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A Study on Foliar Feeding of GA3 and NAA on Vegetative Growth and Yield of Phalsa (*Grewia Subinaequalis* D.C.)

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A B S T R A C T

The experiment was conducted at Main Experiment Station, Horticulture, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh during 2014-2015 in Randomized Block Design with three replications and seven treatments; T1 - Control (Water spray), T2- NAA 100 ppm, T3- NAA 150 ppm,T4- NAA 200 ppm,T5- GA350 ppm,T6 GA3- 100 ppm,T7 GA3–150 ppm. Growth attributes like shoot length, number of shoots per plant, number of leaves per shoot, inter nodal length, yield attributes like number of fruits per node, number of fruiting nodes per shoot, fruit yield per plant (kg), fruit yield per hectare (q). Foliar application of GA3 @ 150 ppm is effective to increase vegetative growth, yield in phalsa fruits. Hence GA3 150 ppm can be recommended for phalsa growers for higher yield.

Introduction

Plant growth regulators are signal molecules produced within the plant, and occur in extremely low concentrations. Hormones regulate cellular processes in targeted cells locally and, when moved to other locations, in other locations of the plant. Hormones also determine the formation of flowers, stems, leaves, the shedding of leaves, and the development and ripening of fruit. Plant hormones shape the plant, affecting seed growth, time of flowering, the sex of flowers, senescence of leaves, and fruits. Plant growth regulators improved yield of fruit plants (Chandra *et al.*, 2015, Chaudhary *et al.*, 2013, Chundawat and Randhawa 1973, Debnath *et al.*, 2011, Sharma and Dhillon 2015, Sharma *et al.*, 2003). They affect which tissues grow upward and which grow downward, leaf formation and stem growth, fruit development and ripening, plant longevity, and even plant death. Hormones are vital to plant growth, and, lacking them, plants would be mostly a mass of undifferentiated cells. So they are also known as growth factors or growth hormones. Phalsa is a hardy fruit plant well suited for cultivation under adverse climatic condition. Although fruits are quite nutritive and have medicinal value, Phalsa bushes are rarely manure in India. Moreover, no schedule based nutritional approaches has yet

been standardized for phalsa. Hormone is an important and vital aspect of plant life. However, a great deal of variation in various regions of world with respect to its quantity exists. Methods of application and quality of hormones incorporation differ in all the fruit trees. The relevant information's available on plant growth regulators studies in phalsa and other fruit crops used as base for planning and execution of the present study are reviewed in this chapter under following heads. Higher inter-nodal length achieved might be due to cell division, cell elongation and growth enhancing properties of gibberellin reported by Singh *et al.,* (2015) with the spray of 20 ppm GA3 and Kumar e.t al. (2014) in phalsa, GA3 influence vegetative and reproductive growth hence it increases yield of fruit plants (Kacha*et al.,* 2012, 2014, Kumar *et al.,* 2014, Singh *et al.,* 2011, Grewal *et al.,* 2000, Yadav and Pandey 1974).The increase in growth and yield attributes particularly number of shoots per plant, number of fruiting nodes per shoots, number of fruits per node and increased yield per plant which contributed towards such an increase in average yield per hectare.

Growth attributes

Pandey and Narwadkar (1984) found that spraying of urea and auxin indicated more vegetable growth over control on mango cv. Dasheri.

Moon Young *et al.,* (2003) noted that foliar application of GA3 (at 0, 25, 50 and 100 mg/liter) in Satsuma mandarin, increased the number of vegetative shoots, fruit set and fruit size.

Rajput *et al.,* (2011) founded that spraying 200 ppm NAA increased the leaf index, length of flower panicles, fruit set, reduction of malformation and even the bio-chemical status like carbohydrate, nitrogen and enhanced RNA and DNA level. Whereas length of terminal shoots, percentage of hermaphrodite flower and level of mangiferin was enhanced by 50 ppm GA3 recorded in mango tree.

Singh *et al.,* (2011) reported that foliar application of GA3 at 50 ppm increased number of leaves size of phalsa and fruit set.

Choudhary *et al.,* (2013) revealed that application of GA3@ 100 ppm showed superior results with respect per cent increase in plant spread (20.59%) and crown volume (38.42%) over control on 150 days after treatment of Nagpur mandarin.

Kumar *et al.,* (2014) reported that the shoot length, number of shoots, leaves, internodal length, number of fruits, fruiting node and yield were recorded maximum significantly with foliar application of GA3 @ 20ppm + NAA @ 50ppm + ZnSO4 @ 0.4% + Urea @ 2% followed by GA3 @ 20 ppm + Urea @ 2 % whereas minimum with control in phalsa.

Karole and Tiwari (2016) revealed that Maximum values for leaf length (1.70 cm), leaf width (1.49 cm) and leaves/shoot were recorded with foliar application of 60 ppm NAA + 30 ppm GA3 + 2.0% urea followed by 40 ppm NAA + 20 ppm GA3 + 1.5% urea whereas minimum in control of ber.

Yield attributes

Rema and Sharma (1991) reported significantly maximum fruit weight and volume with the application of 150ppm NAA or 480 ppm Ethrel [ethephon] + 150 ppm NAA during full bloom, whereas total soluble solids were also recorded with the 480ppm Ethrel during full bloom, as well as after applying 920 ppm Ethrel or 960 ppm Ethrel + 2.5ppm 2,4D one week before harvesting in phalsa fruit.

Oosthuyse (1993) noted that foliar application of CPPU (10 ppm) + GA3 (40 ppm), NAA (40 ppm) + GA3 (40 ppm) after flowering increases fruit retention in mango Cv. Tommy Atkin.

Brahmachari and Rubi (2001) stated that spraying of GA3, Kinetin and Melic Hydrazide increase fruit retention and reduced fruit drop in litchi cv. Purbi.

Brahmachari and Rubi (2000) advocated that foliar application of 2, 4, 5-T (50-100 ppm), GA3 (100-200 ppm), CCC (500-1000) Cu (NO3)2 and CuCl2 (82%) increased fruit retention.

Ingle *et al.,* (2001) reported that foliar application of 2, 4-D (10 ppm) NAA (30 ppm) and Gibberellic acid (25 ppm) with dry grass mulching increased the number of fruit of Nagpur mandarin.

Barun and Kumar (2003) observed that foliar application of zinc sulphate (0.5%), NAA (20 ppm) and urea @ 2% increased yield in litchi cv. Purbi.

Yadav *et al.,* (2004) reported that significant reduction in total fruit drop was observed when foliar feeding of NAA @ 10 ppm followed by NAA @ 20 ppm and NAA 10 ppm + $ZnSO_4$ @ 0.5% in ber (Zizyphus mauritiana Lamk.).

Birendra *et al.,* (2006) observed that foliar application of NAA at 10, 20, 30 and 40 ppm, 2,4-5-T at 10, 20, 30 and 40 ppm, 2, 4, 5-T at 20, 40, 60 and 80 ppm, GA3 at 50, 100, 150 and 200 ppm improved the flowering, fruit set and fruit retention of mango.

Sharma *et al.,* (2008) reported that crop was sprayed with zinc sulphate (0.5%), urea (1.0%), potassium sulphate (1.0%), NAA (20 ppm), GA3 (50 ppm) and water as control at different growth stages. Foliar application of all the chemicals improved the yield and quality of ber fruits significantly over control. Srivastava *et al.,* (2009) obtained foliar spray of GA3 (50 ppm) + 2, 4-D (10 ppm) + urea (2%) increased the quality and fruit yield of aonla.

Katiyar*et al.,* (2010) noted that pre-harvest spray of NAA, GA3 and urea increased the fruit size, weight and yield of ber cv. Banarasi Karaka.

Sharma *et al.,* (2011) reported that foliar application of nutrients (urea 1.0%, $ZnSO_4$ 0.5%, potassium sulphate 1.0%) and growth regulators (GA3 50 ppm and NAA 20 ppm) significantly increased the fruit set, fruit retention and fruit yield of ber

Singh *et al.,* (2011) reported that foliar application of GA3¬ at 50 ppm increased berries weight, pulp content and yield of phalsa.

Nkansah *et al.,* (2012) noted that GA3 (25 ppm) and NAA (25 ppm) gave the best results in terms of increasing fruit set, fruit retention, number of fruits per cluster and per plant, fruit weight and yield of mango.

Kacha *et al.,* (2012) observed that the application of NAA 150 ppm, significantly increased number of flowers per shoot (151.21), number of fruits per shoot (60.74), 100 fruits weight (49.80 g), juice percentage (57.78 %) and minimum seed percentage (30.44 %) and the maximum yield per plant (1.71kg/plant) and kg per hectare (5800 kg/ha) followed by NAA 200 ppm. The quality of fruits in terms of total soluble solids (25.23 %), reducing sugar (2.01 %) and total sugar (5.74 %) were significantly higher in treatment ethrel 1000 ppm followed by ethrel 750 ppm. An application of GA3 150 ppm significantly reduced acidity (2.55 %) and

increased ascorbic acid content (39.50 %) in phalsa fruits.

Kundu *et al.,* (2013) obtained minimum fruit drop and maximum productivity was depicted in foliar and soil application of PP333 followed by foliar spray of GA3 on pear. However, fruit growth (length and width) and volume at maturity and total sugar content was recorded maximum in combined application of GA3 and BA.

Choudhary *et al.,* (2013) The physical characters of fruit like maximum increase in diameter (horizontal and vertical), weight, volume and number of sacs per fruit, minimum days taken to first harvesting and complete harvesting was recorded with the spray of 100 ppm GA3, which was closely followed by 30 ppm 2,4-D. The minimum peel thickness, number of seeds per fruit and average seeds weight per fruit was recorded with 30 ppm 2, 4-D treatment. The maximum number of fruit per tree, fruit retention per cent and yield per plant and per hectare was recorded with the spray of 30 ppm 2, 4-D which was significantly higher to control.

Kacha*et al.,* (2014) conducted an experiment on phalsa with ten treatments comprised of NAA (100, 150 and 200 ppm), GA3 (50, 100 and 150 ppm), Ethrel (500, 750 and 1000 ppm) and control (water spray). The results showed that NAA 150 ppm and ethrel 1000 ppm significantly increased the flower & yield attributes and GA3 150 ppm improve quality characters of phalsa.

Rajput *et al.,* (2015) concluded that the treatment T10 (0.2% boron + GA3 60 ppm+ NAA 150 ppm + ethrel 750 ppm) was found best for physical parameters and treatment T5 (0.2% boron + NAA 150 ppm) for yield was found best. As far as the relative economics of the treatment is concerned, the maximum net realization of Rs. 1,72,807 per hectare with highest 1:6.6 cost benefit ratio (CBR) was obtained by the treatment T5 (0.2% boron + NAA 150 ppm) as compared to other treatments. Therefore, the treatment T5 (0.2% boron + NAA 150 ppm) is best among all treatment for higher production.

Materials and Methods

The experiment was conducted on twenty years old trees of phalsa at the Main Experimental Station, Department of Horticulture, NDUA&T, Kumarganj, Faizabad (U.P.) during 2014-15.The experiment was laid out in randomized block design with 7 treatments and three replications. The treatment consisted two foliar applications of naphthalene acetic acid and gibberellic acid. The treatments were T1 Control (Water spray), T2 (NAA 100 ppm), T3 (NAA 150 ppm), T4 (NAA 200 ppm), T5 (GA3 50 ppm), T6 (GA3 100 ppm), T7 (GA3 150 ppm). The treatments were imposed at two times first spray of plant growth regulators was done in Pre-blooming Stage and second spray just after fruit setting. The observations were recorded on the parameters viz. Length of shoot (m), Number of shoots per plant, Number of leaves per plant, Interndal length (cm), Number of fruits per node, Number of fruiting nodes per shoot, Fruit yield per plant (kg) and Fruit yield per ha (q). Statistical analyses of the data obtained in the different sets of experiments were calculated as suggested by Panse and Sukhatme (1985) and results were evaluated at 5% level of significance.

Results and Discussion

Plant growth regulators spray significantly affects the shoot length. However, the maximum (2.52 m) shoot length was measured with foliar spray of GA3 @150ppm followed by spray of NAA @100 ppm (Table 1). The increase in vegetative growth of the

phalsa plant with the spray of plant growth regulators and may be attributed to the association of nitrogen in the synthesis of protoplasm and in the primary manufacture of amino acids and increased auxin activities. As a result, meristematic activities increased which in increase the vegetative growth. Similar results have also been reported by Karole and Tiwari (2016) with spray of NAA + GA3 + urea in ber and Kumar *et al.,* (2014) in phalsa. Number of shoots per plant was also influenced significantly by the application of plant growth regulators. However, the maximum (123.33) number of shoots per plant was measured with foliar spray of GA3@150ppm followed with the spray of GA3 @100ppm (Table 1). Number of shoot per plant was increased with the application of plant growth regulators spray. Increase in plant growth parameters might be due to fact that gibberellin (given in the form of GA3 sprayed) is a constituent of protein which is essential for formation of protoplasm and thus, affecting cell division and cell elongation. All these contributed in enhancing shoot length and number of shoots per plant of phalsa. The present findings are in conformed to the report of Moon Young *et al.,* (2003) in Satsuma mandarin and Kumar *et al.,* (2014) in phalsa. The number of leaves per shoot increased significantly with the application of foliar feeding of plant growth regulators and the highest (61.46) number of leaves was obtained with spraying of GA3@150ppm (Table 1). The favorable effect of GA3 and NAA in promoting number of leaves might be due to abundant supply of GA3 on plant growth moreover, the increase in vegetative growth may be attributed to an increase uptake of these elements which being a constituent of protein component of protoplasm, favorably influenced chlorophyll content in leaves. All these factors contributed to cell multiplication, which has resulted in to better photosynthetic activity and it's translocation to promote better vegetative growth. Thus increased the number of leaves per shoot with the spray of GA3. The findings are in agreement with result of Karole and Tiwari (2016) with spray of NAA + GA3 + urea in ber and Singh *et al.,* (2011) and Kumar *et al.,* (2014) in phalsa. The inter-nodal length was increased significantly with plant growth regulators.

Table.1 The effect of foliar feeding of GA_3 and NAA onvegetative growth and yield of phalsa

Treatments	Shoot length (m)	Shoots/ plant	leaves per shoot	Internod-al length (cm)	fruits /node	fruiting nodes/ shoot	Fruit yield (kg/plant)	Fruit yield (q / ha)
T_1-Control (Water spray)	1.78	78.33	43	5.06	9.46	9.93	3.95	43.87
T_2-NAA @100 ppm	2.04	84	47.66	5.4	9.8	10.8	4.37	48.54
T_3-NAA@150 ppm	2.28	84.66	51.13	5.3	10.16	10.26	4.64	51.62
T_4 -NAA@ 200 ppm	2.3	79.33	54.6	5.6	10.56	10.6	4.34	48.06
T_5-GA_3 @ 50ppm	2.41	81.33	56.53	5.63	10.4	11.26	5.34	59.39
T_6-GA_3@100ppm	2.44	95	58.66	5.66	11.3	11.36	4.87	53.84
T_7-GA_3 @150 ppm	2.52	123.33	61.46	6.13	12.06	12.5	5.37	59.65
SEm±	0.11	7.71	1.17	0.11	0.38	0.29	0.25	2.83
CD at 5%	0.33	23.77	3.62	0.37	1.18	0.91	0.78	8.73

The maximum (6.13cm) inter nodal-length was achieved with foliar spray of GA3 @ 150 ppm (Table 1). Higher inter-nodal length achieved might be due to cell division and cell elongation growth enhancing properties of gibberellin reported by Singh *et al.,* (2015) with the spray of 20 ppm GA3 and Kumar *et al.,* (2014) in phalsa. The maximum (12.06) number of fruits per node was obtained with foliar spray of GA3 @150 ppm followed with

the spray of NAA @ 200ppm (Table 1). The higher number of fruits per node might be due to fact that nitrogen is component of chlorophyll and gibberellic acid and auxin help in chlorophyll formation that regulate the buildup of proper C:N ratio, which controls the flowering and fruiting of plants. It is also assumed that gibberellin and auxin play significant role in photosynthetic activity and better translocation of metabolites for developing fruit lets. These results are in close conformed to finding of Kumar *et al.*, (2014) in phalsa. The maximum (12.50) number of fruiting nodes per shoot was counted with the spray of GA 3 @ 150 ppm (Table-1). It might be possible because Gibberellin causes vegetative growth for development of fruiting nodes. Gibberellin and auxin helps in the translocation of carbohydrates and other metabolites for better reproductive growth of plants. These results are in close conformed to finding of Kumar *et al.*, (2014) in phalsa. A perusal of data regarding fruit yield clearly revealed that plant growth regulators spray significantly influenced fruit yield (kg) per plant. The maximum (5.37kg) fruit yield per plant was recorded with the spray of GA3 @150ppm followed by GA3 @ 50ppm (Table 1). This may be due to the better physiology of developing fruits in terms of better supply of water, and other compounds vital for their proper growth and development which resulted in improved size and yield as compared to NAA. These results are in close conformed with finding of Anawal *et al.*, (2015) in pomegranate cv. Bhagwa, Rajput *et al.*, (2015) in guava cv. L-49 and Sharma *et al.*, (2008) in mango.

The increase in growth and yield attributes particularly number of per node and increased yield per plant which contributed towards such an increase in average yield per hectare. The maximum (59.65 q ha.) fruit yield per plant was recorded with the spray of GA3 @150ppm followed by GA3 @ 50ppm (Table 1). The present findings are in conformed with the result of Anawal *et al.*, (2015) in pomegranate cv. Bhagwa and Rajput *et al.*, (2015) in guava cv.L-49.

It may be concluded from the result obtained in present investigation that foliar application of GA_3 150 ppm at pre-bloom stage and fruit setting was found most effective in increasing vegetative growth, yield. Hence GA_3 150 ppm can be recommended for Phalsa growers for getting higher yield.

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