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RESEARCH ARTICLE

Effect of plant spacing and flower inducing chemicals on yield, yield attributing characters and fruit quality of mango cv. Amrapali

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Abstract

Yield and yield attributing factors are of special significance in establishing high and ultra high-density planting of perennial fruit trees. Flowering and fruiting of individual mango trees under high density planting is comparatively low. Among the various strategies developed, the application of paclobutrazol and potassium nitrate has proven effective not only in inducing flowering but also in promoting early and offseason flowering in mango. A field experiment was conducted to study the effect of paclobutrazol (PBZ) and potassium nitrate (KNO_3) on yield and yield-attributing parameters and fruit quality of mango (*Mangifera indica* L.) cv. Amrapali grown under different plant spacings at the Horticultural Research Station, OUAT, Bhubaneswar during 2018-19 and 2019-20. The experiment was laid out in a Factorial Randomized Block Design with 12 treatment combinations and 3 replications. The treatment combinations consisted of two levels of spacings (2.0 x 2.0 m and 4.0 x 2.0 m) and six levels of chemical treatments (Paclobutrazol @ 0.25, 0.50 and 0.75 g a.i. per meter of canopy spread, and KNO_3 @ 2 % and 4 %), along with a control (water application). The results revealed that the plants spaced at 4.0 x 2.0 m and treated with paclobutrazol @ 0.50 g a.i./ m of canopy spread recorded the highest yield (8.79 kg/ tree). Application of KNO_3 @ 4 % increased fruit length by 3.60 %, fruit breadth by 1.41 %, fruit weight by 3.71 %, pulp weight by 4.75 %, stone weight by 1.19 %, pulp to peel ratio by 3.77 % and pulp to stone ratio by 3.41 % compared to the control. Fruit quality parameters were significantly influenced by the plant spacing. Maximum total soluble solids (TSS), TSS: acid ratio, reducing sugar, and total sugar, along with lower titratable acidity were recorded in plants spaced at 4.0 x 2.0 m.

Keywords: Amrapali; high-density planting; mango; paclobutrazol; potassium nitrate

Introduction

Mango (*Mangifera indica* L.) is one of the most important tropical fruits of India. It belongs to the family Anacardiaceae and originated in South-East Asia. The fruit is highly valued because of its excellent flavour, appealing aroma, delicious taste, attractive shades of colour and nutritive value, which has attracted the world market. In India, it is grown in an area of 2.339 million ha with a production of 20.336 million tons (1). India is the major producing country and accounts for more than 60 % of world production. The highest production in India is by virtue of large area but not due to high productivity. The productivity of mango is 6.8 tons/ha which is very less compared to Israel's productivity of 30 tons/ha (1). The poor productivity of orchard can be attributed to wide tree spacing, lack of canopy architecture, long juvenile phase, alternate bearing, high fruit-drop during initial stages of fruit development and unfavourable environmental conditions resulting in low fruit retention (2). To overcome low productivity in high- density planting, controlling the tree vigour and canopy size of the fruit crop is important for enhancing the orchard efficiency and productivity without causing injury to plants. Out of several strategies suggested, the use of growth retardants may dramatically reduce shoot growth.

Among the chemicals suggested, paclobutrazol is considered as one of the important plant growth retardants which restricts vegetative growth and induce flowering in many fruit species including mango (3). PBZ is a cell elongation and internode extension inhibitor that retards plant growth by inhibition of gibberellins (GA) biosynthesis. The inhibitory effect of GA probably arises from its ability to mobilize carbohydrate thereby preventing starch accumulation. Once GA level falls below a threshold, starch can start to accumulate thus allowing the tree's competence to flower.

Several workers have suggested that foliar feeding of nutrients directly to the site of metabolism as a substitute or supplement to soil application considerably enhance fruit yield and quality attributes (4, 5). It has also been recognized that mango leaves absorb most of the nutrients within 24-72 hrs. After spray and thereafter, depletion of leaf nutrient content is seen owing to translocation of N, P and K to actively developing organs within the plant system (6). KNO_3 has been shown to stimulate early flowering and to increase the number of panicles in trees growing in tropical and subtropical regions, thus ensuring increased and regular production (7). Hence, the flower inducers such as PBZ and KNO_3 were tried to regulate the plant growth, flowering and fruiting of mango cv. Amrapali under Odisha condition.

Materials and Methods

The experiment was conducted during 2018-19 and 2019-20 in the Horticulture Research Station, Baramunda, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha. The Horticulture Research Station is about 5 km away from OUAT campus, Bhubaneswar situated at a latitude of 20° 16' N and longitude of 85° 47' E with an altitude of 25.5 m above MSL and about 40 km away from Bay of Bengal. The soil was sandy loam, strongly acidic in reaction and had low organic carbon (< 0.5 %) and N content (< 200 kg ha^{-1}). The experiment was carried out on an 8 year old existing bearing mango orchard (cv. Amrapali) planted under different density and uniform in vigour and canopy spread. The experiment was laid out in a factorial randomized block design with 12 treatment combinations and 3 replications. The treatment combinations consist of two levels (Row-Row x Plant-Plant) of spacing (2.0 x 2.0 m and 4.0 x 2.0 m) and 6 levels of chemical treatments (PBZ @ 0.25, 0.50 and 0.75 g a.i. per meter of canopy spread and KNO_3 @ 2 % and 4 %) and a control with water application.

The quantified amount of PBZ (Lustar- 28 % w/w) was dissolved in 20 L of water and applied around the root zone by making a ring of 20 cm width and 10-15 cm depth with a radius of 1.5 m from the trunk during 1st week of September 2018 and 2019. For preparation of KNO_3 solution 2 % and 4 %, 20 g and 40 g KNO_3 dissolved in one litre of water. Foliar spray of prepared solution of KNO_3 as per the treatments were done to the undersides of leaves using tractor operated sprayer because of the high numbers of stomata on the lower surface during 1st week of November and again in 1st week of December 2018 and 2019. The control trees were treated with water. All the trees were provided with standard orchard management practices including nutrient and pest management.

Observations were recorded on fruit yield (kg/tree) and yield attributing characters like fruit length (cm), fruit breadth (cm), fruit weight (g), pulp weight (g), peel weight (g), stone weight (g), pulp: peel ratio, pulp: stone ratio and on fruit quality parameters *viz*., total soluble solids (°B), titratable acidity (%), TSS: Acid ratio, reducing sugar (%) and total sugar (%). To estimate the fruit yield per plant, fruits were harvested at full maturity, weighed with physical balance and yield was expressed in kg per tree. The average fruit weight was computed by dividing the fruit yield by the number of fruits per tree. The pulp was separated from fully ripe fruits by excluding the peel and stone; weighed and was expressed in gram (g). The peel weight of fruit was taken after removing the pulp and stone from the fruits and expressed in gram (g). Similarly, the stone was taken out from the ripe fruits excluding peel and pulp from fruits and weighed. The stone weight was expressed in gram (g). The ratio of pulp to stone was calculated by dividing the pulp weight to stone weight. Pulp: peel ratio was calculated by dividing the pulp weight to peel weight. For recording observations on fruit quality attributes, 10 fruits of uniform maturity were sampled. TSS were measured by digital refractometer (0-85 °Brix, Hanna) and titratable acidity was estimated by 0.1 N NaOH method (8). Reducing sugar was estimated by titrimetric method Lane and Eynon as narrated (9). The total sugar in the sample was estimated by same method as that of reducing sugar after inversion of the non-reducing sugar using dilute hydrochloric acid and expressed in percentage (9). The data generated on various parameters were tabulated and statistically analyzed out as per factorial randomized block design (10). The level of significance was tested for different variables at 5 % level of significance.

Results and Discussion

Yield

The perusal of data on yield (Table 1) indicated that there was significant variation in the fruit yield per tree of mango as influenced by different spacing. The maximum fruit yield per tree (7.45 kg) was recorded in S_2: 4 m × 2 m. Whereas, the minimum fruit yield per tree (4.55 kg) was noted in S_1: 2 m × 2 m. Enhanced fruit yield and yield attributes due to wider spacing has been reported in guava (11), in pear (12), in mango cv. Kesar (13). Plants grown under lower planting density produced flowers in all quadrants of the canopy and recorded with higher fruit set percentage. Consequently, plants under wider spacing recorded with higher number of fruits per tree at harvest than closer spacing (14).

Significant increase in fruit yield as influenced by the flower inducing chemicals was observed in the present experiment. The highest fruit yield per tree (9.22 kg) was recorded in C_2: PBZ @ 0.50 g a.i./m of canopy spread and the lowest (6.08 kg) in C_6: control. Higher number of fruits per tree at harvesting time in paclobutrazol treated plants as compared to the control have been documented previously (15). PBZ treated plants have increased chlorophyll content and increase in chlorophyll content enhanced the rate of photosynthesis which resulted in higher yield (16). PBZ suppressed vegetative growth of mango by inhibition of GA biosynthesis and the assimilate that was to be expended for vegetative growth was diverted to intensify flowering, fruit set and fruit growth (15).

The interaction effect of plant spacing and flower inducing chemicals had significant influence on this parameter. The maximum fruit yield per tree (8.79 kg) was observed in S_2C_2: plant spaced at 4 m × 2 m and treated with PBZ @ 0.50 g a.i./ m of canopy spread. Whereas, the minimum fruit yield per tree (3.46 kg) was recorded in S_1C_6: plant spaced at 2 m × 2 m and control treatment. Similar results were obtained in plants spaced at 7.5 × 5.0 m spacing and treated with paclobutrazol at 2 mL recorded the higher number of fruits and yield per plant in mango cv. Alphonso (17).

Yield attributing characters

Yield and yield attributing factors are of special significance in establishing high and ultra high-density planting of perennial fruit trees. The results obtained in the present investigation (Table 1) revealed that there was significant variation in the fruit

Table 1. Influence of PBZ and KNO_3 on yield, fruit length and breadth of mango cv. Amrapali planted under different spacings (2018-19)

Treatment	Fruit yield (kg/ tree)	Fruit length (cm)	Fruit breadth (cm)
Spacing (S)			
S_1: 2m × 2m	4.55	9.97	7.69
S_2: 4m × 2m	7.45	11.78	8.43
S E (m)±	0.34	0.15	0.04
C D (0.05)	0.96	0.42	0.10
Flower inducing chemical (C)			
C_1: (PBZ @ 0.25 g a.i./m of canopy spread)	8.27	11.25	8.42
C_2: (PBZ @ 0.50 g a.i./m of canopy spread)	9.22	11.21	8.39
C_3: (PBZ @ 0.75 g a.i./m of canopy spread)	7.82	11.16	8.37
C_4: (2 % KNO_3)	7.37	11.87	8.56
C_5: (4 % KNO_3)	7.87	12.08	8.63
C_6: (Control - water application)	6.08	11.66	8.51
S E (m)±	0.41	0.18	0.04
C D (0.05)	1.17	0.51	0.13
Interaction: Spacing (S) × Flower inducing chemical (C)			
S_1C_1: (2 m×2 m & 0.25 g a.i. PBZ)	4.97	9.42	7.64
S_1C_2: (2 m×2 m & 0.50 g a.i. PBZ)	5.26	9.38	7.61
S_1C_3: (2 m×2 m & 0.75 g a.i. PBZ)	4.63	9.30	7.58
S_1C_4: (2 m×2 m & 2 % KNO_3)	4.31	10.52	7.75
S_1C_5: (2 m×2 m & 4 % KNO_3)	4.65	10.94	7.82
S_1C_6: (2 m×2 m & water application)	3.46	10.24	7.71
S_2C_1: (4 m×2 m & 0.25 g a.i. PBZ)	7.94	11.54	8.35
S_2C_2: (4 m×2 m & 0.50 g a.i. PBZ)	8.79	11.48	8.30
S_2C_3: (4 m×2 m & 0.75 g a.i. PBZ)	7.53	11.41	8.27
S_2C_4: (4 m×2 m & 2 % KNO_3)	7.07	12.08	8.55
S_2C_5: (4 m×2 m & 4 % KNO_3)	7.56	12.25	8.62
S_2C_6: (4 m×2 m & water application)	5.82	11.89	8.48
S E (m)±	0.24	0.36	0.09
C D (0.05)	0.68	NS	NS

length and breadth of mango as influenced by different spacing. The maximum fruit length (11.78 cm) and fruit breadth (8.43 cm) were recorded in S_2: 4 m × 2 m and the minimum fruit length and fruit breadth (9.97 cm, 7.69 cm) was noticed in S_1: 2 m × 2 m. Similarly, maximum fruit number, fruit weight, fruit size and yield, stone weight, stone size, kernel weight and size were recorded at wider spacing of 5 m × 5 m in apricot (18). The flower inducing chemicals also had significant influence on fruit length of mango. The highest fruit length and fruit breadth (12.08 cm, 8.63 cm) was recorded in C_5: 4 % KNO_3which was closely followed by C_4 (11.87 cm, 8.56 cm). Whereas the lowest fruit length and breadth (11.16 cm, 8.37 cm) was recorded in C_3: PBZ @ 0.75 g a.i./m of canopy spread, which was at par with C_2 and C_1. The interaction effect of spacing and flower inducing chemicals revealed that there was no significant difference among the various treatment combinations. The results obtained in this experiment were well supported by earlier worker (19). As paclobutrazol is a cell elongation and internode extension inhibitor that retards plant growth by inhibition of gibberellins biosynthesis. Gibberellins stimulate cell elongation. When gibberellin production is inhibited, cell division still occurs, but the new cells do not elongate which leads to reduction in fruit length and breadth.

It was observed from the data presented in Table 2 that fruit weight and pulp weight of mango differed significantly as influenced by the plant spacing. The highest fruit weight and pulp weight (200.38 g, 152.07 g) was recorded in spacing S_2: 4 m × 2 m. The lowest fruit weight and pulp weight (189.10 g, 142.19 g) was noted in S_1: 2 m × 2 m. The above findings are in conformity with earlier work in mango cv. Alphonso (17) and in mango cv. Amrapali (20). An increase in fruit weight in widely spaced trees might be since the plant intercepted maximum radiation which in turn had more efficient photosynthetic activities resulting in higher availability of net photosynthesis which enabled the trees to produce fruits with more weight (21). Similarly, flower inducing chemicals showed significant effect on fruit weight. The maximum fruit weight and pulp weight (210.63 g, 161.44 g) was registered in C_5: 4 % KNO_3 which was closely followed by C_4 and C_6. However, the minimum fruit weight and pulp weight (188.07 g, 140.76 g) was recorded in C_3: PBZ @ 0.75 g a.i./m of canopy spread which was at par with C_2 and C_1. Nitrogen supplement from potassium nitrate may be the reason for the increase in the quantitative parameters of yield. Increased nitrogen fertilization via the soil has also been found to increase fruit retention and tree yield in mango (22). The interaction effect of spacing and flower inducing chemicals revealed that there was no significant difference among the various treatment combinations.

The perusal of data revealed that there was no significant difference observed in the peel weight of mango fruits due to plant spacing. The flower inducing chemicals had no significant effect on peel weigh of mango fruits. However, peel weight of fruit varied from 22.77 g in C_3 to 23.48 g in C_5. The interaction effect of spacing and flower inducing chemicals revealed that there was no significant difference among the various treatment combinations.

Data recorded during the year 2018-19 and presented in Table 3 revealed plant spacing without considering the effect of flower inducing chemicals had marked significant influence on stone weight of mango. The maximum stone weight (24.71 g) was recorded in S_2: 4 m × 2 m. Whereas, the minimum stone weight (23.79 g) was recorded in S_1: 2 m × 2 m. Similarly, flower inducing chemicals irrespective of plant spacing had marked influence on this parameter. The highest stone weight (25.36 g) was recorded in treatment C_5:4 % KNO_3which was at par with C_4 (25.18 g) and C_6 (25.06 g). While the lowest stone weight (23.96 g) was observed in C_3: PBZ @ 0.75 g a.i./m of canopy spread. The interaction effect of spacing and flower inducing chemicals was not significant for stone weight of mango.

The perusal of data (Table 3) during the year 2018-19 indicated that plant spacing had significant influence on pulp:

Table 2. Influence of PBZ and KNO_3 on fruit weight, pulp weight and peel weight of mango cv. Amrapali planted under different spacings (2018-19)

Treatment	Fruit weight (g)	Pulp weight (g)	Peel weight (g)
Spacing (S)			
S_1: 2 m × 2 m	189.10	142.91	22.90
S_2: 4 m × 2 m	200.38	152.07	23.09
S E (m)±	4.50	3.15	0.74
C D (0.05)	12.86	9.01	NS
Flower inducing chemical(C)			
C_1: (PBZ @ 0.25 g a.i./m of canopy spread)	196.02	147.99	22.94
C_2: (PBZ @ 0.50 g a.i./m of canopy spread)	192.11	145.24	22.85
C_3: (PBZ @ 0.75 g a.i./m of canopy spread)	188.07	140.76	22.77
C_4: (2 % KNO_3)	209.05	157.94	23.39
C_5: (4 % KNO_3)	210.63	161.44	23.48
C_6: (Control - water application)	203.08	154.11	23.25
S E (m)±	5.51	3.86	0.91
C D (0.05)	15.74	11.03	NS
Interaction: Spacing (S) × Flower inducing chemical(C)			
S_1C_1: (2 m×2 m & 0.25 g a.i. PBZ)	185.74	140.01	22.74
S_1C_2: (2 m×2 m & 0.50 g a.i. PBZ)	181.92	136.54	22.67
S_1C_3: (2 m×2 m & 0.75 g a.i. PBZ)	177.21	131.98	22.62
S_1C_4: (2 m×2 m & 2 % KNO_3)	196.35	149.42	23.15
S_1C_5: (2 m×2 m & 4 % KNO_3)	200.26	153.03	23.28
S_1C_6: (2 m×2 m & water application)	193.12	146.48	22.95
S_2C_1: (4 m×2 m & 0.25 g a.i. PBZ)	197.65	149.60	22.90
S_2C_2: (4 m×2 m & 0.50 g a.i. PBZ)	193.24	145.38	22.81
S_2C_3: (4 m×2 m & 0.75 g a.i. PBZ)	189.58	142.04	22.71
S_2C_4: (4 m×2 m & 2 % KNO_3)	208.12	158.57	23.40
S_2C_5: (4 m×2 m & 4 % KNO_3)	210.45	162.66	23.48
S_2C_6: (4 m×2 m & water application)	203.23	154.13	23.25
S E (m)±	11.03	7.73	1.81
C D (0.05)	NS	NS	NS

Table 3. Influence of PBZ and KNO_3 on stone weight, pulp: peel ratio and pulp: stone ratio weight of mango cv. Amrapali planted under different spacings (2018-19)

Treatment	Stone weight (g)	Pulp: peel ratio	Pulp: stone ratio
Spacing (S)			
S_1: 2 m × 2 m	23.79	6.24	6.00
S_2: 4 m × 2 m	24.71	6.58	6.12
S E (m)±	0.20	0.12	0.05
C D (0.05)	0.58	0.34	0.14
Flower inducing chemical(C)			
C_1: (PBZ @ 0.25 g a.i./m of canopy spread)	24.23	6.45	6.10
C_2: (PBZ @ 0.50 g a.i./m of canopy spread)	24.06	6.32	6.00
C_3: (PBZ @ 0.75 g a.i./m of canopy spread)	23.96	6.18	5.87
C_4: (2 % KNO_3)	25.18	6.75	6.27
C_5: (4 % KNO_3)	25.36	6.88	6.36
C_6: (Control - water application)	25.06	6.63	6.15
S E (m)±	0.25	0.14	0.06
C D (0.05)	0.71	0.41	0.17
Interaction: Spacing (S) × Flower inducing chemical(C)			
S_1C_1: (2 m×2 m & 0.25 g a.i. PBZ)	23.49	6.16	5.96
S_1C_2: (2 m×2 m & 0.50 g a.i. PBZ)	23.21	6.02	5.88
S_1C_3: (2 m×2 m & 0.75 g a.i. PBZ)	23.11	5.83	5.71
S_1C_4: (2 m×2 m & 2 % KNO_3)	24.28	6.45	6.15
S_1C_5: (2 m×2 m & 4 % KNO_3)	24.45	6.57	6.26
S_1C_6: (2 m×2 m & water application)	24.19	6.38	6.06
S_2C_1: (4 m×2 m & 0.25 g a.i. PBZ)	24.41	6.53	6.13
S_2C_2: (4 m×2 m & 0.50 g a.i. PBZ)	24.13	6.37	6.02
S_2C_3: (4 m×2 m & 0.75 g a.i. PBZ)	24.03	6.25	5.91
S_2C_4: (4 m×2 m & 2 % KNO_3)	25.20	6.78	6.29
S_2C_5: (4 m×2 m & 4 % KNO_3)	25.37	6.93	6.41
S_2C_6: (4 m×2 m & water application)	25.11	6.63	6.14
S E (m)±	0.50	0.29	0.12
C D (0.05)	NS	NS	NS

peel ratio and pulp: stone ratio of mango. The highest pulp: peel ratio and pulp: stone ratio (6.58, 6.12) was recorded in S_2: 4 m × 2 m. Whereas, the lowest pulp: peel ratio and pulp: stone ratio (6.24, 6.00) was noticed in S_1: 2 m × 2 m. As the density of the plants per unit area reduces in wider spacing, it helps in proper distribution of light, good aeration in the canopy and less competition for the nutrient and produced fruits with higher weight and maximum pulp: peel ratio and pulp: stone ratio. Similarly, flower inducing chemicals had significant influence on this parameter. The maximum pulp: peel ratio and pulp: stone ratio (6.88, 6.36) was recorded in C_5: 4 % KNO_3 which was closely followed by C_4 and C_6. The minimum pulp: peel ratio and pulp:

stone ratio (6.18, 5.87) was recorded in C_3: PBZ @ 0.75 g a.i./m of canopy spread. Less than 0.1 % of the hermaphrodite flowers develop into mature fruit. He stated that, assuming there are 100000 flowers and each flower contains 10 µg nitrogen, then each time a tree flowers, it loses 1 kg of nitrogen. The tree will, therefore, need to have adequate nitrogen reserves for subsequent flowering, fruit set and fruit development (23). The pulp: peel ratio was not influenced by the interaction effect of spacing and flower inducing chemicals.

Fruit quality parameters

The data pertaining to fruit quality parameters are presented in Table 4. Total soluble solids, titratable acidity, TSS: acid ratio and reducing sugar of mango fruits were significantly influenced by plant spacing. The maximum total soluble solids (21.31 °B), TSS: Acid ratio (137.48), reducing sugar (4.61 %) and lower titratable acidity (0.155 %) was recorded in plants spaced at 4 m x 2 m. Higher photosynthesis and availability of metabolites due to higher interception of photosynthetically active radiation by individual tree might have improved fruit quality at wider spacing (21). The present findings are in line with earlier reports of higher TSS in wider spacing (5 m × 5 m) of apricot than closure spacing (3.5 m × 3.5 m) (18).

Flower inducing chemicals had no significant influence on fruit quality parameters of mango cv. Amrapali under study. Fruit quality parameters are genotypical features of the cultivar, therefore did not vary significantly due to chemical treatments. There was no improvement in fruit quality with the application of paclobutrazol (24). The interaction effect of plant spacing and flower inducing chemicals had no significant effect on fruit quality. Similar, trends were also noticed in mango cv. Alphonso (17).

Conclusion

Among the planting densities, plants spaced at 4.0 × 2.0 m recorded higher fruit yield, improved yield-attributing parameters, and better fruit quality compared to those spaced at 2.0 × 2.0 m. Among the chemical treatments, application of PBZ @ 0.50 g a.i. per meter of canopy spread resulted in the highest yield. Yield-attributing parameters such as fruit weight, fruit length, and fruit breadth were maximized in plants treated with 4 % KNO_3.

The interaction between 4.0 × 2.0 m spacing and PBZ @ 0.50 g a.i. application produced the highest fruit yield per plant. However, fruit quality parameters such as TSS, acidity, reducing sugar, and total sugar content were not significantly influenced by flower inducers like PBZ and KNO_3.

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Table 4. Influence of PBZ and KNO_3 on TSS, titratable acidity, TSS: acid ratio, reducing sugar and total sugar of mango cv. Amrapali planted under different spacings (2018-19)

Treatments	TSS (°B)	Titratable acidity (%)	TSS: acid ratio	Reducing sugar (%)	Total sugar (%)
Spacing (S)					
S_1: 2m × 2m	20.92	0.165	127.73	4.50	16.62
S_2: 4m × 2m	21.31	0.155	137.48	4.61	17.05
S E (m)±	0.16	0.011	13.20	0.19	0.60
C D (0.05)	0.47	0.031	37.62	0.54	NS
Flower inducing chemical (C)					
C_1: (PBZ @ 0.25 g a.i./m of canopy spread)	21.43	0.145	149.77	4.97	17.25
C_2: (PBZ @ 0.50 g a.i./m of canopy spread)	21.65	0.125	176.10	5.08	17.48
C_3: (PBZ @ 0.75 g a.i./m of canopy spread)	21.47	0.135	161.49	4.92	17.31
C_4: (2 % KNO_3)	21.42	0.155	139.82	4.68	17.18
C_5: (4 % KNO_3)	21.59	0.148	150.79	4.81	17.37
C_6: (Control - water application)	21.05	0.165	129.13	4.47	16.61
S E (m)±	0.44	0.013	16.17	0.26	0.74
C D (0.05)	NS	NS	NS	NS	NS
Interaction: Spacing (S) × Flower inducing chemical (C)					
S_1C_1: (2m×2m & 0.25 g a.i. PBZ)	20.92	0.165	126.79	4.65	16.69
S_1C_2: (2m×2m & 0.50 g a.i. PBZ)	21.34	0.145	147.17	4.76	16.92
S_1C_3: (2m×2m & 0.75 g a.i. PBZ)	20.95	0.155	135.16	4.60	16.75
S_1C_4: (2m×2m & 2 % KNO_3)	20.91	0.175	119.49	4.36	16.62
S_1C_5: (2m×2m & 4 % KNO_3)	21.22	0.165	128.61	4.49	16.81
S_1C_6: (2m×2m & water application)	20.20	0.185	109.19	4.15	15.93
S_2C_1: (4m×2m & 0.25 g a.i. PBZ)	21.42	0.155	138.19	4.94	17.09
S_2C_2: (4m×2m & 0.50 g a.i. PBZ)	21.84	0.135	161.78	5.05	17.32
S_2C_3: (4m×2m & 0.75 g a.i. PBZ)	21.45	0.145	147.93	4.89	17.15
S_2C_4: (4m×2m & 2 % KNO_3)	21.41	0.165	129.76	4.65	17.02
S_2C_5: (4m×2m & 4 % KNO_3)	21.72	0.155	140.13	4.78	17.21
S_2C_6: (4m×2m & water application)	20.70	0.175	118.29	4.44	16.48
S E (m)±	0.88	0.027	32.33	0.51	1.47
C D (0.05)	NS	NS	NS	NS	NS

Authors' contributions

All authors contributed equally. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

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