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RESEARCH PAPER

Response of summer sesamum (*Sesamum indicum* L.) to different spacings and levels of nitrogen under north Gujarat condition

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Abstract : An experiment was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during 2011 on response of summer sesamum (*Sesamum indicum* L.) to different spacings and levels of nitrogen under north Gujarat condition. Spacing of 60 cm showed its superiority by producing highest seed (569 kg ha^{-1}) and stalk yields (1977 kg ha^{-1}). The same treatment exhibited significant improvement by recording maximum values for the growth and yield parameters *viz*., number of branches $plant^{-1}$, dry matter production $plant^{-1}$, number of capsules $plant^{-1}$ and seed yield $plant^{-1}$ but plant population and plant height was lower at 60 cm. With regard to N content in seeds and stalk as well as N, P and K uptake by seeds, stalk and total, 60 cm spacing, surpassed rest of the treatments bearing maximum values. Application of nitrogen @ 75 kg ha^{-1} recorded significantly higher seed (630 kg ha^{-1}) and stalk yields (2119 kg ha^{-1}) over 0, 25 and 50 kg N ha^{-1} and significantly improved growth and yield attributing characters *viz.*, plant height, number of branches $plant^{-1}$, dry matter production $plant^{-1}$, number of capsules $plant^{-1}$, seed yield $plant^{-1}$ and 1000 seed weight. Application of nitrogen @ 75 kg ha^{-1} significantly improved N, P and K content (seeds and stalk) and uptake (seeds, stalk and total). Treatment combination 60 cm spacing and 75 kg N ha^{-1} bearing maximum values of all these parameters ranked at top. Maximum net realization of Rs. 35069 ha^{-1} and BCR 2.47 was noted under 60 cm spacing. Similarly the respective figures were maximum (Rs. 40795 ha^{-1} and 2.68) when crop was fertilized with 75 kg N ha^{-1}. Experimentation showed that for securing higher yield as well as net realization, summer sesamum should be sown at 60 cm spacing and fertilized with 75 kg N ha^{-1} along with 25 kg P_2O_5 ha^{-1} and 20 kg S ha^{-1}.

Key Words : Levels, Sesamum, Spacings, Nitrogen

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INTRODUCTION

Sesame (*Sesamum indicum* L.) which is variously known as sesamum, til, simsim, benised, gingelly, gergelim etc. and one of the most important oilseed crops extensively grown in India. Sesamum an important oilseed is cultivated under different agro-climatic regions of India because of its fast growth rate, short duration, less water requirement and wide adaptability under varying soil types. Sesamum seeds useful in confectionary and in religious rites. Being rich in protein, calcium, phosphorus and vitamin E., the sesamum cake is a valuable cattle feed for farm and dairy animals. Its oil content generally varies from 46 to 52 per cent. The productivity of sesamum crop is very low which can be boosted up by adopting suitable agronomic practices of various agronomic factors known to augment the sesamum yield. Fertilizers, especially nitrogen play a vital role to enhance the productivity. The application of nitrogenous fertilizers has shown positive response in term of grain production and oil content. For full exploitation of the yield potential of the summer sesamum, it is important to maintain optimum plant population. Proper spacing is necessary for

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Sr. No.	Determination	Method	Reference
Soil analysis			
1.	Available N	Alkaline Potassium Permaganate method	Subbiah and Ashija (1956)
2.	Available P_2O_5	Extraction 0.5 M $NaHCO_3$ pH (8.5) Colorimetric method	Olsen *et al.*(1954)
3.	Available K_2O	Flame photometric method	Jackson (1973)
Plant analysis			
1.	Nitrogen	Kjeldhal' method	Waranke and Barber(1974)
2.	Phosphorus	Vanodomolybdo phosphoric yellow colour method	Jackson (1973)
3.	Potash	Flame photometric method	Jackson (1973)

interception of sunlight to each strata of leaves. This will promote the rate of photosynthesis and consequently the dry matter production. In case of sesamum crop, proper spacing provides sufficient interception of sunlight and satisfactory absorption of nutrients and water from the soil. The information regarding proper spacing and nitrogen requirement of summer sesamum cultivation is lacking hence, the present investigation was proposed.

MATERIAL AND METHODS

A field experiment was carried out on plot number C-9 of Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat during the *Rabi* season of the year 2011-12 on loamy sand soil having pH 7.40, low in organic carbon (0.25 %) and available nitrogen (160.00 kg ha^{-1}), while medium in available phosphorus (30.10 kg ha^{-1}) and potassium (275.00 kg ha^{-1}). The experiment was laid out in Randomized Block Design (RBD) with factorial concept. Twelve treatment combinations involving three levels of spacing (30 cm, 45 cm and 60 cm] and four levels of nitrogen (0 kg ha^{-1}, 25 kg ha^{-1}, 50 kg ha^{-1} and 75 kg ha^{-1}) were incorporated in the study. The field was ploughed and cross cultivated with tractor followed by planking to level the plot. The experiment was laid out as per layout plan and plots were leveled manually to open the furrows. The furrows were opened manually in each plot according to spacing. The treatment wise half quantities of nitrogen and entire quantity of phosphorus and sulphur was applied in the opened furrows just before sowing. The remaining half dose of nitrogen was applied in the form of urea after one month of sowing. The sowing was done in furrow at a depth of 1.5 to 2 cm on 2nd March, 2011. The first irrigation was given to the crop immediately after sowing. The number of plants from each net plot was counted at the time of 15 DAS and at harvest recorded separately. Five plants were selected at random from each net plot of all the replications and were tagged for recording different observations. Oil content in seed was determined using pulsed Nuclear Magnetic Resonance (NMR) method as suggested by Tiwari *et al.* (1974). The protein content in grain was calculated by multiplying the nitrogen content of the grains (per cent) with the factor 6.25 as reported by Gupta *et al.* (1972).

RESULTS AND DISCUSSION

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

Effect of spacing:

The levels of spacing showed an appreciable influence on plant height (Table 1). The increase of 3.16 and 9.37 per cent plant height at harvest was observed when crop was grown at a spacing of 30 cm over 45 cm and 60 cm spacings, respectively. But at 30 DAS the plant height was not affected by different spacings. In case of number of branches plant^{-1} (Table 1) recorded under 45 cm and 60 cm spacings were higher to the tune of 22.0 and 23.5 per cent over 30 cm spacing, respectively. This might be due to no competition between the plants for utilization of space, sun-light, moisture and nutrients grown under different spacings during initial stage. But during later stage a competition occurs between the plants for utilization of space, sun-light, moisture and nutrients grown under different spacings resulted in taller plants under narrow spacing than wider spacing. These results are akin to those reported by Shekh (1982), Rao *et al.* (1985), Majumdar and Roy (1992), Kadam *et al.* (1989) and Gungarde *et al.* (1992).

Similarly, dry matter production plant^{-1}measured at 60 DAS and at maturity indicated that on an average 16.6 and 6.9 as well as 21.3 and 9.3 per cent higher dry matter production was observed under 60 cm spacing over 30 cm and 45 cm spacings, respectively. These results are akin to those reported by Gungarde *et al.* (1992).

The data presented in Table 2 indicated that increase in spacings remarkably increased the seed yield of sesamum. The magnitude of increase in seed yield under 45 cm and 60 cm spacing were to the tune of 21.1 and 10.1 per cent over 30 cm spacing. Majority of the growth and yield attributing characters recorded under 45 cm spacing were higher than 30 and 45 cm spacings. Number of capsules plant^{-1} was higher under 60 cm spacing to the tune of 61.2 and 19.6 per cent over 30 cm and 45 cm spacing, respectively. The increase in number of capsules plant^{-1} could be explained in light of increased plant height under wider spacing which provided more space for setting of capsules and also increased photosynthesis activity. Like seed yield, stalk yield of sesamum was also higher under increased spacing (Table 2). The magnitude of increase in stalk yield under 60 cm spacing was to the tune of 25.4 and 9.4 per cent over 30 and 45 cm spacings, respectively. Oil content of sesamum seeds was remained unaffected due to different spacings. These finding corroborate the reports of Shekh (1982), Rao *et al.*(1985), Majumdar and Roy (1992), Kadam *et al.* (1989), Gungarde *et al.* (1992), Raiz Ahamad *et al.* (2002), Asgar Ali *et al.* (2005) and Nandita *et al.* (2009).

A perusal of data presented in Table 3 showed that the extent of increase in nitrogen content in seeds and stalk under 60 cm spacing was to the tune of 8.0 and 18.5 per cent over

Table 1 : Plant height, no. of branches plant^{-1}, dry matter production plant^{-1} (g), length of capsules (cm), no. of capsules plant^{-1}, 1000 seed weight (g), harvest index (%) and oil content (%) as influenced by different spacings and levels of nitrogen

Treatments	Plant height (cm)			No. of branches plant^{-1}	Dry matter production plant^{-1} (g)			Length of capsules (cm)	No. of capsules plant^{-1}	1000 seed weight (g)	Harvest index (%)	Oil content (%)
	30 DAS	60 DAS	At harvest		30 DAS	60 DAS	At harvest					
Levels of spacing												
30 cm	19.8	94.5	96.9	2	1.42	28	30.69	2.39	37.1	2.67	23.1	47.99
45 cm	19.8	88.6	91.4	2.44	1.48	30.55	34	2.43	50	2.78	22.45	48.3
60 cm	19.6	85.6	88.6	2.47	1.47	32.65	37.19	2.52	59.8	2.83	22.56	48.32
S.E..±	0.53	1.63	1.7	0.07	0.02	0.67	0.67	0.06	0.9	0.08	0.38	0.22
C.D. (P=0.05)	NS	4.7	4.89	0.19	NS	1.93	1.94	NS	2.58	NS	NS	NS
Levels of nitrogen												
No nitrogen	18.2	74.5	78.3	2.02	1.42	24.98	27.25	2.4	35.3	2.32	22.22	47.44
25 kg N/ha	19.9	88.8	91.9	2.08	1.46	29.15	31	2.44	47.3	2.63	22.32	48.35
50 kg N/ha	20.1	96.3	98.4	2.44	1.45	32.23	37.33	2.47	55.1	2.95	23.06	48.37
75 kg N/ha	20.6	98.6	100.5	2.67	1.51	35.23	40.25	2.48	58.3	3.13	22.92	48.65
S.E..±	0.61	1.89	1.96	0.08	0.03	0.78	0.78	0.07	1.04	0.09	0.44	0.26
C.D. (P=0.05)	NS	5.43	5.64	0.22	NS	2.23	2.24	NS	2.98	0.27	NS	0.74
C.V.%	10.7	7.3	7.4	11.5	6.2	8.8	7.9	10.3	7.3	11.8	6.7	1.8
S x N	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant

Table 2 : Seed yield, stalk yield and economics as influenced by different spacings and levels of nitrogen

Treatments	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Gross realization (Rs. ha^{-1})	Total cost of cultivation (Rs. ha^{-1})	Net realization (Rs. ha^{-1})	BCR
Spacing (3 levels)						
30 cm	468	1,571	48,371	23,808	24563	2.03
45 cm	517	1,792	53,492	23,808	29684	2.25
60 cm	569	1,977	58,877	23,808	35069	2.47
S.E.±	10	37	-	-	-	-
C.D. (P=0.05)	30	106	-	-	-	-
Nitrogen (4 levels)						
No nitrogen	348	1,218	36,018	23,232	12,786	1.55
25 kg N/ha	500	1,740	51,740	23,676	28,064	2.19
50 kg N/ha	595	2,043	61,543	24,000	37,543	2.56
75 kg N/ha	630	2,119	65,119	24,324	40,795	2.68
S.E.±	12	42	-	-	-	-
C.D. (P=0.05)	34	122	-	-	-	-
C.V.%	7.9	8.3	-	-	-	-
S x N	NS	NS	-	-	-	-

NS=Non-significant

30 and 45 cm, respectively. But phosphorus and potash content in seeds and stalk was not influenced by different spacings (Table 3).

A perusal of data indicated (Table 3) that different spacings had significant influence on nitrogen, phosphorus and potash uptake by seeds, stalk and total of both. Nitrogen, phosphorus and potash uptake were increased with increasing the spacings from 30 cm to 60 cm. Nitrogen uptake by seeds, stalk and total of both (Table 3) was 31.3, 48.5, 39.8 and 14.3, 17.0, 15.6 per cent higher under 60 cm spacing over 30 cm and 45 cm spacings, respectively. Phosphorus uptake by seeds, stalk and total of both (Table 3) was 34.6, 47.5, 42.3 and 12.9, 21.8, 18.2 per cent higher under 60 cm spacings over 30 cm and 45 cm spacing, respectively. Like wise nitrogen and phosphorus uptake, potash uptake by seeds, stalk and total of both (Table 3) was 40.4, 34.0, 34.8 and 21.4, 11.7, 12.8 per cent higher under the spacing of 60 cm over 30 cm and 45 cm spacings, respectively. This was mainly due to higher seed and stalk yields (Table 2) achieved under 60 cm spacing. These results are corroborated with the finding of Shekh (1982).

Effect of nitrogen level:

Sufficient application of N manifests plant growth in terms of plant height and number of branches plant^{-1} ultimately increases the seed and stalk yield of plant. The data presented in Table 1 showed that increasing rates of N considerably increased the plant height upto 75 kg N ha^{-1}. The magnitude of increase in plant height under application of 75 kg N ha^{-1} was to the tune of 28.4, 9.4 and 2.13 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. The data on number of branches plant^{-1} (Table 1) recorded higher with application of 75 kg N ha^{-1} were to the tune of 32.2, 28.4 and 9.4 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. As like number of branches plant^{-1}, the dry matter production plant^{-1} was also increased with increasing the rates of nitrogen upto 75 kg N ha^{-1} at 60 DAS and at maturity. Application of 75 kg N ha^{-1} produced on an average 47.9, 29.8 and 7.8 per cent higher dry matter production plant^{-1} at maturity over 0, 25 and 50 kg ha^{-1}, respectively. This might be due to better response of sesamum to higher doses of nitrogen. Increase in these parameters with higher doses of nitrogen might be due to favourable function of nitrogen to enlarge and multiply the cells with thinner cell walls, promotes vegetative growth and encourage the formation of good quality foliage by producing more carbohydrates. The basic fact that the nitrogen being a major constituent of cell, helps in cell division and cell elongation which might have ultimately increased plant growth. The results are akin to those reported by Tomar (1990), Mondal *et al.*(1992), Shrivastava and Tripathi (1992), Roy *et al.*(1995), Dinakaran *et al.* (2001), Kalaiselvan *et al.*(2001), Patra (2001) and Tiwari *et al.*(2001).

A perusal of data (Table 2) showed that increasing rates of N remarkably influenced the seed yield of sesamum. It responded to N upto 75 kg ha^{-1}. Significant yield response of 282, 130 and 35 kg ha^{-1} was observed over 0, 25 and 50 kg N ha^{-1}, respectively. The magnitude of increase in seed yield under application of 75 kg N ha^{-1} was to the tune of 81.0, 26.0 and 5.9 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. The increase in seed yield of sesamum due to increase in levels of nitrogen is supported by the increase in growth and yield contributing characters like, plant height, number of branches plant^{-1}, number of capsules plant^{-1}, seed yield plant^{-}

Table 3 : N, P, K content and uptake by seed and stalk as influenced by different spacings and levels of nitrogen

Treatments	N content (%)		P content (%)		K content (%)		Nitrogen uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Potash uptake (kg ha^{-1})		
	Seed	Stalk	Seed	Stalk	Seed	Stalk	Seed	Stalk	Total	Seed	Stalk	Total	Seed	Stalk	Total
Levels of spacing															
30 cm	2.23	0.65	0.39	0.17	0.19	0.43	10.44	10.13	20.57	1.82	2.65	4.47	0.89	6.7	7.59
45 cm	2.32	0.72	0.42	0.18	0.2	0.45	12	12.86	24.86	2.17	3.21	5.38	1.03	8.04	9.07
60 cm	2.41	0.77	0.43	0.2	0.22	0.46	13.71	15.04	28.75	2.45	3.91	6.36	1.25	8.98	10.23
S.E.±	0.03	0.01	0.01	0.01	0.01	0.01	0.28	0.19	0.39	0.06	0.09	0.1	0.03	0.22	0.23
C.D. (P=0.05)	0.07	0.02	NS	NS	NS	NS	0.82	0.55	1.13	0.16	0.24	0.3	0.07	0.64	0.66
Levels of nitrogen															
No nitrogen	2.16	0.59	0.32	0.12	0.15	0.38	7.52	7.19	14.71	1.11	1.46	2.57	0.52	4.63	5.15
25 kg N/ha	2.29	0.7	0.41	0.18	0.19	0.43	11.45	12.18	23.65	2.05	3.13	5.18	0.95	7.48	8.43
50 kg N/ha	2.39	0.77	0.46	0.21	0.22	0.48	14.22	15.28	29.5	2.74	4.17	6.91	1.31	9.53	10.84
75 kg N/ha	2.43	0.8	0.48	0.23	0.23	0.5	15.31	16.95	32.26	3.02	4.87	7.89	1.45	10.6	12.05
S.E.±	0.03	0.01	0.01	0.01	0.01	0.01	0.33	0.22	0.45	0.07	0.1	0.12	0.03	0.26	0.27
C.D. (P=0.05)	0.08	0.02	0.02	0.02	0.02	0.04	0.94	0.64	1.31	0.19	0.28	0.35	0.09	0.74	0.77
C.V.%	4.3	3.72	4.28	6.79	4.61	9.26	9.33	5.89	6.25	10.15	9.83	7.35	9.18	10.89	9.92
S x N	NS	NS	NS	NS	NS	NS	NS	NS	Sig.	NS	Sig.	Sig.	Sig.	Sig.	Sig.

NS=Non-significant

^{1} and 1000 seed weight (Table 1).

Significantly higher nitrogen, phosphorus and potash uptake (Table 3) by crop under higher levels of nitrogen application is also responsible for favourable improvement in growth and yield components, consequently the seed yield. Number of capsules plant^{-1} (Table 1) was also recorded remarkably higher with application of 75 kg N ha^{-1} to tune of 65.2, 23.3 and 5.8 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. The probable reason for such a positive response due to addition of nitrogen might be tended to put more vegetative growth and better root development resulted in efficient photosynthesis and finally produced more seed yield. Nitrogen played an important role in plant metabolism by virtue of being an essential constituent of diverse type of metabolically active component, like amino acid, protein, nucleic acid, enzymes, co-enzymes and alkaloids which are important for higher growth and yield.

Similarly, 1000 seed weight of sesamum was also recorded higher under application of 75 kg N ha^{-1} to the tune of 34.9, 19.0 and 6.1 per cent over 0, 25 and 50 kg N ha^{-1}, respectively (Table 1). Stalk yield (Table 2) recorded higher under the application of 75 kg N ha^{-1} to the tune of 74.0, 21.8 and 6.8 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. It could be attributed to higher plant height and higher number of branches plant^{-1} (Table 1). Results obtained in this study are in agreement with those reported by Ankineedu *et al.*(1983), Rao *et al.*(1985), Anonymous, (1990a), Anonymous, (1990b), Tomar (1990), Jadhav *et al.* (1991), Jadhav *et al.* (1992), Mondal *et al.* (1992), Shrivastava and Tripathi (1992), Patra(2001), Tiwari *et al.*(2001) and Nahar *et al.*(2008).

Data (Table 1) clearly indicated increase in oil content of sesamum with increasing rates of nitrogen. The magnitude of increase in oil content of sesamum seeds under application of 75 kg N ha^{-1} was to the tune of 2.55, 0.62 and 0.58 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. The magnitude of increase in protein content of sesamum under the application of 75 kg N ha^{-1} was to the tune of 12.52, 6.15 and 1.67 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. This was evidently due to higher seed yield of sesamum and higher N content in seeds achieved under higher rates of nitrogen. Similar results were reported by and Mankar *et al.* (1995), and Ahmad *et al.* (2001).

A perusal of data presented in Table 3 showed that the

Table 4 : Interaction effect of different spacings and levels of nitrogen on total N uptake

Level of spacings	Levels of nitrogen			
	No nitrogen	25 kg N/ha	50 kg N/ha	75 kg N/ha
30 cm	11.63	19.86	25.65	26.95
45 cm	15.79	23.74	29.27	31.69
60 cm	16.80	27.46	34.97	38.40
S.E.±	0.79			
C.D. (P=0.05)	2.27			
C.V. %	6.25			

Table 5 : Interaction effect of different spacings and levels of nitrogen on P uptake by stalk

Level of spacings	Levels of nitrogen			
	No nitrogen	25 kg N/ha	50 kg N/ha	75 kg N/ha
30 cm	1.26	2.52	3.76	3.83
45 cm	1.39	3.19	4.21	4.91
60 cm	1.66	3.62	4.99	6.07
S.E.±	0.2			
C.D. (P=0.05)	0.5			
C.V. %	9.9			

Table 6 : Interaction effect of different spacings and levels of nitrogen on total P uptake

Level of spacings	Levels of Nitrogen			
	No nitrogen	25 kg N/ha	50 kg N/ha	75 kg N/ha
30 cm	2.08	4.23	6.15	6.47
45 cm	2.58	5.28	6.93	7.86
60 cm	2.98	5.95	8.06	9.51
S.E..±	0.21			
C.D. (P=0.05)	0.60			
C.V. %	7.4			

extent of increase in nitrogen content in seeds and stalk under 75 kg N ha^{-1} was to the tune of 12.5 and 35.6 per cent over 0 kg N ha^{-1}, 6.1 and 14.3 per cent over 25 kg N ha^{-1} and 1.7 and 3.9 per cent over 50 kg N ha^{-1}, respectively. Phosphorus content in seeds and stalk was increased with increasing the rates of N application. Phosphorus content in seeds and stalk was increased from 0.32 per cent to 0.48 per cent and 0.12 per cent to 0.23 per cent, respectively.The extent of increase in the potash content in seeds and stalk under 75 kg N ha^{-1} was to the tune of 4.5 and 2.9 per cent over 50 kg N ha^{-1}, respectively.

Like wise N and P content, K content was also increased with increasing the levels of N. Potash content in seeds and stalk was increased from 0.15 per cent to 0.23 per cent and 0.38 per cent to 0.50 per cent, respectively. The increase in N, P, K content in seeds and stalk under increasing levels of N is mainly due to higher growth of sesamum recorded under higher levels of nitrogen application. Almost similar results were reported by Kene *et al.* (1991), Kharwada and Bindra (1992) and Rao (1992).

A data presented in Table 3 showed that the extent of increase in nitrogen uptake by seeds and stalk under 75 kg N ha^{-1} was to the tune of 103.6 and 135.7 per cent over no nitrogen, 33.7 and 39.2 per cent over 25 kg N ha^{-1} and 7.7 and 10.9 per cent over 50 kg N ha^{-1}, respectively.

Application of 75 kg N ha^{-1} increased the total N uptake to the tune of 119.3, 36.4 and 9.4 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. Nitrogen fertilization increase the cation exchange capacity of plant roots and thus makes them more efficient in absorbing nutrient ions. The positive effect of nitrogen on nutrient uptake might be due to increase in the photosynthesis which resulted into the accumulation of higher quantity of carbohydrates in the vegetative portion of the plant and ultimately enhancing the vegetative growth, yield and nutrients uptake. The increase in N uptake due to increase in levels of nitrogen could be attributed to the favourable effects of nitrogen application on growth and yield attributes which resulted in higher seed and stalk yields (Table 2) and consequently higher N uptake. The results are in accordance with the finding of Kene *et al.* (1991) and Rao (1992).

With respect to uptake of phosphorus (Table 3), it was observed that the magnitude of increase in phosphorus uptake by seeds under 75 kg N ha^{-1} over 0, 25 and 50 kg N ha^{-1} was to the tune of 172.0, 47.3 and 10.2 per cent, respectively.

Table 7 : Interaction effect of different spacings and levels of nitrogen on K uptake by seeds

Level of spacings	Levels of nitrogen			
	No nitrogen	25 kg N/ha	50 kg N/ha	75 kg N/ha
30 cm	0.41	0.86	1.11	1.22
45 cm	0.58	1.03	1.34	1.39
60 cm	0.69	1.27	1.57	1.88
S.E..±	0.05			
C.D. (P=0.05)	0.15			
C.V. %	9.18			

Table 8 : Interaction effect of different spacings and levels of nitrogen on K uptake by stalk

Level of spacings	Levels of nitrogen			
	No nitrogen	25 kg N/ha	50 kg N/ha	75 kg N/ha
30 cm	3.97	6.93	8.66	7.97
45 cm	4.97	7.64	9.55	10.31
60 cm	4.98	8.33	10.97	13.58
S.E.±	0.44			
C.D. (P=0.05)	1.28			
C.V. %	10.89			

Table 9 : Interaction effect of different spacings and levels of nitrogen on total K uptake

Level of spacings	Levels of nitrogen			
	No nitrogen	25 kg N/ha	50 kg N/ha	75 kg N/ha
30 cm	4.38	7.79	9.77	9.19
45 cm	5.54	8.67	10.89	11.70
60 cm	5.67	9.60	12.55	15.47
S.E.±	0.46			
C.D. (P=0.05)	1.32			
C.V. %	9.9			

Similarly, a remarkable increase in phosphorus uptake by stalk of 233.6, 55.6 and 16.8 per cent was also observed with 75 kg N ha^{-1} over 0, 25 and 50 kg N ha^{-1}, respectively (Table 3). With respect to total uptake of phosphorus (Table 3), it was observed that the magnitude of increase in total phosphorus uptake under 75 kg N ha^{-1} over 0, 25 and 50 kg N ha^{-1} was to the tune of 207.0, 52.3 and 14.2 per cent, respectively. The application of higher doses of nitrogen is responsible for better root and shoots development. This may necessiated greater absorption of phosphorus. Moreover, remarkably higher seed and stalk yields (Table 3) with higher levels of N might also have indirectly partly contributed toward higher P uptake. These results are in conformity with those reported by Kene *et al.* (1991) and Rao (1992).

A perusal of data (Table 3) showed that the extent of increase in potash uptake by seeds under 75 kg N ha^{-1} was to the tune of 178.8, 52.6 and 10.7 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. Similarly, a remarkable increase in potash uptake by stalk of 129.0, 41.7 and 11.2 per cent was also observed under 75 kg N ha^{-1} over 0, 25 and 50 kg N ha^{-1}, respectively (Table 3). With respect to total uptake of potassium (Table 3), it was observed that the magnitude of increase in total potassium uptake under application of 75 kg N ha^{-1} was to the tune of 134.0, 42.9 and 11.2 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. The application of higher doses of nitrogen is responsible for better root and shoots development. This might be due to increase in cation exchange capacity of the root and application of higher doses of nitrogen increased plant growth as well as seed and stalk yields of sesamum (Table 2) which increased the potassium demand for balanced growth. These results are corroborated with those of Kene *et al.* (1991) and Rao (1992).

Interaction effect:

The plant height at 30, 60 DAS and at harvest, number of branches $plant^{-1}$, dry matter production $plant^{-1}$, average length of capsule, number of capsules $plant^{-1}$, 1000 seed weight, seed yield, stalk yield and oil content was significantly not affected due to interaction effect between different spacings and different levels of nitrogen.

The results presented in Table 4, 5, 6, 7, 8 and 9 regarding interaction effect between spacings and nitrogen levels indicated that total N, P and K uptake was increased with increasing the spacings and N application. Maximum total N, P and K uptake was recorded when sesamum was grown at 60 cm spacing and fertilized with 75 kg N ha^{-1}. This was evidently due to higher seed and stalk yields achieved under this combination.

Economics:

From the data (Table 2), it is indicated that the highest net realization of Rs. 35069 ha^{-1} registered under 60 cm spacing which was 38.1 and 18.1 per cent higher than that recorded under 30 cm and 45 cm spacing, respectively because of higher yield of sesamum. Data further revealed that the highest net realization of Rs. 40795 ha^{-1} and BCR of 2.68 was recorded when sesamum was fertilized with 75 kg N ha^{-1}, followed by 50 kg N ha^{-1}. The increase in net realization with 75 kg N ha^{-1} was to the tune of 219.0, 45.4 and 8.7 per cent over 0, 25 and 50 kg N ha^{-1}, respectively. Higher net realization and BCR recorded under higher rates of nitrogen is attributed to the fact that they produced higher yield of sesamum.

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