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Effect of different fertilizer doses on the yield of sesame in Charland

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ABSTRACT

To determine the optimal nutrient management packages for BARI Til-4 in Charland areas and increase production along with farmers' income, an experiment was conducted under Charland at the multi-location testing site, Bhuapur of the On-Farm Research Division, Bangladesh Agricultural Research Institute, Tangail under AEZ-8 Tangail during two consecutive years of Kharif 2016 and 2017.Three different fertilizer doses were used, namely T_1: 107-39-32-17-3.6-0.6 kg ha^{-1} (based on soil test), T_2: 37-20-16-13-2-1 kg ha^{-1} + 5 t ha^{-1} cowdung (based on IPNS), and T_3: 18-8-18-0-0-0 kg ha^{-1} NPKSZnB. (farmers practice). Between the two years, among the treatments, the soil test-based fertilizer dose provided the highest seed yield (1.39 t ha^{-1}), which was comparable to the IPNS-based fertilizer dose (1.29 t ha^{-1}), while the farmers' practiced fertilizer dose produced the lowest seed yield (0.78 t ha^{-1}). T_1 treatment resulted in a yield increase of 7.75 and 78.20 percent when compared to T_2 and T_3 treatments, respectively. The highest gross return (Tk. 65500 ha^{-1}) and gross margin (Tk. 27637.64 ha^{-1}) from T_1 treatment, whereas the lowest return (Tk. 41500 ha^{-1}) and gross margin (Tk. 2505.04 ha^{-1}) were obtained from farmer practice. According to the overall results, a soil test-based fertilizer dose may be recommended in Charland sections of AEZ-8 for increased production and economic return.

Key Words: *Charland, Sesame, BARI Til-4, Fertilizer dose and Yield.*

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I. Introduction

Sesame (*Sesamum indicum* L.) belongs to the family Pedaliaceae a significant oil-producing crop that grows widely in different parts of the world. It is an annual, self-pollinated, indeterminate minor oil crop grown in the Kharif season (Akhtar et al., 2015). Sesame contains high-quality protein and oil

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(Johnson et al., 1979; Elleuch et al., 2007). Sesame, or "Til," is the third most significant source of edible oil in Bangladesh. Due to the presence of sesamolin and sesamin, two naturally occurring antioxidants that prevent rancidity, sesame oil is exceptionally stable. Low in cholesterol and high in polyunsaturated fatty acids in sesame oil (about 80 percent unsaturated fatty acids). Methionine and tryptophan, two sulfur-containing amino acids that are crucial for health, are abundant in sesame proteins (Bedigian, 2010). In addition, it is also used for manufacturing margarine, soap, paint, drugs, perfumery products and preparing different insecticides as dispersing agents (Chaubey et al., 2003). Sesame is very sensitive to the length of the day and the amount of water in the ground. However, it needs only 500-650 mm of rain annually because it has a deep taproot that can get water and nutrients from lower soil levels (Bedigian, 2010).

Ethiopia is considered the center of cultivation of Sesame (Weiss, 2000). A matter of discussion is present among scientists about the origin of sesame. Africa is presumed to be sesame's origin and later spread to Japan, China and India (Gangaiah, 2012). On the contrary, the Indian subcontinent is predicated on developing fertile hybrids, NMR spectroscopy and shared lignan components (Bedigian et al., 1985). It is now widely accepted that sesame was cultivated in the Indian subcontinent and subsequently spread to Mesopotamia during the Early Bronze Age (IPGRI, 2004). Sesame output in Bangladesh is impressive, accounting for the second-largest production share behind rapeseed and mustard. Sesame is grown on around 3,21,338 hectares of land, producing about 19795 metric tons (BBS, 2020). However, both the land area and output are steadily declining. Sesame was grown on around 36,000 hectares of land in 2009–2010, with a total yield of 32306 metric tons (BBS, 2010). Sesame production in Bangladesh is 500-600 kg ha^{-1} which can be increased to 1200 kg ha^{-1} by practicing improved variety and production technology (Azad et al., 2020).

The mid-channel island that occasionally rises from the riverbed due to accretion is known in Bengali as "Charland" (Elahi, 1991). Charland soil does not exhibit waterlogging or excessive moisture stress. Farmers in Bangladesh's char regions often plant mungbean or sesame as a stand-alone crop or mixtures with rice, jute, peanuts, millets and sugarcane after the Rabi crops (Malek et al., 2021). Sesame may be grown in Bangladesh because of its favourable climatic and edaphic conditions. Bangladesh's main sesame-growing regions are Jashore, Khulna, Barisal, Pabna, Rangpur, Sylhet and Tangail etc. Bhuapur Upazila in the Tangail district contains 12841 hectares of Charland (SRDI, 2017), compared to 0.82 million hectares nationwide (EGIS, 2000). Low yield is a common outcome of the old variety and poor management used by farmers in the Charland regions of Tangail. Crop production will rise with high-yielding varieties, soil testing and appropriate fertilizer application, including organic manure. To boost output and farmers' income, Bangladesh Agricultural Research Institute (BARI) introduced the high-yielding variety BARI Til-4 in the Charland region. This study was thus conducted to discover the appropriate nutrition management packages for this variety.

II. Materials and Methods

The trial was conducted at Bhuapur, Tangail, under AEZ-8 (Young Brahmaputra and Jamuna Floodplain) during Kharif 2016 and 2017. The Bangladesh Meteorological Department, Dhaka, provided meteorological data such as temperature (^{0}C) and total rainfall (mm) for the cropping period of the experiment (Figure 01) (BMD, 2017). Initial composite soil samples (0-20 cm) were collected from the experimental plot before the experiment and the collected samples were analyzed (Table 01). The test crop was BARI Til-4 (a high-yielding sesame variety that BARI introduced in 2009) and the unit plot size was 8 m x 5 m. The average plant height of this variety is 90-120 cm and the number of capsules is 85-90. BARI Til-4 has a red seed coat and takes 90-95 days to complete its life cycle. The average yield per hectare is 1.4 to 1.5 t ha^{-1} (Azad et al., 2020). The experiment was set up in an RCB design with six replications. Treatments were as follows:

Treatments	Descriptions	
T_1	107-39-32-17-3.6-0.6 kg ha^{-1} NPKSZnB	based on soil test basis inorganic fertilizer for high yield goal (HYG),
T_2	37-20-16-13-2-1 kg ha^{-1} NPKSZnB	Integrated Plant Nutrient System basis (IPNS) fertilizer management for HYG with 5 t ha^{-1} cowdung
T_3	18-8-18-0-0-0 kg ha^{-1} NPKSZnB	farmers' practice

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According to FRG (2012), the actual fertilizer dose for the farmers was calculated using the average of ten farmers' general fertilizer doses for sesame. At the flower initiation stage, the remaining nitrogen was added as a top-dressing in the following forms: urea, triple super phosphate, muriate of potash, gypsum, zinc sulfate and boric acid (25 days after sowing). The seeds were sowed on April 20–21, 2016, and April 1–2, 2017, with a 30 cm line-to-line spacing. Pesticides and other crop management techniques were necessary to maintain the crop's healthy growth and development. The crop was harvested on July 18-19, 2016 and July 2-3, 2017, respectively. Data on various plant characteristics, yield components, and seed yield were collected using two linear meter squares from each plot and ten randomly chosen plants from each plot. The data were analyzed using the R Project for Statistical Computing Software Version (3.5.1) (R Core Team, 2018) and the means were compared using the LSD test with a probability threshold of 5%. The gross return, variable cost, gross margin and BCR were computed based on the commodities' current market prices.

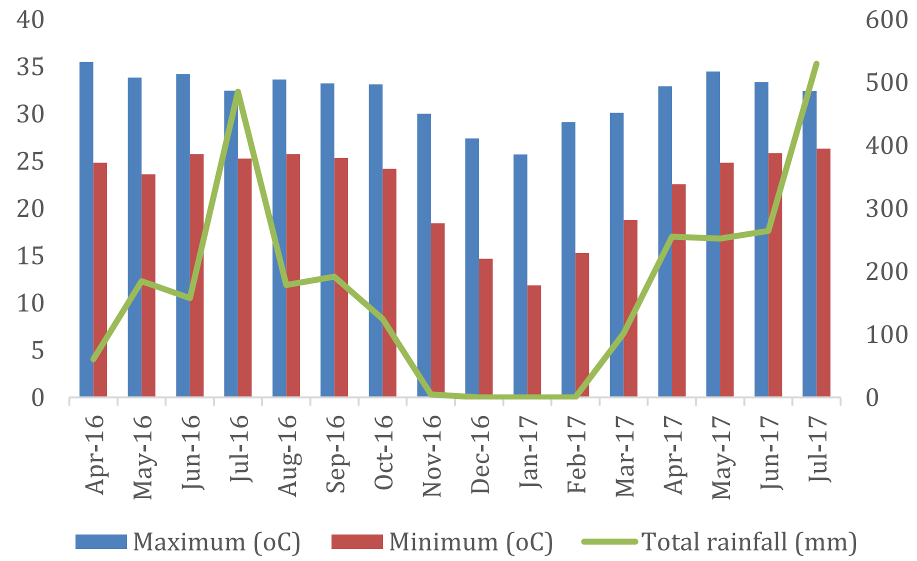

Figure 01. Monthly record of air maximum, minimum temperature (°C) and total rainfall (mm) of the experimental site during the period from April 2016 to July 2017

Table 01. Chemical properties of the experimental soil at MLT Site, Bhuapur, Tangail (AEZ-8) during Kharif 2016

	pH	OM (%)	N (%)	P (µg/g)	K (meq/100g)	S (µg/g)	Zn (µg/g)	B (µg/g)
Soil test value	6.97	1.48	0.07	4.39	0.181	15.46	0.49	0.25
Critical level	-	-	0.10	8	0.08	8.0	0.50	0.46
Interpretation	-	-	very low	very low	Medium	Medium	Low	Medium

III. Results and Discussion

Plant population m^{-2} (no.)

Results indicated no significant difference among the treatments in the case of plant population m^{-2} in both growing seasons of 2016 and 2017. Maximum plant population m^{-2} was observed in T_1 (37.33 and 34.33 in 2016 and 2017, respectively), followed by T_2 (34.67 and 32.33) (Table 02). The lowest plant population 31.67 and 32.00 in 2016 and 2017, respectively, were noted in farmers' practice. This may be due to fertilizer doses having no significant effect on the plant population.

Plant height (cm)

The statistical analysis showed no significant difference between T_1 and T_2, whereas there was a significant difference between T_1 and T_3; T_2 and T_3. Highest plant height observed in T_2 (122.40 and 95.56 cm in 2016 and 2017, respectively) treatment, followed by T_1 (120.03 and 86.96 cm in 2016 and 2017, respectively) whereas lowest in T_3 treatment (108.03 and 69.96 cm in 2016 and 2017, respectively) (Table 02). The tallest plant is the consequence of optimal vegetative development, made possible by nitrogen. Because protein and chlorophyll are made up of part of nitrogen, having enough nitrogen encourages cell growth and cell division (Ibrahim et al., 2014). Nitrogen fertilization results

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in an increase in plant height (Auwalu et al., 2007). Additionally, it was shown that the tallest plants grow when boron is applied in greater quantities (Deasarker et al., 2001).

Effective pod plant^{-1}

A significant difference was observed among the different treatments in 2016 and 2017. The highest number of effective pods plant^{-1} was observed in T_1 (29.40 and 29.60 in 2016 and 2017) followed by T_2 (29.26 and 29.46 in 2016 and 2017, respectively) and these two treatments are statistically identical. The lowest number of effective pods plant^{-1} was observed in T_3 (19.53 and 21.93 in 2016 and 2017, respectively) (Table 02). An appropriate supply of phosphate and nitrogen may cause producing more pods. A crucial part of the development of seeds is phosphorus. This result was consistent with studies by Shehu et al. (2010) and Haggai (2004), which found that increasing N (Prakash et al., 2001) and P treatment greatly increases the number of pods in plant^{-1}.

Table 02. Effect of fertilizer management on plant population m^{-2}, plant height (cm), number of effective pod plant^{-1} on BARI Til-4 in of Bhuapur during Kharif 2016 and 2017

Treatment	Plant population m^{-2} (no.)		Plant height (cm)		Effective pods plant^{-1} (no.)	
	2016	2017	2016	2017	2016	2017
T_1	37.33 a	34.33 a	120.03 a	86.96 a	29.40 a	29.60 a
T_2	34.67 a	32.33 a	122.40 a	91.56 a	29.26 a	29.46 a
T_3	31.67 a	32.00 a	108.03 b	69.96 a	19.53 b	21.93 b
$LSD_{0.05}$	NS	NS	2.36	NS	1.35	3.63
CV (%)	10.09	7.40	2.48	13.9	6.33	5.90

T_1: 105-38-32-14-2.5-0.7 kg ha^{-1} N-P-K-S-Zn-B (Based on a soil test basis fertilizer dose)
T_2: 37-20-16-13-2-1 kg ha^{-1} N-P-K-S-Zn-B + 5 t ha^{-1} (Integrated Plant Nutrient System basis fertilizer dose);
T_3: 18-8-18-0-0-0 kg ha^{-1} N-P-K-S-Zn-B (Farmers' practice)

Table 03. Effect of fertilizer management on the number of seeds pod^{-1}, the weight of 1000 seed (g) and yield (t ha^{-1}) BARI Til-4 in Charland of Bhuapur during Kharif 2016 and 2017

Treatment	Seeds pod^{-1} (no.)		1000 seed weight (g)		Seed yield (t ha^{-1})	
	2016	2017	2016	2017	2016	2017
T_1	73.96 a	61.20 a	2.71 a	2.73 a	1.50 a	1.28 a
T_2	72.26 a	57.53 a	2.70 a	2.68 a	1.40 a	1.19 a
T_3	66.53 a	51.93 a	2.23 b	2.26 b	0.82 b	0.75 b
$LSD_{0.05}$	NS	NS	0.11	0.39	0.11	0.27
CV (%)	8.90	10.30	1.97	6.40	10.9	9.71

The number of seeds pod^{-1}

It was revealed that the number of seeds pod^{-1} was significantly affected by applying different fertilizer doses. The highest number of seeds pod^{-1} was observed in T_1 treatment (73.96 and 61.20 in 2016 and 2017), followed by T_2 treatment (72.26 and 57.53 in 2016 and 2017, respectively). The lowest number of seeds pod^{-1} was found in T_3 treatment (66.53 and 51.93 in 2016 and 2017, respectively) (Table 03). The higher number of seeds pod^{-1} observed may be due to the increased nutrient supply (Okpara et al., 2007). According to Nahar et al. (2008), the seeds capsule^{-1} considerably increased up to 100 kg N ha^{-1}. Kathiresan (1999) indicated that the P level of 35 kg ha^{-1} affected how many seeds of sesame were produced per capsule. Potassium (Mandal et al., 1992) and K_2O (Tiwari et al., 1994) significantly raised the quantity of seeds capsule^{-1}.

Thousand seeds weight (g)

The data regarding thousand seeds' weight showed significant differences among the treatments. The highest 1000 seeds weight was observed in T_1 (2.71 and 2.73 g in 2016 and 2017, respectively) followed by T_2 (2.70 and 2.68 in 2016 and 2017, respectively) and these treatments are identical. The lowest thousand seeds weight was recorded in T_3 treatment (2.23 and 2.26 in 2016 and 2017, respectively) (Table 03). Compared to farmers' inadequate nutrient management, the delivery of necessary nutritional components at sufficient levels leads to a higher yield of 1000 seeds. The outcomes are consistent with Ahmad et al. (2001) findings. According to Ghosh and Patra (1994), Sesame can weigh up to 60 kg N ha^{-1} per 1000 seeds. The weight of the 1000 seeds grew dramatically with each subsequent increment in N dosage up to 60 kg ha^{-1} (Prakash et al., 2001). According to

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Nahar et al. (2008), the weight of 1000 seeds grew noticeably up to 100 kg N ha^{-1}. The greatest 1000-seed weight, according to Mian et al. (2011), was 90 kg P_2O_5 ha^{-1}. The weight of the 1,000 seeds rose significantly after potassium application (Mandal et al., 1992).

Seed yield

The results obtained from seed yield (t ha^{-1}) revealed that the maximum yield was found in T_1 treatment (1.50 and 1.28 t ha^{-1} in 2016 and 2017), followed by T_2 (1.40 and 1.19 t ha^{-1} in 2016 and 2017) though all treatments were statistically identical. Poor seed yield was obtained from farmers who practiced fertilizer dose (T_3) (0.82 and 0.75 t ha^{-1} in 2016 and 2017, respectively) (Table 03). A sufficient supply of nutrients has a good impact on the yield-contributing characteristics, improving yield. A higher number of pods per plant and a higher weight per thousand seeds might contribute to higher seed production (Ali and Ahmed, 2012). According to Jadhav et al. (1992), the application of 120 kg N and 75 kg P_2O_5 ha^{-1} resulted in maximum grain production since more capsule plants and seeds were produced per plant. With each further increase in the N and K application rates, up to 80 and 60 kg ha^{-1}, respectively, seed production rose (Mandal et al., 1992).

Cost and return

Gross return (Tk. 69500 and Tk. 64500 ha^{-1} in T_1 and T_2 treatment, respectively) was higher, although total cultivation cost (Tk. 37862 and Tk. 36718 ha^{-1} in T_1 and T_2 treatment, respectively) was also more in soil taste based and IPNS based fertilizer dose due to higher fertilizer and cowdung price. A higher gross margin Tk. 31638 and Tk. 27782 ha^{-1} in T_1 and T_2 treatment, respectively, was found compared to T_3 treatment (Tk. 11606 ha^{-1}) (Table 04). In summary, soil taste-based fertilizer dose produced the highest gross return (Tk. 69500 ha^{-1}), gross margin (Tk. 31638 ha^{-1}) and BCR (Benefit Cost Ratio) of 1.83, while farmers' actual fertilizer dose produced the lowest gross return (Tk. 39000 ha^{-1}), gross margin (Tk. 11606 ha^{-1}) and BCR (Benefit Cost Ratio) of 1.42. The ideal sesame fertilizer dose for obtaining maximum BCR in the Charland of Bhuapur, Tangail, would be 55-10-14-7 kg ha^{-1} NPKS (AEZ- 8) (Islam and Rahman, 2016).

Table 04. Cost and return analysis of BARI Til-4 at Charland of Bhuapur during Kharif 2016 and 2017

Treatment	Mean yield of 2016 and 2017 (t ha^{-1})	Gross return (Tk ha^{-1})	Total cultivation cost (Tk ha^{-1})	Gross margin (Tk ha^{-1})	BCR* (%)
T_1	1.39	69500	37862	31638	1.83
T_2	1.29	64500	36718	27782	1.75
T_3	0.78	39000	27394	11606	1.42

The market price of different inputs (Tk kg^{-1}): BARI Til-4 grain- 50, Urea- 16, TSP (Triple Super Phosphate)- 22, Muriate of Potash (MoP)- 15, Gypsum-13, Boric acid- 400, Cowdung- 2, Labour wage- 300 day^{-1} person^{-1}

IV. Conclusion

In the Charland of Bhuapur, Tangail, the results of the study over two years show that BARI Til-4 with 105-38-32-14-2.5-0.7 kg ha^{-1} NPKSZnB, respectively, offered the maximum yield and economic returns. This fertilizer dosage may be suggested for sesame cultivation in Bangladesh's AEZ-8 regions and the Charland of Bhuapur.

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