International Journal of Plant & Soil Science

25(4): 1-6, 2018; Article no.IJPSS.44830
ISSN: 2320-7035

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

Syed Arvin Hassan[1], Md. Ehsanul Haq[2], Montasir Ahmed[3*], Md. Masfiqur Rahman[1] and Alok Kumar Paul[1]

[1]Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.
[2]Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.
[3]Plant Pathology Division, Bangladesh Rice Research Institute, Gazipur, Bangladesh.

Authors' contributions

This work was carried out in collaboration between all authors. Author AKP planned the experiment and lead the research. Authors SAH and AKP designed and carried out the research. Author MEH performed the statistical analysis. Author SAH carried out the research on field. Authors SAH and MMR collected the data. Authors SAH and MA took the lead in writing the manuscript. Authors SAH, MEH and MMR managed the literature searches. All authors provided critical feedback and helped in shape the research, analysis and manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2018/44830
Editor(s):
(1) Dr. Yong In Kuk, Department of Development in Oriental Medicine Resources, Sunchon National University, South Korea.
Reviewers:
(1) R. K. Mathukia, Junagadh Agricultural University, India.
(2) Rebecca Yegon, University of Embu, Kenya.
Complete Peer review History: http://www.sciencedomain.org/review-history/27334

Original Research Article

Received 03 September 2018
Accepted 06 November 2018
Published 21 November 2018

ABSTRACT

The experiment was conducted at the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, from 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 reveals that a combination of different levels

**Corresponding author: E-mail: ahmed.montasir@ymail.com;*

of nitrogen and phosphorous have a significant influence on the 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 fertiliser 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 an 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 the skeleton of the 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 shrivelled 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 a higher yield. The present investigation was carried out to find the response and sort out the dose of nitrogen and phosphorus fertilisers for better yield of sesame varieties.

2. MATERIALS 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°77′ N latitude and 90°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 analysed in the laboratory (Table 1).

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.

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

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 fertilised 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 a number of capsules $plant^{-1}$, a 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 the 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 analysed 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 $Plant^{-1}$

The combined effect of different levels of nitrogen and phosphorus showed significant differences on a 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 the number of capsule $plant^{-1}$ was increased significantly with increasing nitrogen rates.

3.2 Number of Seeds $Capsule^{-1}$

The combined effect of different levels of nitrogen and phosphorus showed significant differences on a 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 the 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)

The 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.

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

The 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 (1637 kg) 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 fertiliser 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 the recommended dose of mixed fertiliser (NPKS).

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}

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}

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

The 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

The 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.

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 fertiliser would be beneficial to increase the yield of sesame variety BARI Til-3.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Pham TD, Nguyen TDT, Anders CC, Bui TM. Morphological evaluation of sesame *(Sesamum indicum* L.) varieties from different origins. Australian J. Crop Sci. 2010; 4(7): 498-504.
2. BARI (Bangladesh Agricultural Research Institute). *Krishi Projukti Hatboi* (Handbook of Agrotechnology). Bangladesh Agril. Res. Inst. Joydebpur, Gazipur 1701. 2004;129-132 (In Bangla).
3. AIS (Agricultural Information Service). Krishi Diary (Agricultural Diary). Agril. Info. Service. Khamarbari, Fanngate, Dhaka-1215. 2014;14 (In Bangla).
4. BBS (Bangladesh Bureau of Statistics). Statistical Yearbook of Bangladesh. Stat.

Div. Minis. Planning, Govt. People's Repub. Bangladesh; 2011.
5. Raja A, Hattab LO, Gurusamy G, Vembu G, Suganya S. Sulphur application on growth and yield of sesame varieties. Int. J. Agrl. Res. 2007;2(7):599-606.
6. FAO. FAOSTAT; 2014. Available:http://www.fao.org/faostat/en/
7. Olaniyi, JO, Akanbi WB. Effects of cultural practices on mineral compositions cassava peel compost and its efects on the performance of cabbage (*Brassica oleraceae* L.). Journal of Applied Biosciences. 2008;8(1):272-279.
8. Tiessen KD, Flaten, CA, Grant R, Karamanos E, Burton DL, Entz MH. Efficiency of fallbanded N: Effects of application date, landscape position and inhibitors. In: proc. of 2004 Manitoba Agronomist's Conference, Winnipeng. 2003;118-132.
9. Akanbi WB, Akande MO, Adediran JA. Suitability of composted maize straw and mineral nitrogen fertilizer for tomato production. Journal of Vegetable Science. 2005;11(1):57-65.
10. Akanbi WB, Akande MO, Baiyewu RA, Akinfasoye JO. Effect of maize stover compost and nitrogen fertilizer on growth, yield and nutrient uptake of amaranth. Moor Journal of Agricultural Sciences. 2000;1:6-15.
11. Akanbi WB, Oyediran GO, Olaniran OA, Adeyeye SA, Akande MO, Adediran JA. Effects of organic and inorganic fertilizers and their combination on growth, nutrient uptake and shoot yield of celosia (*Celosia argentea* L.). Science Focus. 2006;11-(1) 84-90.
12. Panday SN, Sinha BK. Plant physiology. Vikas Publishing House Pvt. Ltd. 5 Ansari Road, New Delhi, 11002.1986;112-130.
13. Sahrawat KL, Islam MS. Phosphorus requirements and management of oil-seeds. In: Phosphorus Requirements for Sustainable Agriculture in Asia and Oceania. IRRI (Int. Rice Res. Inst.). Los Banos. Laguna, Philippines. 1990;371-381.
14. Kaul AK, Das ML. Oilseeds in Bangladesh. Bangladesh Canada Agriculture Sector Team, Ministry of Agriculture, Govt. of the People's Republic of Bangladesh. Dhaka. 1986;36-98.
15. Gomez KA, Gomez AA. Statistical Procedures for Agriculture Research. Second Edition. Published by John Wiley and Sons, New York. 1984;680.
16. Maiti D, Jana PK. Effect of different levels of nitrogen and phosphorus on yield and yield attributes of sesame. J. Oilseeds Res.1985;3(1):252-259.
17. Mondol DK, Sounda G, Panda PK, Ghosh P, Maitra S, Roy DK. Effects of different irrigation levels and nitrogen doses on growth and yield of sesame (*Sesamum indicum* L.). Indian Agriculturist. 1997; 41(I):15-21.
18. Kanade VM, Chavan SA, Khanvilkar SA. Effects of sowing dates and fertilizers levels on yield of sesamum. J. Maharashtra Agrl. Univ. 1992;17:12-14.
19. Itnal CJ, Halemani HL, Radder GD, Surkod VS, Sajjan GC. Response of sesamum genotypes to application of fertilizers in drylands. J. Maharashtra Agric. Univ. 1993;18(3):374-375.
20. Thorve SB, Katwate MT, Jadhav JD. Response of sesame *(Sesamum indicum* L.) cultivars under varying levels of fertilizers under rainfed conditions. Asian J. Soil Sci. 2011;6(1):1-10.
21. Jagvir S, Monga D, Deshmuch MS. Direct and residual effect of sulphur on growth, yield and quality of cotton (*Gossypium hirsutum*)-mustard (*B. juncea*) cropping system. Journal of Cotton Research and Development. 2004; 18(2):172-174.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/27334