean value of 30 × 30 cm spacing			49.1	37.0	3.09
T_7	30 × 20 cm Spacing	100 % RDF alone	44.0	32.8	2.79
T_8		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	45.3	34.0	2.83
T_9		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	50.5	38.4	3.18
T_{10}		125 % RDF alone	46.2	35.8	2.95
T_{11}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	49.0	36.8	3.09
T_{12}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	51.8	38.8	3.14
Mean value of 30 × 20 cm spacing			47.8	36.1	2.99
SEd			1.45	1.09	0.09
CD (p = 0.05)			3.20	2.40	0.15

This might be due to lesser inter-plant competition for space, light, nutrient and moisture and further enhances photosynthetic rate. These results are fall in line with Subramaniyan (2001).On reducing row space,

number of capsules plant^{-1} decreased. Sowing taken with 30 × 20 cm spacing along with 100 % RDF alone recorded lower number of capsules plant^{-1} (44) and the reason might be due to less population and had more chances to get nutrients. The alike result was reported by Bakhshandeh (2010).

Table 2. Effect of planting geometry, soil and foliar nutrition on seed and stalk yield, harvest index (HI) of rainfed sesame

Treatments			Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	HI*
T_1	30 × 30 cm spacing	100 % RDF alone	472	1289	0.27
T_2		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	498	1355	0.27
T_3		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	547	1444	0.27
T_4		125 % RDF alone	524	1415	0.27
T_5		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	558	1462	0.28
T_6		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	598	1549	0.28
T_7	30 × 20 cm spacing	100 % RDF alone	535	1434	0.27
T_8		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	585	1539	0.27
T_9		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	620	1618	0.28
T_{10}		125 % RDF alone	605	1609	0.28
T_{11}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	651	1691	0.27
T_{12}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	706	1799	0.28
SEd			19.28	49.66	-
CD (p = 0.05)			40.05	103.00	-

*Data are not statistically analysed

N plays an essential constituent of diverse types of metabolic compounds like amino acids, nucleic acid, enzymes, co- enzymes and alkaloids for higher growth and yield. Similar results given by Pathak *et al*. (2002) and Duary and mandal (2006). Foliar application of DAP and $MnSO_4$ in sesame had increase in number of seeds capsule^{-1} than the basal application of NPK alone. This might be due to foliar application at flowering stage to prevent pre mature abortion of embryos and to improve seed quality. This is in conformity with the results of Terman (1997) and Hasani *et al*. (2012). 1000 seed weight of the rainfed sesame would have positive results due to soil nutrient management and foliar nutrition. The lower test weight value recorded in the treatment received 125 per cent NPK alone than the treatment received 100 per cent NPK coupled with foliar spray. The increased 1000 seed weight due to micronutrients application might be due to their positive effects on assimilates translocation, activation of photosynthetic enzymes, chlorophyll formation and improvement of plant growth. Similar findings were reported earlier by Pilbean and Kirby (1983) and Movahhedi-Dehnavi *et al*.

(2009). The application of MC positively increases 1000 seed weight may be due to increase in photosynthetic activity and drymatter production (Bednarz and Oosterhuis, 1999)

Effect on yield of rainfed sesame

The maximum seed yield (706 kg ha^{-1}) recorded in the 30 × 20 cm spacing with basal application of 125 % RDF + foliar spraying of 125 ppm Mepiquat Chloride at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at flower initiation and capsule formation stage (Table 2).

Table 3. Economics of the treatments as influenced by various planting geometry and nutrient management in rainfed sesame

Treatments			Cost of cultivation* (₹ ha^{-1})	Gross income* (₹ ha^{-1})	Net income* (₹ ha^{-1})	B:C ratio*
T_1	30 × 30 cm spacing	100 % RDF alone	21207	35400	14193	1.67
T_2		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	22843	37350	14507	1.64
T_3		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	23264	41025	17761	1.76
T_4		125 % RDF alone	21480	39300	17820	1.83
T_5		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	23116	41850	18734	1.81
T_6		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	23537	44850	21313	1.91
T_7	30 × 20 cm spacing	100 % RDF alone	21467	40125	18658	1.87
T_8		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	23103	43875	20772	1.90
T_9		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	23524	46500	22976	1.98
T_{10}		125 % RDF alone	21740	45375	23635	2.09
T_{11}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	23376	48825	25449	2.10
T_{12}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	23797	52950	29153	2.22

*Data are not statistically analysed

It was 33.14 per cent of higher grain yield than the recommended practices of sesame comprising 30 × 30 cm spacing +100% RDF as basal. The closer plant geometry might be due to that the greater number of sesame per unit area in narrow distance between hills compensate that reduction in yield attributes of individual plants such as number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$ and 1000 seed weight. Similar results evidenced by Bakhshandeh (2010), Caliskan *et al*. (2004). Application of nitrogen and phosphorus fertilizers to sesame increases the drymatter and seed yield which is in the findings of Shehu *et al*., (2010), Schilling

and cattan(1991). Foliar application of 2 % DAP enhanced the seed yield of crop than soil application alone. Application of DAP as foliar spray at FIS and CF along with RDF recorded higher yield than without DAP as foliar spray. This findings is also in accordance with Mahajan *et al*. (2015), Bhowmick (2006) and Kalpana *et al*. (2003). Foliar application of micro nutrients increase the seed yield in rainfed sesame due to irrespective of NPK levels. It might be due to improvement in growth and enhancement in the photosynthetic, metabolic activities and translocation of drymatter from source to sink. Similar results were found in Dixit and Elamathi (2007).

Stalk yield of rainfed sesame was also significantly influenced by plant spacing. A distinct enhancement in stalk yield with increase in nutrient levels was evident of this study. Stalk yield is directly proportional to plant population and drymatter accumulation in sesame SVPR 1. Hence, the plant spacing of 30 × 20 cm with application of fertilizer level of 125 per cent ha^{-1} + foliar spraying of 125 ppm Mepiquat Chloride at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at flower initiation and capsule formation stage recorded more growth and DMP resulted in higher stalk yield. It was the maximum (1799 kg ha^{-1}) with application of 125 % RDF + foliar spraying at flower initiation and capsule formation stage than the recommended practices of rainfed sesame which recorded 28.34 % lower stalk yield. The increased stalk yield might be due to profound increase in plant height, number of branches $plant^{-1}$ with increasing N application results in higher stalk yield. Similar findings support to the results of Shrivastava and Tripathi (1992) and Vaghani (2010).

Cost and returns of rainfed sesame

The ultimate aim of addition of any input, whether it is cash or farm produced input, depends on how far it is profitable. The cost of cultivation was did not much varied due to different plant spacing except for the seed cost. However the variation was found owing to the different graded levels of NPK and foliar nutrition.

Total cost of cultivation (₹23797 ha^{-1}) was found higher in 30 × 20 cm plant spacing with 125 % RDF as basal + 125 ppm Mepiquat Chloride at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at flower initiation and capsule formation stage as foliar spray (Table 3).The reason might be due to the additional use of inputs and labour requirement for spraying as compared to the conventional and recommended practice. Further, the cost of seed would have been more as compared to wider spacing of 30 × 30 cm.

When gross and net returns and so also the B: C ratio considered adoption of closer plant geometry, soil application of 125 per cent fertilizer and foliar micro nutrition would be more profitable. The higher gross and net return of ₹ 52950 ha^{-1} & ₹ 29153 $ha^{-1}$was found in closer plant geometry (30×20 cm) with 125% RDF + Mepiquat Chloride + $MnSO_4$ & DAP at flower initiation and capsule formation stage as foliar spray with B:C ratio of 2.22 due to higher seed and stalk yield than the other treatments (Table 3). Maintaining optimal plant population with foliar spraying of nutrients enhanced the economic yield and inturn increased the net return and B:C ratio. The similar results regarding gross return, net return and B:C ratio with higher plant population, levels of fertilizer, foliar nutrition were also observed by Verma *et al*. (2012) and Sharma (2005).

Conclusion

It was concluded that sowing of moderately branched SVPR 1 sesame at 30 × 20 cm spacing with application of 125 % RDF as basal + foliar spray 125 ppm Mepiquat Chloride at 30 DAS+0.5 % $MnSO_4$ & 2 % DAP at flower initiation and capsule formation stage is the viable package for getting higher yield under rainfed condition.

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