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EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS ON GROWTH AND YIELD OF SESAME

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ABSTRACT

This study was conducted at new developmental farm, University of Agriculture, Peshawar, Khyber Pakhtunkhwa during the year 2012. The experiment was laid out in randomized complete block design (RCBD) using three replications. Four nitrogen (40, 60, 80 and 100 kg N/ha) and three phosphorus levels (40, 60 and 80 kg P/ha) were used. Number of pods/plant, number of seeds/pod, seed yield (kg/ha), thousand seed weight (g) and harvest index (%) were significantly affected by nitrogen and phosphorus. While, the parameters i.e. days to emergence and emergence (m^2) were non-significantly affected. The interaction between nitrogen and phosphorus showed that optimum grain yield (891.26 kg/ha) was at 100:80 kg N: P/ha, while, minimum seed yield (502.33 kg/ha) was at 100:40 kg N: P/ha as compared to the control (662 kg/ha). Nitrogen and phosphorus applied @ 100:80 kg N: P/ha may be recommended for better growth and yield of Sesame.

Key-words: Sesame, plant growth, N and P levels.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an annual, self-pollinated, indeterminate minor kharif, edible oil seed crop and belongs to pedaliaceae family. In Pakistan, sesame cultivated on an area of 90.7 ha with an annual production of 41 tones and an average yield of 452 kg/ ha. Whereas, in Khyber Pakhtunkhwa its average yield was 500 kg/ha (MINFAL, 2009). The average yield of sesame in Pakistan is low as compared to 1083 kg/ha in Saudi Arabia, 1960 kg/ha in Venezuela, and 1295 kg/ha in Nigeria (Okpara *et al.*, 2007). The main reasons behind the low yield are unfertile soils, imbalanced use of fertilizers, low yielding varieties, insect pests, weed and diseases infestation.

Soil is the natural medium that supplies essential nutrients to plants for their proper growth and development. Among sixteen essential nutrients nitrogen and phosphorus are considered as macro nutrients. Nitrogen is most essential for protein metabolism, cell division, leaf enlargement, root development and growth that results in increased crop and dry matter yield (Ahmed *et al.*, 2001). While, phosphorus is required for energy transformation, storage in plant cell, early root development, flowering, early maturity and seed development (Mohsin *et al.*, 2014).

Jouyban and Moosavi (2011) stated about significant increase in seed yield, plant height, pods diameter, number of auxiliary branch/plant, first capsule distance from ground and capsule length were observed with increase in N level from 0 to 200 kg/ha. While, Mian *et al.*, (2011) concluded that highest seed yield of sesame was 1290-1366 kg/ha at 90 kg P/ha. Shehu *et al.*, (2010 a) reported highest number of branches, leaves, seed/pod, seed yield and dry matter against N application rate of 112.5 kg N/ha. Haruna *et al.* (2010) were of the view that sesame production gave significantly better yields and economic returns with applications of 13.2 kg P/ha of phosphorus fertilizer. Shehu *et al*., (2010 b) concluded that application of 45 kg P/ha produced the highest seed yield of sesame. EI-Nakhlawy and Shaheen (2009) reported that Saudi Local cultivar under 150 and 200 kg N/ha produced the highest significant seed yield of 862.47 and 869.45 kg/ha respectively.

Keeping in view the economic value and important constraints related to the existing low yield of the crop, a study was conducted to evaluate the effect of different levels of nitrogen and phosphorus on growth and yield of sesame under agro-climatic conditions of Peshawar valley, Pakhtun Khuwa, Pakistan.

MATERIALS AND METHODS

The field experiment was conducted at new developmental farm, University of Agriculture, Peshawar, Pakhtun Khuwa, Pakistan during the year 2012. The experiment was laid out in randomized complete block design (RCBD) with three replications. Different levels of nitrogen and phosphorus were applied at sowing time. A plot of 10.8 m^2 (4m×2.7m) size having 6 rows (each 4 m long with 45 cm row to row space). Four nitrogen levels 40, 60, 80,100 Kg/ha and three phosphorus levels 40, 60 and 80 kg/ha were used in the experiment as per following combination.

T1	N1P1	40:40	T8	N3P2	80:60
T2	N1P2	40:60	T9	N3P3	80:80
T3	N1P3	40:80	T10	N4P1	100:40
T4	N2P1	60:40	T11	N4P2	100:60
T5	N2P2	60:60	T12	N4P3	100:80
T6	N2P3	60:80	T13	Control	
T7	N3P1	80:40			

Local variety "Black" was sown on 28.06.2012 with seed rate of 3.5 kg/ha. Urea and Di-ammonium phosphate (DAP) fertilizers were used as source of nitrogen and phosphorus respectively and applied at the time of sowing. A total of four irrigations were applied during entire period of experiment. The weeding was performed manually twice. The crop was sprayed twice with Thiodan 35 EC pesticide in order to control Til Leaf Roller. The crop was harvested on 21.10.2012 and left in the field for few days to become completely dry. The growth and yield parameters i.e. days to emergence, emergence (m^2), number of pods/plant, number of seeds/pod, thousand seed weight (g), seed yield (kg/ha) and harvest index (%). Harvest index was calculated using the following formula.

$$\text{Harvest Index (\%)} = \frac{\text{Grain yield kg/ha}}{\text{Biological yield kg/ha}} \times 100$$

While, data were further subjected to analysis of variance (ANOVA) and mean difference between treatments were compared by least significance difference at 5% level of probability (Steel and Torrie, 1980).

RESULTS

Days to emergence

Data concerning days to emergence are presented in Table 1. Statistical analysis of data showed that days to emergence were not significantly affected by application of nitrogen, phosphorus and control vs. rest of the treatments. While, the interaction between nitrogen and phosphorus were also found non-significant.

Maximum days to emergence (7 days) were taken by the plots that received 40 kg N/ ha. It decreased with an increase in N levels as minimum days to emergence (6 days) were recorded where N was applied @ 60 kg/ha. The low level of phosphorus (40 kg/ha) helped in early emergence (6 days) whereas; high level of phosphorus (80 kg/ha) delayed the parameter (7 days). The interaction between nitrogen and phosphorus affected maximum days to emergence (7 days) at 40:80 kg N: P/ha, While, minimum days to emergence (5 days) were recorded at 80:60 kg N: P/ha.

Emergence/m^2

Statistical analysis of data showed that nitrogen and phosphorus and their interaction had non-significant effect on emergence. The data for control vs. rest was found significant. Maximum emergence/m^2 (170) was noted at 80 kg N/ha, while minimum emergence/m^2 (160) was recorded at 40 kg N/ha. For phosphorus maximum emergence/m^2 (173) was noted at 60 kg P/ha. Emergence/m^2 decreased with an increase in phosphorus level and minimum emergence/m^2 (161) was recorded at 80 kg P/ha. The Interaction between nitrogen and phosphorus showed maximum emergence/m^2 (193) was noted at 60:80 kg N: P/ha, while minimum emergence/m^2 (140) was recorded at 80:80 N: P/ha.

Number of pods/plant

The statistical analysis of the data showed that number of pods/plant was significantly affected by different levels of nitrogen and phosphorus, while interaction between nitrogen and phosphorus was also found significant.

Mean values for nitrogen revealed that optimum numbers of pods/plant (65) was noted at 100 kg N/ha and minimum number of pods/plant (53) was noted at 40 kg N/ha. Mean values for phosphorus showed that optimum number of pods/plant (64) was recorded at 80 kg P/ha. Number of pods/plant increased with increase in phosphorus levels and minimum number of pods/plant (58) was noted at 40 kg P/ha. The Interaction between nitrogen and phosphorus showed maximum number of pods/plant (70) at 100:80 kg N: P/ha, while minimum number of pods/plant (48) was recorded at 40:40 kg N: P/ha. The lowest number of pods/plant (35) was recorded in control plot.

Number of seeds/pod

Meditation of the data revealed that number of seed/pod was significantly affected by nitrogen, phosphorus and control vs. rest, while the interaction between nitrogen and phosphorus was remained non-significant. Mean values for nitrogen showed that higher number of seeds/pod (61.6) was noted at 60 kg N/ha, while lower number of seeds/pod (56.6) was recorded where nitrogen was applied @ 40 kg/ha. In case of phosphorus, the mean values showed higher number of seeds/pod (61.8) at 80 kg P/ha. Number of seeds/pod increased with an increase in phosphorus level and minimum number of seeds/pod (57.8) was recorded at 40 kg P/ha. The Interaction between nitrogen and phosphorus showed maximum number of seeds/pod (65.0) noted at 60:80 kg N: P/ha, while minimum number of seeds/pod (55.7) was noted at 40:40 kg N: P/ha. The other plots produced higher number of seeds/pod (60) than control plots (55.8).

Table 1. Days to emergence of sesame as affected by different levels of nitrogen and phosphorus.

	Phosphorus (kg/ha)			
Nitrogen (kg/ha)	40	60	80	Mean
40	6	6	7	7
60	7	6	7	6
80	7	5	6	6
100	6	6	6	6
Mean	6	6	7	
Control	7			
Overall mean for treatments	6.25			

LSD (0.05) for N; LSD (0.05) for P; LSD (0.05) for interaction

Table 2. Emergence/m^2 of sesame as affected by different levels of nitrogen and phosphorus.

	Phosphorus (kg/ha)			
Nitrogen (kg/ha)	40	60	80	Mean
40	168	162	170	167b
60	164	161	183	169b
80	146	193	140	160a
100	189	173	150	170b
Mean	167b	173b	161a	
Control	105a			
Overall mean for treatments	167b			

LSD (0.05) for N= 21.43; LSD (0.05) for P= 18.56; LSD (0.05) for interaction= 37.12

Thousand seeds weight (g)

The data revealed that thousand seed weight (g) was significantly affected by nitrogen and phosphorus levels and control vs. rest comparison, while interaction between nitrogen and phosphorus was found non-significant. Mean values for nitrogen revealed that maximum thousand seed weight (4.28 g) was recorded at 60 kg N/ha, while the lower thousand seed weight (4.022 g) was noted at 40 kg N/ha. Mean values for phosphorus showed that higher thousand seed weight (4.28 g) was noted at 60 kg P/ha, while lower thousand seed weight (4.11 g) was recorded at 80 kg P/ha. The Interaction between nitrogen and phosphorus showed that maximum thousand seed weight (4.43 g) was noted at 100:60 kg N: P/ha, while minimum thousand seed weight (3.80 g) was recorded at 40:60 kg N: P/ha. In rest treated plots higher thousand seed weight (4.43 g) was recorded than control (4.0 g) plots.

Seed yield (kg/ha)

Data concerning seed yield of the sesame is depicted in Table 6. Nitrogen, phosphorus and control vs. rest comparison had significantly affected seed yield, however the interaction between nitrogen and phosphorus was also found significant. Mean values for nitrogen showed that higher seed yield (706.04) was recorded at 80 kg N/ha, while minimum seed yield (553.82) was noted at 60 kg N/ha. The mean values for phosphorus revealed that optimum seed yield (717.81) was obtained at 80 kg P/ha. It was further noted that seed yield increased with an increase in phosphorus level while, minimum seed yield (603.88) was recorded at 40 kg P/ha. The interaction between nitrogen and phosphorus showed that higher seed yield (891.26) was noted in plots treated with 100:80 kg N: P/ha, while minimum seed yield (502.33) was recorded in 100:40 kg N: P/ha. In rest plots higher seed yield (891.26) was obtained than the control (661.00) plots.

Table 3. Number of pods per plant of the sesame as affected by different levels of nitrogen and phosphorus.

	Phosphorus (kg/ha)			
Nitrogen (kg/ha)	40	60	80	Mean
40	48	58	53	53 b
60	58	63	69	63 a
80	69	56	63	63 a
100	59	67	70	65 a
Mean	58a	61a	64b	
Control	35b			
Overall mean for treatments	62a			

LSD (0.05) for N= 5.20; LSD (0.05) for P; LSD (0.05) for interaction= 9.01

Table 4. Number of seeds per pod of the sesame as affected by different levels of nitrogen and phosphorus.

	Phosphorus (kg/ha)			
Nitrogen (kg/ha)	40	60	80	Mean
40	55.7	55.0	59.2	56.6 b
60	56.2	63.5	65.0	61.6 a
80	58.9	60.2	64.3	61.1 a
100	60.5	63.3	58.9	60.9 a
Mean	57.8 b	60.5 a	61.8 a	
Control	55.8b			
Overall mean for treatments	60.0a			

LSD (0.05) for N= 3.0; LSD (0.05) for P= 2.60; LSD (0.05) for interaction

Table 5. Thousand seed weight (g) of the sesame as affected by different levels of nitrogen and phosphorus.

	Phosphorus(kg/ha)			
Nitrogen (kg/ha)	40	60	80	Mean
40	4.06	4.20	3.80	4.02 b
60	4.33	4.33	4.20	4.28 a
80	4.23	4.16	4.26	4.22 a
100	4.13	4.43	4.20	4.25 a
Mean	4.19 ab	4.28 a	4.11 b	
Control	3.8b			
Overall mean for treatments	4.0a			

LSD (0.05) for N=0.15; LSD (0.05) for P= 0.13; LSD (0.05) for interaction

Harvest index (%)

Data concerning harvest index (%) of the sesame is depicted in Table 7. Nitrogen, phosphorus and control vs. rest comparison had significantly affected the harvest index (%), however the interaction between nitrogen and phosphorus were also found significant. Mean values for nitrogen revealed that maximum harvest index (%) (11.67%) were recorded at 60 kg N/ha, while minimum harvest index (9.70%) was noted at 80 kg N/ha. Mean values for phosphorus showed that optimum harvest index (11.301 %) were noted at 40 kg P/ha, while lower harvest index (10.10%) were recorded at 60 kg P/ha. The Interaction between nitrogen and phosphorous showed that optimum harvest index (12.90 %) were recorded at 60:80 kg N: P/ha, while minimum harvest index (9.07 %) was recorded in 80:80 kg N: P/ha. The higher harvest index (11%) was recorded in rest of plots than control (8.80%) plots.

Table 6. Seed yield (kg/ha) of the sesame as affected by different levels of nitrogen and phosphorus.

	Phosphorus (kg/ha)			
Nitrogen (kg/ha)	40	60	80	Mean
40	806.33	553.21	719.33	692.96a
60	545.13	587.33	529.00	553.82b
80	561.79	824.66	731.66	706.04a
100	502.33	683.33	891.26	692.31a
Mean	603.89 a	662.13 a	717.81 b	
Control	418.66b			
Overall mean for treatments	661.00a			

LSD (0.05) for N=105.37; LSD (0.05) for P= 91.26; LSD (0.05) for interaction=182.51

Table 7. Harvest index (%) of the sesame as affected by different levels of nitrogen and phosphorus.

	Phosphorus(kg/ha)			
Nitrogen (kg/ha)	40	60	80	Mean
40	12.27	9.25	12.03	11.18a
60	10.15	11.97	12.90	11.67a
80	10.73	9.29	9.07	9.70ab
100	12.04	9.92	10.12	10.69b
Mean	11.30a	10.10b	11.03ab	
Control	8.80b			
Overall mean for treatments	11.0a			

LSD (0.05) for N=1.12; LSD (0.05) for P=0.97; LSD (0.05) for interaction=1.94

DISCUSSION

Application of nitrogen affected the growth and yield parameters of sesame significantly. The nitrogen up to level of 80 kg/ha and above mainly influenced on all growth and yield characters. An increase in plant growth and yield behavior might be due to the presence of nitrogen that was mainly involved in cell formation and its growth because of result of carbohydrate and protein metabolism. The results are in agreement with the findings of Noorka *et al.,* (2011) and Malik *et al.,* (2003) who were of view that application of nitrogen fertilizer positively enhanced the growth and yield parameters of sesame accordingly.

Presence of Phosphorus had pronounced effect on pod formation, no of seeds, seed yield and thousand weight due to its key role in formation of healthy and vigorous root that help to absorb sufficient nutrients and water from soil. The continuous and balanced uptake of essential nutrients and sufficient water enhanced the yield traits of sesame (Shehu *et al.,* 2010 b, Havlin *et al.*, 2006).

Days to emergence were not affected either with the application of nitrogen or phosphorus. While, non-significant results were also recorded regarding the interaction between nitrogen and phosphorus. The results are confirmed with the findings of who revealed that application of fertilizers had not direct effect on days to emergence, as the emergence quality might be a genetically behavior of any variety (Nakhlawy and Shaheen, 2009).

An increase in number of pods/plant was observed up to a maximum application of 100 and 80 kg/ha of nitrogen and phosphorus respectively. The positive increase in number of pods/plant might be due to presence of adequate amount of nitrogen and role of phosphorus in seed formation supplied from the soil as added during the experiment. The above results are in line with the findings of Shehu *et al*., (2010 a) and Haggai (2004), who pointed out that number of pods/plant' was significantly increased by nitrogen and phosphorus fertilization.

Greater number of seed/pod was recorded where nitrogen and phosphorus was applied @ of 60: 80 Kg/ha respectively. The higher increase in number of seed/pod achieved was might be due to balanced supply of essential nutrients needed by the plants in order to produce greater number of seed/pod (Okpara *et al.,* 2007).

Seed weight increased positively from increased nitrogen and phosphorus rates as compared to lower rates and control. Significant increase in thousand seed weight was obtained at N: P level of 100 and 80 Kg/ha. The supply of essential nutrients i.e nitrogen and phosphorus to plants in adequate amounts produced great thousand seed weight as compared to plants grown in control where nutrients supply was poor. Similar results were reported by Ahmad *et* *al.,* (2001).

The results obtained regarding seed yield/ha revealed that higher seed yield was affected due to increase in nitrogen level up to 80 kg/ha. The addition of nitrogen fertilizer enhanced the nitrogen level in soil and enhanced the growth parameters that positively affected yield traits of sesame such as seed yield. High seed yield might also be due to higher number of pods/plant and greater thousand seed weight (Ali and Ahmed, 2012). Harvest index (%) was significantly affected by presence of nitrogen and phosphorus nutrients applied during the study period. The crop which was supplied with a dose of N: P @ of 100:80 Kg/ha showed significantly higher harvest index.

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