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Effect of Foliar Application of Various Growth Regulators on Yield and Quality of Aonla (*Phyllenthus Emblica* Gaerth L) Cv. Na – 7

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Abstract: *Spray of GA_3 had maximum impact to increase the size, weight and volume of fruit. However the NAA @ 50 ppm was found to increase the pulp thickness, while the maximum weight of pulp was found when the trees are treated with the combined spray of NAA + 2, 4-D 25 ppm (T_6). The yield per treatment and TSS of fruit was appreciably influenced by all the growth regulators over control. However, the maximum impact (21.67 kg yield and 10.02^{0}Brix TSS) was recorded under T_9 treatment (2, 4-D 50 ppm). The maximum acidity (1.86 %) was found under T_7 treatment, spray of GA_3 50 ppm. The Vitamin C content of fruits was recorded maximum (563.44 mg/100 g) under T_6 treatment (NAA + 2, 4-D 25 ppm). From the findings of present study it meight be concluded that spray of growth regulators like GA_3, NAA and 2, 4-D alone or in combination may increase the yield and quality of aonla.*

Keyword*: GA_3, 2, 4-D, NAA. Aonla, quality, yield,*

INTRODUCTION

The Indian gooseberry *(Emblica officinallis* Gaertn L.) is an important indigenous and minor fruit. It belongs to family Euphorbiaceae. Naturally growing aonla has been reported from Ceylon, Cuba, Puertorico, Hawaii, Florida, Iran, Iraq, Jawa, West Indies, Trinidad, Pakistan, Malaya and China (Benthal, 1946). The aonla finds mention in 'Vedas', Ramayana; Charak Samhita, Sushrat Samhita and other Ancient Indian literature describing its fruits as highly valuable food, medicine and hair dye.

It is the rich source of vitamin 'C'(500-600mg/ 100gm) among fruits and ranks second after Barbados cherry (*Malpighia globra* L.) (Asengo, C.F. 1953). Aonla is also considered as 'wonder fruit for health' because of its unique qualities. The fruits are used to make preserve, candy, dried chips, pickles, powder etc. and posses' diverse medicinal and industrial uses. Among the commercial varieties, NA-7 is the most popular variety among the aonla growers and also covers the maximum areas in eastern Uttar Pradesh due to its bearing potential, late fruit maturity, moderate fruit size, and higher self life.

The role of growth regulators for improving the growth and development, fruit set, control of fruit drops, fruit maturation, fruit quality including of physiological and nutritional disorders has been well established in number of topical, sub-tropical and temperate fruit crops (Singh *et al*., 1976; Bhatia and Yadav, 2003 and Singh *et al*., 2007). However, it has been studied that the physiological, biochemical and biological activities in plant system are highly influenced due to interaction of micro nutrients. Among the foliar application of different level of growth regulators, viz. GA_3, 2,4-D, NAA have been found more effective in improving flowering, fruit set, fruit size ,fruit yield and fruit quality in number of fruit crops.

Similar studies on foliar application of growth regulators have earlier been undertaken to find out their effect on fruit set, fruit size, fruit drop, fruit maturation, fruit yield, and fruit quality of aonla (Ram *et al*., 1977; Shymal *et al*., 1984; Singh *et al*., 2001; Divya and Prasad, 2006 and Singh *et al*., 2009). A sporadic research work has been carried out so far to overcome the problem of heavy pre-harvest fruit drop and improving the fruit yield and quality of aonla cv. NA-7 grown under degraded sodic land having low soil fertility levels. The effect of different bio-regulators on growth, yield and quality of aonla crop is variable

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at different regions due to variation in climate and soil.

MARERIALS AND METHODS

The experiment was conducted on six year old trees of aonla cv. NA-7 at the Department of Horticulture, HNB Garhwal University, Srinagar, Garhwal, Uttrakhand, during 2013-14. The experiment was laid out in randomized block design with 13 treatments and three replications. The treatment consisted two foliar application of gibberellic acid, 2, 4-Dichloro phenoxy acetic acid and á naphthalene aceitic acid. The treatments were T_1 (GA_3 + 2, 4-D 50 ppm), T_2 (GA_3 + 2,4-D 25 ppm), T_3 (NAA + GA_3 50 ppm), T_4 (NAA + GA_3 25 ppm), T_5 (NAA + 2, 4-D 50 ppm), T_6 (NAA + 2, 4-D 25 ppm), T_7 (GA_3 50 ppm), T_8 (GA_3 25 ppm), T_9 (2, 4-D 50ppm), T_{10} (2, 4-D 25ppm), T_{11} (NAA 50 ppm), T_{12} (NAA 25 ppm), T_{13} (Control). The treatments were imposed at two times at flowering stage and pea stage of fruits. For recording various growth parameters of fruit ten healthy fruits were selected randomly from each tree at full maturity stage. The observations were recorded on the following parameters:

(A) Physical characters -Number of fruits/kg, fresh weight of fruits (gm), fruit diameter (cm), fruit length (cm), fruit volume, fruit specific gravity, pulp thickness (cm), pulp weight (gm), fruits stone weight (g), yields per treatments (kg).

(B) Chemical Characters- Total soluble solids, acidity, vitamin C,

Fruit length, pulp thickness and diameter were noted using the vernier caliper, volume of fruit was recorded by water displacement method and weight of fruit, weight of stone, pulp weight, yield per treatment (kg) and number of fruits/kg was recorded by using electronic weigh balance. Hand refractometer was used for determination of T.S.S. in ^{0}Brix. Acidity was estimated by simple acid–alkali titration method (A.O.A.C., 1970) and assay method for ascorbic acid was followed given by Ranganna (1977).

RESULTS AND DISCUSSION

Physical Characters

Fruit Size

The length, diameter and volume of fruits was affected by all the growth regulators over control. However, T_8 treatment spray of GA_3 25 ppm was found to give the maximum impact on fruit length (3.53 cm) and volume (40.33) while the maximum diameter of fruit (4.11 cm) was recorded under T_7 treatment sprays of GA_3 50 ppm, This can be attributed to nature of gibberellins to increase the vegetative growth due to which more food material might be made available to the developing fruits. These results are in close conformity with findings of Painkara *et al*., (2012) in mango cv. Langra, Shukla *et al*., (2011) in aonla, Pandey, (1999) in *zizyphus mauritiana*, Berhow, (2000) in grape fruits, Chen *et al*., (2000) and Aljubri *et al*., (2001) in date palm.

Fruit Weight

The weight of fruit was improved appreciably by all the growth regulators over control. However, the maximum impact (32.58gm) was recorded under T_8 treatment, spray of GA_3 25 ppm, It may be due to the involvement of GA_3 to increase the cell division and translocation of food material which might be responsible to improve the weight of fruits. These results are in close conformity with the findings of Painkara *et al*., (2012) in mango cv. Langra, Shukla *et al*., (2011) in aonla, Pandey, (1999) in *zizyphus mauritiana*, Berhow, (2000) in grape fruits, Chen *et al*., (2000) and Aljubri *et al*., (2001) in date palm.

Number of Fruit Per Kg

Spray of growth regulators decrease the number of fruit/kg due to the increase in the size and weight of indivisual fruit The minimum number of fruits/kg was recorded (36) under T_6 spray of NAA+2, 4-D @ 25 ppm. It may be due to involvement auxins in cell division translocation of food material The results of present study are almost match with the findings of Almeida *et al*., (2008) in orange, Aljubri *et al*., (2001) in date palm, Nawaz *et al*., (2008) in kinnow mandarin, Saleem *et al*., (2008) in sweet orange, Ghosh *et al*., (2009) in pomegranate with the spray of 2; 4-D 50 ppm.

Specific Gravity of Fruits

The specific gravity of fruits was appreciably influenced by all the growth regulators over control. However, the maximum impact (1.19) was recorded under T_3 treatment spray of NAA + GA_3 50 ppm, whereas, minimum fruit volume (0.81) recorded in T_8.These results closely match with the findings of Kher *et al*., (2005) in guava cv. Sardar, Dutta *et al*., (2007) in guava cv. Sardar, Kumar *et al*., (2013) in guava cv. Chittidar, Singh *et al*., (2009) in aonla with the spray of NAA + GA_3.

Pulp Thickness

The pulp thickness of fruits was increased with the spray of growth regulators over control. However,

the maximum value (1.42 cm) was recorded under T_{11} treatment (NAA 50 ppm). It may be due to involvement of auxins in cell division and enlargement. Results related to pulp thickness of fruit found to be close agreement with that of Kaseem *et al*., (2011) in Jujube and Singh *et al*., (2007) in aonla.

Pulp Weight

The pulp weight of fruits was affected by the application of all growth regulators over control. However, the maximum impact (32.80 g) was recorded that under T_6 treatment combined sprays of (NAA + 2, 4-D 25 ppm), whereas minimum pulp weight (13.00 g) was recorded under T_{13} (control). These results are in close conformity with findings of Painkara *et al*., (2012) in mango cv. Langra.

Yield Per Treatment

The yield per treatment was appreciably influenced by all the growth regulators over control. However, T_9 treatment spray of (2, 4-D 50 ppm) was found to gave maximum yield (21.67 kg), whereas, minimum yield per treatment (11.67 kg) was recorded under T_{13} (control). Better fruit yield with spray of 2, 4-D was obtained due to the increasing number of fruit set and decrease in the fruit drop. These results are in close conformity with finding of Painkara *et al*., (2012) in mango cv. Langra, Al-qurash *et al*., (2012) in date palm, Kaur *et al*., (2010) in plum, Ghosh *et al*., (2009) in pomegranate. Who reported that application of growth regulators like 2, 4-D, increase the fruit set and decrease the fruit drop.

Chemical Characters

TSS of Fruits

The TSS of fruits was found to influence by application all the growth regulators over control. However, the maximum TSS (10.02) was observed under T_9 treatment spray of (2, 4-D 50 ppm). 2, 4-D increased the TSS of fruit due to increase in the mobilization of carbohydrates from source to sink. These results are in close conformity with findings of Nawaz *et al*., (2008) in kinnow mandarin, Kaur *et al*., (2010) in plum.

Acidity Percentage

Application of growth regulators had direct impact on the Acidity of fruits over control. However, the maximum acidity (1.86%) was recorded under T_7 treatment spray of (GA_3 50 ppm), whereas, minimum Acidity (1.09%) was recorded under T_1. These results are in close conformity with findings of Pandey (1999) in *Zizyphus mauritiana* with spray GA_3.

Vitamin-C

The Vitamin C of fruits was appreciably influenced by all the growth regulators over control. However, the maximum impact (563.44 mg/100 g) was recorded that under T_6 treatment (NAA + 2, 4-D 25 ppm), whereas, minimum Vitamin C (534.54 mg/100 g) was recorded under T_{13} (control). These results are in close conformity with findings of Almeida *et al*., (2008) in orange, Nawaz *et al*., (2008) in kinnow mandarin, Kaur *et al*., (2010) in plum with spray NAA + 2, 4-D 25 ppm.

Table 1

Treatments	*Number of fruits per kg*	*Fresh fruit weight (g)*	*Fruit Size Diameter (cm)*	*Length (cm)*	*Volume of fruits*	*Specific gravity of fruits*	*Pulp thickness (cm)*	*Pulp weight (g)*	*Fruits stone weight (g)*	*Yield per treatment (kg)*	*TSS (^{0}Brix)*	*Acidity (%)*	*Vitamin C*
T_1 (GA_3+2,4-D 50 ppm)	39.00	26.25	3.73	3.13	29.17	0.94	1.53	30.02	1.70	12.33	8.94	1.09	559.28
T_2 (GA_3+2,4-D 25 ppm)	41.67	26.60	3.64	2.91	28.17	0.90	1.27	25.83	2.87	14.33	8.38	1.29	561.75
T_3 (NAA+GA_3 50 ppm)	36.00	32.11	3.96	3.38	30.33	1.19	1.35	27.28	2.84	17.00	9.28	1.36	558.83
T_4 (NAA+GA_3 25 ppm)	40.67	30.66	3.88	3.34	30.00	1.03	1.38	28.59	2.54	14.00	9.70	1.40	557.29
T_5 (NAA+2, 4-D 50 ppm)	45.67	24.96	3.39	3.05	30.00	0.84	1.25	22.85	1.82	20.33	8.82	1.80	561.57
T_6 (NAA+2, 4-D 25 ppm)	32.00	31.26	3.95	3.52	30.00	1.04	1.36	32.80	2.78	19.67	9.27	1.75	563.44
T_7 (GA_3 50 ppm)	41.67	32.54	4.11	3.30	29.83	1.10	1.41	32.57	2.48	18.33	9.40	1.86	558.30
T_8 (GA_3 25 ppm)	38.33	32.58	4.09	3.53	40.33	0.81	1.36	28.77	2.93	21.00	8.69	1.82	553.70
T_9 (2,4-D 50ppm)	51.00	23.71	3.52	3.15	26.00	0.92	1.16	21.52	1.63	21.67	10.02	1.77	547.22
T_{10} (2,4-D 25ppm)	46.33	23.09	3.45	3.20	27.67	0.84	1.19	23.06	2.46	18.67	9.95	1.80	547.78
T_{11} (NAA 50 ppm)	39.33	30.39	4.01	3.29	32.03	0.95	1.42	29.07	2.99	20.00	9.39	1.68	551.60
T_{12} (NAA 25 ppm)	39.67	30.21	4.06	3.29	32.17	0.95	1.42	26.77	2.99	20.00	9.33	1.77	555.50
T_{13} (Control)	42.00	27.64	3.87	3.20	30.00	0.92	1.37	13.00	1.77	11.67	8.48	1.40	534.54
S.EM±	1.935	0.97	0.06	0.05	0.332	5.007	1.004	3.685	0.985	0.816	0.141	1.0083	2.549
CD at 5%	5.649	2.822	0.19	0.16	0.970	0.166	4.001	10.756	2.875	2.381	0.412	5.003	7.440

CONCLUSION

Thus, it may be concluded from the findings of the present investigation that the foliar application of (GA_3 25 ppm) was found to be the most effective in improving the fruit size and fruit weight, volume of fruits compared to other treatments. However, 2, 4-D was found effective to increase the yield. Based an overall experimental findings, it may be recommended that two foliar sprays of GA_3 (25 ppm) with 2, 4-D (50 ppm) after fruit set may be done in Aonla cv. NA-7 for better yield and quality of fruits.

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