Original Research Article

Effect of Combined Application of Nitrogen and Phosphorus on the Yield of Sesame

ABSTRACT

The experiment was conducted at the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during February 2014 to June 2014. BARI Til-3 variety developed by Bangladesh Agricultural Research Institute (BARI), Gazipur. This experiment consisted of two factors; Factor-A: four levels of nitrogen *viz*. (i) N_0 (Control), (ii) N_1 (80 kg ha^{-1}), (iii) N_2 (100 kg ha^{-1}) and (iv) N_3 (120 kg ha^{-1}) and Factor B: four levels of phosphorus *viz*. (i) P_0 (Control), (ii) P_1 (20 kg ha^{-1}), (iii) P_2 (30 kg ha^{-1}) and (iv) P_3 (40 kg ha^{-1}). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Data were recorded on different parameters such as the number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$, the weight of 1000 seeds, seed yield ha^{-1} and stover yield ha^{-1}. The study reveal that combination of different levels of nitrogen and phosphorous have significant influence on yield of sesame. Highest seed yield ha^{-1} of sesame (1652 kg) and highest harvest index of sesame (37.33%) were recorded from N_3P_2 (120 kg N ha^{-1} with 30 kg P_2O_5 ha^{-1}). Therefore, the results suggest that the combined use of 120 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1} gave the highest yield of sesame.

Keywords: Sesame, BARI Til-3, Nitrogen, Phosphorous, Sesamum indicum

1. INTRODUCTION

The oldest cultivated plants in the world and indigenous oil plant is known as sesame *(Sesamum indicum* L.) is one of longest history in Indian sub-continent. It is under cultivation in Asia for over 5000 years [1]. Sesame is an important source of edible oil has diverse nutritive values. It is one of the popular oilseeds in Bangladesh which occupies the second position after mustard among the edible oils [2]. Total area coverage of sesame is 87,000 hectares with an annual production of 97,000 metric tons [3]. Its average yield in Bangladesh is 889 kg ha^{-1} [4]. It has multiple uses for mixing with various food items. Sesame oil is used as hair tonic from very old age in the country. Therefore, it is traditionally cultivated in the different parts of Bangladesh. Among the oil crops, sesame has the highest oil content of 46 - 64% [5]. Despite being such an important crop, the productivity of sesame in Bangladesh is only 889 kg ha^{-1} [6].

Nutrient management is very important for yield improvement of crops [7]. Nitrogen and phosphorus are important plant nutrients which help in growth and development of plant and ultimately improved crop yield. They involve in many biochemical functions in the physiological system of the plant. Application of nitrogen fertilizer significantly enhanced the growth, nitrogen uptake and yield attributes over control. Nitrogen is the most dynamic nutrient element and becomes the first limiting nutrient as land use intensifies [8, 9]. It is taken up in the highest amount by crops and its role in plants cannot be easily substituted [7]. Its supply in the soil is the most important factor limiting growth and yield [10]. Increases in N supply within limits are associated with increase in leaf area and weight, carboxylases and chlorophyll content, all of which determine the photosynthetic activities of leaf and ultimately dry matter production and allocation to the various organs of a plant [11]. Phosphorus is essential parts of skeleton of plasma membrane, nucleic acid, many coenzymes, organic molecules and phosphorylated compounds in plant system [12]. It plays an important role in energy transfer reactions and oxidation-reduction process. Lack of phosphorus, therefore, hampers metabolic process such as the conversion of sugar into starch and cellulose. Phosphorus is mostly concentrated in the reproductive organ of plant contributing to seed development. A seed needs enough phosphorus and its deficiency, therefore, causes shriveled seed. Thus phosphorus is an important nutrient for seed development and seed filling contributing to better yield formation [13]. Consequently, it increases seed yield of sesame especially under irrigation condition [14].

Therefore, the study was undertaken to estimate the optimum and levels of nitrogen and phosphorus for better yield of sesame. Among the agronomic manipulation, proper nutrient management plays a vital role in getting higher yield. Present investigation was carried out to find the response and sort out the dose of nitrogen and phosphorus fertilizers for better yield of sesame varieties.

2. MATERIAL AND METHODS

The experiment was conducted at the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, from February to June 2014. The experimental site was located at $23^0 77'$ N latitude and $90^0 3'$ E longitude with an elevation of 8.5 m from sea level. The soil of the experimental site belongs to Tejgaon series under the Agro-ecological zone, Madhupur Tract (AEZ -28), which falls into Deep Red Brown Terrace Soil. Initial soil samples were collected from the experimental plots to a depth of 0-15 cm from the surface before the initiation of the experiment and analyzed in the laboratory (Table 1).

Table 1. Physical and Chemical Properties of the Experimental Soil

Soil properties	Value
A. Physical Properties	
1. Particle Size	
% Sand	29.04
% Silt	41.8
% Clay	29.16
2. Soil Texture	Clay Loam
B. Chemical Properties	
1. Soil pH	5.80
2. Organic Carbon (%)	0.78
3. Organic Matter (%)	1.35
4. Total N (%)	0.08
5. C : N ratio	9.75 : 1
6. Available P (ppm)	22
7. Exchangeable K (me100 g)	0.18
8. Available S (ppm)	18

BARI Til-3, a popular variety of sesame developed by Bangladesh Agricultural Research Institute (BARI), was used as planting material for the experiment. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Individual plot size was 1.2 × 2 m^2. The row-to-row and seed to seed distance were 30 and 5 cm, respectively. Two factors were considered for the study. Factor A, conducted with four different levels of nitrogen (N_0=Control, N_1= 80 kg ha^{-1}, N_2=100 kg ha^{-1}, N_3=120 kg ha^{-1}), and Factor B, consisted of four different level of phosphorous (viz. P_0= Control, P_1= 20 kg ha^{-1}, P_2=30 kg ha^{-1}, P_3=40 kg ha^{-1}). The land was prepared by four successive ploughing and cross ploughing and followed by laddering to have a desirable tilth. Experimental plots were fertilized with 5 t ha^{-1}, 45 kg ha^{-1}, 5 kg ha^{-1}, 10 kg ha^{-1} Cowdung, MoP, $ZnSO_4$ and Boron, respectively except Urea and TSP that were applied as per treatment [2]. All necessary intercultural operations were done whenever required. Five sample plants $plot^{-1}$ were selected randomly before harvesting of the crop for recording the data of number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$ and 1000-seed weight. Then plants were harvested, bundled, tagged and recorded the seed yield and stover yield per plot and converted it to t ha^{-1}. Biological yield (t ha^{-1}) and harvest index (%) was calculated by following formula:

Biological yield = Seed yield + Stover yield

Harvest index (HI) (%) = (Grain yield ×100)/Biological yield

2.1 Statistical Analysis

All the collected data were analyzed following the Analysis of Variance (ANOVA) technique and the mean differences were adjudged by LSD [15] using a computer operated program named MSTAT-C.

3. RESULTS AND DISCUSSION

3.1 Number of Capsules Plant^{-1}

Combined effect of different levels of nitrogen and phosphorus showed significant differences on number of capsules plant^{-1} of sesame (Table 2). Results designated that the highest number of capsules plant^{-1} (29.58) was recorded from N_3P_2. On the other time, the lowest number of capsules plant^{-1} of sesame (14.97) was recorded from N_0P_0. Similar results were found by Maiti and Jana [16]. Mondol *et al*. [17] observed that number of capsule plant^{-1} was increased significantly with increasing nitrogen rates.

3.2 Number of Seeds Capsule^{-1}

Combined effect of different levels of nitrogen and phosphorus showed significant differences on number of seeds capsule^{-1} of sesame (Table 2). Results revealed that the highest number of seeds capsule^{-1} of sesame (79.85) was recorded from N_3P_2. The lowest number of seeds capsule^{-1} of sesame (40.59) was recorded from N_0P_0 which was statistically identical with N_0P_1 and N_0P_3. Mondol *et al*. [17] observed that number of seeds capsule^{-1} was increased significantly with increasing nitrogen rates. Maiti and Jana [16] stated that application of 30 kg P_2O_5 ha^{-1} produced significantly the highest capsules and capsules plant^{-1} as compared to other levels of phosphorus.

3.3 1000-Seed Weight (g)

Combined effect of different levels of nitrogen and phosphorus showed significant differences for 1000-seed weight (g) of sesame (Table 2). Results were expressed that the highest 1000-seed weight (3.97 g) was recorded from N_3P_2 which was significantly different from all other treatment combinations. Again, the lowest 1000-seed weight of sesame (2.69 g) was recorded from N_0P_0 which was statistically similar with N_0P_1 followed by N_0P_2 and N_0P_3.

Table 2. Combined Effect of Nitrogen and Phosphorus on Yield Contributing Parameters of Sesame

Treatments	Yield contributing parameters of sesame		
	Number of Capsules Plant^{-1}	**Number of Seeds Capsule^{-1}**	**1000-Seed Weight (g)**
N_0P_0	14.97	40.59	2.69
N_0P_1	17.63	43.25	2.77
N_0P_2	18.97	54.92	2.85
N_0P_3	17.97	44.59	2.81
N_1P_0	20.30	49.25	2.90
N_1P_1	21.50	54.69	3.19
N_1P_2	27.63	74.79	3.94
N_1P_3	25.22	63.12	3.56
N_2P_0	20.97	50.59	2.99
N_2P_1	28.38	75.84	3.95
N_2P_2	23.26	58.26	3.26
N_2P_3	25.58	69.12	3.81
N_3P_0	21.33	51.59	3.10
N_3P_1	24.29	60.65	3.67
N_3P_2	29.58	79.85	3.97
N_3P_3	26.92	73.20	3.88
$LSD_{0.05}$	0.7153	3.923	0.09133
CV (%)	6.55	10.18	5.36

N_0: 0 kg N ha^{-1}, N_1: 80 kg N ha^{-1}, N_2: 100 kg N ha^{-1}, N_3: 120 kg N ha^{-1}
P_0: 0 kg P_2O_5 ha^{-1}, P_1: 20 kg P_2O_5 ha^{-1}, P_2: 30 kg P_2O_5 ha^{-1}, P_3: 40 kg P_2O_5 ha^{-1}

3.4 Seed Yield (kg ha^{-1})

Combined effect of different levels of nitrogen and phosphorus had statistically significant on seed yield (Table 3). Results exposed that the highest seed yield ha^{-1} of sesame (1652 kg) was recorded from N_3P_2. The treatment arrangement of N_2P_1 (1637kg) and N_1P_2 (1558 kg) also showed significantly higher seed yield ha^{-1} and that was expressed as second and third highest seed yield ha^{-1} respectively but significantly different from all other treatment combinations. The lowest seed yield of sesame (978.80 kg) was recorded from N_0P_0 followed by N_0P_1 (1056 kg) and N_0P_3 (1252 kg) which was the second lowest and third seed yield ha^{-1}, respectively. The results obtained from the treatment combination of N_3P_3 and N_2P_3 also gave promising seed yield but significantly lower than the treatment arrangement of N_3P_2. Kanade *et al.* [18] observed that expressively higher grain yield was obtained with 50 kg N ha^{-1} and 25 kg P_2O_5 ha^{-1} compared to 25 kg N ha^{-1} and 12.5 kg P_2O_5 ha^{-1}. Itnal *et al.* [19] opined that application of 50 kg ha^{-1} N + 25 kg P_2O_5 ha^{-1} produced the highest yield, which was 69 percent greater than control. Thorve *et al.* [20] opined that yield attributes and yield of sesame was increased with every successive increased level of N and P fertilizer and were maximum with 37.5 kg N ha^{-1} + 18.5 P_2O_5 ha^{-1}.

3.5 Stover Yield (t ha^{-1})

Stover yield showed statistically significant among the combination of different levels of nitrogen and phosphorus (Table 3). Results exposed that the highest stover yield of sesame (3.10 t ha^{-1}) was recorded from N_1P_1 which was closely followed by N_2P_0, N_0P_2, N_0P_3 and N_3P_0. The lowest stover yield of sesame (2.65 t ha^{-1}) was recorded from N_0P_0 (Control) treatment which was statistically similar with N_0P_1 (2.68 t ha^{-1}) followed by N_1P_2 (2.71 t ha^{-1}) treatment. Jagvir *et al.* [21] observed that stover yield mustard is increased significantly with the application of recommended dose of mixed fertilizer (NPKS).

3.6 Biological Yield (t ha^{-1})

Combined effect of nitrogen and phosphorus had significant influence biological yield of sesame (Table 3). Results exposed that the highest biological yield of sesame (4.56 t ha^{-1}) was recorded from N_1P_1 which was statistically similar with N_2P_0 followed by N_2P_2, N_3P_0 and N_3P_2. The lowest biological yield of sesame (3.63 t ha^{-1}) was recorded from N_0P_0 treatment.

3.7 Harvest Index

Combined effect of nitrogen and phosphorus had significant influence harvest index of sesame (Table 3). Results exposed that the highest harvest index of sesame (37.33%) was recorded from N_3P_2 which was statistically similar with N_2P_1 (36.77%) and N_1P_2 (36.49%) and that was expressed as second and third highest harvest index respectively. The lowest harvest index of sesame (27.06%) was recorded from N_0P_0 which was statistically similar to N_0P_1 (28.33%) followed by N_0P_2 and N_0P_3.

Table 3. Combined Effect of Nitrogen and Phosphorus on Yield Parameters of Sesame

Treatments	Yield Parameters of Sesame			
	Seed yield (kg ha^{-1})	Stover yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest Index (%)
N_0P_0	978.8	2.65	3.63	27.06
N_0P_1	1056	2.68	3.73	28.33
N_0P_2	1281	3.06	4.17	29.56
N_0P_3	1252	3.05	4.30	29.15
N_1P_0	1320	2.91	4.23	31.24
N_1P_1	1464	3.1	4.56	32.12
N_1P_2	1558	2.71	4.27	36.49
N_1P_3	1481	2.84	4.33	34.28

N_2P_0	1431	3.08	4.51	31.68
N_2P_1	1637	2.82	4.33	36.77
N_2P_2	1477	2.97	4.46	33.17
N_2P_3	1514	2.8	4.32	35.13
N_3P_0	1429	3.03	4.46	32.07
N_3P_1	1481	2.87	4.35	34.09
N_3P_2	1652	2.78	4.43	37.33
N_3P_3	1520	2.75	4.27	35.66
$LSD_{0.05}$	4.329	0.05273	0.07457	1.306
CV (%)	7.39	11.56	10.28	9.43

N_0: 0 kg N ha^{-1}, N_1: 80 kg N ha^{-1}, N_2: 100 kg N ha^{-1}, N_3: 120 kg N ha^{-1}
P_0: 0 kg P_2O_5 ha^{-1}, P_1: 20 kg P_2O_5 ha^{-1}, P_2: 30 kg P_2O_5 ha^{-1}, P_3: 40 kg P_2O_5 ha^{-1}

4. CONCLUSION

Form the above findings, it can be concluded that combined effect of nitrogen and phosphorus, N_3P_2 (120 kg ha^{-1} nitrogen with 30 kg ha^{-1} phosphorus) had the best performance in respect of yield and yield contributing characters compared to the combinations of control treatment of nitrogen and phosphorus. Therefore, the present experimental results suggest that the combined use of 120 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1} along with recommended doses of other fertilizer would be beneficial to increase the yield of sesame variety BARI Til-3.

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