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Effect of Nitrobenzene on Flowering, Fruiting and Quality Parameters of Apple cv. Royal Delicious under Cold Dry Temperate Region of Himachal Pradesh

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ABSTRACT

Apple accounts for more than 74 per cent of total fruit production in Himachal Pradesh. Poor fruit-set as well as heavy fruit drop due to improper pollination, moisture stress and adverse environmental conditions during flowering are the major barriers in dry temperate zone fruit production of apple. Apple tree blooms abundantly but only very few of them matures into fruit and it is the need of the hour to induce better fruiting with chemicals that ultimately augment the productivity. With such an intent the experiment was carried out. Nitrobenzene 20% EW applied as a foliar treatment at three stages i.e. pink bud, petal fall and fruit setting stage. The highest number of fruits and flowers/plant was observed in T_4 (3ml/liter) and T_3 (2 ml/liter) of Nitrobenzene 20% applied treatments. On the other hand the lowest number of flowers as well as fruits were recorded from T_2 (1 ml/liter) and T_1 (control). Among different treatments tested, 20% nitrobenzene applied at 3 ml/litre showed superior results in contrast to other nitrobenzene levels with enhancing flowering, fruit set, yield and quality.

Key words: Apple, Flowering, Fruit set, Nitrobenzene, Pink bud, Yield.

INTRODUCTION

Apple is a predominant fruit crop of Himachal Pradesh and in recent years, it has emerged as the leading cash crop amongst fruit crops. It alone accounts for 49 per cent of total area under fruit crops and 74 per cent of the total fruit production. The area under apple has increased from 97438 hectares in 2008-09 to 112634 hectares on 2017-18 (Anonymous, 2019). The fruit crops contribute more than Rs. 3313 crore towards the gross domestic product. The apple production level has gradually touched to 368603 MT with 3.27 MT productivity in 2018-19 (Anonymous, 2019). The chilling hour's requirement for apple standard variety is 800-1100 (Byrne and Bacon, 1992). As long as there have been enough chilling units, the flower and leaf buds develop normally. The production of apple has gradually increased but the productivity has fallen from 10.8 to 3.27 MT/ha (Anonymous, 2019). The reasons attributed to it are improper pollination, climate variability, biotic and abiotic stresses etc. Among all the productivity-reducing factors, climate is difficult to manage and the changes in climate in the form of erratic temperature fluctuations and precipitation have started affecting the dry temperate agricultural production systems and ultimately the food security of the people. The objective of this study was not to examine the change in climatic parameters and its associated changes in apple productivity but to study the effect of Nitrobenzene application on flowering and fruiting under adverse environmental conditions. The apple flowering is very sensitive to harsh environmental conditions as when the temperature goes below -2.2°C the flower may drop. The optimum temperature requirement for proper pollination is 21.1°C to 26.7°C. High and low temperatures is detrimental during critical periods of flowering and fruit set. When plants are exposed to environmental stresses during the flowering and fruiting period, abscission of flowers and flower buds may occur. This loss of reproductive structures can result in serious yield decrease and constitutes an important factor in apple production. Plant growth regulators play an important role in manipulation of flowering and fruiting in many perennial fruit crops like apple, pear, grapes etc. Nitrobenzene acts as a plant energizer, flowering stimulant and yield booster. Due to the more number of flowers, it increases the yields by better quality of fruits (Shyamalee *et al.,* 2019). Nitrobenzene is a combination of nitrogen and plant growth regulators that act as plant energizer, flowering stimulant and yield enhancer (Aziz and Miah, 2009). Nitrobenzene produces best results in increasing flowering in plants and prevent flower shedding, by which it is especially

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recommended for flowering plants. Application of flora also performed well in case of individual fruit weight and shelf life but it provided maximum average fruit weight of secondary fruit (Nuruzzamani *et al.,* 2015). Nitrobenzine 20% EW is a new generation plant energizer and yield enhancer of low cost PGRs compared to others. Nitrobenzene is quickly absorbed into the plants and it influences the biochemical pathway of the plants to uptake more nutrients from the soil. It also increases the nutrient use efficiency thus improves the vegetative growth, induces profuse flowering and helps in the retention of the flowers and fruits (Mithila *et al.,* 2012). On the other hand, Nitrobenzene 20% EW improves the organoleptic factors and keeping quality of the produce, which increases the harvestable yield of any crops (Karim and Fattah, 2004). As a further improvement step for fruit set of apple, Nitrobenzene 20% EW can be adopted. Unfortunately, very limited researches have been carried out regarding the use of growth regulators on fruit crops, in the present investigation, we studied the effects of plant growth chemicals like Nitrobenzene, applied at different concentrations on flowering, fruiting and the quality of apple cv. Royal Delicious.

MATERIALS AND METHODS

The research was carried out during the year 2016-17 with the objective to examine the bio-efficacy, physiology and phytotoxicity of Nitrobenzene 20% EW in apple plants at demonstration orchard of Krishi Vigyan Kendra, Tabo, Spiti, Himachal Pradesh (30°41' and 32°-36°N latitude and 76°-79°E longitudes, altitude 3243-meter amsl), which delineates true arid cold temperate climate of North-West Himalayas. The Spiti valley is characterized with the sloppy desert mountain with the short growing season of 5-6 months from April to October with mean minimum and maximum temperatures of 8°C and 25°C respectively. A high concentration of UV and IR radiation, high diurnal temperature variation, negligible rainfall, heavy snowfall and high wind velocity (45-60 miles hr^{-1}) during winter is some of the main highlights of this region. In this field trial, 20 uniform and healthy, 18 years old Royal Delicious cultivars of Apple planted at 3.5x3.5 meters apart were selected. All plants were given recommended dose of fertilizers, micronutrients and other agricultural inputs as and when needed. The Nitrobenzene 20% based experiment consist of nine treatments, *viz*., T_1, Control (No sprays); T_2, (1ml/litre); T_3, (2ml/litre); T_4, (3ml/litre) and replicated thrice under randomized block design. The application of Nitrobenzene 20% EW as foliar treatment done at three stages i.e.1 (Pink bud 2) (petal fall and 3) fruit setting stage.

The data on fruit characteristics like fruit weight, length and breadth and finally the yield were recorded at the harvesting stage of apple crop. Total soluble solids (TSS) and fruit firmness were recorded by hand refractometer and penetrometer, respectively. The contemplation on the fruit set were recorded at two weeks after petal fall and then were again corroborated at six weeks after full bloom so as to allow advisable time for the abscission of unfertilized fruits. The final fruit set was then computed by applying the following formula as propounded by Westwood (1978). The total number of fruit set was enumerated from five randomly selected branches of each experimental tree. The number of fruits dropped from these branches between the time of fruit set and harvest/maturity was observed at monthly intervals and articulated as per cent fruit drop. Productivity was numerated on kg/plant and per unit area basis. The fruits harvested from each selected plants were counted at every harvest and finally summed up to work out the average number of fruits per plant. Ten fruits were selected randomly from each treatment and kept in normal environmental conditions and at the same time remaining five fruit samples were kept in refrigerator to determine the shelf life (days). Physical and chemical characteristics of fruit were laid down as per standard methods. The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS).

RESULTS AND DISCUSSION

The data recorded for the flowering and fruiting characteristics i.e. fruit set, fruit drop, yield, fruit size and fruit weight as influenced by the different treatments of Nitrobenzene 20% EW is hereby presented in Table 1.

It is apparent from the data presented in Table 1 that during the course of study, different treatments varied significantly in respect to fruit set, drop, yield, fruit size and fruit weight. The fruit set was maximum (11.54%) under T_4 (Nitrobenzene 20% EW @ 3ml/ lt) followed by treatment T_2 (Nitrobenzene 20% EW @ 1ml/ lt) and T_3 (Nitrobenzene 20% EW @ 2ml/ lt). These treatments were significantly at par with each other. This might be due to the fact that Nitrobenzene is quickly absorbed into the plants, which has capacity to increase flowering in plants and maximum

Table 1: Effect of different concentrations of Nitrobenzene on flowering and fruiting characteristics of Royal Delicious cultivar of apple.

Treatment	Fruit Set (%)	Fruit Drop (%)	Yield (kg/tree)	Yield/ha (t/ha)	Fruit Size (mm) Length	Breadth	Fruit Weight (g)
T_1	3.03	10.66	7.50	6.12	69.18	74.05	181.00
T_2	8.41	5.99	8.17	6.67	69.95	75.67	186.37
T_3	8.21	2.00	23.09	18.84	70.71	76.13	194.40
T_4	11.54	5.49	23.35	19.06	69.73	74.30	183.90
$CD_{0.05}$	4.20	6.14	14.47	11.81	2.19	2.10	11.20

Table 2: Effect of different treatment of Nitrobenzene on fruit quality of apple.

Treatment	Colour (%)	TSS (°Brix)	TA (%)	Total Sugars (%)	Fruit firmness (kg/cm²)	Shelf life (days)	Reducing Sugars (%)
T_1	90.00	14.60	1.22	9.70	5.05	151.25	5.83
T_2	92.67	16.70	0.71	9.09	6.53	152.12	5.33
T_3	92.85	16.46	0.57	9.60	5.67	154.05	5.35
T_4	93.00	18.16	0.44	9.45	5.44	150.00	5.11
$CD_{0.05}$	NS	1.63	0.59	NS	1.24	NS	NS

Table 3: Effect of foliar application of Nitrobenzene on appearance of phytotoxicity on apple cv. Royal Delicious.

Treatments	Phyto-toxicity symptoms		
	Phyto-toxicity on Fruits Surface	Effect on Fruits Drop	Phyto-toxicity on Foliage
T_1 (Control)	No symptoms	No symptoms	No symptoms
T_2	No symptoms	No symptoms	No symptoms
T_3	No symptoms	No symptoms	No symptoms
T_4	No symptoms	No symptoms	No symptoms

number of fruits per plant (Mithila *et al.,* 2012). Furthermore, it stimulates growth of flower parts and promotes early fruit setting. Highest fruit drop (10.66%) was observed in treatment T_1, which was significantly higher than rest of the treatments, whereas, lowest (2.00%) fruit drop was recorded under treatment T_3. This was statistically at par with T_2 (Nitrobenzene 20% EW @ 1ml/l) and T_3 (Nitrobenzene 20% EW @ 2ml/l). The reduction in fruit drop might be due to Nitrobenzene transport to the axillary buds would have resulted in a better sink for the mobilization of photo assimilates at a faster rate. Highest yield per tree (23.35 kg/ tree) and yield per hectare (19.06 t/hac) were observed in T_4 (Nitrobenzene 20% EW @ 3ml/l), followed by T_3 (Nitrobenzene 20% EW @ 2ml/l) and both were statistically at par with each other, whereas the lowest was recorded in T_1 (Control). This might be due to its role in increasing lowering and improvement in the yield of flowers up to 20-40%. Highest fruit length (70.71 mm), breadth (76.13 mm) and weight (183.00 g) were observed under treatment T_3 (Nitrobenzene 20% EW @ 2ml/l). Being energiser perhaps increased the fruit weight as well as bigger fruits thus the total yield increased due to its application compared to control. On the other hand, maximum average fruit weight was obtained from the plants that were treated with Nitrobenzene 20% w/w (Nuruzzamani, *et al.,* 2015). Nitrobenzene can be used as a spray or in granular form, which increases flower forming substances by altering auxin, cytokinin, gibberellic acid and Ethylene ratio favourably tilting to a higher level of flower forming substances, thereby increasing flowers by more than 40 to 45% and yield (Rathinasamy, 2005) Whereas, minimum fruit length (69.18 mm), breadth (74.05 mm) and weight (181.00 g) was observed under control, T_1. The increase might be due to stimulation of cell elongation, which in turn increased yield because of increase in fruit number and size.

It is further apparent from perusal of the data presented in Table 2 that the treatments of Nitrobenzene influenced colour, total soluble solids, titratable acidity, total sugars and shelf life of fruits. The maximum (18.16°B) TSS was found in treatment T_4 (Nitrobenzene 20% EW @ 3ml/l) whereas; minimum (14.60°B) TSS was found in control. This increase might be due to higher stomatal conductance and photosynthetic rate in plants treated with nitrobenzene during fruit set stage as also reported by Firoz Hussain, *et al.,* (2017) in pomegranate. The treatment differences on apple quality parameters *viz*. fruit colour, total sugars, reducing sugars and shelf life of fruits were found statistically non-significant. The maximum (93.00%) colour was observed in treatment T_4 (Nitrobenzene 20% EW @ 3ml/l). Whereas, minimum (90.00%) was in control. The observations on total sugars, reducing sugars and shelf life, there were non-significant among treatments, as maximum reducing sugars (5.85 %) and total sugars (9.70%) were observed under T_1 whereas, minimum (5.11%) in T_4 (Nitrobenzene 20% EW @ 3ml/ l) and (9.09%) T_2 (Nitrobenzene 20% EW @ 1ml/ l) respectively. Significant decrease in titratable acidity from 1.22% (control) to 0.44% (T_4), among treatments were observed with increasing doses of Nitrobenzene 20% EW, whereas maximum was recorded under control, which was statistically higher than the rest of the treatments. Non-significant differences in shelf life of fruits were obtained which ranged from 150.00 days to 154.05 days (T_4). Furthermore, Maximum fruit firmness (5.67 kg/cm²) of apple fruits were recorded in treatment T_3. While, minimum (5.05 kg/cm²) in untreated control (T_1). Nitrobenzene acts as a flowering stimulant and yield booster and due to the higher number of flowers, it increases the yields by better quality of fruits (Shyamalee *et al.,* 2019).

Symptoms of phyto-toxicity were not observed (Table 3) on the fruit surface, leaf surface and initiation of fruit fall during the study period.

CONCLUSION

Results enumerated that the application of nitrobenzene had a significant effect on flowering, fruiting and quality parameters of apple cv. Royal Delicious. Among different treatments tested, T_4, 20% Nitrobenzene @ 3ml/litre showed optimum results in terms of the yield as well as the quality improvement of apple. However, 2ml/litre (T_3) and l ml/litre (T_2) Nitrobenzene applied treatments also depicted better results as compared to control (T_1). Furthermore, high Nitrobenzene levels showed a significant positive impact on quality of apple as higher TSS, firmness and reduced titratable acidity was recorded. All treatments showed non-significant differences in Colour, Total Sugars, reducing sugars and Shelf life parameters when tested. In the light of this situation application of 20% Nitrobenzene @ 3ml/litre can be considered the most effective to get better quality yield from apple trees.

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