J. Agrofor. Environ. 2(1): 1-6, 2008 ISSN 1995-6983

Effect of concentrations and time of application of NAA on malformation of mango

M. N. A. Chowdhury and M. A. Rahim[1]
Spices Research Center, Shibganj, Bogra, [1]Department of Horticulture,
Bangladesh Agricultural University, Mymensingh,

Abstract: The experiment was carried out for controlling mango malformation and achieving higher yield and quality of mango cv. Amrapali at the Germplasm Centre of the Fruit Tree Improvement Project (GPC-FTIP), Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from July 2000 to July 2001. The treatments were different concentration of NAA viz. 100, 200 and 300 ppm and spray times viz. $_1^{st}$ week of October and 1st week of November. The highest sex ratio (1:5.33) was found in 1st November and the lowest (1:6.02) was found in 1St October spray. It was found that the highest (8.49 t/ha) yield was recorded from 1st October application of NAA and the lowest (7.22 t/ha) was observed in 1st November. NAA at 200 ppm gave the highest (10.17 t/ha) yield while control treatment gave the lowest (4.65 t/ha) yield. 1st October × 200 ppm NAA produced the highest (11.39 t/ha) yield than 1St November × control (4.48 t/ha).
Key words: Mango, NAA, time of application, malformation, yield

Introduction

Mango *(Mangifera Indica* L.) belongs to the family Anacardiaceae, originated in South Asia or Malayan archipelago. In Bangladesh times of area and production it crops mango ranks first in area and third in production. It occupies 50990 hectares of land and total production is 188000 tons per annum with an average yield of 4.75 tons per hectare (BBS, 2005). Still the yield is very low compared to that of India, Pakistan and many other mango growing countries iii the world (I-Iossain and Ahmed, 1994). Mango malformation is mainly caused by *Fusarium moniliformae* (Ram and Yadav, 1999). Mango malformation is a serious malady and causes considerable losses to the mango growers in Bangladesh and in various countries like India, Pakistan, Egypt, South Africa, Central America, Mexico and USA (Chadha *et al.,* 1979). It causes a great loss of mango fruits ranging from 50-80% (Rawal, 1990). Malformation is found in both vegetative and floral parts. In India several researchers stated that this malady is controlled by foliar spray of NAA at 200 ppm concentration (Majumder *et al.,* 1970). In Bangladesh scanty research work has been conducted to control malformation spraying with NAA. The present investigation was undertaken to evaluate the effect of NAA and its time of application to control malformation.

Materials and Methods

The experiment was carried out from July 2000 to July 2001 at Germplasm Centre (GPC), FTIP, Department of Horticulture, BAU, Mymensingh. The two-factor experiment was conducted in randomized complete block design (RCBD) with 3 replications. The treatments were different concentration of NAA viz. 100, 200 and 300 ppm and spray times viz. 1st week of October and 1st week of November. The spacing was 2.5m × 2.5m. Plants, which were severely affected by floral malformation in previous season, were selected for the treatment. Fertilizers were applied after harvest of the previous year's fruit. The stock solution of NAA along with adhesive agent (Tween-80) was sprayed individually by hand sprayer. Three plants were sprayed with each NAA solution. Spray was done in the 1st October and 1st November. Amount of spray solution per plant was determined by spraying water in the plant. All exposed surfaces of the plants including leaves, twigs, and branches were sprayed. Data were recorded on total number of inflorescences per plant; percentage of healthy and malformed inflorescences per plant; percentage of unopened male and hermaphrodite flowers per inflorescence; sex ratio; fruit retention per inflorescence and per plant (%); total number of fruit per plant, fruit weight (g); yield/plant; yield (t/ha), benefit cost ratio and Total Soluble Solids (TSS).

Results and Discussion

Effect of spray times

Significant effect was found on total number of inflorescences per plant (Table 1). From the table, it was observed that the highest (69.00) number of inflorescences was found when the plant was sprayed with NAA in 1st October and the lowest (53.75) was recorded from 1st November. The highest (67.92) percentage of healthy inflorescences per plant was found incase of 1st October and the lowest (60.25) was obtained from 1st November application of NAA. Significantly the highest (39.75) percentage of malformed inflorescence per plant was found incase of 1st November and the lowest (39.75) was obtained from 1st October application (Table 1). Spraying with NAA in 1st October produced the highest number of inflorescences per plant, highest percentage of healthy inflorescences per plant and less percentage of malformed inflorescences per plant. These results were in agreement with Singh *et al.* (1980) and Majumder *et al.* (1976) who reported that application of 200 ppm NAA during the first week of October was the most effective in reducing the incidence of floral malformation and increased the number of inflorescences per shoot. Different time of application showed significant difference in respect of total number of flowers per inflorescence and it was the highest (1677.75) incase of 1st October application on

the other hand the lowest (1587.67) was noticed in 1st November application. These results might be due to the highest percentage of healthy inflorescences and lowest percentage of malformed inflorescences per plant in this treatment, which led to the highest number of flowers per inflorescence. Percentage of unopened flowers per inflorescences was varied significantly due to the influence of time of application and it was found the highest (11%) incase of 1st November and the lowest (10.08%) was obtained from 1st October application. Significantly 1st October application of NAA produced higher percentage (13.75) of hermaphrodite flowers per inflorescence than that of 1st November (12.50). 1st October application produced the highest percentage of hermaphrodite flowers per inflorescence. It was observed that the lowest (1:5.33) sex ratio was found in 1st October application. On the other hand, 1st November application produced the highest (1:6.02). Different time of application had significant influence on fruit set per inflorescence at different days after fruit set (DAFS) shown in Table 2. The highest (17.61) fruit set and retention (17.61 and 1.90, respectively) per inflorescence and plant was recorded from 1st October application of NAA and the lowest (15.90 and 1.55 respectively) was found in 1st November application (Table 2). The highest (10.580 o) fruit retention per plant was observed in 1st October application and the lowest (9.67%) was exhibited in 1st November at 60 DAFS. Time of application had significant influence on the total number of fruits per plant. In 1st October produced the highest (39) number of fruits per plant whereas, the lowest (33) was obtained from 1st November. The highest (5.3 1 kg) weight of fruits per plant was found in 1st October application while the lowest (4.51 kg) was obtained from 1st November application. The highest (190.75 g) weight of individual fruit was found incase of 1st November application while the lowest (187 g) was found incase of 1st October application. Significantly the highest yield and TSS (8.49 t/ha and *25.25*, respectively) was recorded from 1st October application of NAA and the lowest (7.22 t/ha) was observed in 1st November.

Table 1. Single effect of spray time and growth regulator on floral malformation and sex ration of mango

Treatments	TNI/Plant	% of healthy inf./plant	% malformed inf./plant	Total no. of flowers/inf.	% of unopened flowers/inf.	% of male flowers/inf.	% of herm. flowers/ inflorescence	sex ratio
1st Oct.	69.00	67.92	31.83	1677.75	10.08	76.00	13.75	1:5.33
1st Nov.	53.75	60.25	39.75	1587.67	11.00	76.33	12.50	1:6.02
LSD at P ≤ 0.01	1.92	2.09	1.71	112.50	1.00	1.14	0.30	-
100 ppm	58.33	61.67	38.33	1631.50	10.67	76.67	12.67	1:6.11
200 ppm	74.17	75.50	24.50	1954.33	8.33	75.00	16.33	1:4.60
300 ppm	60.33	62.50	37.17	1685.00	12.33	74.00	13.33	1:5.56
Control	52.67	56.67	43.17	1260.00	10.83	79.00	10.17	1:7.52
LSD at P ≤ 0.01	2.72	2.95	2.41	159.00	1.41	1.67	0.46	-

Effect of NAA

Total number of inflorescences per plant varied significantly among the different concentrations of NAA. NAA at 200 ppm recorded the highest (74.17) number of inflorescences per plant whereas, it was the lowest (52.67) incase of control treatment (Table 1). Among the different concentrations of NAA, 200 ppm recorded the highest (75.50) percentage of healthy inflorescences per plant, while the lowest (56.67%) was found in control. 200 ppm NAA produced the lowest (24.50) percentage of malformed inflorescences per plant and the control plant resulted the highest (43.17) percentage of malformed inflorescences per plant. Among the different concentrations of NAA, 200 ppm NAA produced the highest number of inflorescences per plant, highest percentage of healthy inflorescences per plant and the lowest percentage of malformed inflorescences per plant. Similar results were also reported by Reza and Al-Amin (1996), Singh (1996) and Singh and Dhillon (1989). Singh (1996) reported that 200 ppm NAA improved the vegetative growth, increased C:N ratio, dry matter accumulation and mineral content in shoots and minimized the incidence of floral malformation. Reduction of the incidence of malformation was also reported by Singh and Dhillon (1989). NAA at 200 ppm recorded with the highest (1954.33) number of flowers per inflorescence and the lowest was found 1260 incase of control. It was found that 300 ppm treatment was recorded with the highest percentage (10.83) of unopened flowers per inflorescence while, 200 ppm NAA gave the lowest percentage (8.33) of unopened flowers per inflorescence (Table 1). These results might be due to the fact that 200 ppm NAA produced the less percentage of malformed flowers per plant which led to produce the highest number of flowers and lowest percentage of unopened flowers per inflorescence. The highest percentage (79) of male flowers per inflorescence was observed in the untreated control, while the lowest (74%) was recorded from 300 ppm NAA. Among the different concentrations, 200 ppm NAA produced the highest percentage (16.33) of hermaphrodite flowers per

inflorescence, while the control was recorded with the lowest (10.17%). Increased percentage of hermaphrodite flowers at 200 ppm NAA was also reported by Singh and Dhillon (1986). Application of 200 ppm NAA resulted the lowest (1:4.60) sex ratio while, the highest (1:7.52) was obtained from the control (Table 1). These results were close to Singh *et al.* (1977). He reported that 150 ppm NAA resulted the lowest sex ratio. Different concentrations of NAA had highly significant influence on the fruit set per inflorescence (Table 2). NAA at 200 ppm produced the highest (18.50 and 2.17, respectively) fruit set and retention per inflorescence the lowest (13.90 and 1.10, respectively) was observed incase of untreated control. Application of 200 ppm NAA significantly produced the highest (11.83) fruit retention per plant and the lowest (7.50%) was recorded from control. Total number of fruits per plant varied significantly due to different concentrations of NAA (Table 2). Among the different treatments, 200 ppm NAA produced the highest (46.50) number of fruits per plant and the control plant resulted the lowest (19.50) number of fruits per plant. 200 ppm NAA resulted the highest (6.36 kg) weight of fruits per plant and the lowest (2.91 kg) was recorded from control plant (Table 2). NAA at 200 ppm resulted the lowest (184.50 g) weight of individual fruit and the highest (204.17 g) was recorded from control plant. Significantly the highest (10.17 t/ha) yield was obtained from 200 ppm NAA and the lowest (4.65 t/ha) was obtained from control. Spraying with NAA in 1st October increased the total number of fruit per plant and yield (t/ha) as compared to 1st November. This might be due to 1st October treatment gave the higher fruit set and retention which resulted the highest number of fruit per plant as well as yield per hectare. NAA at 200 ppm gave the highest (27.00) TSS and the lowest (22.50) were recorded from the control. NAA at 200 ppm resulted the highest yield (t/ha) and TSS. Similar results were reported by Singh and Dhillon (1989) who stated that 200 ppm NAA reduced the incidence of malformation and increased the fruit yield.

Table 2. Single effect of spray time and growth regulator on fruit set, fruit retention, yield and quality of mango

Treatments	FS/I	Fruit retention/inflorescence at different DAFS			Fruit retention/plant (%) at different DAFS			TNF/plant	Total wt. of fruits/plant (kg)	Wt. of individual fruit (g)	yield (t/ha)	TSS
		20	40	60	20	40	60					
1st Oct.	17.61	8.51	3.39	1.90	47.58	19.33	10.58	39.00	5.31	187.00	8.49	25.25
1st Nov.	15.90	9.73	3.00	1.55	41.58	18.75	9.67	33.00	4.51	190.75	7.22	24.25
LSD at P ≤ 0.01	0.56	0.68	0.23	0.13	1.95	1.29	0.54	1.55	0.27	4.02	0.65	0.43
100 ppm	16.91	7.56	3.17	1.63	43.83	19.33	9.67	35.50	4.82	188.50	7.71	25.50
200 ppm	18.50	9.10	3.85	2.17	49.00	20.67	11.83	46.50	6.36	184.50	10.17	27.00
300 ppm	17.72	8.57	3.47	1.99	47.83	19.67	11.50	42.50	5.56	186.50	8.90	24.00
Control	13.90	5.25	2.28	1.10	37.67	16.50	7.50	19.50	2.91	197.00	4.65	22.50
LSD at P ≤ 0.01	0.80	0.96	0.33	0.25	2.75	1.82	0.76	2.19	0.39	5.68	0.97	0.61

FS/I = Fruit set per inflorescences at the initial stage; DAFS = Days after fruit set; TNF = Total no. of fruits; TSS = Total Soluble Solid

Combined effect of spray time and growth regulator

Total number of inflorescences per plant was found significant due to the application of different treatment combinations and it was obtained the highest (81.33) from 1st October x 200 ppm NAA and the lowest (45.67) was found in control × 1st November (Table 3). Different time of application and concentration of NAA significantly influenced the percentage of healthy inflorescences per plant. Among the different treatment combinations, application of 200 ppm NAA in 1st October produced the highest (82) percentage of healthy inflorescences per plant whereas, the lowest (54.33%) was obtained from untreated control in 1st November application (Table 3). Percentage of malformed inflorescences per plant also varied significantly due to time of application and different concentrations of NAA. 1st October application x 200 ppm NAA produced the lowest percentage (18) of malformed inflorescences per plant, whereas the highest (45.67%) was observed incase of the treatment control × 1st November. The highest (2062) number of flowers per inflorescence was found in 1st November with 200 ppm NAA while the lowest (1260) from control treatment in 1st October application (Table 3). The highest (14) percentage of unopened flowers per inflorescence was observed incase of 1st November along with 300 ppm NAA while, the lowest (8%) was noticed by 200 ppm NAA × 1st November application. The highest (80.33) percentage of male flowers per inflorescence was observed in 1st October × control and the lowest (73.33) was found in 1st October × 200 ppm NAA. The highest percentage (18.33) of hermaphrodite flowers per inflorescence was recorded from 1st October x 200 ppm NAA treatment and the lowest (9.33%) was obtained from 1st October × control treatment. The lowest (1:4.05) sex ratio was recorded from 1st October x 200 ppm NAA treatment and the highest (1:8.42) was found in 1st October ×

control treatment. In 1st October with 200 ppm NAA resulted the highest number and percentage of hermaphrodite flowers and the lowest sex ratio. These results were close to Majumder *et al.* (1976). They reported that single application of 200 ppm NAA in the first week of October increased the percentage of perfect flowers, which led to the increased number of hermaphrodite flowers. Fruit set per inflorescence was also varied significantly due to different time of application and concentration of NAA. 1st October × 200 ppm NAA was recorded with the highest (19.00) fruit set per inflorescence whereas, the lowest (13.60) fruit set was observed from 1st November × control treatment (Table 4). At 60 DAFS, 1st October x 200 ppm NAA was recorded the highest (2.40) fruit retention per inflorescence whereas, the lowest (1.00) was observed from 1st November × control. At 60 DAFS, 1st October × 200 ppm NAA was recorded the highest (12.67) fruit retention per plant whereas, the lowest (7.00) was observed from 1st November x control treatment. The highest fruit retention per inflorescence and per plant was found in 1st October × 200 pm NAA. This result might be due to the application of NAA in 1st October which checked the fruits dropping and resulted more retention.

Table 3. Combined effect of spray time and growth regulator on floral malformation and sex ratio of mango

Spray times	NAA (ppm)	TNI/Plant	% of healthy inf./plant	% malformed inf./plant	Total no. of flowers/inf.	% of un opened flowers/inf.	% of male flowers/ inf.	% of herm. flowers/ inflorescence	sex ratio
11st Oct.	100	66.67	66.33	33.67	1713.00	10.67	76.33	13.00	1:5.95
	200	81.33	82.00	18.00	2062.00	8.67	73.33	18.33	1:4.05
	300	68.33	64.00	35.00	1676.00	10.67	74.00	14.33	1:5.21
	Control	59.67	59.00	40.67	1260.00	10.33	80.33	9.33	1:8.42
1st Nov.	100	50.00	57.00	43.00	1550.00	10.67	77.00	12.33	1:6.23
	200	67.00	69.00	31.00	1847.00	8.00	76.67	14.33	1:5.37
	300	52.33	60.67	39.00	1694.00	14.00	74.00	12.33	1:5.96
	Control	45.67	54.33	45.67	1260.00	11.33	77.67	11.00	1:6.98
LSD at P ≤ 0.01		3.84	4.18	3.41	224.90	1.99	2.27	0.65	-

Table 4. Combined effect of spray time and growth regulator on fruit set, fruit retention, yield and quality of mango

Treatments	FS/I	Fruit retention/inflorescence at different DAFS			Fruit retention/plant (%) at different DAFS			TNF/plant	Total wt. of fruits/plant (kg)	wt. of indi. fruit (g)	yield (t/ha)	TSS	BSR
		20	40	60	20	40	60						
1st Oct.													
100	18.62	8.72	3.47	1.80	46.33	19.00	9.67	40.00	5.37	187	8.58	26.00	2.27
200	19.00	9.90	4.07	2.40	52.00	21.00	12.67	50.00	7.12	182	11.39	27.00	3.04
300	18.63	9.60	3.60	2.20	51.33	20.00	12.00	45.00	5.73	185	9.17	25.00	2.24
Control	14.20	5.80	2.40	1.20	40.67	17.33	8.00	21.00	3.01	196	4.82	23.00	1.37
1st Nov.													
100	15.20	6.40	2.87	1.47	41.33	19.67	9.67	31.00	4.26	190	6.82	25.00	1.81
200	18.00	8.30	3.63	1.93	46.00	20.33	11.00	43.00	5.60	187	8.96	27.00	2.28
300	16.80	7.53	3.33	1.78	44.33	19.33	11.00	40.00	5.39	188	8.62	23.00	2.11
Control	13.60	4.70	2.15	1.00	34.67	15.67	7.00	18.00	2.80	198	4.48	22.00	1.27
LSD at P ≤ 0.01	1.12	1.36	0.46	0.35	3.89	2.58	1.08	3.10	0.55	8.04	0.86	0.86	-

FS/I = Fruit set per inflorescences at the initial stage; DAFS = Days after fruit set; TNF = Total no. of fruits; TSS = Total Soluble Solid; BSR=

The highest (50) number of fruits per plant was recorded from the treatment combination of 1St October x 200 ppm NAA and the lowest (18.00) was obtained from 1st November × control (Table 4). It was found that the highest (7.12 kg) weight of fruits per plant was noticed in 1st October × 200 ppm NAA and the lowest (2.80 kg) was obtained from 1st November × control. It was found that the highest (198 g) weight of individual fruit was noticed from 1st November x control treatment and the lowest (182 g) was obtained from 1st October x 200 ppm NAA. 1st October x 200 ppm NAA produced the highest (11.39 t/ha) yield followed by 1st October × 300 ppm NAA (9.17 t/ha) and 1st October × 100 ppm NAA (8.58 t/ha), whereas the lowest (4.48 t/ha) yield was obtained from control. 1st October × 200 ppm NAA gave the highest (27.00) TSS than 1st November ×

control treatment (22.00). The data relating to the economic analysis of cost of production (Table 4) revealed that the highest BCR (3.04) was obtained from 200 ppm NAA with 1st October application and the lowest BCR (1.27) were obtained from 1st November × control treatment. From the result, it is concluded that spraying with 200 ppm NAA in 1st October is the best for controlling mango malformation and higher (11.39 t/ha) yield.

Acknowledgement

The authors express their sincere thanks to Swiss Foundation for Development and Co-operation, Embassy of Switzerland, Dhaka for awarding scholarship and logistic supports to complete the study through Fruit Tree Improvement Project (FTIP), BAU-DH.

References

BBS. 2005. Monthly Statistical Bulletin, Bangladesh (July, 2002). Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning. Government of The Peoples' Republic of Bangladesh. pp. 390-392.

Hossain, A. K. M. A. Ahmed, A. 1994. A monograph on mango varieties in Bangladesh. HRC-BARI and FAO/UNDP Mango Improvement Project. p. 3.

Chadha, K. L., Pal, R. N. Prakash, O. M. Tandon, P. L. Harmail, S. Singh, N. P. Rao, M. R. K. and Lal, B. 1979. Studies on mango malformation - its causes and control. Indian J. Hort., 36 (4): 3 59-362.

Majumder. P. K. Sinha, G. C and Singh, R. N. l970. Effect of exogenous application of alfa naptliyl acetic acid on mango malformation. Indian J. Hort, 27: (3-4) 130-131.

Ram, S. and Yadav, V. K. 1999. Mango malformation - a review. J. Appl. Hort., 1(1): 70-78.

Rawal, R. D. 1990. Fungal and bacterial diseases of fruits. A decade of research on disease of Horticultural crops under AICRP (1980-1989). Bangalore. pp. 215-231.

Reza, M. M. A. and Al-Amin, M. 1996. Incidence of floral malformation in mango varieties and its control. Regional Horticulture Research Station. BARI. Nawabganj. pp. 61-62.

Singh, I. S., Singh, H. K. and Chauhan, K. S. 1980, Effect of deblossoming and alfa-naphthyl acetic acid on floral malformation productivity of mango, Bangladesh Hort., 8 (1): 22-24.

Singh, S. J. 1996. Advances in Diseases of fruit crops in India. Kalyani Publisher. Ludhiana, New Delhi, India. pp. 197-199.

Singh, Z. and Dhillon, B. S. 1986. Effect of naphthalene acetic acid, ethrel, dikegulac and hand deblossoming on floral malformation, flowering, yield and fruit quality of mango. Acta Hort.,175 : 307-3 13.

Singh, Z. and Dhillon, B. S. 1989. Presense of malformation like substances in malformed floral tissues of mango. J. Phytopath., 125 (2): 117-123.