Original Research Article

Effect of different levels of beheaded heights and foliar spray of micronutrients on flowering and fruiting attributes of mango cv. Amrapali under high density planting

Abstract

An experiment was conducted at the Department of Horticulture and Post-Harvest Technology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal during 2019-20 and 2020-2021 with objective to find out the effect of different levels of beheaded heights and foliar spray of micronutrients on flowering and fruiting attributes of mango cv. Amrapali. Six different beheaded height viz. T_1- 80cm, T_2-100 cm, T_3-120 cm, T_4-140 cm, T_5-160 cm, and T_6-180 cm and two foliar sprays of micronutrients (just before flowering and fruiting) were taken as treatment. Experiment was design in split plot with three replication. Days to flowering, days to 50 % flowering, days to fruit set, number of panicles per plant, length of panicles, fruit length, fruit width, fruit weight, fruit volume, pulp weight, stone weight, peel weight and pulp stone ratio were taken for observation. It was found that different levels of beheaded height and foliar spray of micronutrients had significant effect on flowering and fruiting attributes. Plant beheaded at 80 cm height from ground level showed early days to flowering (23.42 days), days to 50 % flowering (31.07), days to fruit set (37.05 days), the highest number of panicles per plant (71.58 cm), the largest panicles length (30.52 cm), maximum fruit length (13.11 cm), fruit width (9.68 cm), fruit weight (291.52 g), fruit volume (274.86 cc), pulp weight (233.16 g) and pulp stone ratio (7.17). Foliar spray of 0.4% Zinc Sulphate, Copper Sulphate (0.2%), Borax (0.2%) [2 sprays at just before flowering and marble stage] found to have significant effect on flowering and fruiting attributes expect pulp weight, peel weight and pulp stone ratio. Interaction of different levels of beheaded height and foliar spray of micronutrients showed significant effect on flowering and fruiting attributes. Early days to flowering (21.67), 50 % flowering (30.67 days), fruit set, (36.43 days), number of panicles per plant (77.50), panicles length (30.53 cm), fruit length (13.50 cm), fruit width (9.92 cm), fruit weight (312.83 g), fruit volume (300.89 cc), pulp weight (253.96 g) and pulp stone ratio (7.56) was recorded highest in T_1F_2 (plant beheaded with 80 cm height with foliar spray of 0.4% Zinc Sulphate, Copper Sulphate (0.2%), Borax (0.2%). It can be concluded that plant beheaded with 80 cm height with foliar spray of 0.4% Zinc Sulphate + Copper Sulphate (0.2%) + Borax (0.2%) [2 sprays at just before flowering and marble stage] can produce higher fruit yield in terms of maximum fruit weight, fruit size, fruit volume with early flowering and fruiting.

Key words: *beheaded height; flowering; fruiting; high density; mango*

1. INTRODUCTION:

Mango is one of the most famous fruit crops in the world and belongs to the family Anacardiaceae, which originated in the Indo-Burma region [1]. Mango plants are grown for their delicious taste and quality. It is a rich source of carbohydrates, sugars, fibers, protein, vitamins, and minerals [2]. In India, the high-density planting system get momentum after the development of mango cv. Amrapali (a hybrid of Dashehri and Neelum). But mango plants under high-density planting show a progressive decline in yield after 11-12 years of planting. To overcome this problem rejuvenation of the orchard is generally suggested [3] but which height is suitable for rejuvenation is not recommended yet for the high-density orchard. There are few pieces of research on fruit crops that showed that beheaded height had a significant effect on flowering and fruiting attributes [3, 4]. But rejuvenation alone cannot solve the problem unless additional nutrients are not provided. Foliar application of nutrients especially micronutrients had been a common practice for fruit production in the world, especially for the elimination of nutrient disorders of fruit. Its popularity is also gaining in India in recent years. It is also evident from previous research that foliar application of micronutrients increases the earlier bud formation by the synthesis of essential hormones and metabolite translocation to the bud of the tree [5]. It is also well documented that the application of boron enhanced the emergence of flowers and fruits [6]. There is plenty of research that proved foliar spray of micronutrients increased the fruit weight and fruit size. Foliar spray of 0.4% borax and 1% ZnSO4 in the litchi plant increased the fruit size and fruit weight [7]. In pomegranate foliar application of ZnSO4 (0.4%) increased the maximum pulp weight [8], Maximum fruit weight was found with foliar spray of ZnSO4, FeSO4, and Borax in pomegranate [9]. Foliar application of Zinc sulphate (0.4%) and Boric acid (0.4%) gave a significant effect on the yield attributes of pomegranate [10]. In papaya, foliar application of borax (0.50 %) and ZnSO4 (0.25 %) resulted in maximum fruit weight [11]. A similar result was found with foliar spray of zinc sulphate (0.5 %) and boric acid (0.1 %) in papaya giving the highest fruit weight, fruit length, and fruit circumference [12]. In guava, foliar application of borax (0.4%) increased the fruit length, fruit width, and fruit weight [13]. Foliar application of borax 1.0 % was also found beneficial in yield attributing characters of guava [14]. Similarly, foliar application of CuSO4 (1%), FeSO4 (1%), ZnSO4 (1%), and borax (0.5%) resulted in maximum fruit weight and pulp weight in guava [15] while foliar application of 0.75% zinc sulphate in guava resulted in maximum fruit weight, fruit length, fruit width, and high pulp and pulp seed ratio [16]. Foliar spray of 0.5% borax resulted in higher fruit weight and fruit volume in mango [17]. Considering the importance of rejuvenation pruning and foliar spray of micronutrients, this experiment was done to find out the effect of different levels of beheaded height and foliar spray of micronutrients on flowering and fruiting attributes of rejuvenated mango orchard cv. Amrapali planted under high-density planting.

2. MATERIALS AND METHODS

The experiment was conducted on thirty years old, high-density planted (3 m x 3 m) mango orchard cv. Amrapali. It was beheaded at six different heights: T_1- 80cm, T_2-100 cm, T_3-120 cm, T_4-140 cm, T_5-160 cm, and T_6-180 after having a continuous decline in fruit production, with two foliar applications viz. F_1: Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid (2 sprays at just before flowering and marble stage), F_2: Foliar spray of 0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) [2 spray at just before flowering and marble stage]. The experiment was laid out in split plot design with three replication. The following observations were recorded: Days to flowering: It was counted from the first panicle initiation days to the first flowering days of tagged shoots. Days to 50% flowering: It was counted from the first panicle initiation days to 50 % flowering of the tagged shoot. Days to fruit set: It was counted from the first panicle initiation days to the first fruit set of the tagged shoot. Number of panicles per branch: The tagged shoots were observed to see how many panicles were formed per shoot. The number of panicles producing shoots was also counted. Length of panicle at anthesis: The length of the panicle was measured by measuring a scale from the shoot apex to that of the panicle apex. An average of five values was taken for computing the mean panicle length. Average fruit weight (g): Weight of ten fruits from each plant, was recorded by weighing the samples on balance and expressed in grams. Fruit length: The length of ten fruits was measured from apex to stem end by vernier calipers and expressed in centimeters. Fruit width: The width of ten fruits was recorded with the help of a vernier caliper and expressed in terms of centimeters. Volume of fruit (cc): The data on the fruit volume was recorded by the water displacement method. Stone weight (g), Peel weight (g) and pulp weight (g), and pulp stone ratio: This was calculated by weighing the ripened fruits separately, followed by pulp and stone after peeling of fruits, and the ratio was calculated by dividing pulp weight by stone weight. The data were analyzed by the methods suggested by [18].

3. RESULTS

3.1 Days to flowering: A perusal analysis of pooled data presented in table-1 showed that beheaded height and micronutrients had shown significant on days to flowering. Early days to flowering were found in T_1 i.e plant beheaded at 80 cm from ground level (23.50 days, 23.33 days, and 23.42 days) during 2020, 2021, and pooled respectively followed by T_4 (25 days). Foliar spray of micronutrients found to exert significant effect on days to flowering. Foliar spray F2 [0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) recorded early flowering (25.94 days and 26.04 days) during the investigation period 2021 and pooled respectively while interaction of different levels of beheaded height and foliar spray of micronutrients showed a significant effect on days to flowering. Early days to flowering were recorded in T_1F_2 (22.00 days, 21.33 days, and 21.67 days) during 2020, 2021, and respectively followed

by T_2F_2 (24.50 days) and late flowering was observed in T_6F_1 (30.17 days) in pooled analysis of both years.

3.2. Days to 50% flowering: The data presented in table-2 showed that beheaded height had shown a significant effect on days to 50 flowerings. Early days to 50 % flowering were recorded in T_1 (31.33, 30.47, and 30.90) during the investigation period 2020, 2021, and pooled respectively. Foliar spray exerted a non-significant effect on days to 50 % flowering while interaction of beheaded height and foliar spray of micronutrients showed a significant effect on days to flowering. Early days to 50 % flowering were recorded in T_1F_2 (30.67 days) followed by T_1F_1 (31.13 days).

Table: 1 Effect of different level of beheaded heights and foliar spray of micronutrients on days to flowering

Days to flowering									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	25.00	22.00	**23.50**	25.33	21.33	**23.33**	25.17	21.67	**23.42**
T2	25.00	25.00	**25.00**	26.33	24.00	**25.17**	25.67	24.50	**25.08**
T3	25.67	27.00	**26.33**	27.33	26.33	**26.83**	26.50	26.67	**26.58**
T4	25.00	24.67	**24.83**	24.67	25.67	**25.17**	24.83	25.17	**25.00**
T5	29.67	29.17	**29.42**	29.00	29.33	**29.17**	29.33	29.25	**29.29**
T6	30.33	29.00	**29.67**	30.00	29.00	**29.50**	30.17	29.00	**29.58**
Mean	**26.78**	**26.14**	**26.46**	**27.11**	**25.94**	**26.53**	**26.94**	**26.04**	**26.49**
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		0.16	0.11		0.18	0.13*		2.04	1.44*
T		0.42	1.19**		0.51	0.36**		1.01	0.72**
T at same F		0.59	2.14*		0.72	0.51*		1.43	1.01*
F at same T		0.56	2.04*		0.69	0.48*		2.42	1.71*

*P < 0.05; **P < 0.01.

Table: 2 Effect of different level of beheaded heights and foliar spray of micronutrients on days to 50 % flowering.

Days to 50% flowering									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	31.33	31.33	31.33	30.93	30.00	30.47	31.13	30.67	30.90
T2	33.00	33.33	33.17	37.33	31.00	34.17	35.17	32.17	33.67
T3	33.00	32.00	32.50	40.67	30.67	35.67	36.83	31.33	34.08
T4	32.67	32.67	32.67	36.33	33.33	34.83	34.50	33.00	33.75
T5	36.00	38.50	37.25	34.33	31.50	32.92	35.17	35.00	35.08
T6	34.00	39.33	36.67	40.00	34.33	37.17	37.00	36.83	36.92
Mean	**33.33**	**34.53**	33.93	36.60	31.81	34.20	34.97	33.17	34.07
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		0.15	0.11*		0.49	0.34*		1.61	1.14
T		0.69	0.49**		0.77	0.54**		1.49	1.06**
T at same F		0.98	0.69*		1.08	0.77*		2.11	1.49*
F at same T		0.91	0.64*		1.10	0.78*		2.51	1.78*

*P < 0.05; ** P < 0.01.

3.3. Days to fruit set: The pooled data illustrated in table-3 showed that beheaded height had shown a significant effect on days to fruit set. Early days to fruit set were recorded in T_1 (38.17, 35.93, and 37.05) during 2020, 2021, and pooled respectively. Foliar spray of micronutrients showed significant effect on days to fruit set. Early days to 50% was recorded by foliar application, F2 [0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) during investigation 2020 (39.17), 2021 (38.32), and pooled (38.74 days) respectively. Interaction of beheaded height and foliar spray of micronutrients showed a significant effect on days to fruit set. Early days to the fruit set were found in T_4F_2 (36.00), T_1F_2 (34.87 and 36.43 days) during 2020, 2021, and pooled respectively.

Table: 3. **Effect of different level of beheaded heights and foliar spray of micronutrients on days to fruit set.**

Days to fruit set									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	38.33	38.00	38.17	37.00	34.87	35.93	37.67	36.43	37.05
T2	40.00	39.00	39.50	38.33	35.33	36.83	39.17	37.17	38.17
T3	40.67	38.00	39.33	38.00	36.33	37.17	39.33	37.17	38.25
T4	39.67	36.00	37.83	40.00	37.00	38.50	39.83	36.50	38.17
T5	43.67	41.33	42.50	41.67	44.15	42.91	42.67	42.74	42.70
T6	41.67	42.67	42.17	43.00	42.23	42.62	42.33	42.45	42.39
Mean	40.67	39.17	39.92	39.67	38.32	38.99	40.17	38.74	39.45
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		0.25	0.17**		0.21	0.15**		1.99	1.41**
T		0.52	0.37*		0.59	0.41**		0.96	0.68**
T at same F		0.73	0.52*		0.83	0.59*		1.36	0.96*
F at same T		0.71	0.50*		0.79	0.56*		2.34	1.66*

*P < 0.05; **P < 0.01

3.4. Number of panicles per plant: The pooled analysis of data presented in table-4 showed that beheaded height had shown a significant effect on the number of panicles per plant. The highest number of panicles per plant was recorded in T_1 (71.50, 71.67, and 71.58) during 2020, 2021, and pooled respectively while lowest was recorded in T_6 (45.42). The foliar spray of micronutrients showed significant effect on number of panicles per plant during the investigation period. Foliar spray, F2 [0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) recorded highest number of panicles per plant during the investigation period 2020 (59.11), 2021 (59.67), and pooled (59.39) respectively. Interaction of beheaded height and foliar spray of micronutrients also showed a highly significant effect on the number of panicles per plant. The highest number of panicles per plant was recorded in T_1F_2 (76.00, 79.00 and 77.50), during the investigation period 2020, 2021, and pooled respectively. The lowest number of panicles per tree was recorded in T_6F_2 (44.17) in pooled analysis of both years..

3.5. Length of panicles (cm): A perusal analysis of data presented in table-5 reveals that beheaded height had shown a significant effect on the length of panicles. The largest panicle length was recorded in

T_1 (30.72 cm, 30.32, and 30.52 cm) during 2020, 2021, and pooled respectively and lowest panicles length was recorded in T_4 (25.03 cm). The foliar spray of micronutrients had a highly significant effect on panicle length during the investigation. The maximum panicles length was recorded by foliar spray of 0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) during the investigation period 2020 (27.12 cm), 2021 (27.99 cm), and pooled (27.56 cm) respectively. Interaction of beheaded height and foliar spray of micronutrients also showed a highly significant effect on the length of panicles. The largest panicles length were recorded in T_1F_1 (31.00 cm), and T_1F_2 (30.61 cm, 30.53 cm) during the investigation period 2020, 2021, and pooled and lowest panicles length was observed in T_3F_1 (23.72 cm) in pooled analysis of both years.

Table: 4. Effect of different level of beheaded heights and foliar spray of micronutrients on number of panicles per plant.

Number of panicles per plant									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	67.00	76.00	71.50	64.33	79.00	71.67	65.67	77.50	71.58
T2	57.67	69.00	63.33	56.67	69.00	62.83	57.17	69.00	63.08
T3	56.00	60.33	58.17	57.67	57.67	57.67	56.83	59.00	57.92
T4	54.00	55.33	54.67	53.00	53.33	53.17	53.50	54.33	53.92
T5	48.67	52.00	50.33	52.33	52.67	52.50	50.50	52.33	51.42
T6	45.67	42.00	43.83	47.67	46.33	47.00	46.67	44.17	45.42
Mean	**54.83**	**59.11**	**56.97**	**55.28**	**59.67**	**57.47**	**55.06**	**59.39**	**57.22**
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		0.69	0.49*		0.57	0.40*		7.55	5.33**
T		1.64	4.65**		1.81	5.20**		4.28	3.02*
T at same F		2.32	7.31*		2.55	7.70*		6.05	4.27**
F at same T		2.23	7.05*		2.40	7.19*		9.36	6.60**

*P < 0.05; ** P < 0.01

Table: 5. Effect of different level of beheaded heights and foliar spray of micronutrients on length of panicles.

Length of panicles(cm)									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	31.00	30.44	30.72	30.03	30.61	30.32	30.52	30.53	30.52
T2	28.33	29.22	28.78	28.37	28.13	28.25	28.35	28.68	28.51
T3	22.00	26.33	24.17	25.44	28.33	26.89	23.72	27.33	25.53
T4	22.67	23.89	23.28	26.89	26.67	26.78	24.78	25.28	25.03
T5	22.89	27.83	25.36	25.89	28.10	26.99	24.39	27.97	26.18
T6	27.00	25.00	26.00	25.00	26.12	25.56	26.00	25.56	25.78
Mean	**25.65**	**27.12**	26.38	26.94	27.99	27.47	26.29	27.56	26.92
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		0.23	0.16*		0.17	0.12**		1.75	1.24**
T		0.80	2.37**		0.39	1.14**		1.30	0.92*
T at same F		1.14	3.53*		0.54	1.78*		1.83	1.30**
F at same T		1.06	3.30*		0.52	1.72*		2.42	1.71**

*P < 0.05; **P < 0.01.

3.6. Fruit Length (cm): The pooled data presented in table-6 showed that beheaded height and micronutrients had shown significant on the length of fruits. The maximum fruit length (13.52 cm, 12.70 cm, and 13.11 cm) was recorded in plant beheaded at 80 cm (T_1) from ground level during 2020, 2021, and pooled respectively followed by T2 (12.68 cm). The maximum fruit length was recorded by foliar spray of 0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%)F_2 was found to be significant during the investigation period 2020 (13.03 cm) 2021 (12.36 cm), and pooled (12.69 cm). Interaction of beheaded height and foliar spray of micronutrients showed a significant effect on fruit length. The maximum fruit length was recorded in T_1F_2 (13.90 cm, 13.11 cm, and 13.50 cm) during the investigating period 2020, 2021 and pooled respectively.

Table: 6. Effect of different level of beheaded heights and foliar spray of micronutrients on fruit length.

Fruit Length (cm)									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	13.13	13.90	13.52	12.29	13.11	12.70	12.71	13.50	13.11
T2	13.06	12.64	12.85	11.93	13.10	12.52	12.49	12.87	12.68
T3	12.27	13.80	13.04	11.87	12.72	12.30	12.07	13.26	12.67
T4	12.37	12.45	12.41	11.95	11.82	11.88	12.16	12.13	12.15
T5	12.37	12.85	12.61	11.59	11.63	11.61	11.98	12.24	12.11
T6	12.31	12.53	12.42	11.48	11.77	11.62	11.89	12.15	12.02
Mean	**12.59**	**13.03**	**12.81**	**11.85**	**12.36**	**12.11**	**12.22**	**12.69**	**12.46**
		SEm (±)	CD		**SEm (±)**	**CD**		**SEm (±)**	CD
F		0.07	0.44*		0.07	0.40*		0.35	1.28**
T		0.19	0.55**		0.17	0.49**		0.31	0.89*
T at same F		0.26	0.85*		0.23	0.76*		0.44	1.27*
F at same T		0.25	0.81*		0.22	0.72*		0.53	1.54*

*P < 0.05; **P < 0.01

3.7. Fruit width (cm): The data presented in table-7 reveals that beheaded height and micronutrients had shown a significant effect on fruit width. The maximum fruit width (9.67 cm, 9.68 cm, and 9.68 cm) was recorded in plant beheaded at 80 cm height (T_1) from ground level during 2020, 2021, and pooled respectively. The minimum fruit width was recorded in T_6 (8.76 cm). Foliar spray of micronutrients shows significant effect on fruit width. Foliar spray of 0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) recorded highest fruit width during the investigation period 2020 (9.48 cm) 2021 (8.97 cm), and pooled 9.23 cm) respectively. Interaction of beheaded height and foliar spray of micronutrients showed a significant effect on fruit width. The maximum fruit length was recorded in T_2F_2 (9.83 cm), and T_1F_2 (10.09 cm and 9.92 cm) respectively during 2020, 2021 and pooled respectively. The minimum fruit width was recorded in T_6F_2 (8.50 cm) in pooled analysis of both years.

Table :7 Effect of different level of beheaded heights and foliar spray of micronutrients on fruit width.

Fruit width (cm)									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	9.59	9.75	9.67	9.27	10.09	9.68	9.43	9.92	9.68
T2	9.11	9.83	9.47	9.03	9.44	9.23	9.07	9.63	9.35
T3	9.29	9.42	9.35	8.98	9.30	9.14	9.13	9.36	9.25
T4	9.10	9.42	9.26	8.61	9.17	8.89	8.85	9.30	9.07
T5	9.18	9.42	9.30	8.56	7.87	8.22	8.87	8.64	8.76
T6	9.35	9.06	9.20	8.31	7.93	8.12	8.83	8.50	8.66
Mean	**9.27**	**9.48**	**9.38**	**8.79**	**8.97**	**8.88**	**9.03**	**9.23**	**9.13**
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		0.03	0.15*		0.02	0.15*		0.31	1.13**
T		0.10	0.29*		0.17	0.50**		0.27	0.78**
T at same F		0.14	0.42*		0.24	0.72*		0.39	1.10**
F at same T		0.13	0.39*		0.22	0.66*		0.47	1.34**

*P < 0.05; **P < 0.01

3.8. Fruit volume (cc): A perusal analysis of data presented in table-8 showed that beheaded height and micronutrients had shown significant on fruit volume. The maximum fruit volume (277.07 cc, 272.64 cc, and 274.86 cc) was recorded in plant beheaded at 80 cm height (T_1) from ground level during 2020, 2021, and pooled respectively, and found highly significant among the treatments. The lowest fruit volume was recorded in T6 (226.66 cc). Foliar spray of micronutrients shows significant effect on fruit volume. The highest fruit volume were observed with foliar application 0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) during the investigation period 2020 (263.43 cc) 2021 (265.19 cc), and pooled 264.31cc). Interaction of beheaded height and foliar spray of micronutrients showed a significant effect on fruit volume. The maximum fruit volume was recorded in T_1F_2 (307.67 cc, 294.11 cc and 300.89 cc) during the investigation period 2020, 2021, and pooled respectively, while lowest fruit volume was recorded in T_6F_1 (212.82 cc) in pooled analysis of both years.

Table: 8. Effect of different level of beheaded heights and foliar spray of micronutrients on fruit volume.

Fruit volume (cc)									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	246.47	307.67	277.07	251.17	294.11	272.64	248.82	300.89	274.86
T2	255.00	248.00	251.50	248.60	263.70	256.15	251.80	255.85	253.82
T3	224.17	275.89	250.03	234.78	276.01	255.40	229.47	275.95	252.71
T4	241.67	260.00	250.83	228.41	277.59	253.00	235.04	268.79	251.92
T5	217.50	243.00	230.25	225.67	244.68	235.18	221.58	243.84	232.71
T6	208.00	246.00	227.00	217.63	235.02	226.33	212.82	240.51	226.66
Mean	**232.13**	**263.43**	**247.78**	**234.38**	**265.19**	**249.78**	**233.26**	**264.31**	**248.78**
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		3.20	19.47*		1.18	7.19*		14.04	51.03*

T	7.25	21.38**		5.48	16.17**		12.27	34.94**
T at same F	10.25	33.60*		7.75	23.52*		17.35	50.24**
F at same T	9.89	32.42*		7.17	21.77*		21.17	61.29**

*P < 0.05; **P < 0.01 cc=cubic centimeters

3.9. Fruit weight (g): The pooled analysis of data presented in table-9 showed that beheaded height and micronutrients had shown significant on fruit weight. The maximum fruit weight (301.91 g, 281.14 g cm, and 291.52 g) was recorded in plant beheaded at 80 cm from ground level during 2020, 2021, and pooled respectively while lowest fruit weight was recorded in T_6 (228.22 g). Foliar spray of micronutrients showed highly significant effect on fruit weight during the investigation period. Foliar spray, F_2 [0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%)] recorded highest fruit weight. during the investigation period 2020 (272.48 g), 2021 (263.07g), and pooled (267.77g). Interaction of beheaded height and foliar spray of micronutrients showed a significant effect on fruit weight. The maximum fruit weight was recorded in T_1F_2 (333.73 g, 291.94 g, and 312.83 g) during the investigation period 2020, 2021, and pooled respectively and minimum fruit weight was recorded in T_6F_2 (224.93 g) in pooled..

Table: 9 Effect of different level of beheaded heights and foliar spray of micronutrients on fruit weight.

Fruit Weight (g)									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	270.08	333.73	301.91	270.34	291.94	281.14	270.21	312.83	291.52
T2	267.17	288.07	277.62	279.09	272.37	275.73	273.13	280.22	276.67
T3	250.40	265.27	257.83	253.61	278.92	266.26	252.00	272.10	262.05
T4	242.20	255.17	248.68	240.13	272.22	256.18	241.17	263.70	252.43
T5	239.33	258.90	249.11	230.93	246.81	238.87	235.13	252.86	243.99
T6	236.33	233.73	235.03	226.67	216.14	221.40	231.50	224.93	228.22
Mean	**250.92**	**272.48**	**261.70**	**250.13**	**263.07**	**256.60**	**250.52**	**267.77**	**259.15**
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		3.35	20.37*		2.04	12.42*		18.60	67.62**
T		6.75	19.91**		5.08	14.99**		11.62	33.10**
T at same F		9.54	32.00*		7.19	23.19*		16.44	48.52*
F at same T		9.33	31.30*		6.87	22.17*		23.90	70.55*

*P < 0.05; **P < 0.01

3.10. Pulp weight (g): According to analysis of data presented in table-10 showed that beheaded height and micronutrients had shown significant on pulp weight. The maximum pulp weight (241.03 g, 225.29 g and 233.16 g) was recorded in plant beheaded at 80 cm (T_1) from ground level during 2020, 2021 and pooled respectively. The minimum pulp weight was recorded in T_6 (159.31g). Foliar spray of micronutrients was found to be non-significant during the investigation period. Interaction of beheaded height and foliar spray of micronutrients showed a highly significant effect pulp weight. The highest pulp weight was recorded in T_1F_2 (273.90 g, 234.02 g and 253.96 g) during the investigation period 2020, 2021 and pooled respectively. The minimum pulp weight was found in T_6F_2 (152.68 g) in pooled analysis of both years.

Table: 10 Effect of different level of beheaded heights and foliar spray of micronutrients on pulp weight (g).

Pulp weight (g)									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	208.16	273.90	241.03	216.57	234.02	225.29	212.37	253.96	233.16
T2	202.41	229.28	215.85	220.90	212.79	216.84	211.66	221.04	216.35
T3	185.73	194.21	189.97	191.01	212.59	201.80	188.37	203.40	195.88
T4	179.20	197.83	188.52	172.60	205.98	189.29	175.90	201.91	188.90
T5	177.74	195.09	186.42	165.05	177.58	171.31	171.40	186.34	178.87
T6	167.81	168.00	167.90	164.07	137.37	150.72	165.94	152.68	159.31
Mean	**186.84**	**209.72**	**198.28**	**188.37**	**196.72**	**192.54**	**187.60**	**203.22**	**195.41**
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		3.40	20.70*		2.34	14.25		21.55	78.34
T		6.38	18.81**		4.77	14.07**		12.87	46.78**
T at same F		9.02	30.73*		6.75	22.57*		18.20	54.94**
F at same T		8.91	30.35*		6.59	22.04*		27.21	81.14**

*P < 0.05; **P < 0.01

3.11. Stone wt (g): A perusal analysis of pooled of data presented in table -11 showed that beheaded height and micronutrients had shown significant on stone weight. The maximum stone weight (g) was found in T_5 (36.95), and T_6 (36.75 and 36.66) during the investigation period 2020, 2021 and pooled respectively. The minimum stone weight was found in T_1 (32.50 g) . The foliar spray of micronutrients was found to be highly significant during the investigation period. The maximum stone weight was recorded with foliar application of 0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) during the investigation period 2020 (35.67g), 2021 (36.10 g) and pooled (35.89 g) respectively. Interaction of beheaded height and foliar spray of micronutrients showed a highly significant effect on stone weight. The maximum stone (g) was recorded in T_6F_2 (39.80, 41.17 and 40.48) during the investigation period 2020, 2021 and pooled respectively. The minimum stone weight was recorded in T_1F_1 (31.43 g) in pooled analysis of both years..

Table: 11. **Effect of different level of beheaded heights and foliar spray of micronutrients on stone weight.**

Stone wt (g)									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	31.00	33.50	32.25	31.86	33.64	32.75	31.43	33.57	32.50
T2	32.78	31.75	32.27	31.75	35.58	33.67	32.27	33.67	32.97
T3	32.00	35.23	33.62	31.17	34.60	32.88	31.58	34.92	33.25
T4	35.17	35.33	35.25	35.11	34.47	34.79	35.14	34.90	35.02
T5	35.50	38.39	36.95	35.08	37.17	36.13	35.29	37.78	36.54
T6	33.33	39.80	36.57	32.33	41.17	36.75	32.83	40.48	36.66
Mean	**33.30**	**35.67**	**34.48**	**32.88**	**36.10**	**34.49**	**33.09**	**35.89**	**34.49**
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		0.26	1.60*		0.17	1.01**		1.51	5.47**
T		0.75	2.21*		0.92	2.70*		1.89	5.37*
T at same F		1.06	3.35*		1.30	3.90**		2.67	9.69*
F at same T		1.00	3.17*		1.20	3.60		2.86	10.40*

*P < 0.05; **P < 0.01

3.12. Peel weight (g): The polled data presented in table-12 showed that beheaded height had shown significant on peel weight. The maximum peel weight was found in T_6 (30.56, 33.93) and T3 (32.25 g) during the investigating period 2020, 2021 and pooled while minimum peel weight was recorded in T_1 (25.86 g). Foliar spray of micronutrient and interaction showed non-significant effect on peel weight.

3.13. Pulp stone ratio: A perusal analysis of data presented in table-13 reveals that beheaded height had shown significant on pulp-stone ratio. The maximum pulp-stone ratio was recorded in T_1 (7.44, 6.89 and 7.17) during the investigating period 2020, 2021 and pooled respectively followed by T_2 (6.60) and minimum pulp weight was found in T_6 (4.42). Foliar spray of micronutrients was found to be non-significant during the investigation period while the interaction of beheaded height and foliar spray of micronutrients showed a significant effect on pulp-stone ratio. The highest pulp-stone ratio (8.16, 6.96, and 7.56) were recorded in T_1F_2 during the investigation period 2020, 2021 and pooled respectively while minimum pulp-stone ratio was recorded in T_6F_2 (3.79) in pooled analysis of both years. .

Table: 12. **Effect of different level of beheaded heights and foliar spray of micronutrients on peel weight.**

Peel weight (g)									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	30.92	26.33	**28.63**	21.91	24.28	**23.09**	26.41	25.31	**25.86**
T2	31.97	27.03	**29.50**	26.44	24.00	**25.22**	29.21	25.52	**27.36**
T3	32.67	35.82	**34.25**	31.43	31.73	**31.58**	32.05	33.78	**32.91**
T4	27.83	22.00	**24.92**	32.42	31.78	**32.10**	30.13	26.89	**28.51**
T5	26.08	25.42	**25.75**	30.80	32.07	**31.43**	28.44	28.74	**28.59**

T6	35.19	25.93	**30.56**	30.27	37.60	**33.93**	32.73	31.77	**32.25**
Mean	**30.78**	**27.09**	**28.93**	**28.88**	**30.24**	**29.56**	**29.83**	**28.67**	**29.25**
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		0.46	**2.79***		0.19	**1.13****		2.26	**8.23**
T		0.65	**1.92****		0.67	**1.98****		1.46	**5.30****
T at same F		0.92	**3.38****		0.94	**2.91****		2.06	**6.61**
F at same T		0.96	**3.51****		0.88	**2.72****		2.94	**9.44**

*P < 0.05; ** P < 0.01

Table:13. Effect of different level of beheaded heights and foliar spray of micronutrients on pulp stone ratio.

Pulp stone ratio									
Treatments	**2020**			**2021**			**Pooled**		
	F1	**F2**	**Mean**	**F1**	**F2**	**Mean**	**F1**	**F2**	**Mean**
T1	6.72	8.16	**7.44**	6.83	6.96	**6.89**	6.77	7.56	**7.17**
T2	6.17	7.23	**6.70**	6.99	5.99	**6.49**	6.58	6.61	**6.60**
T3	5.80	5.55	**5.68**	6.13	6.16	**6.14**	5.97	5.85	**5.91**
T4	5.11	5.60	**5.35**	4.91	5.99	**5.45**	5.01	5.79	**5.40**
T5	5.04	5.12	**5.08**	4.71	4.80	**4.75**	4.88	4.96	**4.92**
T6	5.04	4.22	**4.63**	5.07	3.35	**4.21**	5.06	3.79	**4.42**
Mean	**5.65**	**5.98**	**5.81**	**5.77**	**5.54**	**5.66**	**5.71**	**5.76**	**5.74**
		SEm (±)	**CD**		**SEm (±)**	**CD**		**SEm (±)**	**CD**
F		0.13	**0.79**		0.12	**0.76**		0.84	3.06
T		0.21	**0.62****		0.19	**0.56****		0.53	**1.94****
T at same F		0.30	**1.05****		0.27	**0.96***		0.76	**2.30****
F at same T		0.30	**1.06****		0.27	**0.99***		1.09	**3.32****

*P < 0.05; **P < 0.01

4. DISCUSSION:

4.1. Effect of different levels of beheaded height on flowering and fruiting attributes of mango cv. Amrapali.

Different levels of beheaded height and foliar application of micronutrients (Cu, Zn, and Boron) had shown significant effects on days to flowering, 50% flowering, days to fruit set, number of panicles per plant, panicles length, fruit weight, fruit size, fruit volume, and pulp-stone ratio. Among the treatments, plant beheaded at 80 cm height from ground level showed early days to flowering (23.42), days to 50 % flowering (31.07), days to fruit set (37.05), the highest number of panicles per plant (71.58 cm), largest panicles length (30.52 cm), fruit length (13.11 cm), fruit width (9.68 cm), maximum fruit weight (291.52 g), fruit volume (274.86 cc), pulp weight (233.16 g) and pulp stone ratio (7.17). This might be due to lower canopy volume which received maximum light penetrance within the canopy [19] leading to higher mobilization of nutrients within the canopy [20, 21]. Earlier flowering in plants beheaded at 80 cm also is

due to the boron and zinc effect [22]. An increase in fruit weight, fruit size, fruit volume, pulp weight, and pulp stone ratio may also be due to more absorption of water, and nutrients which increase the volume of intercellular spaces in the pulp [23]. Such type of results is also reported by [8, 24, 25].

4.2. Effect of foliar spray of micronutrients on flowering and fruiting attributes of mango cv. Amrapali.

Foliar spray of 0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) [2 sprays at just before flowering and marble stage] showed a significant effect on days to flowering (26.04 days), days to fruit set (38.74), number of panicles per plant (59.39), length of panicles (27.56 cm), fruit length (12.15 cm), fruit width (9.23 cm),fruit volume (264.31 cc), fruit weight (267.77 g) and stone weight (35.89 g). Increase in fruit size, fruit volume and fruit weight was due to combined effect of Zinc and boron because zinc had vital role in starch formation, and boron actively involved in transportation of carbohydrates in plants [26]. Combined effect of zinc and boron increase the fruit size and volume of fruit in this finding. These results are also in conformity with the earlier findings by [27, 28, 29, 30]

4.3. Interaction of different levels of beheaded height and micronutrients (Zn, Cu, and Boron) on flowering and fruiting attributes of mango cv. Amrapali.

Interaction of different levels of beheaded height and foliar spray of micronutrients exerted a significant effect on flowering and fruiting attributes. Early days to flowering (21.67), 50 % flowering (30.67 days), Fruit set, (36.43 days) maximum number of panicles per plant (77.50), panicles length (30.53 cm), fruit length (13.50 cm) , fruit width (9.92 cm) fruit weight (312.83 g), fruit volume (300.89 cc), pulp weight (253.96 g) and pulp stone ratio (7.56) was recorded in T_1F_2.(Plant beheaded with 80 cm height with foliar spray of 0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%). This might be due to interaction effect of beheaded height and foliar spray of micronutrients which lead to increase the fruit size, fruit weight and fruit volume with early flowering and fruiting. This finding is supported by [31, 32, 33, 34, 35, 36, and 37].

REFERENCES:

1. Vavilov NI. The Origin, Variation, Immunity, and Breeding of Cultivated Plants. Chronica Botanica.1926; 13 (6):1949-1950
2. Maldonado-Celis Maria Elena, Yahia Elhadi M, Bedoya Ramiro, Landázuri Patricia, Loango Nelsy, Aguillón Johanny et al; Chemical Composition of Mango (Mangifera indica L.) Fruit: Nutritional and Phytochemical Compounds. 2019. Plant Sci., 10:1073
3. Lal B, Rajput MS, Rajan S. and Rathore DS. Effect of pruning on rejuvenation of old mango trees. *Indian J. Hort*. 2000; 57: 240–24.

4. Raj Amit, Patel VB , Kumar Ravindra, Verma RB, Kumar Anil and Mahesh SS. Effect of high density planting systems on growth, yield and quality of mango (Mangifera indica L) cv. Amrapali after rejuvenation. Journal of Pharmaco. and Phytochem. 2020; 9(1): 229-234
5. Usenik V, Stampar F. Effect of late season boron spray on boron accumulation and fruit set of 'Summit' and 'Hedelfinger' sweet cherry (Prunus avium L.). Acta Agric. Slov, 2007; 89: 5158.
6. Perica S, Brown PH, Connell JH, Nyomora AMS, Dordas C, Hu H, Stangoulis J. Foliar boron application improves flower fertility and fruit set of olive. Hort Science. 2001; 36(4): 714716.
7. Rani R, Brahmachari VS (2001). Effect of foliar application of calcium, zinc and boron and cracking and physico-chemical composition of litchi. Orissa. J. Hortic. 29(1):50-57.
8. Yadav VK, Jain MC, Sharma MK, & Suman M. Effect of Micronutrients Spray on Physical and Chemical Characteristics of Pomegranate (Punica granatum L.) cv. Sindhuri. *Int. J.Curr. Microbiol. App.Sci.* 2018; (7), 998- 1005.
9. Afria BS, Pareek CS, Garg DK, Singh K Effect of foliar spray of micronutrients and their combinations on yield of Pomegranate. Ann. Arid Zone 199; 38(2):189-190.
10. Dhurve MK, Sharma TR, Bhooriya, M. and Lodha G. Effect of foliar application of zinc and boron on growth, reproductive and yield of pomegranate cv. Ganesh in hasta bahar. International J. of Chemical Studi. 2018; 6 (5): 499-503.
11. Singh DK, Gosh SK, Paul PK and Suresh CP. Effect of different micronutrient on growth, yield and quality of papaya (Carica papaya L.) cv. Ranchi. J. of Hortic. Sci. 2012; 5 (1): 351-355.
12. Monika G, Soorianathasundaram K, Auxcilia J, Chitdeshwari T, Kavitha C and Muthulakshmi P. Effect of foliar nutrition of calcium and sulphur on growth and yield of papaya (Carica papaya L.). International J. of Chemical Stud. 2018; 6 (5): 765- 769.
13. Gaur B, Beer Karma, Hada TS, Kanth N and Syamal M.M. Studies on the effect of foliar application of nutrients and GA3 on fruit yield and quality of winter season guava. An International quarterly Journal of Envir. Sci. 2014; VI: 479-483.
14. Shreekant Ram D and Kumar U. Effect of foliar application of micronutrients on fruit set, yield attributes and yield of winter season guava (Psidium guajava L.) cv. International J. of Pure & Applied Biosci. 2017; 5 (5): 1415-1419.
15. Zagade PM. Munde, GR and Shirsath, AH. Effect of foliar application of micronutrients on yield and quality of Guava (*Psidium guajava* L.) cv. Sardar. IOSR Journal of Pharmacy and Biol. Scie. 2017; 12 (5) Version-VI (Sep. – Oct.): 56-58
16. Waskela RS, Kanpure RN, Kumawat BR, Kachouli BK. Effect of foliar spray of micronutrients on growth, yield and quality of guava (Psidium guajava L.) cv. Dharidar. International Journal of Agricultural Sci. 2013; 9(2):551-556.
17. Bhatt A, Mishra NK, Mishra DS and Singh CP. 2012. Foliar application of potassium, calcium, zinc and boron enhanced yield, quality and shelf life of mango. Hort Flora Research Spect. 2012; (4): 300-305.

18. Rangaswamy R. A text book of agricultural statistics, New age international publishing limited, Hyderabad, 2010.
19. Sharma RR, Singh R. Effect of pruning intensity on light penetration and leaf physiology in Amrapali mango trees under high density planting. Tropical Sci. 2006; 46: 16-19.
20. Singh SK, Sharma RR, Shrivastav M. Effect of pruning on morpho-physiological parameter and microclimate under high-density planting of mango (*Mangifera indica* L.). Indian J. of Agric. Sci. 2010; 79 (8):632-635
21. Raj Amit, Patel VB, Kumar Ravindra, Barman Kalyan, Verma RB, Sashikant, Pathak SK. Effect of high-density planting systems on physiological and biochemical status of rejuvenated mango plants of cv. Amrapali. Indian J. Hort. 2017; 74(3) : 351-356
22. Banik BC, Sen SK. Effect of three levels of zinc, iron, boron and their interactions on growth, flowering and yield of mango cv. Fazli. Hortic. J. 1997; 10(1):23-29.
23. Vejendla V, Maity PK, Banik BC. Effect of chemicals and growth regulators on fruit retention, yield and quality of mango cv. Amrapali. Journal of Crop and Weed. 2008; 4(2):45-46. 2.
24. Moazzam A, Tahir FM, Shahzad J, Mahmood N. Effect of foliar application of micronutrients on the quality of mango (Mangiferaindica L.) cv. Dasheharifruit. Mycopath. 2011; 9(1):25-28.
25. Bhoyar MG and Ramdevputra MV. Effect of foliar spray of zinc, iron and boron on growth, yield and quality characters of guava (Psidium guajava L.) cv. L- 49. J. of Applied and Natural Sci. 2012; 8 (2): 701-704.
26. Nehete DS, Padhiar BV, Shah NI, Bhalerao PP, Kolambe BN and BhaleraoRR. 2011. Influence of micronutrient spray on flowering, yield, quality and nutrient content in leaf of mango cv. Kesar. Asian Journal of Horticulture 6 (1): 63-67.
27. Kumar R, Chauhan KS, Sharma S . A not on the effect of zinc sulphate on berry set, panicale drying and quality of grapes cv. Gold. Haryana J. Hortic. Sci. 1988; 17(3-4):213-215.
28. Kamble AB, Desai UT and Chaudhari SM. Effect of micronutrients on fruit set, fruit retention and yield of ber (Zizyphus mauritiana L) cv. Banarsi Karaka. Annuals of Arid Zone. 1994 33 (1): 53-55
29. Haque R, Roy A, Pramanic M. Response of foliar application of Mg, Zn, Cu and B on improvement of growth, yield and trial quality of Mandarin orange in Darjeeling Hills of West Bengal. Hortic 2000; J. 13(2):15-20.
30. Dutta P. Effect of foliar boron application on panicle growth, fruit retention and physio-chemical characters of mango cv. Himsagar. Indian J. of Horti. 2004; 61 (3): 265-266
31. Rath S, Singh RL, & Singh DB. Effect of boron and zinc sprays on the physico-chemical composition of mango fruits. Punjab Hort. J. 1980; 2: 33- 35.
32. Misra RS, Khan I. Effect of 2, 4, 5-Trichlorophenoyacetic acid and micronutrients on fruit size cracking, maturity and quality of litchi cv. Rose scented. Prog. Hortcult. 1981; 13(3-4):87-90.
33. Sarkar GK, Singh MM, Misra RS, Srivastava RP. Effect of foliar application of mineral elements on cracking of litchi fruits. Haryana J. Hortic. Sci. 1984; 13(1-2):18-21.

34. Kumar S, Pathak RA. Effect of foliar application of micronutrients on the yield and quality of grapes cv. Perlette. Prog. Hortic. 1992; 22(1- 2):13-16
35. Veena P, Lavania ML (1998). Effect of foliar sprays of iron, zinc and boron on growth and yield of papaya. South Indian Hortic. 1998; 46 (1-2):1- 5.
36. Dutta P, Dhua RS (2002). Improvement on fruit quality of Himsagar mango through application of zinc, iron and manganese. Hortic. J. 15(2):1-9.
37. Bhowmick N, Banik BC, Hasan MA, Ghosh B. Response of pre-harvest foliar application of zinc and boron on mango cv. Amrpali under New Alluvial Zone of West Bengal. *Indian J. of Hort.* 2012; 69(3):428- 431

.