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Effect of spacing and nutrient management on summer sesame (*Sesamum indicum*) under south Gujarat conditions

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ABSTRACT

A field experiment was conducted during summer 2015 at Navsari (Gujarat) to study the effect of spacing and nutrient management on summer sesame (*Sesamum indicum* L.) under south Gujarat conditions. Among almost all the growth and yield attributes, maximum plant height and minimum number of branches/plant, dry matter production/plant, seed yield/plant, number of capsules/plant and number of seeds/capsule were recorded with spacing of 30 cm × 10 cm. While, maximum seed yield, straw yield, oil yield, nutrient uptake, net realization and BCR were recorded with spacing of 45 cm × 10 cm. Among all the growth and yield attributes, maximum plant height, number of branches/plant, dry matter production/plant, number of capsules/plant, number of seeds/capsule, seed yield/plant, seed yield and straw yield, were recorded with the application of 100% RDF, i.e. 50-25-0 kg N-P_2O_5-K_2O/ha). Treatments receiving 100% RDF realized the highest net realization of 35477 ₹ ha with the highest BCR of 2.69.

Key words: Nutrient management, *Sesamum indicum,* Spacing, South Gujarat

Sesame (*Sesamum indicum* L.), which is variously known as sesamum, *til, simsim, benised, gingelly, gergelim* etc. and one of the most important oilseeds crops, extensively grown in India. Sesame plays an important role in agricultural and industrial economics of our country. Sesame stand next to groundnut so far as the production of edible oil is concerned.

Sesame was cultivated on an area of 17.78 lakh ha with production of 8.11 lakh tonnes and productivity of 456 kg/ha during 2014-15 (Anonymous 2016). Gujarat occupies about 2.36 lakh ha area with production of 1.21 lakh tonnes and 513 kg/ha productivity of sesame.

Sesame is "the queen of the oilseed crops" by virtue of the excellent quality of the oil, flavour, taste and softness. Its oil content generally varies from 46 to 52%. In case of sesame proper spacing provides sufficient interaction of light and satisfactory absorption of nutrients and water from the soil due to proper development of root system and results in higher crop yield. Nutrient management is an old concept in traditional agriculture because of low nutrient turn over in soil plant system (Meelu and Singh 1991). Nutrient management approach involving inorganic fertilizer, biological sources and organic manure will go a long way in build up soil fertility on sustainable basis, since the system will supply almost all the nutrients in a judicious way, besides increasing the nutrient use efficiency and improving the physico-chemical properties of soil. The seed inoculation with strain of biofertilizer such as *Azotobacter* and PSB are the low cost, non-bulky agricultural inputs for enhancing crop yields. The role of biofertilizer is also well recognized which supplies macro and micro nutrients necessary for the plant growth. It also develops a sustainable agriculture system by maintaining soil fertility, soil physical properties, ecological balance and providing stability to the production without polluting soil, water and air. Considering the above facts and views, the present experiment was conducted.

MATERIALS AND METHODS

A field experiment was conducted on B-04 plot of the College Farm, N M College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) during summer season of 2015-16. Geographically, the Navsari is situated at 200 57' N latitude and 720 54' E longitude with an elevation of 10 m above the mean sea level and situated in the south Gujarat agro-climate region. Usually the summer season commences during the middle of February and the temperature reaches to maximum in April and May, hence these two are the hottest months. The maximum and minimum temperature ranged between 36.7°C to 12.9°C. The daily sunshine hours varies from 6.1 to 10.5 hr. The evaporation recorded during the experimental period was 3.8

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to 6.6 mm/day. The wind velocity during growing season was not recorded. The soil of the experimental field was clayey in texture and showed low, medium and high rating for available nitrogen (182 kg/ha) and phosphorus (32 kg/ha) and high rating for available potassium (342 kg/ha). The soil was found slightly alkaline (pH 7.8) with normal electrical conductivity. Total 12 treatment combinations of three spacings (S_1: 30 cm × 10 cm, S_2: 45 cm × 10 cm and S_3: 60 cm × 10 cm) and four nutrient management treatments (N_1: 100% RDF, i.e. 50-25-0 kg N-P_2O_5-K_2O/ha, N_2: 50% RDF + Biocompost 5 t/ha, N_3: 50% RDF + FYM 5 t/ha and N_4: 50 % RDF + *Azotobacter* + PSB) were tried in a factorial randomized block design with three replications. The experimental plot was manured by biocompost @ 5 t/ha, FYM @ 5 t/ha and application of biofertilizer and inorganic fertilizer as per treatments. *Azotobacter chroococcum* and PSB (Phosphate solubilizing biofertilizer) *Bacillus megaterium* culture obtained from Department of Plant Pathology, N M College of Agriculture, Navsari. The required quantity of both biofertilizers *Azotobacter* and PSB @ 4 g (30 g/kg seeds) for the each experimental plot was applied as seed treatment before sowing. The culture inoculated with seed was uniformly as per treatments. The required quantity of inorganic fertilizer was applied through urea (46% N) and single super phosphate (16% P_2O_5) as per treatments. The 100% phosphorus and 50% nitrogen was applied as basal at the time of sowing and remaining 50% nitrogen as apply top dressing. The seeds of sesame variety Gujarat Til 2 received from Main Oilseeds Research Station, Amreli, Gujarat was used for this experiment. First irrigation was given just after sowing for proper germination, whereas other six irrigations were applied uniformly to all the experimental plots. All other cultural practices were performed uniformly for all treatments. The crop was sown on 14 February 2015 using recommended seed rate (3.00 kg/ha). Thinning were carried out after 15 days of sowing to maintain optimum plant population in the experimental plots. Weeding and plant protection measures were undertaken as per the need and the required plant population was maintained. The collected data for various parameters were statistically analysed using Fisher's analysis of variance (ANOVA) technique and the treatments were compared at 5% level of significance.

RESULTS AND DISCUSSION

Effect of spacing

So far maximum plant height was recorded with spacing S_1 (30 cm × 10 cm) at 20 DAS, 40 DAS, 60 DAS and at harvest. It might be due to tendency of plant to elongate towards light, when insufficient incidental solar radiation are intercepted in the plant canopy particularly lower one. Maximum number of branches/plant at 30 DAS (1.06), at 60 DAS (2.81) and at harvest (2.98), dry matter production/plant at 20 DAS (0.93 g), at 40 DAS (4.65 g), at 60 DAS (13.58) and at harvest (16.62), number of capsules/plant

Table 1 Effect of spacing and nutrient management on growth

Treatment	Plant population per ha.		Plant height (cm)				No. of branches/plant			Dry matter production/plant (g)			
	At 20 DAS	At harvest	At 20 DAS	At 40 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest	At 20 DAS	At 40 DAS	At 60 DAS	At harvest
Spacing													
S_1	331167	328308	13.34	49.53	92.02	95.65	0.92	2.24	2.51	0.88	4.00	9.94	12.61
S_2	220157	218171	13.25	46.50	87.75	91.00	0.96	2.62	2.90	0.90	4.33	12.94	15.67
S_3	164462	162266	12.68	44.02	85.92	88.82	1.06	2.81	2.98	0.93	4.65	13.58	16.62
SEm ±	1086	1099	0.22	0.97	1.36	1.32	0.04	0.07	0.07	0.01	0.11	0.33	0.35
CD (P=0.05)	3186	3224	NS	2.85	4.00	3.87	NS	0.19	0.19	NS	0.32	0.97	1.01
Nutrient management													
N_1	238972	236792	13.61	49.39	92.36	95.85	1.10	2.66	3.00	0.94	4.58	13.09	16.27
N_2	238669	236267	13.15	46.72	88.59	91.91	1.00	2.57	2.80	0.91	4.36	12.08	15.14
N_3	238493	236091	12.86	45.55	87.20	90.36	0.94	2.50	2.76	0.90	4.31	11.90	14.58
N_4	238245	235843	12.75	45.06	86.09	89.16	0.88	2.48	2.63	0.89	4.05	11.55	13.87
SEm ±	1254	1269	0.25	1.12	1.57	1.52	0.05	0.07	0.08	0.01	0.12	0.38	0.40
CD (P=0.05)	NS	NS	NS	NS	NS	4.47	NS	NS	0.22	NS	NS	NS	1.17
Interaction													
S × N	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	1.58	1.61	5.87	7.21	5.35	4.98	15.91	8.9	8.07	5.44	8.64	9.4	8.01

DAS: Days after sowing, NS: Non-significant, Spacing: S_1: 30 cm × 10 cm, S_2: 45 cm × 10 cm, S_3: 30 cm × 10 cm, Nutrient management: N_1: 100% RDF (50-25-0 kg N-P_2O_5-K_2O/ha), N_2: 50% RDF + Bio-compost (5 t/ha), N_3: 50% RDF + FYM (5 t/ha) and N_4: 50% RDF + *Azotobacter* + PSB.

Table 2 Effect of spacing and nutrient management on yield attributes and yield

Treatment	No. of capsules/ plant	No. of seeds/ capsule	Seed yield/ plant (g)	Test weight (g)	Seed yield (kg/ha)	Straw yield (kg/ha)
Spacing						
S_1	36.73	47.23	2.27	3.02	855.5	1847.2
S_2	48.01	49.29	4.05	3.03	905.7	1955.2
S_3	54.81	50.04	4.36	3.18	709.6	1664.3
SEm ±	0.92	0.79	0.11	0.05	20.3	56.1
CD (P=0.05)	2.69	2.32	0.34	NS	59.6	164.7
Nutrient management						
N_1	51.29	50.57	3.93	3.20	909.0	1968.9
N_2	47.28	49.41	3.74	3.09	845.7	1859.0
N_3	45.60	48.51	3.39	3.05	802.9	1792.2
N_4	41.90	46.93	3.18	2.97	736.9	1668.8
SEm ±	1.06	0.91	0.14	0.05	23.4	64.85
CD (P=0.05)	3.10	NS	0.40	NS	68.8	190.2
Interaction						
S × N	NS	NS	NS	NS	NS	NS
CV (%)	6.83	5.6	11.43	5.35	8.55	10.68

NS: Non-significant, Spacing: S_1: 30 cm × 10 cm, S_2: 45 cm × 10 cm, S_3: 30 cm × 10 cm, Nutrient management: N_1: 100 % RDF (50-25-0 kg N-P_2O_5-K_2O/ha), N_2: 50% RDF + Bio-compost (5 t/ha), N_3: 50% RDF + FYM (5 t/ha) and N_4: 50% RDF + *Azotobacter* + PSB.

(54.81), number of seeds/capsule (50.04), seed yield per plant (4.36 g) and test weight (3.18 g) were observed in spacing of 60 cm × 10 cm as compared to 30 cm × 10 cm and 45 cm × 10 cm (Table 1 and 2). It might be due to less competition exerted for light, moisture and nutrients. Sufficient interception of sunlight promotes efficient photosynthesis activities and ultimately greater accumulation of photosynthates under wider spacing. Narrow spacing with dense plant population resulted in the lower values of yield attributes. The reduction in yield with increase in plant density could be attributed to keen competition for moisture, photosynthesis and solar radiation. In wider spacing might be attributed to relatively less inter-plant competition because of more space availability to individual plants. The same trend was observed by Yadav *et al.* (2007), Patel (2012) and Shekh *et al.* (2014). The progressive increase in yield was observed with medium spacing because performance of yield attributing characters in the narrow spacing is lower while wider spacing lower the plant population. The higher seed and stover yields were recorded with spacing of 45 cm × 10 cm as compared to 30 cm × 10 cm and 60 cm × 10 cm. It might due to better utilization of available resources, viz. mineral, nutrients, water, solar radiation etc. these findings were corroborated the results of Anon. (1987), Ali *et al.* (2005) and Paraye *et al.* (2009). Maximum net returns of 35266 ₹/ha and BCR value of 2.68 were recorded under 45 cm × 10 cm spacing over 30 cm × 10 cm and 60 cm × 10 cm. This was due to higher yields of seed and stover registered under 45 cm × 10 cm spacing treatment. Similar results were also reported by Kumar *et al.* (2012) and Sivagamy and Rammohan (2013).

Effect of nutrient management

The plant height and dry matter production per plant at 20 DAS, 40 DAS and 60 DAS was found non-significant but the treatment N_1 (100% RDF) produced significantly the higher plant height (95.86 cm) and dry matter production/ plant (16.27 g) at harvest (Table 1). This was because fertilizer induce the growth of the plant through active protein metabolism, transportation of photosynthates and synthesis of nucleic acid and proteins. Hence, during the vegetative stage, N nutrition of the plant to a large extent controls the growth of plant phosphorus has important role in conversion of solar energy into chemical energy and it has also beneficial effect on root proliferation that increase the absorption of plant nutrients from the soil. This was oblivious as phosphorus meristematic activities of the tissue in plant system are bound to increase morphological organs of the plant. Number of branches/plant at 30 DAS and 60 DAS was observed non-significant but the treatment N_1 (100% RDF) recorded significantly higher number of branches/ plant (3.00). Significantly higher values of the yield and yield attributes, viz. number of capsules/plant, seed yield/ plant, seed yield and straw yield were recorded under the treatment receiving 100% RDF over 50% RDF + biocompost (5 t/ha), 50% RDF + farmyard manure (5 t/ha) and 50% RDF + *Azotobacter* + PSB. This was largely attributed to better growth of plant height and root which resulted in adequate supply of photosynthates for development of sink under adequate level of inorganic fertilizer. The

Table 3 Effect of spacing and nutrient management on economics

Treatment	Yield (kg/ha)		Gross realization (₹/ha)	Total cost of culti-vation (₹/ha)	Net realization (₹/ha)	BCR
	Seed	Straw				
Spacing						
S_1	855.5	1847.2	53177	20931	32246	2.54
S_2	905.7	1955.2	56297	21031	35266	2.68
S_3	709.6	1664.3	44240	20831	23409	2.12
Nutrient management						
N_1	909	1968.9	56509	21031	35478	2.69
N_2	845.7	1859	52601	27802	24799	1.89
N_3	802.9	1792.2	49966	25302	24664	1.97
N_4	736.9	1668.8	45883	20342	25541	2.26

Selling price of sesame: Seed @ 60 ₹/kg, Straw @ 1 ₹/kg. Spacing: S_1: 30 cm × 10 cm, S_2: 45 cm × 10 cm, S_3: 30 cm × 10 cm, Nutrient management: N_1: 100% RDF (50-25-0 kg N-P_2O_5-K_2O/ha), N_2: 50% RDF + Bio-compost (5 t/ha), N_3: 50% RDF + FYM (5 t/ha) and N_4: 50% RDF + *Azotobacter* + PSB.

significantly increase in seed yield due to inorganic sources of nutrients might be due to improvement in reproduction. The other reason is due to an adequate supply of all the nutrients early in the life of a plant, which is considered important in promoting vegetative growth and reproductive growth, thereby increased assimilating surface of plant as well as total photosynthesis. In physiological terms, the test weight of sesame is governed by source (photosynthesis) and sinks (seed) relationship. Positive response in terms of yield attributes to inorganic fertilizer have also been reported by Singh *et al.* (2009), Ghosh *et al.* (2013), Verma *et al.* (2013) and Sen *et al.* (2015). The highest net return of 35477.2 ₹/ha with BCR values of 2.69 was obtained under treatment receiving 100% RDF (Table 3). This was due to higher yield with this level ultimately reflected into higher net realization and BCR. Similar results were also reported by Javia *et al.* (2010), Ghosh *et al.* (2013) and Verma *et al.* (2013).

Interaction effect

The combined effect of spacing and nutrient management was found non-significant in yield and yield attributes of sesame.

Conclusion

From the results of one year experimentation, it can be concluded that sesame var. GT 2 should be grown with 45 cm × 10 cm spacing and fertilized with 100% RDF (50-25-0 kg N-P_2O_5-K_2O/ha) in summer season under south Gujarat condition for getting higher yield and monetary returns.

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