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Research Article

Responses of tiba on growth, yield and biochemical components of BARI Maize-6

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ABSTRACT

A field trial was carried out to investigate the responses of TIBA (0, 25, 50, 75, and 100 ppm) on growth, yield, and biochemical components of BARI Maize-6. Results revealed that plant height gradually reduced with the rising levels of TIBA but non-significantly. The application of 75 ppm TIBA resulted in the highest number of leaves and maximum dry weight of leaves and stems, whereas the dry weight of leaves was significantly higher than that of the control. Plants treated with 50 ppm TIBA resulted in maximum dry weight of roots, absolute growth rate, and relative growth rate, but statistically, they were at par with the rest of the treatments. The total number of cobs per plant was noted to be the highest at 50 ppm, followed by 75 ppm TIBA. Application of 75 ppm TIBA produced the highest fresh (127.10 g) and dry (111.51 g) weight of cobs, the longest cob (17.07 cm), the maximum number of kernels per row (31.81) and cob (408.17), dry weight of tassel (3.75 g), yield per plant (107.07 g) yield per hectare (7138.08 kg) and harvest index (89.72%). Significantly higher values were noted in the case of fresh and dry weight of cobs, number of kernels per cob, yield per plant, and yield per hectare. Yield per plant due to 75 ppm TIBA increased by 65.72% over control. Pigment contents of leaves responded positively following most of the TIBA treatments except chl. a content at the tassel initiation stage. Positive responses of TIBA in the protein content of leaves were also obtained in most cases. The maximum protein content of seeds was recorded from 50 ppm (94.88 mg/g) followed by 75 ppm (83.94 mg/g) TIBA but with a similar statistical identity. Among five treatments, 75 ppm TIBA produced better stimulations.

Introduction

Rice, wheat, and maize comprise a chief factor of the human diet, representing 42 and 37% of the world's calories and protein intake, respectively (FAOSTAT, 2021). Among cereals, the worldwide annual production of maize (*Zea mays* L.) is greater than 1 billion metric tons (García-Lara and Serna-Saldivar, 2019). Comparatively, maize is a more versatile crop than wheat and rice used as a feed crop and plays a pivotal role in global food security (Grote et al., 2020; Poole et al., 2021).

Maize is a crucial task in our country's agri-based economy. It is consumed in many forms across the country and has become a good source of nutrition for the escalating population of Bangladesh. Farmers could not obtain higher yields in Bangladesh due to diverse constraints, and the country needed to import a large amount of maize annually to mitigate its rising demand. Among the various methods of improving crop production, using plant growth regulators (PGRs) is the best technique for such an attempt. Insufficiency of these magical substances

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may generate an obstacle in attaining the desired yield. Additionally, these hormones can develop physiological efficacy, photosynthetic capability, and suitable partitioning in various crops.

Previous findings indicated that TIBA (2,3,5 tri-iodo benzoic acid) at minute dose had inducing effect in promoting physiological parameters, yield attributes and biochemical components of various important crop plants *viz*. chickpea (Islam and Jahan, 2019), soybean (Basuchaudhuri, 2016), papaya (Mutum et al., 2021), rice (Adam et al., 2015, Doel et al., 2021). However, no investigation has been completed in Bangladesh regarding applying TIBA for maize. Thus, the current investigation was conducted to assess the responses of TIBA to some growth parameters, yield attributes, and biochemical components of maize var. BARI Maize-6.

Materials and Methods

A trial was carried out in the research field of the botanical garden at Jagannath University, Dhaka, Bangladesh. The trial was laid out in RBD and had three replications. The size of the investigational area was 40.0 m^2, which was divided into three plots. Each plot consisted of 5 rows, maintaining a distance of 75 cm between two rows and 20 cm between plant to plant. Preparation of the experimental field was done conventionally. Cow dung was mixed homogenously, and chemical fertilizers were applied as described by Chowdhury and Hassan (2013). One-third of urea and a full dose of other fertilizers were given during final plowing. The remaining doses of urea were applied at tassel initiation and before the silking stage. Calcium hypochlorite (0.5%) was used for seed sterilization. Cultural practices were maintained following methods described by Chowdhury and Hassan (2013) in the Handbook of Agricultural Technology. This experiment comprised control, 25, 50, 75, and 100 ppm foliar TIBA treatments. The foliar spray was done in the early morning of the sunny day. Height of plant, number of leaves, dry weight of leaves, stem and root, shoot-root ratio, biomass duration (BMD), absolute growth rate (AGR), and relative growth rate (AGR) were recorded after harvest following standard methods. Yield contributing parameters and yield were estimated after harvest. Leaf pigment and protein content were recorded at tassel initiation and grain filling stages, whereas the protein content of seed after harvest as per approved procedures (Mckinney, 1940; Lowry et al., 1951; von Wettstein, 1957; Maclachalan and Zalik, 1963).

Six plants from each treatment were arbitrarily selected to collect data on different parameters. Collected data were subjected to statistical analysis, and LSD test treatment was done at a 5% level of significance for the comparison of treatment means (Steel et al., 1997).

Results and Discussion

Findings indicated that the plant height of BARI Maize-6 reduced gradually with the increasing concentration of TIBA (Table 1). The maximum decrease due to 100 ppm TIBA was 6.08% higher than the control. The leaf number of BARI Maize-6 was positively influenced by the application of TIBA but non-significantly. A maximum number of leaves, 11.83, was noted from 75 ppm TIBA followed by 100 ppm (11.67) treatment. Findings on the height of plant and leaf number are in harmony with the results of other investigations (Adam et al., 2015; Basuchaudhuri, 2016; Islam and Jahan, 2019; Doel et al., 2021).

Table 1 indicated that foliar application of TIBA as foliar treatment produced a higher amount of biomass, i.e., dry weight of leaves, stem, and root, than control, where 75 ppm TIBA resulted in maximum dry weight of leaves (39.99 g) and stem (73.47 g). The dry weight of leaves was recorded at 50, 75, and 100 ppm. Even though they produced significantly superior weights to the control, they were identical to the 25 ppm treatment. Results also showed that the highest dry weight of roots was recorded from 50 ppm (14.02 g) but not statistically

dissimilar from other treatments. This result is very similar to the findings of Adam and Jahan (2014) on BARI Mung-5 and Jahan and Khan (2014) on soybean.

TIBA as foliar spray had retarding responses on the shoot-root ratio of BARI Maize-6. However, BMD, AGR, and RGR were positively influenced due to TIBA treatments (Table 1).

per plant due to TIBA treatment augmented but with non-significant variations.

On the other hand, the report of Adam et al. (2018) revealed positive responses of TIBA on the number of productive tillers per plant. The experiment's findings showed that the fresh and dry weight of cobs was enhanced significantly due to all applications of TIBA treatments, with an exception. The maximum fresh

Table 1. Effect of TIBA on growth parameters of BARI Maize-6 at harvest.

Treatments	Height (cm)	No. of leaves/ plant	Dry weight of leaves (g)	Dry weight of stem (g)	Dry weight of roots (g)	Shoot-root ratio	BMD	AGR (g/day)	RGR (g/g/day)
Control	243.83	10.50	23.40 [b]	48.83	8.52 [a]	7.91	1286.00	-0.803	-0.007
25 ppm TIBA	241.00	11.17	35.54 [ab]	51.37	11.62 [a]	4.19	1362.80	-0.660	-0.002
50 ppm TIBA	239.33	11.00	39.16 [a]	58.69	14.02 [a]	2.49	1320.18	0.503	0.015
75 ppm TIBA	236.50	11.83	39.99 [a]	73.47	12.91 [a]	6.03	1463.30	-0.023	-0.006
100 ppm TIBA	229.00	11.67	39.01 [a]	71.48	9.49 [a]	4.82	1298.50	0.433	0.011
CV (%)	6.53	11.83	29.83	17.05	11.43	5.61	25.44	27.46	17.31
LSD (0.05)	NS	NS	14.52	NS	10.56	NS	NS	NS	NS

The mean followed by an identical letter (vertically) or without a letter is statistically similar at a 5% level.

Outcomes are reasonably in harmony with the conclusion of Islam and Jahan (2016) on chickpeas. Table 2 revealed that spraying of TIBA had inducing effects on yield components of BARI Maize-6. A total number of cobs per plant was positively responded to due to TIBA application, where 50 ppm TIBA produced a maximum number of cobs (1.50) followed by 75 ppm (1.33) and both 25 and 100 ppm (1.17) treatments, respectively. A higher number of cobs per plant following TIBA treatments has also been reported by Mutum et al., (2021). Results showed that TIBA as foliar spray did not influence the number of productive cobs per plant, whereas all the treatments produced a similar number of productive cobs (1.0). Several non-productive cobs

(127.10 g) and dry weight of cobs (111.51 g) was

The highest dry weights were obtained from 75 ppm TIBA, followed by 50, 25, and 100 ppm TIBA treatments, respectively. Several researchers also obtained increases in dry weight of pods due to TIBA application in different crops (Adam et al., 2018; Doel et al., 2021).

TIBA treatments positively responded to the length of the cob, and the application of 75 ppm resulted in the longest cob in BARI Maize-6. Many researchers have observed the stimulating effects of TIBA on pod length in different crops (Adam et al., 2018; Doel et al., 2021). Thus, the findings are fairly similar to those of earlier workers.

Outcomes presented in Table 2 indicated that the number of kernels per row, kernels per cob, dry weight of tassel, 1000-grains weight, yield per plant, and hectare were remarkably influenced by TIBA application where a significantly higher number of kernels per cob was noted from 75 ppm but statistically similar to other treatments. A foliar spray of 75 ppm TIBA also produced maximum cob length, number of kernels per row, yield, and harvest index. The weight of 1000-grain due to 25 ppm TIBA treatment was recorded as a superior value but statistically at par with other treatments.

Table 2. Effect of TIBA on yield attributes and yields of BARI Maize-6 at harvest.

Treatments	Total no. of cobs /plant	No. of productive cobs/ plant	No. of non-productive,cos/ plant	Fresh weight of Cob (g)	Dry weight of Cob (g)	Length of cob (cm)	No. of Karnels rows/ cob	No. of kerns/row	No. of kernels/ cob	Dry weight of tassel (g)	1000-grain weight (g)	Yield/ plant (g)	Yield /hectare (kg)	Harvest Index (%)
Control	1.00	1.00	0.00	83.48 ^{b}	70.43 ^{b}	14.15	12.83	21.42	273.33 ^{b}	1.78	236.73 ^{b}	64.61 ^{b}	4306.89 ^{b}	84.56
25 ppm TIBA	1.17	1.00	0.17	108.56 ^{ab}	95.71 ^{a}	16.20	12.83	24.69	318.17 ^{ab}	2.48	283.70 ^{a}	88.57 ^{ab}	5904.34 ^{ab}	88.26
50 ppm TIBA	1.50	1.00	0.50	124.48 ^{a}	109.40 ^{a}	16.62	12.50	28.46	355.00 ^{ab}	3.24	279.23 ^{ab}	99.43 ^{a}	6628.83 ^{a}	83.66
75 ppm TIBA	1.33	1.00	0.33	127.10 ^{a}	111.51 ^{a}	17.07	12.83	31.81	408.17 ^{a}	3.75	262.80 ^{ab}	107.07 ^{a}	7138.08 ^{a}	89.72
100 ppm TIBA	1.17	1.00	0.17	104.32 ^{a}	95.86 ^{a}	15.50	12.17	24.63	293.50 ^{b}	3.44	276.73 ^{ab}	82.39 b	5492.35 ^{ab}	65.43
CV (%)	14.88	0.00	8.36	22.06	23.07	12.02	9.63	7.18	23.26	43.52	11.65	24.30	24.30	31.73
LSD (0.05)	NS	-	NS	33.41	29.52	NS	NS	NS	102.89	NS	42.03	27.36	1824.18	NS

The maximum yield per plant due to 75 ppm TIBA was 65.72% higher than the control, followed by 50 ppm (53.89%), 25 ppm (37.14%), and 100 ppm (27.52%), respectively. Results also showed that 75 ppm, although producing a significantly superior yield than the control and 100 ppm TIBA, was statistically equal to the 25 and 50 ppm treatments.

The stimulating responses of TIBA on yield attributes and yield have also been observed by various authors on diverse plants, viz. chickpea (Islam and Jahan, 2019), papaya (Mutum et al., 2021), mungbean (Adam and Jahan, 2014). Hence, the current results concur with the outcomes for many workers.

Findings revealed that TIBA as a foliar spray had mostly inducing effects on the leaf pigment of BARI Maize-6 at both the tassel initiation and grain-filling stages.

At the tassel initiation phase, 25, 50, and 75 ppm TIBA resulted in higher chlorophyll b and carotenoid content of leaves than the control with an exception.

Chlorophyll content decreased due to all concentrations of TIBA (Table 3). At the grain-filling stage, a higher quantity of chlorophyll a, b, and carotenoid content was noted from TIBA treatments except chlorophyll content due to 100 ppm treatment. The results also revealed that 50 ppm TIBA at the tassel initiation stage and 25 ppm TIBA at the grain filling stage resulted in maximum pigment content except for chlorophyll content in the case of the tassel initiation stage.

Similar results of increases were observed by Adam et al., 2018).

Leaf protein at both tassel initiation and grain filling stages were positively influenced by TIBA application except due to 75 and 100 ppm treatments at the grain filling stage (Table 4). Findings also indicated that the protein content of the seed increased by 14.31% and 1.13% due to 75 and 100 ppm treatment, respectively. However, applying 25 ppm and 100 ppm TIBA reduced the protein content of seeds by 33.06% and 21.13%, respectively. The outcome of this investigation contradicts the results of Doel et al. (2021), where they obtained higher protein content from 25 ppm TIBA in BRRI Dhan-55, but is in compliance with the findings of Ridge (1991).

Table 3. Responses of TIBA on the photosynthetic pigment of leaves (mg/g) of BARI Maize-6 at tassel initiation and grain filling stages.

Treatments	Tassel initiation stage			Grain filling stage		
	Chl [a]	Chl [b]	Carotenoids	Chl [a]	Chl [b]	Carotenoids
Control	0.252 [a]	0.121	6.803 [ab]	0.235 [b]	0.088 [b]	2.600 [bc]
25 ppm TIBA	0.170 [b]	0.159	7.036 [a]	0.424 [a]	0.142 [a]	3.477 [a]
50 ppm TIBA	0.166 [b]	0.300	7.722 [a]	0.366 [a]	0.111 [ab]	3.175 [ab]
75 ppm TIBA	0.213 [ab]	0.215	7.114 [a]	0.384 [a]	0.123 [a]	2.813 [abc]
100 ppm TIBA	0.077 [c]	0.135	5.782 [b]	0.226 [b]	0.089 [b]	1.517 [d]
CV (%)	6.87	8.03	21.57	7.86	6.64	6.27
LSD (0.05)	0.063	NS	1.090	0.090	0.031	0.701

The mean followed by an identical letter (vertically) or without a letter is statistically similar at a 5% level.

Table 4. Responses of TIBA on the protein content of leaves and seeds (mg/g) of BARI Maize-6.

Treatments	Leaves		Seeds
	Tassel initiation stage	Grain filling stage	At harvest
Control	6.50	3.25[b]	83.00 [ab]
25 ppm TIBA	8.13	7.70[a]	55.56 [b]
50 ppm TIBA	8.70	4.50[ab]	94.88 [a]
75 ppm TIBA	7.08	1.48[b]	83.94 [ab]
100 ppm TIBA	10.53	1.23[b]	65.46 [ab]
CV (%)	12.73	16.74	33.27
LSD (0.05)	NS	3.29	29.57

The mean followed by an identical letter (vertically) or without a letter is statistically similar at the 5% level.

Conclusion

The overall findings indicated that TIBA as a foliar spray had promoting responses regarding growth, yield, photosynthetic pigment, and protein content of leaves and seeds. Among the 25, 50, 75, and 100 ppm TIBA treatments, the application of 75 ppm produced better stimulation for obtaining higher yield.

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