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Growth and yield of sesame (*Sesamum indicum* L.) as Influenced by nitrogen levels and weed management practices under south Gujarat condition

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Abstract

A field experiment was conducted on heavy black soil at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) during the summer season 2019. The study consisted combinations of three levels of nitrogen viz. 25 kg N/ha (N₁), 50 kg N/ha (N₂) and 75 kg N/ha (N₃) and seven weed management practices viz. Weedy check (W₁), Weed free check (W₂), HW at 30 DAS (W₃), Pendimethalin (PE) @ 0.75 kg/h (W₄), Pendimethalin (PE) @ 0.75 kg/ha + One HW at 30 DAS (W₅), Quiazalfop-p-ethyl (PoE) at 20 DAS @ 0.05 kg/ha (W₆) and Pendimethalin (PE) @ 0.75 kg/ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ha (W₇) were tested in randomized block design with three replications. Significantly higher values of all the all the growth and yield attributes such as plant height, number of leaves per plant, number of primary branches per plant, length of capsule, number of capsule per plant, number of seed per capsule, seed yield per plant and weight of 1000 seeds were recorded with application of 75 kg N/ha (N₃) and in case of weed management treatments, Significantly higher values were recorded under weed free check (W₂) which remained at par with treatments W₃, W₅ and W₇. Significantly highest seed yield (954.71 kg/ha) and Stover yield (1560.95 kg/ha) were recorded with application of 75 kg N/ha (N₃). In case of weed management practices significantly higher seed yield (971.61 kg/ha) and Stover yield (1640.23 kg/ha) were recorded under treatment of weed free check (W₂) which remained at par with treatments W₃ (HW at 30 DAS), W₅ (Pendimethalin (PE) @ 0.75 kg/ha + One HW at 30 DAS) and W₇ (Pendimethalin (PE) @ 0.75 kg/ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ha). Lower weed density and weed index with higher weed control efficiency were recorded in treatment weed free check (W₂), which was followed by application of Pendimethalin (PE) @ 0.75 kg/ha + One hand weeding at 30 DAS (W₅).

Keywords: sesame, weed density, weeds dry weight, grain yield and stover yield

Introduction

Sesame (*Sesamum indicum* L.) is an important oilseed crop in India. It has earned a poetic label "Queen of oilseeds" due to high quality of polyunsaturated stable fatty acids in seeds (26g), Moreover, seeds are rich source of edible oil (48-55%) and protein (20-28%) consisting both methionine and tryptophan, vitamins (niacin) and minerals (Ca and P). Sesame is a good catch crop and performs well in pure and mixed stand in residual soil moisture. Sesame is widely cultivated in tropical and sub-tropical parts of the world. India is world's largest producer of the sesame accounting 35 percent of the total production, but its average productivity is extremely low (274 kg ha⁻¹). Nitrogen is primary essential element required to increase agricultural production. It plays an important role in synthesis of chlorophyll and amino acids that contribute to the building unit of protein and thus growth of plants (Singh *et al.*, 2001) [10]. The deficiency of nitrogen results in yellowing of plant and stunted growth, which adversely affects the yield of crop, hence judicious use of this element is advocated. Inadequate weed management appears to be one of the major constraints for such low productivity of sesame. Being slow growing during seedling phase, weeds affect the growth of sesame and reduced the yield. The period from 15 to 30 days after sowing is the most critical period of crop weed competition in the sesame (Duary and Hazra, 2013) [3]. Several annual grasses and broad leaf weeds invade this crop causing heavy losses. In oilseed crops, yield loss due to weed competition varied from 50-75% (Bhadauria *et al.*, 2012) [1]. Hand weeding is commonly practiced by the farmer but weeding is not possible due to scarcity of the farm labour and cost of weeding operation.

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Chemical weed control is easier, time saving and economical compared to hand weeding. Keeping in view the above facts, a study was undertaken.

Materials and Methods

A field experiment was conducted during *rabi* season of 2019 at Instructional farm, N. M College of Agriculture, N. A. U., Navsari, Gujarat. The soil of the experimental site clayey in texture and PH was high (7.8). The soil was low in available nitrogen (197 kg/ha), medium in available phosphorus (52 kg/ha) and high in available potassium (481 kg/ha). The study consisted combinations of three levels of nitrogen *viz.* 25 kg N/ha (N₁), 50 kg N/ha (N₂) and 75 kg N/ha (N₃) and seven weed management practices *viz.* Weedy check (W₁), Weed free check (W₂), HW at 30 DAS (W₃), Pendimethalin (PE) @ 0.75 kg/h (W₄), Pendimethalin (PE) @ 0.75 kg/ha + One HW at 30 DAS (W₅), Quiazalfop-p-ethyl (PoE) at 20 DAS @ 0.05 kg/ha (W₆) and Pendimethalin (PE) @ 0.75 kg/ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ha (W₇). These treatments were replicated three times in a randomized block design. Main field was prepared by two dry ploughing at an interval of 10 to 15 days followed by passing the harrow and leveler. The seeds of GJ Til-5, 2.5 kg/ha was sown at the spacing of 45 cm X 10 cm. The recommended full dose of P₂O₅ fertilizer 25 kg ha⁻¹ was applied as a basal dose. Application of 50 per cent dose of nitrogen was applied as a basal dose and remaining 50 per cent nitrogen was applied at 30 days after sowing as per treatment. The observation on Plant height (cm), No. of leaves per plant, No. of primary branches per plant, Dry matter production per plant, Length of capsule (cm), No. of capsules per plant, No. of seeds per capsule, Seed yield per plant (g), 1000 seed weight (g), Seed yield (kg/ha) Stover yield (kg/ha), Weed count of grasses

(No./m²), Weed count of BLW (No./m²), Weed count of sedges (No./m²) were recorded at 40 DAS and at harvest. Since the data on weed density and weed dry weight showed high variation, the data were subjected to square root transformation and the statistical analysis was done. Weed index and weed control efficiency were calculated as per the standard formulae.

$$\text{Weed control efficiency} = \frac{\text{Dry matter production of weed in unweeded plot} - \text{Dry weight production of weeds in treated plot}}{\text{Dry matter production of weed in unweeded plot}} \times 100$$

$$\text{Weed control index} = \frac{\text{Yield from weed free plot} - \text{Yield from treatment plot}}{\text{Yield from weed free plot}} \times 100$$

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads.

Effect of nitrogen levels

Weed density (No. m²) and Weed dry weight (g/m²)

The major weeds infested with the experimental field were *Echinochloa crusgalli*, *Digitaria sanguinalis*, *Sorghum halepense*, *Cynodon dactylon*, *Bracharia* spp. among grassy weeds and *Amaranthus viridis*, *Alternanthera sessilis*, *Digera arvenses*, *Convolvulus arvensis*, *Eclipta alba*, *Vernonia cineraria*, *Euphorbia hirta*, *Euphorbia madarsptiensis*, *Cassia tora*, *Physalis minima*, *Trianthema portulacastrum* among broad leaf weeds and *Cyprus rotundus* among sedges. The data pertaining to weed density and total dry weight of weeds at different nitrogen levels were found to be non-significant. (Table 1)

Table 1: Effect of weed management treatments on total weeds, weed dry weight (gm²), Weed index (%) and weed control efficiency (%).

Treatments	Total weed density (No/m ²)	Total dry weight of weed (kg/ha)	Weed control efficiency (%)	Weed index (%)
Nitrogen levels (N)				
N ₁ : 25 kg/ha	9.28(98.70)	1097.32(30.62)	-	-
N ₂ : 50 kg/ha	9.37(101.00)	1124.01(30.96)	-	-
N ₃ : 75 kg/ha	9.52(104.04)	1159.18(31.46)	-	-
SEM±	1.68	22.41	-	-
CD (P=0.05)	NS	NS	-	-
Weed management treatments (W)				
W ₁ : Weedy check	12.34(151.75)	1702.24(41.25)	0.00	34.86
W ₂ : Weed free check	0.71(0.00)	0.00(0.71)	100.00	0.00
W ₃ : HW at 30 DAS	10.59(111.91)	1243.08(35.23)	26.97	9.11
W ₄ : Pendimethalin (PE) @ 0.75 kg/ha	11.79(138.63)	1551.06(39.35)	8.88	26.17
W ₅ : Pendimethalin (PE) @ 0.75 kg/ha+ One HW at 30 DAS	9.30(86.38)	948.77(30.76)	44.26	2.78
W ₆ : Quiazalfop-p-ethyl (PoE) at 20 DAS @ 0.05 kg/ha	10.85(117.49)	1307.41(36.13)	23.19	14.46
W ₇ : Pendimethalin (PE) @ 0.75 kg/ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ha	10.15(102.56)	1135.32(33.65)	33.30	9.91
SEM±	2.56	34.23	-	-
CD (P=0.05)	7.32	97.85	-	-
Interaction	SEM±	4.44	59.29	-
	CD (P=0.05)	NS	NS	-
	CV%	7.59	9.11	-

*Figures indicating ($\sqrt{X + 0.5}$) transformed values, Figures in parenthesis are indicating original values. NA - Not analyzed

Growth characters

The data revealed significantly higher plant height was recorded at harvest (96.87 cm) in treatment N₃ (75 kg N/ha). Similar results obtained in case of number of leaves per plant *i.e.* 76.54. (Table 2). The increase in plant height and number of leaves per plant with increased nitrogen levels would be attributed to favorable effect of nitrogen in increasing cell

wall material resulted in increased size of cell which in turn expressed morphologically as increased plant height. (Enhance vegetative growth under the influence of nitrogen application). These findings are in agreement with finding of Vaghani (2010)^[11].

The results pertaining to number of primary branches per plant in the treatment N₃ (75 kg/ha) recorded significantly

higher number of branches per plant at harvest i.e. 5.20. This might be due to favourable influence of nitrogen enhanced cell division and cell elongation which promoted vegetative growth and ultimately increased number of primary branches per plant. These results are in agreement with those reported by Patel (2007)^[9] and Vaghani (2010)^[11].

In case of dry matter production per plant, treatment N₃ (75 kg/ha). Recorded significantly higher (g) at harvest (32.84). The increase in the total dry matter production may be due to better source and sink capacity developed and its

accumulation in assimilatory surface area and increase in the photosynthetic efficiency and thus increased the production of photosynthates reflected in better growth and ultimately in higher dry matter accumulation. The present result is in accordance with that of Kalaiselvan *et al.* (2001)^[5] and Patel *et al.* (2014)^[8].

The results pertaining to days to 50% flowering in Table 4.6 showed that the different levels of nitrogen did not produced significant effect on days to 50% flowering.

Table 2: Effect of weed management treatments on growth characters of sesame

Treatments	Plant height (cm)	No. of leaves per plant	No. of primary branches per plant	Dry matter production per plant (g/plant)	Days to 50% flowering	
Nitrogen levels (N)						
N ₁ : 25 kg/ha	84.30	40.06	4.42	25.31	42.34	
N ₂ : 50 kg/ha	91.31	59.82	4.88	30.70	43.21	
N ₃ : 75 kg/ha	96.87	76.54	5.20	32.84	43.72	
SEm±	1.36	0.68	0.07	0.47	0.56	
CD (P=0.05)	3.88	1.94	0.19	1.33	NS	
Weed management treatments (W)						
W ₁ : Weedy check	71.63	38.37	3.74	22.62	38.62	
W ₂ : Weed free check	97.92	71.62	5.16	31.87	45.11	
W ₃ : HW at 30 DAS	95.23	64.85	5.07	31.35	42.21	
W ₄ : Pendimethalin (PE) @ 0.75 kg/ha	89.31	51.45	4.82	29.17	43.61	
W ₅ : Pendimethalin (PE) @ 0.75 kg/ha+ One HW at 30 DAS	97.09	65.55	5.14	31.70	44.47	
W ₆ : Quiazalfop-p-ethyl (PoE) at 20 DAS @ 0.05 kg/ha	89.62	54.93	4.83	28.99	43.78	
W ₇ : Pendimethalin (PE) @ 0.75 kg/ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ha	95.00	64.89	5.07	31.62	43.82	
SEm±	2.08	1.03	0.10	0.71	0.86	
CD (P=0.05)	5.93	2.96	0.30	2.03	2.45	
Interaction	SEm±	3.59	1.79	0.18	1.23	1.48
	CD (P=0.05)	NS	NS	NS	NS	NS
	CV%	6.86	5.28	6.42	7.21	5.96

Yield and yield attributes

The results pertaining to yield attributing characters showed that fertilizing the crop with nitrogen significantly influenced the yield attributes like length of capsule, number of capsule per plant, number of seeds per capsule, seed yield per plant and 1000 seed weight of sesame crop. The highest length of capsule (3.34 cm) of sesamum *viz.* 3.34 cm was recorded with treatment N₃ (75 kg N/ha). Statistically it reminded at par with treatment N₂. Significantly the highest number of capsules per plant (32.46), number of seed per capsule (61.62), seed yield per plant (995.98 g), 1000 seed of sesamum (3.37 g) was recorded with N₃ (75 kg N/ha). Nitrogen had increased photosynthetic activity during the reproductive. The results pertaining to yield attributes characters (Table 4.7 to 4.12) showed that fertilizing the crop with nitrogen significantly not influenced the yield attributes like number of seeds per capsule, length of capsule and test weight of sesame crop. Photosynthesis accumulated from source to the sink. The results are in accordance with the findings of Chaubey *et al.* (2003)^[2] and Patel *et al.* (2014)^[8].

Application of nitrogen brought about significant variation in seed yield and stover yield of sesame. Significantly higher seed yield (954.71 kg/ha) and stover yield (1560.95 kg/ha) was recorded under application N₃ (75 kg N/ha). While, the lowest seed yield (718.83 kg/ha) was observed with treatment N₁ (25 kg N/ha). This might be due to the improvement in growth characters that favorably modified the yield attributes. Higher seed yield with application of 75 kg N/ha was also probably a consequence of greater amount of nutrient uptake by seed. Amount of nitrogen plays an important role in plant metabolism by virtue of being an essential constituent of diverse types of metabolically active compounds like amino

acids, proteins, nucleic acid, enzymes, co-enzymes and alkaloids which are important for higher growth and yield. This increase in growth and yield attributes ultimately helped in realization of higher seed yield. The results obtained in this study are in agreement with those reported by Dinakaran *et al.* (2001), EL-Mahdi (2008)^[4] and Patel *et al.* (2014)^[8].

The result revealed that the differences in various treatment of nitrogen levels were found to be non-significant with respect to harvest index.

Effect of weed management

Weed density (No. m²) and Weed dry weight (g/m²):

In weed management treatments, significantly lower number of grasses, BLW and sedges were recorded with treatment W₂ (weed free check) followed by treatment W₅ (Pendimethalin (PE) @ 0.75 kg/ha + One HW at 30 DAS). Whereas, significantly higher number of grasses, BLW and sedges were found under treatment weedy check (W₁). Significantly lower dry weight of weed was found in treatment W₃ (weed free check) followed by treatment W₅ (Pendimethalin (PE) @ 0.75 kg/ha + One HW at 30 DAS). However, Treatment W₁ (weedy check) recorded highest dry weight of weed at harvest. (Table 1)

Weed control efficiency and weed index

Weed-control efficiency of different weed-management practices varied from 8.88 to 44.26%, maximum (44.26%) was recorded with application of W₅ (Pendimethalin (PE) @ 0.75 kg/ha+ One HW at 30 DAS) The lower weed index (2.78%) was recorded with W₅ (Pendimethalin (PE) @ 0.75 kg/ha+ One HW at 30 DAS) followed by T₃ (Two hand weeding (HW) and inter culturing (IC) at 20 & 40 DAS). This

was mainly due to better control of weed growth even up to harvest resulting in lower dry weight of weeds. This might be due to effective weed control achieved under efficient method of weed management in terms of lower weed population per unit area, reduced biomass production of weeds and higher weed control efficiency. Ultimately, this treatment gave more yield of crops. The results have confirmed the findings of Mathukia *et al.* (2015)^[6] and Mruthul *et al.* (2015)^[7].

Growth characters

Significant differences among the various growth attributes *viz.*, plant height, number of leaves per plant, number of primary branches per plant, dry matter production per plant and days to 50% flowering were observed under the effect of various weed management treatments. (Table 2)

Significantly higher plant height *i.e.* 97.92 cm, number of leaves per plant (71.62), number of primary branches per plant (5.16) was recorded under treatment weed free check (W₂) at harvest. However, it was at par with W₃ (HW at 30 DAS), W₅ (Pendimethalin (PE) @ 0.75 kg/ha + One HW at 30 DAS), and W₇ (Pendimethalin (PE) @ 0.75 kg/ ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ ha) remained at par for plant height at harvest.

The highest dry matter production per plant was recorded under treatment weed free check (W₂) *viz.* 31.87 g at harvest. Statistically it was at par with W₃ (HW at 30 DAS), W₅ (Pendimethalin (PE) @ 0.75 kg/ha + One HW at 30 DAS) and W₇ (Pendimethalin (PE) @ 0.75 kg/ ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ ha). The highest days to 50 per cent flowering were recorded under treatment weed free check (W₂) *viz.* 45.11. However, it was at par with treatments W₄, W₅, W₆ and W₇. The maximum values of all these growth parameters in these treatments (W₂, W₃, W₅, W₆ and W₇) and lowest value in treatment W₁ (weedy check) might be due to the application of pendimethalin as pre-emergence and Quiazalfop –ethyl as post emergence gave better control of weeds at an early stage reduced weed competition lead to more nutrient and soil moisture available to the crop enhanced vegetative growth of sesamum. The results are in agreement with the findings of Mathukia *et al.* (2015)^[6].

Yield and yield attributes

Significantly the highest length of capsule of sesamum was observed under treatment weed free check (W₂) *i.e.* 3.56 cm and it remained at par with W₅ (Pendimethalin (PE) @ 0.75

kg/ha + One HW at 30 DAS). Maximum number of capsules per plant (31.88), number of seeds per capsule (61.04), seed yield per plant (985.93 g) was recorded under weed free check (W₂). However it was at par with W₃ (HW at 30 DAS), W₅ (Pendimethalin (PE) @ 0.75 kg/ha + One HW at 30 DAS) and W₇ (Pendimethalin (PE) @ 0.75 kg/ ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ ha). The lowest values of above yield attributes were observed under the treatment W₁ (weedy check). This trend of results indicating least competition offered by weeds for nutrients and moisture at crucial growth stages under these treatments ultimately improved all yield attributes besides increased rate of N, P and K absorption as evident from nutrient uptake studies cumulatively helped the crop plants to produce more surface area for high photosynthetic rate as well as maximum translocation of photosynthates from source to sink, subsequently resulted in improvement of above yield attributes. Because of synergistic effect among the yield attributes they benefited each other.

The data further indicated that the maximum seed yield (971.61 kg/ha) and stover yield (1640.23 kg/ha) were recorded under treatment weed free check (W₂). However it was at par with W₃ (HW at 30 DAS), W₅ (Pendimethalin (PE) @ 0.75 kg/ha + One HW at 30 DAS), and W₇ (Pendimethalin (PE) @ 0.75 kg/ ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ ha). While the lowest seed yield (632.86 kg/ha) and lowest stover yield (1189.57 kg/ha) were recorded under treatment weed check (W₁). The remarkable increase in seed and stover yield under these treatments might be due to effective control of weeds, lower dry weight of weeds which cumulatively facilitated the crop to utilize more nutrients and water for better growth and development in terms of various growth attributing characters such as length of capsule, number of capsules per plant, number of seeds per capsule, seed yield per plant and 1000 seed weight. All the parameters showed positive and highly significant influence on seed and straw yield of sesamum. These findings are in accordance with those of Mathukia *et al.* (2015)^[6] and Mruthul *et al.* (2015)^[7].

There was no significant effect of weed management treatments with respect to 1000 seed weight and harvest index. The contradictory result was recorded in this regard by Mathukia *et al.* (2015)^[6] and Mruthul *et al.* (2015)^[7]. (Table 3)

Table 3: Effect of weed management treatments on yield and yield attributes of sesame

Treatments	Length of capsules (cm)	No. of capsule per plant	No. of seeds per capsule	Seed yield per plant (g)	1000 seed weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
Nitrogen levels (N)								
N ₁ : 25 kg/ha	3.09	24.94	53.76	783.20	2.64	718.83	1312.88	35.38
N ₂ : 50 kg/ha	3.24	28.98	55.15	900.54	3.06	836.17	1444.04	36.67
N ₃ : 75 kg/ha	3.34	32.46	61.62	995.98	3.37	954.71	1560.95	37.95
SEm±	0.04	0.38	0.66	17.11	0.04	22.57	36.90	0.98
CD (P=0.05)	0.10	1.07	1.89	48.91	0.12	64.51	105.46	NS
Weed management treatments (W)								
W ₁ : Weedy check	2.62	19.82	51.18	627.14	2.05	632.86	1189.57	34.73
W ₂ : Weed free check	3.56	31.88	61.04	985.93	3.32	971.61	1640.23	37.20
W ₃ : HW at 30 DAS	3.35	31.31	59.54	939.39	3.22	883.12	1520.28	36.74
W ₄ : Pendimethalin (PE) @ 0.75 kg/ha	3.14	28.18	52.73	895.41	3.02	717.31	1316.26	35.33
W ₅ : Pendimethalin (PE) @ 0.75 kg/ha+ One HW at 30 DAS	3.44	31.58	60.56	976.63	3.31	944.60	1584.43	37.35
W ₆ : Quiazalfop-p-ethyl (PoE) at 20 DAS @ 0.05 kg/ha	3.14	28.59	53.23	910.59	3.03	831.14	1333.22	38.40
W ₇ : Pendimethalin (PE) @ 0.75 kg/ha + Quiazalfop-p-ethyl (PoE) at 30 DAS @ 0.05 kg/ha	3.30	30.29	59.61	917.60	3.21	875.32	1491.04	36.99
SEm±	0.05	0.57	1.01	26.14	0.07	34.48	56.36	1.49

	CD (P=0.05)	0.15	1.64	2.89	74.72	0.19	98.55	161.09	NS
Interaction	SEm±	0.09	0.99	1.75	45.28	0.11	59.72	97.62	2.59
	CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
	CV%	4.99	5.98	5.34	8.78	6.51	12.36	11.75	12.24

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