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Effect of foliar application of miyobi hormone on morphophysiological attributes and yields in summer tomato

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Abstract: A pot experiment was conducted at the pot-yard of Bangladesh Institute of Nuclear Agriculture, Mymensingh, during the period from February to June 2010, to investigate the effect of foliar application of Miyobi hormone (0, 2, 4, 6 and 8 mg L^{-1}) on morphological, growth, reproductive and yield attributes, and yield in two summer tomato genotypes (BARI tomato-5 and TM-219). The experiment was laid out in a two-factor completely randomized design with eight replications. Miyobi solution sprayed on tomato plants at 30 days after transplanting (DAT), just before initiation of flowering. Results revealed that most of the morphological, growth, reproductive and yield attributes were increased with increasing concentration of Miyobi up to 6 mgL^{-1} resulted the highest fruit yield followed by a decline. The genotypic variation existed in morphological, growth, reproductive and yield attributes with BARI tomato-5 was superior to TM-219. The combined effects of genotypes and Miyobi hormone on yield attributes and fruit yield were superior at 6 mgL^{-1} in both the genotypes with magnitude was higher in BARI tomato-5 than in TM-219. Therefore, Miyobi at 6.0 mgL^{-1} may be used at vegetative stage for getting maximum fruit yield in tomato.
Key words: Tomato, Miyobi hormone, fruit yield.

Introduction

Tomato (*Lycopersicon esculenturn* Mill.) is widely grown not only in Bangladesh but also in many countries of the world for its taste and nutritional status. Tomato is considered to be a day neutral plant but it is not productive under high temperature (> 30^0 C) due to thermo-sensitiveness for flowering (Mondal *et al*. 2011). The crop performs better under an average monthly temperature of 20-25^0 C. But commercially, it may grow at temperature ranging from 15-27^0 C (Haque *et al*. 1999). Plant could set fruit abundantly when the night temperature is between 15^0 and 20^0 C and the day temperature at about 22-25^0 C (Kalloo, 1985). In Bangladesh, congenial atmosphere remains for tomato production during November to March. So, tomato is widely grown in Bangladesh usually in winter season. High temperature during day and night above 32^0 and 21^0 C, respectively was recorded as limiting factor to fruit set due to impaired complex physiological processes in the pistil which results on floral or fruit abscission (Picken, 1984) during summer season. Both day and night temperatures in Bangladesh are very high, which is the major environmental challenges for tomato cultivation in summer season (Chowdhury, 1989). Therefore, it is very essential to find out the suitable varieties/genotypes that are tolerant to high temperature. In this regard, the scientists of different research Institutes in Bangladesh are successful in developing tomato genotypes those are suitable for summer season and has been cultivated commercially for few years in Bangladesh.

However, the yield performance of summer tomato varieties is very poor. So, it is urgent to increase tomato yield by proper management and cultural practices. Plant growth regulators are one of the most important factors for increasing higher yield. Application of hormone has good management effect on growth and yield of tomato. On the other hand, flower and fruit abortion are common phenomenon in tomato (Mondal *et al*. 2011). A large proportion of tomato reproductive structures abscise before reaching maturity, which is the primary cause of lowering yield in summer season (Mondal *et al*. 2011). Fruit yield of tomato can be increased through reducing reproductive abscission. Hormones regulate abscission process and synthetic hormones may reduce abscission and ultimately increase in yield of soybean (Nahar and Ikeda, 2002) and tomato (Abdel *et al*. 1996).

Application of plant growth regulator seems to be one of the important practices in view of convenience, cost and labour efficiency. Recently, there has been global realization of the important role of PGRs in agriculture for better growth and yield of crops. Developed countries like Japan, China, Poland, South Korea etc. have long been using PGRs to increase crop yield.

Like other crop plants, the physiological mechanisms of tomato growth are hormonally mediated. Additional supply of plant growth regulators (PGRs) control growth and yield in plants. Miyobi, a new synthetic growth hormone (composition is unknown) developed by a Japanese Company (BAL Planning Co. Ltd., Ichinomiyo, Japan). The company claimed that foliar application of Miyobi before flowering enhanced plant growth and development thereby fruit yield in vegetable crops. In Bangladesh, some workers reported that application of Miyobi at vegetative stage increased plant height, total dry mass and seed yield in mungbean (Rahman, 2006), in sesame (Hossain, 2007) and in soybean (Khatun, 2008). Research work with Miyobi on growth, yield attributes and fruit yield of tomato is scanty. Considering the above facts, the present research work was undertaken to study the effect of Miyobi on growth, morphological features, yield attributes and yield in summer tomato under Bangladesh conditions.

Materials and Methods

A pot experiment was carried out at the pot-yard of Bangladesh Institute of Nuclear Agriculture, Mymensingh ($24^0$75″ N and $90^0$50″ E), Bangladesh, during February to June 2010. The soil of the experiment was sandy loam having a total nitrogen 0.06%, organic matter 1.15%, available phosphorus 18.5 ppm, exchangeable potassium 0.28 meq%, sulphur 18 ppm and pH 6.8. The experiment comprised of five concentrations of Miyobi *viz*., 0, 2, 4, 6 and 8 mgL^{-1} which were applied at 30 days after transplanting (DAT) i.e. just before flowering start phase. The spray was done by a hand sprayer at afternoon. Two tomato genotypes were selected, one was variety (BARI tomato-5) and another was advanced mutant (TM-219). The soil was thoroughly mixed with the given amounts of urea, triple superphosphate, muriate of potash, gypsum and cowdung at the rate of 3.70, 2.15, 1.30, 0.80 and 150 g pot^{-1} corresponding to 300, 160, 140, 40 and 10000 kg ha^{-1}, respectively. Total amount of TSP, MP, gypsum and cowdung were applied as basal dose during soil preparation. Half of urea was applied as top dress at 21 DAT and rest half was applied at 45 DAT. The pots of the experiment were filled with 12 kg of soils. The experiment was laid out in two factors completely randomized design with 8 replications. Twenty five-day old seedlings were sown in each pot on 15 March 2010. The 5-8th replications were used for growth study. Intercultural operations like irrigation, weeding, mulching, pruning, staking, and pest control were followed as and when necessary for normal plant growth and development. Growth parameters such as total dry mass (TDM) $plant^{-1}$, absolute growth rate (AGR) and relative growth rate (RGR) were recorded at 40 and 60 DAT. Plant sample was oven dried at 80 ^{0}C ± 2 for 48 hours. The total dry matter $plant^{-1}$ was estimated by summing dry matter of leaves, stem, root and fruits dry weight per plant. AGR and RGR were determined following the methods of Hunt (1978). Other morphological, reproductive and yield attributes were recorded during tomato harvest. Per cent fruit set to flowers was calculated as follows: % fruit set = (Number of fruits $plant^{-1}$ ÷ Number of flowers $plant^{-1}$) × 100. Harvesting was done at different dates depending on fruit ripening. The collected data were analyzed statistically using the computer package programme, MSTAT-C and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT).

Results and Discussion

The effects of different concentrations of Miyobi on morphological characters such as plant height, branch and leaf number $plant^{-1}$, growth parameters such as TDM production $plant^{-1}$, AGR and RGR were significant (Table 1). Results revealed that plant height, branch and leaf number, TDM, AGR and RGR were greater in Miyobi applied plants than control plants. Results showed that branch and leaf number and AGR increased with increasing concentration of Miyobi hormone till 6 mgL^{-1} followed by a decline while plant height, TDM production and RGR increased with increasing concentration of Miyobi till 8 mgL^{-1}. However, the above parameters increased significantly till 6mgL^{-1} and thereafter, increased in some parameters but not significantly. The lowest of the above parameters was recorded in control plants. These results indicate that application of Miyobi had tremendous effect on growth and development in tomato. These results have conformity with Khatun (2008) who reported plant growth and development enhanced by the application of Miyobi in soybean.

Table 1. Effect of genotypes and different concentrations of Miyobi on morphological and growth characters of tomato

Treatments	Plant height (cm)	Branches $plant^{-1}$	Leaves $plant^{-1}$	Total dry mass $plant^{-1}$ (g) at 60 DAT	Absolute growth rate at 40-60 DAT (mg $plant^{-1}$ d^{-1})	Relative growth rate at 40-60 DAT (mg g^{-1} d^{-1})
Miyobi Concentrations (mgL^{-1})						
0	52.38 d	5.13 c	38.62 d	19.50 d	560.5 e	42.56 e
2	55.00 c	5.38 c	45.88 c	24.00 c	750.0 d	50.10 d
4	60.88 b	6.75 b	52.00 b	32.71 b	1122.0 c	57.99 c
6	62.88 a	7.63 a	56.00 a	40.20 a	1424.5 a	61.61 b
8	63.00 a	7.38 a	55.18 a	40.55 a	1238.0 b	68.75 a
F-test	**	**	**	**	**	**
Genotypes						
BARI tomato-5	59.00	6.93 a	56.30 a	34.76 a	1098.6 a	57.43 a
TM-219	58.65	5.97 b	42.77 b	28.02 b	939.4 b	54.98 b
F-test	NS	**	**	**	**	**
CV (%)	3.81	4.92	6.26	6.88	4.02	5.17

In a column, figures having the same letter (s) do not differ significantly at P ≤0.05; ** indicates significant at 1% levels of probability; NS = Not significant; DAT = Days after transplanting

The effects of different levels of concentration of Miyobi application on reproductive parameters such as number of effective and non-effective flower clusters $plant^{-1}$, number of flowers $plant^{-1}$ and reproductive efficiency (RE), yield attribute such as number of fruits $plant^{-1}$ and fruit yield were significant except single fruit weight (Table 2). Results revealed that number of effective flower cluster and flowers $plant^{-1}$, RE and number of fruits $plant^{-1}$ increased with increasing concentration of Miyobi hormone till 6 mgL^{-1} followed by a decline. In contrast, the lowest number of non-effective flower cluster $plant^{-1}$ was recorded in 6 mgL^{-1} of Miyobi and the highest was recorded in control plant. These results indicate that application of Miyobi increased flower production as well as increased RE which resulted increase yield attributes and thereby fruit yield. These results are consistent with Rahman (2006) who reported that application of Miyobi increased flower production and decreased flower abortion in mungbean. The increase in the number of effective flower cluster and flowers $plant^{-1}$ and RE at higher doses of Miyobi (6 and 8 mgL^{-1}) reported here might be a result of reduction in the number of non-effective flower clusters $plant^{-1}$ and reduced flower abortion (Table 2). Again, higher RE in Miyobi applied plant might be resulting from the translocation of sufficient assimilate to the flowers (Nahar and Ikeda, 2002). However, the fruit yield was greater in Miyobi applied plants than control plants due to production of higher number of fruits plant^{-1} (Table 2). Again, the fruits plant^{-1} was higher in Miyobi applied plants than control plants due to increase number of flowers and RE (Table 2). The highest/higher fruit yield was recorded in 6 and 8 mgL^{-1} Miyobi (553 and 529 g plant^{-1} for 6 and 8mgL^{-1}, respectively) due to production of highest/higher number of fruits plant^{-1} (15.9 and 14.8 fruits plant^{-1} for 6 and 8 mgL^{-1}, respectively).

Table 2. Effect of genotypes and different concentrations of Miyobi on reproductive characters, yield attributes and yield in tomato

Treatments	Effective flower clusters plant^{-1}	Non- effective flower clusters plant^{-1}	Flowers plant^{-1}	Reproductive efficiency (%)	Fruits plant^{-1}	Single fruit weight (g)	Fruit yield plant^{-1} (g)
Miyobi Concentrations (mgL^{-1})							
0	3.15 e	17.38 a	29.63 d	22.70 c	6.50 d	32.92	210.5 d
2	5.00 d	14.00 b	36.62 c	26.58 ab	9.50 c	33.33	317.5 c
4	5.66 c	10.88 c	43.38 b	26.84 ab	11.8 b	34.50	404.2 b
6	7.25 a	7.50 e	55.50 a	28.22 a	15.9 a	34.19	553.0 a
8	6.49 b	10.12 d	54.38 a	27.22 ab	14.8 a	33.62	529.1 a
F-test	**	**	**	**	**	NS	**
Genotypes							
BARI tomato-5	5.32 b	14.5 a	49.90 a	25.52 b	13.3 a	33.54	453.5 a
TM-219	5.57 a	9.45 b	37.90 b	27.02 a	10.1 b	33.89	352.2 b
F-test	**	**	**	*	**	NS	**
CV (%)	5.15	6.87	5.62	7.31	6.38	4.05	5.55

In a column, figures having the same letter (s) do not differ significantly at P ≤0.05; *, ** indicate significant at 5% and 1% levels of probability, respectively; NS = Not significant

Table 3. Interaction effect of genotypes and different concentrations of Miyobi on reproductive characters, yield attributes and yield in tomato

Interaction		Effective flower clusters plant^{-1}	Non- effective flower clusters Plant^{-1}	Flowers plant^{-1}	Reproductive efficiency (%)	Fruits plant^{-1}	Single fruit weight (g)	Fruit yield plant^{-1} (g)
Genotype	Conc.(mgL^{-1})							
BARI tomato-5	0	2.80 g	8.25 a	33.25 g	16.54 e	5.50 g	32.90	180.9 h
	2	4.50 e	17.50 ab	42.75 e	23.39 d	10.0 de	33.00	330.0 ef
	4	5.31 d	14.50 c	47.75 c	29.32 a	14.0 b	34.10	475.3 c
	6	7.75 a	10.00 e	64.75 a	30.50 a	19.8 a	33.95	675.2 a
	8	6.55 c	12.25 d	61.00 b	27.87 bc	17.0 b	33.74	606.2 b
TM-219	0	3.50 f	16.50 b	26.00 h	28.85 ab	7.50 f	32.93	240.2 g
	2	5.50 d	10.50 e	30.50 g	29.76 a	9.00 e	33.67	305.0 f
	4	6.00 c	7.25 f	39.00 f	24.36 cd	9.50 de	34.91	333.2 ef
	6	6.75 b	5.00 g	46.25 cd	25.94 cd	12.0 c	34.43	430.9 d
	8	6.42 c	8.00 f	47.75 c	26.18 c	12.5 c	33.51	451.9 cd
F-test		**	**	**	**	**	NS	**
CV (%)		5.15	6.87	5.62	7.31	6.38	4.05	5.55

In a column, figures having the same letter (s) do not differ significantly at P ≤0.05; ** indicates significant at 5% and 1% levels of probability; NS = Not significant

The genotypes, BARI tomato-5 and TM-219 differed significantly with each other in their morphological, growth, reproductive, yield attributes and fruit yield except plant height and single fruit weight (Table 1 & 2). Differences in plant parameters between two genotypes were under genetic control (Begum, 2005).

The interaction effect of genotypes and Miyobi concentration on reproductive, yield attributes and fruit yield in tomato was significant except single fruit weight (Table 3). In both the genotypes, fruit yield was greater at 6 mgL^{-1} Miyobi application due to production of higher number of effective flower cluster, flowers and fruits plant^{-1} but the magnitude was higher in BARI tomato-5 (3.73 folds higher compared to control) than TM-219 (1.79 times higher than control).

In conclusion, it can be said that foliar application of Miyobi at vegetative stage enhance plant growth and development which resulted increased fruit yield in tomato. Among the concentrations, 6mgL^{-1} had superiority for plant growth, reproductive characters, yield component and yield over 2, 4 and 8 mgL^{-1}. Therefore, application of Miyobi @ 6mgL^{-1} may be recommended for tomato cultivation after few more field trials.

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