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Research Article

EFFECT OF PLANT GEOMETRY AND NUTRIENT MANAGEMENT PRACTICES ON GROWTH AND YIELD OF SESAME (*Sesamum indicum L.*) UNDER RAINFED VERTISOL

SUVITHA R.[1]*, JOSEPH M.[2], HEMALATHA M.[3], SENTHIL A.[4] AND BHARATHI G.[5]

[123]Department of Agronomy, Agricultural College & Research Institute, Killikulam, Thoothukudi, Tamil Nadu Agricultural University, Coimbatore, 641003, India
[4]Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore, 641003, India
*Corresponding Author: Email - suvitha59528@gmail.com

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Abstract: Field experiment was conducted at black soil farm, Agricultural research station, Kovilpatti, Tamil Nadu. The sesamum variety SVPR 1 was sown during *rabi* season (*October – January*) to find out suitable plant geometry, levels of fertilizers and foliar spray of Mepiquat chloride at 30 DAS, $MnSO_4$ and DAP at flower initiation and capsule formation stage for maximize the growth and yield. The experiment was laid out in randomized block design and three replications. The trial consists of twelve treatments in combination of plant spacing, nutrient levels and foliar nutrition. The Results revealed that, rainfed sesame sown with closer plant spacing of 30 × 20 cm coupled with 125 per cent RDF followed by foliar spray of 125 ppm Mepiquat chloride at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at FIS & CF significantly improved the components *viz*., plant height, dry matter production and crop growth rate. This attributes contributed in producing significantly higher seed (706 kg ha^{-1}) and stalk yield (1799 kg ha^{-1}) over recommended practice of 30 × 30 cm spacing + 100 % RDF alone.

Keywords: Plant spacing, Nutrition, Rainfed sesame

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Introduction

Sesame (*Sesamum indicum L.)* is the antique oilseed crop cultivated in almost throughout India for its high quality oil and it has magnificent potential for export. It ranks first in terms of total oilseed area and production in our country. It gaining substantial importance on account of high economic value as edible oil, protein, calcium, iron and methionine [1]. 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 [2]. Increase in the production of sesame can be achieved by increasing the area, evolving new technologies which can help to increase the seed and oil yield by approaching the modern crop production technologies particularly include the spacing and nutrient management which increase the number of branches and number of capsules per plant and enhances the production of sesame crop. Hence this study was initiated with the objectives of determining the effect of different plant geometry, fertilizers levels, foliar spray of growth retardant and nutrients on the performance of sesame under rainfed conditions.

Materials and Methods

The experiment was conducted at the black soil farm of Agricultural Research Station, Kovilpatti during *rabi* season 2017 (November 2017 to January 2018). The soil was clay loam with low in organic carbon (3.4 g), available nitrogen (176 kg ha^{-1}), phosphorus (10 kg ha^{-1}), high in potassium (365 kg ha^{-1}) and available manganese is 2.22 ppm. The mean annual rainfall is 703 mm and the maximum and minimum temperature ranges from 34.9˚C and 22.8˚C, respectively. During the cropping period, the crop received 267.4 mm of rainfall in 11 rainy days and the maximum and minimum temperature ranges from 34.4˚C and 17.6˚C, respectively. The experiment was laid out in randomized block design with three replication and twelve treatments. The treatment consists of two plant geometry, two different dose of fertilizer (100 % RDF-23:13:13 kg NPK ha^{-1} and 125 % RDF 28.75:16.25:16.25 kg NPK ha^{-1}) and foliar spray of 125 ppm MC at 30 DAS, + 0.5 % $MnSO_4$ + 2 % DAP at flower initiation stage and capsule formation stage. The sesame variety SVPR 1 was chosen for the study. All agronomic operation *viz*., weed control, hoeing, thinning, plant protection measure and harvesting as well as postharvest operation were made uniformly under all treatments. 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.

Result and Discussion

Sesame growth parameters

Growth parameters of rainfed sesame had significant influence on various treatment combinations. The plant height ranged from 79 to 98 cm. Sowing of sesame at 30 × 20 cm spacing and 125 % RDF as basal + 125 ppm Mepiquat Chloride at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at flower initiation and capsule formation stage produced significantly taller plants of 98.0 cm at harvest compared to normal plant spacing of 30 × 30 cm [Table-1]. The taller plants under 30 × 20 cm spacing might be due to narrow row spacing, when number of plants m^{-2} increases then the competition for light in dense population, which may results in internodes elongation and plant grows taller to intercept maximum height. Similar results by Vinod, *et al*., (2000) [3]. The same treatment was also found to accumulate more dry matter production of 2499 kg ha^{-1} at harvest stage [Table-2]. This might be due to greater absorbtion, assimilation and translocation of nutrients for photosynthesis results in increased dry matter production and its translocation to economic parts reflected on the seed yield. Similar results made by [4]. Also by using Mepiquat chloride will inhibit their growth length and their stem thicker, more resistant to lodging [5]. Similarly the earlier advancement of flowering (37th day) was observed in the plant spacing of 30 × 20 cm with basal application of 100 % RDF + foliar spraying of 125 ppm Mepiquat Chloride at 30 DAS+0.5 % $MnSO_4$ at

Table-1 Effect of planting geometry, soil and foliar nutrition on plant height (cm), Number of branches plant^{-1} and Days to 50 % flowering of rainfed sesame

Treatments			Plant height (cm)	No. of branches plant^{-1}	Days to 50 % flowering
T_1	30 × 30 cm spacing	100 % RDF alone	79.0	3.6	39.6
T_2		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	80.8	3.8	38.0
T_3		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	86.5	4.4	39.0
T_4		125 % RDF alone	88.5	4.5	43.3
T_5		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	82.8	4.3	41.3
T_6		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	93.6	4.6	42.0
T_7	30 × 20 cm spacing	100 % RDF alone	83.9	3.5	39.0
T_8		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	89.1	3.6	37.0
T_9		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$+ 2 % DAP at FIS & CF	94.3	3.7	38.0
T_{10}		125 % RDF alone	97.0	4.2	42.0
T_{11}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	91.6	4.2	40.0
T_{12}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$+ 2 % DAP at FIS & CF	98.0	4.4	41.3
SEd			2.40	0.10	1.19
CD (p = 0.05)			5.28	0.24	2.60

Table-2 Effect of planting geometry, soil and foliar nutrition on drymatter production (kg ha^{-1}) of rainfed sesame

Treatments			Drymatter production (kg ha^{-1})		
			30 DAS	60 DAS	At harvest
T_1	30 × 30 cm spacing	100 % RDF alone	460	1040	1768
T_2		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	484	1094	1860
T_3		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	520	1175	1998
T_4		125 % RDF alone	506	1145	1946
T_5		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	528	1192	2027
T_6		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	561	1267	2154
T_7	30 × 20 cm spacing	100 % RDF alone	514	1162	1976
T_8		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	555	1253	2131
T_9		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$+ 2 % DAP at FIS & CF	584	1321	2245
T_{10}		125 % RDF alone	578	1307	2221
T_{11}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	614	1387	2357
T_{12}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$+ 2 % DAP at FIS & CF	650	1470	2499
SEd			16.7	37.6	61.5
CD (p = 0.05)			35.8	79.5	135.8

Table-3 Effect of planting geometry, soil and foliar nutrition on leaf area index of rainfed sesame

Treatments			Leaf area index	
			30 DAS	60 DAS
T_1	30 × 30 cm spacing	100 % RDF alone	0.87	1.66
T_2		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	0.91	1.78
T_3		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	1.18	2.44
T_4		125 % RDF alone	0.96	1.9
T_5		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	1.01	2.01
T_6		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	1.28	2.73
T_7	30 × 20 cm Spacing	100 % RDF alone	0.82	1.58
T_8		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	0.9	1.69
T_9		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$+ 2 % DAP at FIS & CF	1.13	2.35
T_{10}		125 % RDF alone	0.95	1.86
T_{11}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	0.99	1.96
T_{12}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$+ 2 % DAP at FIS & CF	1.17	2.39
SEd			0.03	0.06
CD (p = 0.05)			0.06	0.12

Table-4 Effect of planting geometry, soil and foliar nutrition on crop growth rate (kg ha^{-1} day^{-1}) of rainfed sesame

Treatments			Crop growth rate (kg ha^{-1} day^{-1})		
			0-30 DAS	30-60 DAS	60- At harvest
T_1	30 × 30 cm spacing	100 % RDF alone	15.34	19.32	29.11
T_2		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	16.13	20.33	30.63
T_3		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	17.34	21.84	32.91
T_4		125 % RDF alone	16.88	21.27	32.05
T_5		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ at FIS & CF	17.59	22.16	33.39
T_6		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$ + 2 % DAP at FIS & CF	18.69	23.55	35.47
T_7	30 × 20 cm spacing	100 % RDF alone	17.14	21.60	32.54
T_8		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	18.48	23.29	35.09
T_9		100 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$+ 2 % DAP at FIS & CF	19.48	24.54	36.98
T_{10}		125 % RDF alone	19.27	24.28	36.59
T_{11}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5% $MnSO_4$ at FIS & CF	20.45	25.77	38.82
T_{12}		125 % RDF + FS 125 ppm MC at 30 DAS + 0.5 % $MnSO_4$+ 2 % DAP at FIS & CF	21.68	27.32	41.16
SEd			0.44	0.61	0.96
CD (p = 0.05)			1.00	1.40	2.30

Table-5 Effect of planting geometry, soil and foliar nutrition on Seed and Stalk yield (kg ha^{-1}) of rainfed sesame

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

Table-6 Effect of planting geometry, soil and foliar nutrition on economics of 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

flower initiation and capsule formation stage than the other treatments. This could be attributed to nitrogen increases leaf size and chlorophyll content, delayed maturity time and increased vegetative growth period [6]. However, the maximum number of branches was observed with recommended 30 × 30 cm spacing + 125 % RDF as basal + foliar spray of 125 ppm Mepiquat Chloride at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at flower initiation and capsule formation stage recorded 4.6 branches at harvest stage. This might be due to growing crops in wider distance there was a low competition among the crops for growth factors like moisture, nutrients, space and light, which in turn increased potentiality of sesame seeds. Similar verdicts found by Noorka, *et al*., (2011) [7].

Sesame growth analysis

Sowing at 30 × 30 cm spacing with 125 % RDF as basal + foliar spraying of 125 ppm Mepiquat Chloride at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at flower initiation and capsule formation stage (T6) was found to record significantly more LAI of 1.28 and 2.73 at 30 & 60 DAS [Table-3]. The reason for higher LAI might be due to absorption and utilization of moisture, nutrients and light by the crop which significantly influences the leaf area. Similar findings were also corroborated with [8]. Rainfed sesame expressed slow increase of crop growth rate from sowing to 30 DAS and rapid increase thereafter up to harvest. Sowing at 30 × 20 cm spacing with 125 % RDF as basal + foliar spraying of 125 ppm Mepiquat Chloride at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at flower initiation and capsule formation stage (T_{12}) was found to accumulate more CGR of 21.68, 27.32 and 41.16 kg ha^{-1}day^{-1} during 0 to 30 DAS, 30 to 60 DAS and 60 DAS to harvest stages, respectively [Table-4]. The increased crop growth rate in rainfed sesame might be due to significant increase in drymatter and growth rate of sesame by using integrated chemical fertilizers causes more synthesis of amino acids, increase in chlorophyll content, improving photosynthetic activity, cell division and results in higher crop growth rate. This was similarly evinced through the study [9].

Sesame yield

The maximum seed yield (706 kg ha^{-1}) recorded in 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. It was 33.14 per cent higher grain yield than the recommended practices of sesame comprising 30 × 30 cm spacing +100% RDF as basal without foliar spray [Table-5]. The higher yield under 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 test weight. Similar results evidenced by Caliskan, *et al*., (2004) [3] and Bakhshandeh, (2010) [10]. Application of N and P fertilizers to sesame increases the drymatter and seed yield which is in the findings of Schilling and Cattan, (1991) [11] and Shehu, *et al*., (2010) [12]. Higher seed yield of sesame with application of higher doses of fertilizer as compared to lower dose under rainfed condition [13]. Foliar application of Mepiquat chloride found to be restrict the vegetative growth in the cost of enhances the reproductive organs [14] and foliar spray 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. These findings are also in accordance with [15-17]. 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 [18]. Stalk yield of rainfed sesame was also significantly influenced by plant spacing, nutrient levels and foliar spray. 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 (1799 kg ha^{-1}) of rainfed sesame which recorded 28.34 % higher stalk yield than the recommended practices. 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) [19] and Vaghani, (2010) [20].

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-6]. 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-6]. 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) [21].

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 MC at 30 DAS + 0.5 % $MnSO_4$ & 2 % DAP at flower initiation and capsule formation stage is the viable package for getting higher yield and B:C ratio under rainfed condition.

Application of research: Altering plant spacing and nutrient management in rained sesame under vertisol condition to improve the yield

Research Category: Plant nutrition

Abbreviations:

MC-Mepiquat chloride
RDF-Recommended dose of fertilizer

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***Research Guide or Chairperson of research: Dr M. Joseph**
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