



Research in

**AGRICULTURE, LIVESTOCK and FISHERIES**

ISSN : P-2409-0603, E-2409-9325

An Open Access Peer-Reviewed International Journal

Article Code: 233/2019/RALF

Res. Agric. Livest. Fish.

Article Type: Original Research

Vol. 6, No. 2, August 2019 : 245-251.

## EFFECT OF PHOSPHORUS ON GROWTH AND YIELD OF SESAME

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### ARTICLE INFO

### ABSTRACT

**Received**  
07 August, 2019

**Revised**  
25 August, 2019

**Accepted**  
25 August, 2019

**Online**  
31 August, 2019

**Key words**  
Bari Til-3  
Phosphorus  
Sesame  
Oil content  
Harvest Index

The present study was conducted at the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during March to June 2014 to examine the effect of Phosphorus on the growth and yield of Sesame. BARI Til-3 variety was used for the study. This experiment was consisted of single factor eg. phosphorus. There were three levels of phosphorus viz. (i) P<sub>0</sub> (0 % P), (ii) P<sub>1</sub> (20 % P) and (iii) P<sub>2</sub> (30 % P) and the experiment was laid out in a Randomized Complete Block Design (RCBD) with six replications. Different levels of phosphorus showed significant effect on growth and yield of sesame. Individually phosphorus had significant effect on highest plant height, number of leaves plant<sup>-1</sup>, number of primary branches plant<sup>-1</sup>, number of secondary branches plant<sup>-1</sup>, number of capsule plant<sup>-1</sup>, number of seeds capsule<sup>-1</sup>, 1000 seed weight, seed yield and harvest index. The highest plant height of sesame (136.30 cm), the highest no leaves plant<sup>-1</sup> of sesame (34.44), number of primary branches plant<sup>-1</sup> (5.56), number of secondary branches plant<sup>-1</sup> (7.61), number of capsule plant<sup>-1</sup> (25.87), number of seed capsule<sup>-1</sup> (70.47), 1000 seed weight (3.54), Seed yield (1581.00 kg ha<sup>-1</sup>), Stover yield (3034.42 kg ha<sup>-1</sup>), biological yield (4615.76), harvest index (34.11%), oil content (43.92%) was recorded from P<sub>1</sub>. Again, the highest days to first flowering of sesame (31.67) was recorded from P<sub>1</sub> (20 % P) but the highest days to maturity was (85.67) recorded from P<sub>2</sub> (30% P). Application of P at different percentage is causing effect in growth and yield of sesame.

**To cite this article:** Jahan N, ABMS Alam, AS Mitu, MA Habib and MS Rahman, 2019. Effect of phosphorus on growth and yield of sesame. Res. Agric. Livest. Fish. 6 (2): 245-251.



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## INTRODUCTION

Sesame (*Sesamum indicum* L.) commonly known as TIL is one of the oldest cultivated plants in the world and indigenous oil plant with longest history in India sub-continent. It is under cultivation in Asia for over 5000 years (Toan Due Pham et al., 2010). It was a highly priced oil plant of Babylon and Assyria at least 4000 years ago (Oplinger et al., 1990). Sesame is the second most important edible oil crop in Bangladesh. In our country it occupies 34.8 thousand ha of land and produces 31 thousand metric tons with an average yield of this crop is 889 kg ha<sup>-1</sup> (BBS, 2011). This crop is cultivated in about 80 thousand ha of land and produces about 49 thousand metric tons. It grows both kharif (summer) and rabi (winter) season. In kharif season the growth, yield and production is comparatively lower. But it could be possible to increase up to 1200 kg ha<sup>-1</sup> by improved management practices. As, it is used as oil seed and local preparation of weaning food (Abdel, 2008). Despite of being such an important crop, the productivity of sesame in Bangladesh is very low (889 kg/ha) in comparison to global level (Anonymous, 1996). It is quality food, nutritious, edible oil, biomedicine and health care all in one. The quality of oil seed is determined by the fatty acid compositions of the total oil. Its oil is used for salad and cooking dishes. Sesame is grown mainly for seeds that contain 42-50% oil, 20% protein 5.3% water, 5.2% minerals, 2.9% fiber and 25% carbohydrate per 100g edible portion (Burden, 2005). It is called as “Queen of Oilseeds” as it contains good quality poly-unsaturated fatty acids viz., 47% oleic and 39% linoleic acid. It is also named as “seeds of immortality” due to the presence of antioxidants such as sesamin and sesaminol that prevents the biological system from the effect of free radicals. Among the oil crops, sesame (*Sesamum indicum* L.) has the highest oil content of 46 - 64% (Raja et al. 2007). The major plant nutrient like Nitrogen (N) has the most significant effect for sesame production but the other plant nutrients such as phosphorus, potassium, zinc etc. have also great role for increased yield potential. Haruna *et al.* (2010) opined that the application of 26.4 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> increased the plant height, number of leaves plant<sup>-1</sup> and total dry matter production than other levels viz., 13.2 and 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, further, they noticed Phosphorus (P) application hasten flowering significantly. Mian *et al.* (2011) opined that the highest seed yield, number of capsules plant<sup>-1</sup>, capsule length, and 1000 seed weight were recorded with 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.

A good supply of Phosphorus is usually associated to increased root density proliferation, which aid in extensive exploration, supply of nutrients and water to the growing plant parts, thus increase growth and yield, thereby ensuring more seed and dry matter (Maiti and Jana, 1985). Phosphorus plays a significant role in formation of energy rich phosphate bonds like ADP and ATP, nuclear protein and phospholipids and is essential constituent of nucleic acids (RNA and DNA), nucleoproteins, amino acids, protein, phosphatides, phytin and several co enzymes (NADP). Phosphorus also involves in energy transfer metabolic processes and basic reaction of photosynthesis, transformation of sugar, starch and nutrient movement in plants (Ghosh, 1994). Also, stimulate extensive root system thereby enabling plant to extract moisture and mineral nutrients optimally. The deficiency symptoms are not very distinct to identify, visually the plants are dwarfed or stunted, and plants develop very slowly in relation to other plants growing under similar environmental conditions. Under severe deficiency, leaves develop blue-gray luster, older leaves become brown netted veining (Brady, 2002). As P have significant effect in the production of oil seed plants, also essential for the growth and yield of Sesame plant. This research intends to measure the effect & doses of P particularly in the growth and yield of sesame plant. Higher productivity in any crop can be achieved through a combination of ideal variety with balanced nutrition and associated with proper environment and appropriate cultural practices. Therefore, considering the said facts into deliberation, a field trial in sesame was conducted consecutively to find out the effect of Phosphorus (P) on different growth and yield parameter of sesame.

## MATERIALS AND METHODS

### Study place and time

The experiment was conducted at the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during March to June 2014 to examine effect of Phosphorus on the growth and yield of sesame (BARI TIL-3). The soil of the experimental site belongs to Tejgaon series under the Agro-ecological zone, Madhupur Tract (AEZ -28). BARI Til-3 variety of sesame was used as experiment crop. The seeds were collected from BARI, Gazipur. The life cycle of this variety ranges from 90- 100 days. Maximum seed yield is 1.2 to 1.5 t ha<sup>-1</sup>.

### Study design

The experiment was laid out in a Randomized Complete Block Design (RCBD) with single factor and six replications. Fertilizer treatments consisted of three levels of P (i) P<sub>0</sub> (0 % P), (ii) P<sub>1</sub> (20 % P) and (iii) P<sub>2</sub> (30 % P). Each block consisted of 6 individual plot was 2m × 1m. The row-to-row and seed to seed distance were 30 and 5 cm, respectively.

### Collection of soil samples

Soil samples from the experimental field were collected before land preparation to a depth of 0-15 cm from the surface of the basis of composite sampling method. The collected soil was air dried ground and passed through a 2-mm sieve and stored in a clean, dried plastic container for physical and chemical analysis.

### Use of fertilizer and weeds collection

The fertilizer doses used in the experiment field were cowdung 5 t ha<sup>-1</sup>, Urea 100 kg ha<sup>-1</sup>, TSP (as per treatment), MP 50 kg ha<sup>-1</sup>, ZnO (as per treatment). One third (1/3) of whole amount of Urea and full amount of MP, TSP and Zinc oxide were applied at the time of final land preparation. The remaining Urea was top dressed in two equal installments- at 25 days after sowing (DAS) and 45 DAS, respectively.

Weeds were controlled manually and removed from the field at 25 DAS. The insects were controlled successfully by spraying Malathion 50 EC @ 2ml /L water. 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.

### Data collection

Ten (10) plants from each plot were selected randomly for data collection and marked with sample card. The plants were counted from 2 square meters (2 m × 1 m) of each plot and stover was sundried properly. 1000 seeds were taken from randomly collected seed sample. The weight of all the seeds and stover were measured by an electrical balance and converted the yield in kg ha<sup>-1</sup>.

Harvest index was calculated using the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

Here, Biological yield = Seed yield + Stover yield

For measuring oil content of seed, one gram sesame seed was taken in a mortar which were completely ground with pastle. Thirty mili liter Filch reagent (Chloroform: methanol = 2: 1) was added to it. Oil content was calculated by the following formula:

$$\text{Oil content (\%)} = \frac{\text{Weight of extract (g)}}{\text{Sample weight (g)}} \times 100$$

### Data analysis

The collected data were statistically analyzed by using the ANOVA technique. The test of significance of all parameters was done. The Duncan's Multiple Range Test (DMRT) with Least Significant Difference value was determined with appropriate levels of significance and the means were tabulated. The mean comparison was carried out by DMRT technique at 5% level of probability (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

### Growth Characters

Plant height of sesame (BARI TIL-3) showed statistically significant variation after harvesting at 95 DAS. Among the treatments, the highest plant height of sesame (136.30 cm) was recorded from P<sub>1</sub> (20 % P) whereas the lowest plant height of sesame (126.90 cm) was recorded from P<sub>2</sub> (30 % P). Similar result was found from the findings of Jadhav *et al.* (1992) and they stated that plant height of sesame was increased up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and it was on par with 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> which result was supported by Kathiresan (1999) and Haruna *et al.* (2010).

Results showed that the highest number of leaves plant<sup>-1</sup> of sesame (34.44) was recorded from P<sub>1</sub> (20 % P) which was statistically same (33.89) with P<sub>2</sub> (30 % P). Again, the lowest number of leaves plant<sup>-1</sup> of sesame (29.56) was recorded from P<sub>0</sub> (0 % P) at 60 DAS. Haruna *et al.* (2010) observed that application of 26.40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> increased the number of leaves plant<sup>-1</sup> which was also supported by Ali *et al.* (2002).

The highest number of primary branches plant<sup>-1</sup> of sesame (5.56) was recorded from P<sub>1</sub> (20 % P) which was statistically identical (5.28) with P<sub>2</sub> (30 % P) and the lowest number of primary branches plant<sup>-1</sup> of sesame (4.39) was recorded from P<sub>0</sub> (0 % P) at 30 DAS. The present findings were conformity with finding of Shehu *et al.* (2010) and Haruna *et al.* (2010). Mian *et al.* (2011) found that number of branches were higher with application of 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.

It was found that the highest number of secondary branches plant<sup>-1</sup> of sesame (7.61) was recorded from P<sub>1</sub> (20 % P) where the lowest number of secondary branches plant<sup>-1</sup> of sesame (3.89) was recorded from P<sub>0</sub> (0 % P) at 60 DAS. The present findings were conformity with finding of Shehu *et al.* (2010) and Haruna *et al.* (2010).

The highest days to first flowering of sesame (33.67) was recorded from P<sub>0</sub> (0 % P) where the lowest days to first flowering of sesame (31.11) was recorded from P<sub>2</sub> (30 % P) at 30 DAS.

The highest days to maturity of sesame (88.89) was recorded from P<sub>2</sub> (30 % P) where the lowest days to maturity of sesame (86.33) was recorded from P<sub>0</sub> (0 % P) at 95 DAS. The results obtained from P<sub>1</sub> (20 % P) gave hopeful effect in terms of days to maturity.

**Table 1.** Effect of phosphorus on flowering and maturation of sesame (BARI TIL-3)

Treatments	Flowering and maturity of sesame	
	Days to first flowering	Days to maturity
P <sub>0</sub>	33.67 a	86.33 c
P <sub>1</sub>	31.67 b	88.33 b
P <sub>2</sub>	31.11 c	88.89 a
LSD <sub>0.05</sub>	0.38	0.41

In a column, same letter indicate non-significant difference and different indicate significant difference between them. P<sub>0</sub> = 0% P, P<sub>1</sub> = 20% P and P<sub>2</sub> = 30% P

### Yield contributing characters

Significant variation was found with different levels of phosphorus on number of capsule plant<sup>-1</sup> of sesame at 95 DAS. Results revealed that the highest number of capsule plant<sup>-1</sup> of sesame (25.87) was recorded from P<sub>1</sub> (20 % P) and the lowest number of capsule plant<sup>-1</sup> of sesame (22.03) was recorded from P<sub>0</sub> (0 % P). Similar results were found by Maiti and Jana (1985) and Kathiresan (1999) and they observe that P level of 35 kg ha<sup>-1</sup> influenced number of capsules plant<sup>-1</sup>. Mian *et al.* (2011) opined that the highest number of capsules plant<sup>-1</sup> was recorded with 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.

The highest number of seeds capsule<sup>-1</sup> of sesame (70.47) was recorded from P<sub>1</sub> (20 % P) which was statistically same (69.51) with P<sub>2</sub> (30 % P) and the lowest number of seeds capsule<sup>-1</sup> of sesame (56.44) was recorded from P<sub>0</sub> (0 % P) at 95 DAS. The highest 1000 seed weight of sesame (3.54) was recorded from P<sub>1</sub> (20 % P) which was statistically identical (3.46) with P<sub>2</sub> (30 % P) where the lowest 1000 seed weight of sesame (2.67) was recorded from P<sub>0</sub> (0 % P). Hafiz and El-Bramawy (2012) observed that increasing phosphorus fertilizer rate up to 95 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> significantly increased 1000-seed weight of sesame. Ali *et al.* (2002) Showed that 1000-seed weight was influenced significantly by the application of phosphorus.

### Yield Characters

Significant variation with different levels of Phosphorus was observed for seed yield (kg ha<sup>-1</sup>) of sesame at harvesting time. The highest seed yield of sesame (1581.00 kg ha<sup>-1</sup>) was recorded from P<sub>1</sub> (20 % P) but the lowest seed yield of sesame (1158.00 kg ha<sup>-1</sup>) was recorded from P<sub>0</sub> (0 % P). The result obtained from P<sub>2</sub> (30 % P) showed intermediate result compared to other phosphorus treated treatments. Similar results were observed with the present study. Mian *et al.* (2011) observed that the highest seed yield was recorded with 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Hafiz and El-Bramawy (2012) found that increasing phosphorus fertilizer rate up to 95 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> significantly increased seed yield plant<sup>-1</sup> of sesame. The highest Stover yield of sesame (3070.48 kg ha<sup>-1</sup>) was recorded from P<sub>2</sub> (30 % P). The lowest Stover yield of sesame (2573.00 kg ha<sup>-1</sup>) was recorded from P<sub>0</sub> (0 % P). The result obtained from P<sub>1</sub> (20 % P) showed intermediate result compared to highest and lowest Stover yield but significantly different among the treatments.

It was observed that the highest biological yield of sesame (4636.48 kg ha<sup>-1</sup>) was recorded from P<sub>2</sub> (30 % P) where the lowest biological yield of sesame (3731.33 kg ha<sup>-1</sup>) was recorded from P<sub>0</sub> (0 % P). Mid-level result was obtained from P<sub>1</sub> (20 % P) which was significantly different from other treatments. Significant variation was found for harvest index (%) of sesame with different levels of Phosphorus. Results represented that the highest harvest index of sesame (34.11%) was recorded from P<sub>1</sub> (20 % P) where the lowest (30.98%) was obtained from P<sub>0</sub> (0 % P). The result obtained from P<sub>2</sub> (30 % P) gave intermediate result (34.44%) compared to highest and lowest harvest index of sesame.

**Table 2.** Effect of phosphorus on yield parameters of sesame (BARI TIL-3)

Treatment	Yield parameters of sesame			
	Seed yield (kg ha <sup>-1</sup> )	Stover yield (kg ha <sup>-1</sup> )	Biological yield (kg ha <sup>-1</sup> )	Harvest index (%)
P <sub>0</sub>	1158.00 c	2573.00 c	3731.33 c	30.98 c
P <sub>1</sub>	1581.00 a	3034.42 b	4615.76 b	34.11 a
P <sub>2</sub>	1566.00 b	3070.48 a	4636.48 a	33.74 b
LSD (0.05)	3.06	3.01	2.73	0.42

In a column, same letter indicate non-significant difference and different indicate significant difference between them. P<sub>0</sub> = 0% P, P<sub>1</sub> = 20% P and P<sub>2</sub> = 30% P

### Qualitative character

Different levels of phosphorus showed significant variation for oil content (%) of sesame. The highest oil content of sesame (43.92%) was recorded from P<sub>1</sub> (20 % P) followed the result (42.20%) was obtained from P<sub>2</sub>. The lowest oil content of sesame (38.89 %) was recorded from P<sub>0</sub> (0 % P). Similar results were observed with the present study. Hafiz and El-Bramawy (2012) found that increasing phosphorus fertilizer rate up to 95 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> significantly increased seed oil content (%) and seed and oil yields ha<sup>-1</sup> of sesame.

**Table 3.** Effect of Phosphorus on Oil Content of sesame (BARI TIL-3)

Treatment	Oil content (%)
P <sub>0</sub>	38.89 b
P <sub>1</sub>	43.92 a
P <sub>2</sub>	42.20 a
LSD <sub>(0.05)</sub>	0.74

In a column, same letter indicate non-significant difference and different indicate significant difference between them. P<sub>0</sub> = 0% P, P<sub>1</sub> = 20% P and P<sub>2</sub> = 30% P

## CONCLUSION

The present study indicates that different levels of phosphorus showed significant effect on growth, yield and oil content of sesame. A balanced use of phosphorus can give optimum growth and yield of sesame. Less application of the nutrient can cause yield loss. However, further study may be needed in different Agro-Ecological Zones (AEZ) of Bangladesh with different varieties to recommend a package of technology for use at growers' level.

## ACKNOWLEDGEMENT

The authors sincerely express their gratitude for providing various facilities to the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh.

## CONFLICT OF INTEREST

There is no conflict of interest among the authors about the research.

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