

Influence of methyl jasmonate application on growth and fruit quality of strawberry

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Abstract

A field experiment was conducted at the Instructional Farm (Horticulture), Department of Horticulture, Career Point University, Kota during the session 2024-2025. The experiment consisted of ten treatments comprising different amount of methyl jasmonate levels. The experiment was laid out in Randomized Block Design with three replications. As regard to growth parameters, plants treated with 0.4 mM MeJA (T_3) had the maximum plant height (22.48 cm), leaf area (34.82 cm²), maximum leaf RWC (76.50%), number of leaves per plant (29.56), maximum number of flowers (38.88), earliest flowering (54.93 days), first fruit set (62.16 days) and maximum harvest (78.16 days). In production parameters, treatment 0.4 mM MeJA (T_3) produced maximum number of fruits per plant (19.56), fruits yield per plant with (372.75 g), Based on overall performance, treatment 0.4 mM MeJA was found superior over all other treatments with respect to growth and yield strawberry.

Keywords: Flower, fruit, growth, harvest

Introduction

The luscious, attractive and nutritious modern cultivated strawberry (*Fragaria x ananassa* Duch.) is one of the most important soft fruits in the world. It is a man-made hybrid crop evolved by crossing two species *Fragaria chiloensis* and *Fragaria virginiana*. It is a crop of octaploid in nature ($2n = 8x = 56$), belonging to the family Rosaceae, mainly behaving as a perennial crop when grown in temperate areas and annual crop when grown in sub-tropical areas. Being a rich source of vitamins and minerals, like Vitamin A (60 IU/100 g of edible portion) and Vitamin C (30-120 mg/100g of edible portion), they are mainly consumed as fresh fruits, and are also commonly utilized for flavouring in manufacturing and processing industries for different processed products and beauty products as well. The red colour of the fruits is due to the presence of anthocyanin pigment (Sharma, 2002 and Chadha, 2001) [2, 14]. It contains few aromatic compounds in different concentrations which is responsible for the aroma and flavour of the fruits, viz., ethyl hexanoate, methyl hexanoate, ethyl propionate, ethyl butanoate, methyl butanoate, furanone and linalool. Among acids, citric acid is the most abundant organic acid present in strawberry, followed by malic acid, succinic acid and oxalic acid. Being a crop with high return per unit area and giving quick return, its cultivation is growing in different parts as the demand in industries increases. The high yield and quality of fruits are preferred which fetch a better price in market. As to this, several low-cost strategies have been developed throughout the world to enhance its quality and productivity. Among them is mulching, particularly in strawberry, is an important practice in strawberry production. Depending on the climatic conditions and availability of raw materials, black polythene or organic mulches may be used as they greatly enhance the production and quality of the fruits (Himelrick, 1982; Rebandel and Przysiccka, 1981; Badiyala and Aggarwal, 1981) [1, 7, 12].

Among different PGRs, Methyl Jasmonate, a methyl ester of Jasmonic Acid is a phytohormone with ubiquitous distribution among plants and generally considered to modulate many physiological events in higher plants, such

as defense responses, flowering and senescence (Cheong and Choi, 2003) [3]. There are few experiments which also shows that Methyl Jasmonate enhances ripening, physiological properties and the shelf life of the strawberry and other fruits which enhance the ripening process, maintaining the post-harvest shelf life of papaya cv. 'Sunrise' (Gonzalez-Aguilar *et al.* 2003), stimulating secondary metabolites such as stilbene in leaves and berries of grapevine plants (Larrondo *et al.* 2003). Furthermore, it suppressed green mold growth in grapefruit (Droby *et al.* 1999) [4], controlled Botrytis rot in cut rose flowers (Meir *et al.* 1998) [10], and inhibited grey mold infection in strawberries (Moline *et al.* 1997) [11], enhanced anthocyanin accumulation in soybean seedling (Franceschi and Grimes, 1991) [5], apple fruit (Kondo *et al.* 2001) [8], and strawberry ripening (Perez *et al.* 1997) and increased b-carotene accumulation in ripening tomatoes (Saniewski and Czapski, 1983) [15]. Some reports also suggest that methyl jasmonate plays an important role in defense mechanism of plants and diverse developmental pathways such as seed germination, root growth, etc. However, literatures on the exact response of methyl jasmonate on strawberry plants and fruits to improve the yield and quality is still exiguous as the use of this compound is still uncommon for the improvement of crops in experiments or cultivation practices, particularly on the shelf life of the fruits.

Materials and Methods

Location

Kota district is located at 25.18° N to 75.83° E Latitude in South Eastern Rajasthan. It covers an area of 221.36 km². Agro-climatically, the district falls in Zone V, known as Humid South Eastern Plain. The average rainfall in the region is 660.6. mm. Maximum temperature range in the summer is 40 to 48°C and minimum 1.0- 2.6°C during winter.

Experimental Details

Strawberry (*Fragaria x ananassa* Duch.) cv. Chandler was used for the experiment of which the planting materials

were obtained from K. F. Bioplants, Pune (Maharashtra). The plants were healthy and uniform in growth and vigour. The plants under the experiment were maintained in a uniformed cultural schedule during the entire course of investigation. The plants were planted in a double row raised bed where they are treated with the recommended dose of Methyl Jasmonate. The experimental field consists of six beds, each having five different plots. Each plot is treated with different treatments. Each treatment was replicated five times in Randomized block design (RBD). The beds were laid with black plastic mulch to conserve the soil moisture and to control weeds on the beds, and poly tunnels were imposed during December - January to protect the plants from severe frost. The treatments comprising of different concentration of Methyl Jasmonate *viz.* Control (T₁), 0.2 mM Pre-harvest treatment (T₂), 0.4 mM Pre-harvest treatment (T₃), 0.6 mM Pre-harvest treatment (T₄).

Preparation of working solution of methyl jasmonate

The required amount of methyl jasmonate was taken with the help of micropipette to which it was then mixed with the measured amount of water to prepare the working solution.

Applications of treatments

- The plants were sprayed in two stages *viz.* prior to flowering and 10 days after the first spray.
- The plants under treatment T₂ to T₄ were sprayed during vegetative growth, *i.e.*, before the fruits were harvested.

Measurement of the growth parameters

The plant height was measured by erecting the measuring scale from the bottom to the maximum height of the plant for three different plants under each replication and the average plant height for each replication was calculated thereafter. The number of leaves in a plant was measured by counting the total number of leaves produced per plant for three different plants under each replication and average number of leaves per plant for each replication was calculated thereafter. The relative water content of the mature leaves was measured following the method suggested by Weatherley, (1950) [16]. According to this method, fresh leaf samples were collected and 1 cm² size were cut off from the leaf samples. Fresh weight of these cutoff samples was then taken and were imbibed by floating them in distilled water inside a petri dish overnight. After imbibing for overnight, the samples were then surface dried with filter paper and were re-weighed before being oven-dried. After that, the samples were dried in an oven dryer at

70°C for 24 hrs.

Measurement of the Reproductive and yield parameters

Days to commencement of first flower was measured by counting the total number of days taken by the plants for anthesis of first flower from the date of planting. Total number of flowers per plant was measured by counting the total number of flowers produced by the plants during the entire flowering period. Days to first fruit setting was measured by counting the days taken by the plants to set fruits from the date of planting. Duration of harvesting was recorded by counting the total number of days taken by the plant in each replication under each treatment from harvesting of first fruit to last fruit and expressed in days. Number of fruits per plant was recorded by counting the number of fruits harvested from the individual plant in each treatment. Fruit yield per plant was counted by all the fruits from an individual plant were picked manually in each harvesting and weighing them on digital weighing balance. At the end of last harvesting in each replication, total yield was calculated by adding the value of fruit weight in each harvesting and expressed in gram per plant.

Results

Growth parameters

The plant height of different MeJA treated strawberry plants has been presented in Table 1 and after statistical analysis of the data, it was reflected that the treatment effect was non-significant in this regard. However, the plants treated with 0.4 mM MeJA (T₃) were the tallest with 22.48 cm height, while the control treatment (T₁) were the shortest with 20.23 cm height. After statistical analysis of the data, it was reflected that the treatment effect was significantly affected regarding leaf area. However, the plants treated with 0.4 mM MeJA (T₃) were the maximum leaf area with 34.82 cm², while the control treatment (T₁) were the shortest with 28.89 cm² (Table 1).

The leaf RWC of different MeJA treated strawberry plants has been presented in Table 1 and after statistical analysis of the data, it was reflected that the treatment effect was significant in this regard. However, the plants treated with 0.4 mM MeJA (T₃) were the maximum leaf RWC with 76.50 per cent, while the control treatment (T₁) were the lowest with 56.85 per cent. The number of leaves of different MeJA treated strawberry plants. After statistical analysis of the data, it was reflected that the treatment effect was non-significant in this regard. However, the plants treated with 0.4 mM MeJA (T₃) were the maximum number of leaves with 29.56 while the control treatment (T₁) were the lowest with 25.49 (Table 1).

Table 1: Effect of MeJA on growth parameters

Sl.No.	Treatment	Plant height (cm)	Leaf area (cm ²)	LeafRWC (%)	No. of leaves per plant
T1	Control	20.23	28.89	56.85	25.49
T2	0.2 mM MeJA	20.90	32.44	70.69	27.90
T3	0.4 mM MeJA	22.48	34.82	76.50	29.56
T4	0.6 mM MeJA	21.65	31.55	69.99	26.23
	SE m (±)	1.30	1.34	1.40	1.32
	CD (P=0.05)	-	1.58	1.76	-
	CV (%)	4.782	5.70	5.88	5.39

Reproductive and yield parameters

The number of flowers of different MeJA treated strawberry plants has been presented in Table 2 and after statistical

analysis of the data, it was reflected that the treatment effect was significant in this regard. However, the plants treated with 0.4 mM MeJA (T₃) were the maximum number of

flowers with 38.88 while the control treatment (T1) were the lowest with 26.90. The first flowering of different MeJA treated strawberry plants has been reflected that the treatment effect was non-significant in this regard. However, the untreated plants (control) were the late with 54.93 days while the plants treated with 0.4 mM MeJA (T3) were the earliest with 53.90 days.

After statistical analysis of the data, it was reflected that the treatment effect was non-significant regarding first fruit set. However, the untreated plants (control) were the late with 62.16 days while the plants treated with 0.4 mM MeJA (T3)

were the earliest with 57.87 days. The first flowering of different MeJA treated strawberry plants has been presented in Table 2 and after statistical analysis of the data, it was reflected that the treatment effect was significant in this regard. However, the untreated plants (control) were the lowest with 57.96 days while the plants treated with 0.4 mM MeJA (T3) were the highest with 78.16 days. The duration of harvesting were the lowest (57.96 days) in untreated plants (control), while the plants treated with 0.4 mM MeJA (T3) were the highest with 78.16 days (Table 2).

Table 2: Effect of MeJA on growth parameters

Sl.No.	Treatment	No. of flowers per plant	First flowering (days)	First fruiting (days)	Duration of harvest (days)
T1	Control	26.90	54.93	62.16	57.96
T2	0.2 mM MeJA	30.93	54.42	61.06	69.94
T3	0.4 mM MeJA	38.88	53.90	57.87	78.16
T4	0.6 mM MeJA	32.23	54.12	60.18	63.8
	SE m (\pm)	1.37	2.20	2.17	2.13
	CD (P=0.05)	1.68	-	-	6.40
	CV (%)	6.96	2.67	2.20	3.11

The number of fruits per plant of different MeJA treated strawberry plants has been presented in Table 3 and after statistical analysis of the data, it was reflected that the treatment effect was significant in this regard. However, the plants treated with 0.4 mM MeJA (T3) were the maximum number of fruits per plant with 19.56, while the control treatment (T1) were the lowest with 13.88. The fruits per

yield plant of different MeJA treated strawberry plants was reflected and the treatment effect was significant in this regard. However, the plants treated with 0.4 mM MeJA (T3) were the maximum fruits yield per plant with 372.75 g while the control treatment (T1) were the lowest with 235.32 g.

Table 3: Effect of MeJA on yield parameters

Sl.No.	Treatment	No. of fruits per plant	Fruit yield per plant(g)
T1	Control	13.88	235.32
T2	0.2 mM MeJA	17.90	331.54
T3	0.4 mM MeJA	19.56	372.75
T4	0.6 mM MeJA	16.23	297.06
	SE m (\pm)	1.37	2.98
	CD (P=0.05)	1.67	4.41
	CV (%)	9.13	10.96

Discussion

Growth parameters

Non-significant effect of treatment was found in the plant height where it mainly ranges from 20 cm to 22.48 cm. Methyl jasmonate increases SLR1 levels in rice and RGA in *Arabidopsis*, which are predicted to result in the repression of plant growth. Conversely, it was found reported that JAZ9 could effectively interrupt RGA-PIF3 interaction, suggesting that in the absence of JA signaling, some DELLA repressors could be titrated out by JAZ proteins, which would allow more PIF transcription factors to activate growth programs. Therefore, it gives an important insight for JA interaction in GA signaling and thus promoting its action that further leads to growth promoting of plants. However, the leaf area and its relative water content showed a significant treatment with MeJA in which the leaf area ranges from 28.89 cm² to 34.82 cm². Whereas its relative water content ranges from 56.85 % to 76.50 %. The treatment with methyl jasmonate has influenced the plants to accumulate more moisture in the leaves to enhance their tolerance towards abiotic stress like drought. Sadhegipour (2018) obtained similar findings in cowpea with foliar application of MeJA at the reproductive stage

enhancing RWC in drought-stressed cowpea plants. For the number of leaves per plant, the treatment did not show significant changes as the control treatment showed the least amount with 24.26 leaves while 0.4 mM MeJA treatment showed the most amount with 29.56 leaves per plant. In case of the number of flowers per plant, the treatment showed significant changes on the plants with the untreated plants having the least (26.90 flowers) while the 0.4 mM MeJA treated plants had the most flowers with 38.88. Methyl jasmonate as being shown to induce the growth of plants by enhancing cell division and enlargement in the plants helped in inducing the plant growth, including its production of leaves and flowers.

On the other hand, the treatment for number of days the plants taken for their first flowering and fruiting had no significant changes with the different doses of chemical, but the treatment showed positive influence as compared to control, where the 0.4 mM MeJA treated plants required the least (53.90 days respectively) and the untreated plants required the most days (54.93 days respectively). However, significant changes have been achieved for the duration of fruit harvest with the treatment of MeJA where the fruits of

plants treated with 0.4 mM MeJA were harvested for the longest period (60.79 days) amongst the different treatment, while the fruits of untreated plants were harvest for the shortest period (57.96 days). The beginning of summer heat during March in Rajasthan condition led to the shortening of flowering of plants which resulted in reduction of fruit production, thereby decreasing the duration of harvest. The methyl jasmonate in treated plants helped in inducing resistance to abiotic stress like heat, resulting in longer flowering and fruiting days. Therefore, the duration of harvest was found to be increased in the treated plants.

Yield parameters

The present investigation showed the impact of different concentrations of MeJA in the yield parameters of strawberry cv. Chandler. The data obtained has revealed that the treatment is significant in improving the fruit yield where maximum yield is found in 0.4 mM MeJA treated plants with 19.56 fruits per plant and 372.75 g of fruits per plant. On the other hand, the least favourable result was obtained in control treatment which gave 13.88 fruits per plant and 235.32 g of fruits per plant. Similar findings as to increase of fruit yield in MeJA treatment was also observed by Garcia-Pastor *et al.* (2019) in pomegranate and Abolfazl Lolaei *et al.* (2013) in strawberry where the MeJA treatment shows significant effect in terms of yield. The increase in weight of fruits per plant was due to increase in number of fruits ripened and harvested. The increase of yield in MeJA treated plants could be the result of acceleration of on-plant growth and ripening processes by higher doses of MeJA while on the contrary, 0.9 mM MeJA treatment showed a lesser yield than 0.6 mM MeJA treatment.

Conclusion

Increase in growth characteristics of strawberry, MeJA treatment had a positive response as well in all the parameters like plant height, leaf area, leaf RWC, no. of leaves and flowers per plant, first flowering and fruiting, harvesting duration. For yield parameters, the MeJA treatment showed a positive response with 0.4 mM concentrations found to have the best result. Based on overall performance, treatment 0.4 mM MeJA was found superior over all other treatments with respect to growth and yield of strawberry.

Acknowledgements

We thank the Career Point University for provided all necessary facilities required for fulfillment of this research work.

Declaration of Competing Interest

No interests to declare.

Authors' contributions Statements

Shivani Yadav: contributed to data collection, data analysis and writing,

Mahaveer Suman; contributed to conceptualization, research supervision and writing.

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