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Effect of Nitrogen and Phosphorus on Yield and Yield Components of Sesame (*Sesamumindicum* L.)

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Abstract

Nitrogen is a structural component of chlorophyll and protein therefore adequate supply of nitrogen is beneficial for both carbohydrates and protein metabolism as it promotes cell division and cell enlargement, resulting in more leaf area and thus ensuring good seed and dry matter yield. Theexperiment entitled effect of nitrogen and phosphorus on yield and yield components of sesame were conducted at New Developmental Farm of the University of Agriculture Peshawar during kharif 2013. Randomized complete block design (RCBD) having four replications were used. Nitrogen and phosphorus levels (0, 30, 60, 90 kg ha^{-1}) each were applied in the form of P_2O_5 from DAP and urea respectively. The whole of phosphorus was applied during seed bed preparation and nitrogen in two splits, half at sowing and half after 80% emergence. The seed rate 4 kg ha^{-1} of sesame (Local black) was planted on 28th June 2013. Total of 3 irrigations were applied, and other cultural practices were kept uniform for all the treatments. Highest number of pods $plant^{-1}$ (67), number of seeds $pods^{-1}$ (54), grain yield (520 kg), biological yield (2539 kg), thousand seeds weight (3.91 g) and harvest index (24%) were recorded when higher dose of N i.e. 90 kg ha^{-1} were used. Similarly enhanced lowest number of pods $plant^{-1}$ (55), number of seeds $pods^{-1}$ (50), grain yield (442 kg), biological yield (1570 kg), thousand seed weight (2.94 g), and harvest index (20%) were recorded in control plots.

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Application of phosphorous has significantly affected seeds pod^{-1}, and biological yield. Whereas 90 kg P ha^{-1} increased plant tallness, podsplant^{-1}, grains yield, thousand seeds weight and harvest index (%). The interaction was non-significant for all studied parameters. Therefore, it was concluded from the results that using nitrogen @ of 90 kg ha^{-1} with 90 kg P ha^{-1} have improved the yield and yield components of sesame. Thus the application of 90 kg N ha^{-1} with 90 kg P ha^{-1} is recommended for general cultivation in agro-climatic condition of Peshawar valley.

Keywords: Sesame; Nitrogen; Phosphorus; Seed pod; Yield components.

I. Introduction

Sesame (*Sesamumindicum* L.) belongs to family pedaliaceae is an annual, self-pollinated and indeterminate minor kharif oilseed crop. The stem is variously shaped, 60-120 cm tall and branched. The fruit is in the form of pods varies from 2.5 to 8.0 cm in length and 0.5 to 2.0 cm in diameter. Pods mature form bottom to top, allowing shattering of the lower ones by the time the uppermost pods are mature. Sesame seed are small and ovate with two distinct types, cream-colored and black. Cream-colored seeds are preferred. It is a short-day plant, normally flowering in 42-45 days [20]. Sesame is an important edible oilseed crop. The seed contains all essential amino acids and fatty acids. It is a good source of vitamins (pantothenic acid and vitamin E) and minerals such as calcium (1450 mg 100 g^{-1}) and phosphorous (570 mg 100 g^{-1}) and the seed cake is also an important nutritious livestock feed [8].

In Pakistan, sesame was cultivated on an area of 90.7 ha thousand ha with an annual production of 41.0 tones with an average yield of 452 kg ha^{-1} whereas in Khyber Pakhtunkhwa its average yield was 1000 kg ha^{-1} during 2011-2012 [10]. Sesame was grown on over 7.8 million hectares of world's farms in 2010. The most productive Sesame seed farms in the world were in the European Union with an average yield of 5.5 metric tons ha^{-1} in 2010. Italy reported the best nationwide average yield of 7.2 metric tons ha^{-1} in 2010. There is a huge yield gap and farm losses differences among major sesame seed producers due to knowledge gap, poor crop management practices and use of production technologies [20]. Soil and climatic conditions of Pakistan are highly favorable for sesame production yet its average yield is very low. Among the various factors of crop production, proper sowing dates, nitrogen and phosphorus levels and improved sesame cultivars play a key role in boosting its production.

Application of phosphorous at the rate of 50 kg P_2O_5 ha^{-1} significantly enhanced seed yield, seed oil content and seed protein content increased pods plant^{-1} [3], whereas [15] reported significantly increased growth, yield and yield attributes in Nigeria with the application of 13.2 kg P ha^{-1} and increased number of leaves plant^{-1}; number of seeds pod^{-1} and seed yield ha^{-1} with the application of 26.4 kg P ha^{-1} were reported by [14]. However, higher yields were obtained from the application of nitrogen (N), phosphorus (P) and adequate supply of nitrogen is beneficial for both carbohydrates and protein metabolism as it promote cell division and cell enlargement, resulting in, more leaf area and thus ensuring good seed and dry matter yield [1]. Survey reports have also shown that fertilizers are not applied to sesame even in major sesame growing areas of Nigeria [18].

Keeping in view the above constraints this experiment were conducted to find out the effect of nitrogen and phosphorus levels on the yield and yield components of sesame in agro-climatic condition of Peshawar.

2. Materials and Methods

The experiment entitled effect of nitrogen and phosphorus on yield and yield components of sesame were conducted at New Developmental Farm of the University of Agriculture Peshawar during kharif 2013. The experiment were laid out in randomized complete block design (RCBD) having four replications. The phosphorus P_2O_5 were applied from DAP and the remaining dose of nitrogen were applied from Urea in two splits half at sowing and half after 80% emergence. A plot size of 3 x 3 m was used. Each plot was consisted of 6 rows, 50 cm apart and 3 m long. The seed rate 4 kg ha^{-1} was used. The crop was sown at 28th June and weeds were controlled manually. The field was ploughed 2 times first with cultivator and second time with rooter. Total number of irrigations was 3 for the crop throughout the whole growing season. All other agronomic practices were carried out uniformly for all the experimental units throughout the growing season.

3.Results and Discussion

3.1 Pods plant^{-1}

Data regarding pods plant^{-1} presented in Table 1 showed that both nitrogen and phosphorous application had significantly affected pods plant^{-1}, whereas the interaction was found non-significant. Mean values of the data showed that increasing nitrogen rates had significantly increased pods plant^{-1}. This result is in line with the findings of [1] and [8]. Application of 90 kg N ha^{-1} had resulted 22% higher pods plant^{-1} over control treatment.Similarly, increasing phosphorous rate had increased pods plant^{-1} up to 60 kg P ha^{-1}, with no statistical differences when phosphorus was further increased up to 90 kg ha^{-1}, andis supported with similar findings of [18] and [5]. The results further indicated that highest pods plant^{-1} (63) was recorded at 90 kg P ha^{-1}, followed by 60 kg P ha^{-1} pods plant^{-1} (61) plots as compared to lowest pods plant^{-1} (57) recorded at 0 kg P $ha^{-1.}$

3.2 Biological yield (kg ha^{-1})

Data regarding biological yield shown in Table 1. Indicated that highest biological yield (2539 kg ha^{-1}) was recorded at 90 kg N ha^{-1} compared to control plots (1570 kg ha^{-1}). These significant affects might be associated with the increase in plant height, highest number of pods plant^{-1}, number of leaves plant^{-1}, and number of branches plan^{-1} which increase total biomass of the plant and resulted in more biological yield. This show a 62% increase over control plots. The result is supported with the findings of [12] and [2]. No statistical differences were observed for biological yield in response to phosphorous application, and the interaction between phosphorous and nitrogen on biological yield of sesame supported with the findings of [16].

3.3 Seeds pod^{-1}

Statistical analysis of data showed that nitrogen application has significant effect on number of seeds pod^{-1}. Highest doses of nitrogen had highest number of seeds pod^{-1} while lowest doses (control) of nitrogen had the

lowest number of number of seeds pod^{-1}. This might be due to more number of leaves and high nitrogen use efficiency and more interception of sun light and at the result more photos assimilates goes to reproductive parts of the plant which is seed of sesame. These results is in line with the findings of [8] reported that increase nitrogen application had increase the number of seed pod^{-1},while phosphorus levels and interaction of nitrogen and phosphorus levels were found no significant on number of seed pod$^{-1.}$

Table 1.Pods plant^{-1}, biological yield and seeds pod^{-1} of sesame as affected by different levels of nitrogen and phosphorus.

Treatments	Pods plant^{-1}	Biological yield (kg)	Seeds pod^{-1}
Nitrogen (kg N ha^{-1})			
0	55c	1570c	50c
30	58b	2182b	51b
60	61b	2407ab	52b
90	67a	2539a	54a
$LSD_{0.05}$	3	320	2
Phosphorus (kg P ha^{-1})			
0	57c	2118	52
30	59bc	2229	51
60	61ab	2086	53
90	63a	2265	51
$LSD_{0.05}$	3	NS	NS
N x P interaction	NS	NS	NS

3.4 Grain yield (kg ha^{-1})

Grain yield positively responded to both nitrogen and phosphorus application. The highest grains yield (520 kg ha^{-1}) was recorded in 90 kg N ha^{-1} which was followed by 60 kg N ha^{-1} (512 kg ha^{-1}), followed by 30 kg N ha^{-1} (494 kg ha^{-1}). Significantly the lowest grain yield (442 kg ha^{-1}) was recorded in control plot. The result is supported with the findings of [1] and [8]. The highest grains yield (516 kg ha^{-1}) was recorded in 90 kg P ha^{-1} which was followed by 60 kg P ha^{-1} (509 kg ha^{-1}), followed by 30 kg P ha^{-1} (497 kg ha^{-1}). Significantly the lowest grain yield (446 kg ha^{-1}) was recorded in control plot. The result is supported with the findings of [18] and [5] who reported that increasing phosphorus levels of application significantly increase grain yield. The interactive effect of phosphorus and nitrogen on grains yield was found non-significant.

3.5 ThousandSeeds weight (g)

Nitrogen application had significant effect on thousand seeds weight. Highest doses of nitrogen had highest thousand seeds weight while lowest doses (control) of nitrogen had the lowest thousand seeds weight the result is supported with the findings of [8] who reported the highest thousand seeds weight at (80 kg N ha^{-1}). These

results might be associated with more number of leaves and secondary branches and trapping of more sun light that enhanced rate of photosynthesis and resulted much dry matter production assimilate in fruit (seed) of the plant at reproductive stage. Similarly phosphorus application had significant effect on thousand seeds weight. Highest doses of phosphorus had highest thousand seeds weight while lowest doses (control) of phosphorus had the lowest thousand seeds weight the result is supported with the findings of[9] conducted a field experiment to observe the crop performance under variable phosphorus levels and reported the highest thousand seeds weight at (90 kg P ha^{-1}). While the interaction of phosphorus and nitrogen levels have no significant effect on thousand seeds weight.

3.6 Harvest index (%)

Data regarding harvest index are shown in Table 2. The maximum harvest index (24%) was recorded in 90 kg N ha^{-1} which was followed by 60 kg N ha^{-1} (23%). Significantly the minimum harvest index (20%) was recorded in control plot. The maximum harvest index (25%) was recorded in 90 kg P ha^{-1} which was followed by 60 kg P ha^{-1} (23%). Significantly the minimum harvest index (20%) was recorded in control plot. These results were also supported by [9], [17] and [5] who reported that application of nitrogen and phosphorus significantly affected grain yield. As harvest index is correlated with grain yield, therefore increase in grain yield increase harvest index. The interactive effect of phosphorus and nitrogen on harvest index was found non-significant.

Table 2.Grain yield, thousand seed weight and harvest index (%) of sesame as affected by different levels of nitrogen and phosphorus.

Treatments	Grain yield (kg)	Thousand seeds weight (gm)	Harvest index (%)
Nitrogen (kg N ha^{-1})			
0	442b	2.94d	20c
30	494a	3.16c	22bc
60	512a	3.36b	23ab
90	520a	3.91a	24a
$LSD_{0.05}$	28	0.17	2
Phosphorus (kg P ha^{-1})			
0	446b	3.19c	20b
30	497a	3.23bc	21b
60	509a	3.36b	23a
90	516a	3.61a	25a
$LSD_{0.05}$	28	0.17	2
N x P interaction	NS	NS	NS

NS = Non significant.

Means followed by different letter (s) in each category are significantly different from each other using LSD test at $P \leq 0.05$ using.

4.Conclusion

It was concluded from the results that application of nitrogen @ 90 kg ha^{-1} had significantly improved the yield and yield components, whereas phonological observation were delayed with increased nitrogen application. The phosphorus effects were restricted to influence plant height, number of $pods^{-1}$, grain yield; thousand seed weight, harvest index, and have no effects on days to emergence, emergence m^{-2}, days to flowering, days to maturity, plants ha^{-1}, seeds pod^{-1}, and biological yield.

Thus it was recommended that nitrogen @ 90 kg ha^{-1} with phosphorus @ 90 kg ha^{-1} would result in highest yield and yield components of sesame and is recommended for the farmers of Peshawar valley.

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