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EFFECTS OF TRIIODOBENZOIC ACID ON GROWTH, YIELD AND PHOTOSYNTHETIC PIGMENT CONTENT OF CHICKPEA (*CICER ARIETINUM* L.)

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Abstract

An experiment was conducted to evaluate the effect of seed soaking treatment of TIBA (10, 15, 20, 25, 30 and 35 ppm) on growth, yield and photosynthetic pigment-content of chickpea var. BARI Chhola-6. Results revealed that TIBA had mostly retarding effects on plant height of BARI Chhola-6 with both significant and non-significant variations. The Number of branches and leaves per plant was positively influenced following all concentrations of TIBA where, seed treated with 35 ppm TIBA-produced the highest values. Results revealed that TIBA treatments had inducing effects on flower initiation and completion. Application of TIBA induced the yield and yield attributes of BARI Chhola-6 where, 30 ppm TIBA produced the highest number of pods (72.25), maximum number of seeds per plant (112.13), 100-seed weight (23.84g) and yield per plant (15.92g). TIBA had pronounced effects on the photosynthetic pigment content of BARI Chhola-6 although 35 ppm TIBA resulted-maximum values but not significantly different from 30 ppm and some other treatments. Of the seven treatmnts, 30 ppm TIBA produced better stimulations.

Introduction

Chickpea (*Cicer arietinum* L.) is the world's second-largest food legume crop in total production. In Bangladesh, chickpeas ranked fifth in area and-yield-but second in consumption priority (BBS 2018). It is primarily a major source of protein, essential nutrients *viz.* calcium, zinc and iron for vegetarian population (Lekshmy *et al.* 2009). The average production of chickpea in our country is about 746 kg/ha, which is poor and lower than some other countries (Reja *et al.* 2020). More-than one half of total demand of chickpea has to be imported in every year to meet the requirement of the country (Hoque *et al.* 2021).Therefore, the production needs to be increased to meet the demand of the people and to avoid import and save the foreign currency. Among the various yield boosting agronomic techniques, application of plant growth regulators is one of the best attempts to increase yield. These substances can increase the source-link relationship and stimulate the translocation of photo-assimilates, thereby increasing productivity (Khan and Mazid 2018). In addition, application of PGRs as-seed soaking, foliar spray, soil application, stem injection etc. are very effective in promoting the physiology of plants (Kumar *et al.* 2018). Findings of various investigations showed that application of TIBA (2,3,5 tri-iodo benzoic acid) at proper concentrations had inducing effect on growth and yield of a number of economically important crop plants *viz.* tomato (Mondal and Dutta 2002), cotton (Djanaguiraman *et al.* 2005), jatropha (Abdelgadir *et al.* 2009), mungbean (Adam and Jahan 2014), soybean (Jahan and Khan 2014, Basuchaudhuri 2016), rice (Adam *et al.* 2015, Adam *et al.* 2018, Doel *et al.* 2021), chickpea (Islam and Jahan 2019) and papaya (Mutum *et al.* 2021).

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Materials and Methods

A field experiment was conducted at the botanical garden of the Department of Botany, Jagannath University, Dhaka, Bangladesh. The experiment was laid out in RBD with four replications. The total area of the experimental field was 42 m^2 having a gap of 50 cm in between each plot. The experimental field was prepared conventionally following the methods as described by Chowdhury and Hassan (2013). Seeds were collected from Bangladesh Agricultural Research Institution (BARI), Joydebpur, Gazipur. Sowing was done following the line sowing method maintaining row to row distance of 40 cm and seed to seed distance of 10 cm. Cow dung and chemical fertilizers *viz.* Urea, TSP, MP and boric acid were applied at doses recommended by the Fertilizer Recommendation Guide (2012). Two-thirds of urea and full doses of the other fertilizers were applied as basal doses during final land preparation. The remaining urea was applied immediately after the first irrigation.

Seeds were sterilized with 0.5% calcium hypochlorite. Cultural practices *viz.* thinning, irrigation, weeding etc. were done following methods quoted in Handbook of Agricultural Technology (Chowdhury and Hassan 2013). This experiment consisted of seven treatments *viz.* control (distilled water without TIBA), seed soaking with 10, 15, 20, 25, 30 and 35 ppm TIBA. Seeds were soaked for 12 hrs before sowing. For the preparation of stock solution, TIBA was first dissolved in 1N NaOH solution and then the volume raised with distilled water. Data on plant height, number of branches and leaves per plant were recorded at an interval of 15 days from the age of 30 days up to harvest. Time required for flower initiation and completion were recorded in days. Yield attributes and yield per plants were calculated after harvest at the age of 112 days. Eight plants (2-plants from each replication) from each treatment were taken to record data on different growth and yield parameters. Photosynthetic pigment content of leaves was estimated at three stages *viz.*, vegetative, flowering and harvest with the help of approved procedures (Mckinney 1940, von Wettstein 1957, Maclachalan and Zalik 1963). Data were analyzed statistically and treatment means were compared by LSD test at 5% level of significance (Steel *et al.* 1997).

Results and Discussion

Results presented in Table 1 revealed that application of TIBA had mostly retarding effects on plant height of BARI Chhola-6 with both significant and non-significant variations. Significant decrease in plant height was noted at 90 days and at harvest due to all treatments. Decrease in plant height due to TIBA treatments have also been reported by many researchers (Adam and Jahan 2014, Jahan and Khan 2014, Basuchaudhuri 2016, Islam and Jahan 2019). However, Adam *et al.* (2015) and Doel *et al*. (2021) found stimulatory effect of TIBA at lower concentrations on rice. Thus, the present results are in agreement with those of other workers who have observed that height of plant may decrease depending on concentration of TIBA.

Findings indicated that application of TIBA as seed soaking treatments had resulted-higher number of branches per plant throughout the growth periodswith significant variations following most of the treatments (Table 2). Results showed that number of branches per plant increased with the increasing concentrations of TIBA and the maximum values were noted at 35 ppm treatment in majority of the cases. Similar results of increase in number of branches per plant following TIBA treatments have also been reported by Adam and Jahan (2014) on mungbean, Basuchaudhuri (2016) on soybean, Islam and Jahan (2019) on chickpea and Doel *et al*. (2021) on rice.

Table 1.Effects of TIBA on plant height (cm) of BARI Chhola-6 at different intervals.

Treatments	Age of plants (DAS)						
	30	45	60	75	90	105	(At Harvest)
Control	14.83a	16.85ab	23.48a	28.24ab	32.84a	44.53a	51.08a
10 ppm TIBA	14.18a	13.31e	20.58b	30.03a	30.70b	43.38ab	47.28b
15 ppm TIBA	13.44a	17.40a	23.83a	28.11b	30.55bc	44.31ab	46.24bc
20 ppm TIBA	15.48a	15.66cd	21.64ab	27.57bc	29.12bcd	43.90ab	45.88bc
25 ppm TIBA	14.63a	16.50abc	22.93ab	27.50bc	28.72cd	43.83ab	45.11bcd
30 ppm TIBA	14.09a	15.60cd	21.90ab	27.21bc	27.71de	43.54ab	44.03cd
35 ppm TIBA	14.20a	16.06bcd	22.58ab	26.16c	26.76e	42.43b	43.10d
CV (%)	16.18	15.02	10.81	7.12	8.42	4.83	6.30
LSD (0.05)	2.63	1.11	2.66	1.89	1.87	2.48	1.84

Means in a column followed by the same letter or without a letter are not different significantly at the 5 % level by DMRT. DAS means days after soaking.

Table 2. Effects of TIBA on the number of branches per plant of BARI Chhola-6 at different intervals.

Treatments	Age of plants in days after seed soaking (DAS)						
	30	45	60	75	90	105	(At harvest)
Control	2.50d	5.88b	7.50b	13.00d	17.88d	18.25d	18.50b
10 ppm TIBA	3.38cd	6.13b	8.63b	15.50cd	21.25c	21.75c	21.88ab
15 ppm TIBA	3.75c	7.13b	8.88b	17.25bc	21.50bc	21.75c	22.13ab
20 ppm TIBA	3.88c	7.38ab	9.00b	17.88bc	21.75bc	21.88bc	22.00ab
25 ppm TIBA	4.00b	7.25ab	10.75ab	19.75ab	23.50ab	22.88ab	23.00ab
30 ppm TIBA	5.13ab	8.00a	11.00a	20.63a	24.13a	23.88a	24.00a
35 ppm TIBA	6.00a	8.13a	12.13a	22.00a	24.50a	24.75a	24.90a
CV (%)	34.98	21.42	22.42	20.27	13.54	11.73	11.08
LSD (0.05)	1.18	1.66	1.73	2.55	2.18	2.01	4.71

Means in a column followed by the same letter or without a letter are not different significantly at the 5 % level by DMRT. DAS means days after soaking.

The number of leaves per plant of BARI Chhola-6 was positively influenced by TIBA application with an exception due to 10 ppm at the age of 30 DAS. Seed soaking with 35 ppm TIBA resulted highest number of leaves per plant all over the growth periods and were significantly higher than control at 30 and 45 DAS (Table 3). Islam and Jahan (2019) recorded maximum number of leaves from TIBA treatments on chickpea. The positive effect of TIBA on number of leaves per plant were-also reported by many other authors (Adam and Jahan 2014, Jahan and Khan 2014). However, Doel *et al.*(2021) recorded higher number of leaves due to 10 ppm TIBA only. Thus, the finding of the present study is fairly conforming to the outcome of above-mentioned workers.

The emergence of flower and the time required for completion of the flower are presented in Fig. 1. Results revealed that seed soaking with TIBA treatments had inducing effects on flower initiation and completion. Seed treated with 35 ppm TIBA had taken the lowest time for flower initiation followed by 30, both 15 and 20, 25 and 10 ppm treatments, respectively. Application of

TIBA had almost similar trend on flower completion where flowering was completed in shortest time due to 30 ppm treatment followed by 35 and 25 ppm TIBA, respectively.

Seed soaking with different concentrations of TIBA had inducing effects on yield attributes and yield of BARI Chhola-6 with significant variations in most of the cases (Table 4). Significantly higher values in number of pods per plant were obtained from 15, 25, 30 and 35 ppm TIBA treatments. The maximum increase in number of pods per plant due to 30 ppm TIBA was 47.92% than the control followed by 35 ppm TIBA (45.66%). Present findings are in agreement with the results of other investigators (Jahan and Khan 2014, Adam and Jahan 2014, Basuchaudhuri 2016, Mutum *et al*. 2021).

Table 3. Effects of TIBA on number of leaves per plant of BARI Chhola-6 at different intervals.

	Age of plants (DAS)						
Treatments	30	45	60	75	90	105	(At harvest)
Control	93.13c	235.70b	298.67a	468.12a	670.00a	850.30a	1079.00a
10 ppm TIBA	89.88c	285.20ab	367.50a	564.78a	723.40a	913.54a	1486.25a
15 ppm TIBA	103.00bc	317.06ab	397.31a	596.34a	757.53a	934.50a	1114.00a
20 ppm TIBA	116.13bc	333.43ab	408.76a	606.45a	805.45a	978.23a	1268.13a
25 ppm TIBA	126.50b	317.56ab	426.54a	645.47a	843.75a	1043.54a	1220.63a
30 ppm TIBA	125.13b	353.24a	430.45a	657.50a	864.53a	1154.59a	1492.88a
35 ppm TIBA	155.25a	376.20a	476.56a	689.34a	896.25a	1260.87a	1510.75a
CV (%)	32.04	20.39	29.76	20.67	25.67	39.10	41.35
LSD (0.05)	29.04	98.48	230.43	305.49	379.39	577.89	611.14

Means in a column followed by the same letter or without a letter are not different significantly at the 5 % level by DMRT. DAS means days after soaking.

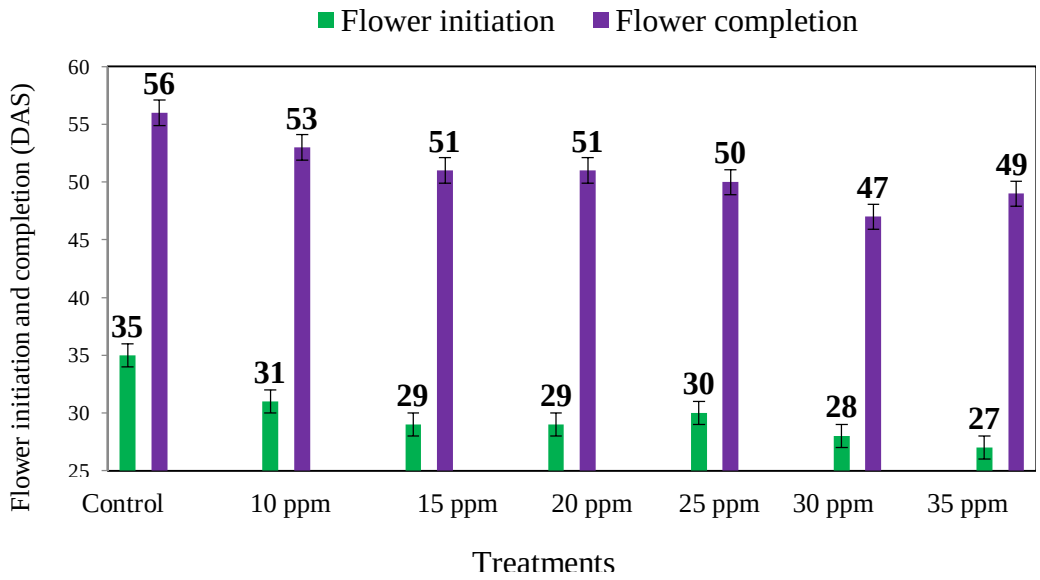

Fig. 1. Effects of TIBA on flower initiation and completion of BARI Chhola-6.

Application of TIBA had positive responses on the pod length of BARI Chhola-6 but with non-significant variations (Table 4). The stimulatory effects of TIBA on length of pod were observed in different crops by many researchers (Adam and Jahan 2014, Adam *et al.* 2018, Doel *et al.* 2021). Number of seeds per plant gradually increased with the increasing concentrations of TIBA from 15 ppm up to 35 ppm where the increase was significantly higher due to 20, 25, 30 and 35 ppm TIBA treatments (Table 4). Results obtained in case of number of seeds per pod are in accord with the findings of Adam and Jahan (2014) on mungbean, Jahan and Khan (2014) on soybean and Doel *et al.*(2021) on rice.

The number of seeds per plant was significantly enhanced following seed soaking with TIBA treatments. Seed treated with 30 ppm TIBA resulted in significantly highest number of seeds per plant (112.13) followed by 35 ppm (91.63) and 25 ppm (76.75), respectively. This result is resembled to the findings of Adam and Jahan (2014), Basuchaudhuri (2016) and Islam and Jahan (2019). Hundred seed weight of BARI Chhola-6 was significantly increased following TIBA treatments where, the maximum was recorded from 30 ppm treatment. Similar results of increase in 100 seed weight due to TIBA treatment are in agreement with the findings of many workers (Adam and Jahan 2014, Jahan and Khan 2014, Adam *et al*. 2018, Islam and Jahan 2019, Doel *et al*. 2021).

Yield per plant of BARI Chhola-6 was positively influenced by TIBA treatments (Table 4). The maximum yield per plant (15.92 g) was obtained from 30 ppm treatment which was 85.76 % higher over the control followed by 35 ppm (70.36%) and 25 ppm treatment (68.96%), respectively.

Table 4. Effects of TIBA on yield attributes and yield of BARI Chhola-6 at harvest.

Treatments	No. of pods/ plant	Length of pod/plant(cm)	No. of seeds/pod	No. of seeds/plant	100-seeds weight (g)	Yield/ plant (g)	Harvest index (%)
Control	37.63c	0.80	1.11c	41.13d	21.37d	8.57b	32.70
10 ppm TIBA	45.00bc	0.84	1.29bc	66.38c	22.15c	12.40ab	32.82
15 ppm TIBA	53.75b	0.87	1.27bc	75.75bc	22.97b	13.08ab	33.03
20 ppm TIBA	47.00bc	0.88	1.44a	64.75c	23.28b	12.87ab	33.22
25 ppm TIBA	52.13b	0.81	1.46ab	76.75bc	22.85b	14.48a	34.40
30 ppm TIBA	72.25a	0.86	1.49a	112.13a	23.84a	15.92a	35.41
35 ppm TIBA	69.25a	0.92	1.56a	91.63b	23.22b	14.60a	33.44
CV (%)	28.37	11.81	12.53	35.59	3.91	12.87	13.10
LSD (0.05)	11.66	NS	0.26	19.87	0.54	5.01	NS

Means in a column followed by the same letter or without a letter are not different significantly at the 5 % level by DMRT.

Results also revealed that yield per plant obtained from 25, 30 and 35 ppm TIBA were significantly higher than control but statistically identical to each other. Findings of the present investigation are in concurrence with the outcome of previous workers on various crops viz. soybean (Basuchaudhuri 2016), chickpea (Islam and Jahan 2019), rice (Doel *et al*. 2021) and papaya (Mutum *et al.* 2021). Application of TIBA had positive impact on harvest index of BARI Chhola-6 where the maximum increase was 8.29% due to 30 ppm TIBA followed by 25 ppm (5.20%). Present outcome is very much resembling to the result of Adam and Jahan (2014), Islam and Jahan (2019) and Doel *et al.* (2021).

Table 5. Effects of TIBA on pigment contents of leaves of BARI Chhola-6 at different stages.

Treatments	Vegetative stage			Flowering stage			At harvest		
	Chl.a	Chl.b	Carotenoids	Chl.a	Chl.b	Carotenoids	Chl.a	Chl.b	Carotenoids
Control	0.61b	0.38b	6.72a	0.55b	0.36c	6.24d	0.90	0.32	4.02
10 ppm TIBA	0.78ab	0.39b	7.03a	0.88b	0.45b	6.71c	0.94	0.45	6.74
15 ppm TIBA	0.95ab	0.41b	6.97a	0.92ab	0.54a	6.95b	0.95	0.42	6.94
20 ppm TIBA	0.65b	0.45ab	7.05a	0.59b	0.55a	6.98b	0.97	0.42	7.03
25 ppm TIBA	1.06ab	0.48ab	7.05a	1.02ab	0.55a	7.05a	0.96	0.48	7.06
30 ppm TIBA	1.00ab	0.55ab	7.07a	0.91ab	0.56a	7.11a	0.98	0.43	6.81
35 ppm TIBA	1.17a	0.62a	7.08a	1.09a	0.58a	7.15a	0.98	0.57	6.93
CV (%)	37.05	19.36	3.33	37.91	15.14	4.40	2.80	23.44	16.51
LSD (0.05)	0.52	0.19	1.21	0.19	0.07	0.12	NS	NS	NS

Means in a column followed by the same letter or without a letter are not different significantly at the 5 % level by DMRT.

Application of TIBA had pronounced responses on pigment content of leaves of BARI Chhola-6 at three different stages (Table 5). Seeds treated with 35 ppm TIBA produced maximum chlorophyll a, chlorophyll b and carotenoid contents at three stages. Results also showed that pigments contents of leaves due to 35 ppm TIBA application were significantly higher than control at the both vegetative and flowering stages with an exception. Jahan and Khan (2014), Adam *et al.* (2018) and Doel *et al.* (2021) also recorded positive responses of TIBA application on various crops. Thus, the results of present research work are in conformity with the findings of previous investigations.

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