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Use Of Plant Growth Regulators In Dry Land Fruit Crops: A Review

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Abstract

Ber, pomegranate, custard apple, aonla and date palm are the major fruit crops which are commercially grown in arid regions. Main characteristics of dry land fruit crops are deep rooted & perennial crops, low water requirement crop, thick & small leaves, hardy & tolerant to rigorous monsoon and shed their leaves during summer & put forth flowering and fruiting during rainy season. The use of plant growth regulators has been proved as a powerful tool to meet this demand by influencing fruit production directly or indirectly. The PGR's include auxins, gibberellins, cytokinins, ethylene, growth retardants and growth inhibitors. PGRs are chemical compounds, which can regulate some important metabolic activities in plants. They influence on growth and development of plants, which influence the improve the seed germination by breaking seed dormancy, root initiation in cuttings and air layers, to regulate proper canopy, flowering and fruit set and increase in yield and quality.

Keywords: Arid zone fruit crops, Canopy management, Growth, Yield, Quality

Introduction

The scope of the growth of dry land fruit industry shall be determined by incentives for farmers, necessity, adaptability of the crops and future scope for expansion depending on the availability of inputs, infrastructure for distribution and marketing system and industrial support. The sick saline and alkaline soils, which can't be put under cereal crops owing to greater sensitivity, can be successfully used for fruit crops like ber, date pomegranate and aonla and even their tolerance can be raised by using resistant root stocks. The processed products viz., Jam, Jelly, Juice, wine etc., have got international market and make a satisfactory contribution in the national economy with a annual turnover of several million dollars. These industries provide job opportunities & extend the export potentiality of the country. They also serve as a good source of organic matter/manures and also fuel such as Ber, Cashew, Jack, Tamarind.

Growth mainly refers to the quantitative increase in plant body such as increase in length of the stem and root, the no. of leaves, the fresh weight and dry weight etc. On the other hand, germination of seed, formation of flowers, fruits and seeds, emergence of lateral buds, falling of leaves and fruits are qualitative changes, referred to as development. Growth and development of the plant body are

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controlled by two sets of internal factors, namely, nutritional and hormonal. Nutritional factors supply the plant necessary mineral ions and organic substances such as proteins, carbohydrates and others. These constitute the raw materials required for growth. However, utilization of these substances for proper development of the plant is controlled by certain chemical messengers, called plant growth substances or plant growth regulators, which in minute amounts increase or decrease or modifies the physiological processes in plants.

Plant growth regulators or plant regulators are the organic compounds other than nutrients which modify or regulate physiological processes in an appreciable measure in the plants when used in small concentrations. They are readily absorbed and these chemicals move rapidly through the tissues when applied to different parts of the plant. Plant hormones or phytohormones are also regulators but produced by the plants in low concentrations and these hormones move from the site of production to the site of action. Therefore, the difference between the plant regulator and plant hormone is in that the former one is synthetic and the latter one is natural from the plant source. Plant growth substances have key role in different physiological processes related to growth and development of crops. It is obvious that changes in the level of endogenous hormones due to biotic and abiotic stress alter the crop growth and any sort of manipulation including exogenous application of growth substances would help for yield improvement or at least sustenance of the crop. The principles of Conservative Agriculture can be well protected by judicious use of plant growth hormones. Plant growth hormones are organic substances produced naturally in the higher plants, controlling growth or other physiological functions at a site remote from its place of production, and active in minute amounts.

Traditionally five major classes of plant hormones are listed: auxins, cytokinins, gibberellins, abscisic acid and ethylene. However, as research progresses, more active molecules are being found and new families of regulators are emerging; one example being polyamines such as putrescine or spermidine. This classification is based partially on the chemical structure and partially on the commonalities of plant physiological effects that certain substances exhibit. Members of one class may not relate from a structural point of view to another.

- The general functions of different phytohormones are as below.
- Auxins: Shoot elongation, thin tree fruit, increase rooting and flower formation
- Gibberellins: Stimulate cell division and elongation, increase stalk length, increase flower and fruit size
- Cytokinins: Stimulate cell division, prolong storage life of flowers and vegetables and stimulate bud initiation and root growth
- Ethylene generators: Ripening, Induce uniform ripening in fruit and vegetables
- Growth inhibitors: Stops growth, Growth retardants: Slows growth

Use of commercial plant growth regulators (PGRs) to:

- Prevent flower abscission.
- To reduce fruit abscission during fruit set, June drop and pre-harvest drop for late hanging fruit.
- To increase fruit size.
- To regulate growth of vegetative shoots and indeterminate floral shoots

PGRs are being used in since long time. However, a short list on usage is narrated below in some important crops.

Aonla

The use of synthetic auxins (naphthalene acetic acid; NAA) and gibberellins (GA_3) in combination with thiourea during mid-May and mid-July may provide an effective solution to minimize yield losses in aonla caused by heavy fruit drop. An increase in fruit quality may be the additional gain with the use of these plant growth regulators. Such a strategy may be of particular importance in sodic soils characterized by production constraints such as limited availability of different mineral nutrients for optimum tree growth and yield. (Anshuman and Singh, 2015). The treatment of seeds with GA_3 500 ppm and thiourea were effective in breaking seed coat dormancy in aonla (Lilabati and Sahoo, 2015). The soaking of the seeds in GA_3 (500 and 750 ppm) for 24 hrs, combined with *Azospirillum* bio-fertilizer was beneficial in increasing seed germination and seedling growth of the aonla (Supe *et al.,* 2012). The spray of NAA at 10 ppm was the best to increase fruit retention which consequently resulted in the highest fruit yield. Fruit quality with regard to TSS, total sugar and ascorbic acid content was better in NAA at 10 ppm. (Ghosh *et. al.* 2009). Total soluble solids were found significantly higher in treatment with NAA 40 mg/l + GA_3 50 mg/l. Significantly the minimum total soluble solids were found in treatment Control (Water spray). However, the total soluble sugars were found significantly higher in treatment NAA 40 mg/l + GA_3 50 mg/l, which was followed by NAA 40 mg/l, NAA 20 mg/l + GA_3 25 mg/l, and NAA 20 mg (Patel, 2017).

Pomegranate

The sprayed three times starting at 50 % flowering stage and subsequently at 21 days interval. The application of NAA at 25 ppm gave significantly high fruit set and fruit retention which resulted in highest fruit yield. Fruit weight and quality improved significantly due to growth regulator sprays. (Ghosh *et al.,* 2016). The importance of synthetic plant growth regulators in achieving higher yield and better quality of fruits. Application of ethrel 200 ppm has improved the TSS, reducing sugar, non-reducing sugar, total sugar and ascorbic acid content. (Goswami *et al.* 2013). The application of 2,4-D at 40 ppm gave significantly high fruit size in length, breadth and volume and higher fruit weight, higher aril percent, maximum number of fruits which resulted in highest fruit yield of Pomegranate. (Reddy and Prasad 2012). The extent of fruit cracking was reduced significantly with application of 300 ppm pacloputrazol, while grain %, fruit juice %, TSS % and acidity % were increased. Yield and fruit weight were increased with applying pacloputrazol. Application of 40 ppm NAA and 80 ppm GA_3 significantly increased fruit length and fruit diameter. Application of 80 ppm GA_3 significantly increased total anthocyanin %, while tannins % was not affected by other two

growth regulators (Khalil and Aly, 2013). In cv. Ganesh. NAA (1500 ppm) and Ethrel (500 ppm) recorded higher thining percentage on percentage of flower thinning as compared to control was in the ratio of 1:1 to 1:5, the NAA spray caused thinning in the ratio of 1:2 to 1:3, whereas ethrel spray caused thinning in the ratio of 1:3 to 1:5, the hand thinning resulted in the ratio of 1:2 to 1:2.5. For ethrel at 250 ppm, the thinning was in order of 1:3. Thus, for one or the other purpose, pomegranate flower thinning by plant growth regulators has effectively been used. The highest percentage increase in fruit yield was of the order of 40.5% over control which was noted for ethrel at 250 ppm, followed by a 15.24 % rise in fruit yield for the water spray (Sheikh, 2015). In an experiment on cv. Bhagawa with NAA (40, 50, 60 ppm) and GA (40, 50, 60 ppm) it is revealed that NAA 40 ppm was found effective in increasing number of fruits per tree, fruit length, fruit diameter, fruit weight and fruit volume (Vidya *et al.,* 2016).

Ber

The maximum fruit retention and minimum fruit drop was recorded in the trees sprayed with 1.5 per cent potassium sulphate and 20 ppm NAA at fruit set stage. Higher fruit size in terms of length and breadth, weight and yield was recorded with 60 ppm NAA sprayed at active growth phase (Singh and Bal, 2006). In a study on a 6-year-old Banarasi Karka cultivar of ber with seven treatments of two growth regulators viz., NAA at 25, 50 and 100 mg/L; GA_3 at 10, 20 and 40 mg/L and control (water spray). It is revealed that application of NAA at 25 mg/L gave significantly highest fruit retention (75 %) which resulted in highest fruit yield of 120.5 quintals as against 64.7 quintals/ha in control. No beneficial effect of GA_3 on fruit retention or improving fruit yield was observed. But fruit quality was significantly improved (Ghosh *et al*., 2009). Significant increase in fruit size traits i.e. fruit length, breadth, weight and volume was recorded with application of NAA 30 ppm. The palatability rating of fruits in terms of taste, colour and texture of fruit was recorded maximum with application of GA_3 50 ppm (Arora and Singh, 2014).

Custard apple

Jadhav *et al.* (2015) studied on effect of PGR, chemicals and plant extract on seed germination and seedling growth of custard apple (*Annona squamosa*). The results of present investigation clearly showed the significant differences with respect to effect of seed soaking in 50 ppm GA_3 for 48 hrs on days required for germination, germination percentage, seedling height, stem diameter and number of leaves per seedling of custard apple. Seed treatment of GA_3 at 50 ppm for 48 hrs was helpful to get higher germination and seedling growth of custard apple. This improvement in seed germination and seedling growth could be due to activation of dormant embryo of seeds with gibberellic acid and also gibberellic acid treatment helps to increase cell division, cell elongation and cell multiplication which might have reflected into maximum seedling growth. Patel, *et al.,* (2010) a trial was conducted to study the influence of wheat straw mulch and different plant growth regulators on fruit set, yield and quality of custard apple. Maximum flowering duration and fruit retention was observed with wheat straw mulch + GA_3 (5 t/ha + 50 ppm) treatments. Highest number of fruits, fruit yield,

fruit diameter and fruit pulp were also recorded under same treatments. Wheat straw mulch gave 21 % higher fruit yield of custard apple. However, application of 20 ppm NAA was at par with GA_3 (50 ppm). On economic basis, 50 ppm GA_3 + wheat straw mulch followed by 20 ppm NAA + wheat straw mulch gave highest net income.

Use of PGRs in Custard Apple:

a) For defoliation and beginning the plants under the rest Ethryl at 1000 ppm is sprayed one month after the harvest of the fruits.
b) 20 ppm NAA is sprayed during the flowering period to improve the fruit set.
c) During the fruit development 50 ppm GA+ 0.5 ppm CPPU, foliar spray improves the fruit size and luster of the fruits.
d) For offseason fruiting i.e. harvesting before start to mansoon the sowing of bajara between two rows found beneficial.

Phalsa

The application of NAA 200 ppm recorded maximum height of bush and length of shoot. An application of NAA 150 ppm, increased number of flowers per shoot, number of fruits per shoot, fruits weight, juice percentage and minimum seed percentage and the maximum yield per plant. The quality of fruits in terms of total soluble solids, reducing sugar, and total sugar were significantly higher in treatment ethrel 1000 ppm. Further, ethrel 1000 ppm also significantly reduced the span of harvesting and number of picking. An application of GA_3 150 ppm significantly reduced acidity and increased ascorbic acid content (Kacha *et al*. 2012). The experiment conducted on influence of bio-regulators on the fruit quality and yield attributes of phalsa and revealed that GA_3 150 ppm registered a significant improvement in fruit physical and biochemical parameters and also fruit yield per plant was increased. The fruits obtained from the plants treated with NAA 25 ppm had small sized and minimum weighed stone. Whereas the yield attributes were enhanced with the application of ethrel 1000 ppm in terms of advancement of harvesting and also reduction in number of pickings. Hence ethrel 1000 ppm may be applied to improve the fruit quality parameters as well as yield parameters and also to fetch the premium price in the market due to their attractive colour appearance than control (Kaur *et al.,* 2018).

Fig

Kurubar *et al.,* (2017) conducted experiment on effects of gibberellic acid on growth, yield and fruit quality of fig cultivar 'Poona'. Fig plants sprayed with Gibberellic acid at 60 ppm with three sprays at an interval of 15 days starting from bud initiation, resulted in significant increase in shoot length, number of functional leaves and fruit length but reduced the fruit diameter and weight. The maturity period was advanced with increase in its concentration and number of sprays. Dahale *et al.,* (2018) studied on effect of different concentration of IBA and NAA comprised on rooting and survival of hard wood cuttings and indicated that 1000 ppm IBA + 1000 ppm NAA treatment gave maximum shoot growth, root growth, percentage of rooted cuttings, survival percentage of rooted cuttings and root to shoot ratio over rest of the treatments.

Bael

The role of plant growth regulators on fruit drop in bael consists of spray NAA, GA_3 and etherl. All the growth substances sprayed, proved beneficial in minimizing drop and enhancing quality characters of bael fruits. Maximum fruit set was recorded with NAA 30 ppm, while minimum fruit drop and maximum fruit retention is beneficial with NAA 20 ppm. Highest fruit length and breadth was recorded with NAA 30 ppm. The spray of NAA 20 ppm estimated highest fruit weight, volume, pulp content and ascorbic acid but least acidity. Maximum TSS was recorded with GA_3 50 ppm (Uniyal and Mishra, 2015). Nodal explants ware transferred MS medium with 0.5 mg BA/l with different concentrations of either kinetin (KN) or gibberellic acid (GA_3) or in combinations has shown healthy shoots with expanded shoot length. Excised shoots (2-3 cm long with 2 to 3 nodes) when grown on 1/2 MS basal medium with 2.5 mg/l indole-3-butyric acid (IBA) and 0.5 % activated char-coal (A.C.)/l has shown rhizogenesis. After excision, in the second passage, the nodal explants also showed bud break when sub cultured on MS basal medium supplemented with 0.5 mg BA/l. These shoots also successfully rooted on the same above said medium (Puspashree and Shiba, 2012).

Jamun

The investigation was carried out to reduce the time required to reach graftable size of jamun seedlings using growth regulators and macronutrients at Regional Horticultural Research and Extension Centre, Bengaluru. The foliar application of GA_3 at 300 ppm found to be beneficial to enhance the seedling height, diameter, fresh weight and dry weight and to reduce the number of days taken to reach graftable size compared to control (Surakshitha *et al.,* 2014). In a study to assess the effect of post-harvest treatments on quality of jamun. Fruits were treated with growth regulators GA_3 (50 and 100 ppm), chemical $CaCl_2$ (1.0 and 1.5 %) and Paraffin wax along with control and kept in with or without perforated polyethylene bag. The treatment $CaCl_2$ 1.5 per cent with perforated polyethylene bag proved to be the best post harvest treatment than the rest of the treatments. The treatment effectively reduced the physiological loss in weight as well as spoilage loss and thereby useful in maintaining good balance between ascorbic acid and sugar content of fruits during storage. The treatment also showed little change in TSS, pH and acidity content and hence, it can be useful in post harvest management of Jamun fruits (Ayer *et al.*, 2011).

Conclusion

Thus, it can be concluded from this review that the use of plant growth regulator in dry land fruit crops has been found beneficial for propagation, canopy management, flowering, fruit set, fruit growth and development, crop regulation and fruit thinning, yield and quality.

References

1. Anshuman, S. and Singh, H. K. 2015. Application of plant growth regulators to improve fruit yield and quality in Indian gooseberry (*Emblica officinalis* Gaertn.). *Journal of Agri. Search,* 2(1): 20-23.
2. Arora R. and Singh, S. 2014. Effect of growth regulators on quality of ber (*Zizyphus mauritiana* lamk) cv. Umran.

Agricultural Science Digest, (34): 102-106.

3. Jadhav, A. C., Bhagure, Y. L. and Rajeswari M. R. 2015. Effect of PGR, chemicals and plant extract on seed germination and seedling growth of custard apple (Annona squamosa). *The Asian Journal of Horticulture*. 10(1): 184-186.
4. Ayar, K, Singh, S. and Chavda, J. C. 2011. Effect of post harvest treatments on quality of Jamun (*Syzygium cuminii* Skeels) fruits during storage. *Asian J. Hort*., 6(3): 297-299.
5. Dahale, M., Ningot, E. P. and Muske N. D. 2108. Effect of plant growth regulators on rooting and survival of hard wood cuttings in fig. *Int. J. Curr. Microbiol. App.Sci.,* 6: 2386-2391.
6. Ghosh, S. N. Bera, B. Kundu, A. and Roy, S 2009. Effect of plant growth regulators on fruit retention, yield and physico-chemical characteristics of fruits in ber 'Banarasi Karka' grown in close spacing. *Acta Horticulturae*, 840.
7. Ghosh, S.N., Bera, B., Roy S. and Kundu A. 2016. Effect of plant growth regulators in yield and fruit quality in pomegranate cv. Ruby. *Journal of Horticultural Science,* 4(2): 158-160.
8. Ghosh, S. N., Bera, B., Royl, S., Kundu A. and Roy. S. K. D. 2009. Effect of nutrients and plant growth regulators on fruit retention, yield and physico-chemical characteristics in aonla cv. NA-10. *J. Hortl. Sci.* 4(2): 164-166.
9. Goswami, J. D., Patel, N. M., Bhadauria, H. S. and Wankhade, V. R. 2013. Effect of plant growth regulators on quality traits of pomegranate cv. Sindur. *The Asian Journal of Horticulture*, 8(1): 361-363.
10. Kaur, G., Singh, M. and Singh, M. 2018. Influence of bio-regulators on the fruit quality and yield attributes of phalsa (*Grewia subinaequalis* DC). *Journal of Experimental Agriculture International,* 21(3): 1-6.
11. Kurubar, A. R., Allolli, T. B., Naik, M. K. and Angadi, S. G. 2017. Effects of gibberellic acid on growth, yield and fruit quality of fig (*Ficus carica* L.). *Acta Horticulture*. 1173:183-188.
12. Kacha, H. L., Viradia, R. R., leua, H .N., Jat, G. and Tank A. K. 2012. Effect of NAA, GA_3 and ethrel on yield and quality of phalsa (*Grewia asiatica* L.) under South-Saurashtra condition. *The Asian Journal of Horticulture,* 7(2): 242-245.
13. Khalil, Hoda A. and Aly, Hoda S. H. 2013. Cracking and fruit quality of pomegranate (*Punica granatum* L.) as affected by pre-harvest sprays of some growth regulators and mineral nutrients. *Journal of Horticultural Science & Ornamental Plants*, 5(2): 71-76.
14. Lilabati L. and Sahoo. U. K. 2015. Effect of pre-treatments on seed germination and seedling vigor of *Emblica officinalis* Gaertn. *Global Journal of Advanced Research.* 2(10): 1520-1526.
15. Sheikh M. K. 2015. Effect of growth regulators and hand thinning of flowers/fruits on size of pomegranate (*Punica granatum* L. 'Ganesh') *Proc. IIIrd IS on Pomegranate and Minor*

Mediterranean Fruits Eds.: Zhaohe Yuan *et al. Acta Hort*. 1089, ISHS 2015.

16. Patel, N. M., Patel, D. K., Verma, L. R. and Patel, M. M. 2010. Effect of cultural and chemical treatments on fruit set and fruit yield of custard apple (*Annona sqamosa* Lin.) cv. Sindhan, *Asian J. Hort.,* 5(2): 498-502.
17. Reddy P. Adi and Prasad. D. M. 2012. Effect of plant growth regulators on fruit characters and yield of pomegranate (*Punica granatum* l.) Cv. Ganesh. *International J. of Plant, Animal and Environmental Science*. 2(2): 91.
18. Patel, J. S. 2017. Influence of plant growth regulators and boron on nutritional quality and shelf life of aonla fruit. *Int. J. Curr. Microbiol. App. Sci.,* 6(4): 2533-2540.
19. Puspashree P. and Shiba P. R. 2012. In vitro propagation of *Aegle marmelos* (L.) corr., a medicinal plant through axillary bud multiplication. *Advances in Bioscience and Biotechnology*, 3:121-125.
20. Singh, C. and Bal. J. S. 2006. Effect of nutrients and growth regulators on fruit drop, size and yield of ber (*Zizyphus mauritiana* Lamk.). *International. J. agric. Sci*. 2(2): 358-360.
21. Supe, V.S., Dhanshree Patil, Anju A. Bhagat and Rashmi S. Bhoge. 2012. Seed germination and seedling growth in aonla (*Emblica Officinalis* Gaertn.) *Bioinfolet* 9(2): 206-208.
22. Surakshitha, N. C., Mahadevamma, M. and Sharath Kumar, M. 2014 Studies on application of plant growth regulators and macro nutrients on seedling growth in jamun [*Syzygium cuminii* (L.) Skeels] *Indian Journal f o Research,* 4(12): 3-5.
23. Vidya V. A., Narayanaswamy, P. and Ekabote, S. D. 2016. Effects of plant growth regulators on fruit set and yield of pomegranate. *Indian Horticulture Journal*, 6(02): 171-174.
24. Uniyal, S. and Mishra, K.K. 2015. Effect of plant growth regulators on fruit drop and quality of bael under Tarai conditions of Uttarakhand. *Indian J. of Horticulture,* 72(1): 126-129.