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RESEARCH ARTICLE

Enhancing fruit set, yield and quality of LeConte pear trees by preharvest foliar spray of some plant growth regulators

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Abstract

The present study was conducted during the two seasons 2021 and 2022 on eight-years-old of LeConte pear cultivar for enhancing fruit set, yield and quality by preharvest foliar spray of some plant growth regulators. Preharvest treatments included: control (spray with water only), nitrophenolate sodium (NPS) at 200 ppm, GA_{4+7} at 10ppm, thidiazuron (TDZ) at 5ppm, NPS plus GA_{4+7}, NPS plus TDZ and NPS plus GA_{4+7} and TDZ. All preharvest foliar treatments were sprayed at full bloom and after fruit set with ten days. The results showed that treatment with 200 ppm of nitrophenolate sodium increased fruit set, fruit firmness, TSS and carotenes. Increases in shoot length, fruit pedicel length and diameter, fruit set, yield, and acidity were seen after treatment with GA_{4+7} at 10 ppm. Carotenes and TSS in fruit were decreased. On the other hand, thidiazuron treatment at 5ppm increased pedicel fruit diameter, fruit set, yield, firmness, fruit diameter and acidity. Fruit TSS and carotenes were decreased.

Keywords: Fruit set; Growth regulators; Pear; Pedicel diameter.

1. Introduction

Low fruit set and inconsistent yield of LeConte pear trees are the most problems under Egyptian conditions. There are many factors which affect fruit set and yield of pear trees such as environmental conditions, plant growth regulators and nutrition (Sanzol and Herrero, 2001; Jackson, 2003). Nitrophenolate sodium is a plant biostimulant has a positive effect on several physiological processes such as enhancing photosynthesis process, nitrate reduction, nutrient uptake, increasing plant tolerance to stresses, enhancing plant antioxidant system, inhibiting IAA oxidase enzyme (Przybysz *et al*., 2014; Calvo *et al*., 2014; Bynum *et al*., 2007). Preharvest application of nitrophenolate on "Valencia" orange during blooming and after fruit set increasing fruit set and quality of oranges (Hamed, 2018). Preharvest application of gibberellic acid enhanced shoot growth, photosynthesis, fruit set, stem growth and development (Richard, 2006; Attia, 2017; Singh, 2008; Ferguson *et al*., 1999; El-Fakharani *et al*., 1990; Arteca, 1996). Preharvest foliar spray of GA_{4+7} at 50ppm induced grater fruit set of "Fuji" apples and higher fruit retention (Watanabe *et al*., 2008). Thidiazuron (TDZ) is a plant growth regulator promotes cell division and elongation, increased antioxidant activity (Guo *et al*., 2011; Schmidt *et al*., 2017; Ali and Abbasi, 2014). Rocha pear trees treated with TDZ at full bloom at 10 ppm increased fruit set, yield and quality (Carra *et al*., 2021). Thus, the objectives of this study were to enhance fruit set, yield and quality of LeConte pear trees by preharvest foliar spray of nitrophenolate sodium, gibberellic $acid_{4+7}$ and thidiazuron.

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2. Material and methods

The present experiment was carried out during 2021 and 2022 seasons on 8-years-old LeConte pear cultivar budded on (*Pyrus betulaefolia*) rootstock. The trees were grown in sandy soil at El Nubaria region, Beheira governorate, Egypt under drip irrigation system. Seven treatments were used in this investigation and each treatment was replicated three times (1 tree= 1 replicate). The experimental design was a randomized complete block design (RCBD). Preharvest foliar treatments included: control (spray with water only), nitrophenolate sodium (NPS) at 200 ppm, GA_{4+7} at 10ppm, thidiazuron (TDZ) at 5ppm, NPS plus GA_{4+7}, NPS plus TDZ and NPS plus GA_{4+7} and TDZ. All preharvest foliar treatments were sprayed at full bloom and after fruit set with ten days.

2.1. The following parameters were studied

Average shoot length (cm): about 20 new spring shoots per tree were randomly selected and measured at the end of the growth stage of shoots (end of September).

Fruit pedicel length and diameter (cm): about 20 fruits per tree were randomly selected and measured during mid-June.

Final fruit set (%): four main branches were selected and tagged during full bloom stage and about 10 spurs on each branch were selected. The fruit set percentage was calculated according to Westwood (1978) by using the following equation:

No. of fruitlets at mid-June/ No. of flowers at full bloom *100.

Yield/ tree (kg): at harvest time, all fruits on the tree were harvested and their weight was calculated by kilogram per tree.

2.2. Fruit physical and chemical characteristics

To evaluate the physical and chemical properties of "LeConte" cultivar, 10 fruits from each tree were picked during 1 September and 12 September during 2021 and 2022 seasons, respectively. Fruit flesh firmness (Ib/in^2) was determined using Effigi pressure tester (mod. Ft327), average fruit weight (g) was determined by weighting of ten fruits of each replication, fruit length and diameter (cm) were measured using a Vernier caliper. On the other hand, total soluble solids (%) was determined in fruit juice using a hand refractometer, titratable acidity (%) was colorimetrical measured based on estimated malic acid according to A.O.A.C. (1985) and carotene in the peel of fruit (µg/ g) was determined according to Mustapha and Babura, (2009).

2.3. The experimental design

Treatments in the field were arranged in a randomized complete block design (RCBD). Three replicates were used for each treatment and one tree represented one replicate (7 treatments* three replicates). Comparison between means was made by using Least Significant Differences (LSD) at 0.05 according to Sendecor and Cochran (1980). The data were analyzed using SAS (2000) program.

3. Results

The data in Table 1 showed that all preharvest treatments contained GA_{4+7} increased shoot length of LeConte pear trees in both seasons in a consistent manner. TDZ-treatment was similar to control treatment. The maximum shoot length was recorded with trees treated by NPS plus GA_{4+7} and the combination contained NPS $+GA_{4+7}$ + TDZ. The lowest shoot length was obtained by TDZ and control treatment.

Fruit pedicel length of LeConte pear trees as influenced by preharvest foliar treatments was reported in Table 1. The data indicated that the maximum pedicel length was recorded by GA_{4+7} treatments. The lowest pedicel length was recorded in control treatment.

Changes of fruit pedicel diameter of LeConte pear trees were reported in Table 1. The data showed that TDZ treatment caused a significant increase in pedicel diameter when compared with control and other individual treatments. The data

also showed that there was no significant difference between NPS and control treatment.

Table 1. Effect of foliar spray of nitrophenolate sodium, GA_{4+7} and thidiazuron on shoot length (cm), fruit pedicel length and diameter of LeConte pear trees during 2021 and 2022 seasons.

Treatments	Shoot length (cm)		Pedicel length of fruit (cm)		Pedicel diameter of fruit (cm)	
	2021	2022	2021	2022	2021	2022
*T1	25.67e**	25.00e	2.30d	2.50c	0.33d	0.40c
T2	28.33e	28.00c	2.73c	2.77b	0.40d	0.43c
T3	32.00b	33.33b	3.43b	3.37a	0.50c	0.57b
T4	26.67de	25.33e	2.73c	2.80b	0.60ab	0.67a
T5	35.33a	34.33ab	3.57ab	3.47a	0.53bc	0.57b
T6	27.67cd	26.67d	2.77c	2.77b	0.60ab	0.67a
T7	36.33a	35.33a	3.63a	3.47a	0.63a	0.70a
LSD	1.35	1.15	0.188	0.114	0.067	0.076

T1: control. T2: nitrophenolate sodium (NPS) at 200 ppm. T3: GA_{4+7} at 10ppm. T4: thidiazuron (TDZ) at 5ppm. T5: NPS plus GA_{4+7}. T6; NPS plus TDZ and T7; NPS plus GA_{4+7} and TDZ . Means within columns with the same letter are not significantly different using least significant difference (LSD) at $P \leq 0.05$ levels.*

Data in Table 2 proved that preharvest foliar application of all treatments increased fruit set percentage of LeConte pear as compared with control treatment in a consistent manner in both seasons of study. The maximum fruit set was obtained by NPS plus GA_{4+7} and TDZ and the lowest fruit set percentage was obtained by control treatment. The changes in yield of LeConte pear trees was reported in Table 2. The data illustrated that preharvest foliar application of GA_{4+7}, TDZ and their combinations increased fruit yield of LeConte pear as compared with control treatment. The highest value of of fruit yield was obtained by NPS plus GA_{4+7} and TDZ. The data in Table 2 illustrated that fruit firmness of pear fruit increased by all preharvest spray of NPS, GA_{4+7} and TDZ and their combinations as compared by control treatment. Higher fruit firmness was obtained by treatment contained NPS plus GA_{4+7} and TDZ.

Table 2. Effect of foliar spray of nitrophenolate sodium, GA_{4+7} and thidiazuron on fruit set, yield and firmness of LeConte pear trees during 2021 and 2022 seasons.

Treatments	Fruit set (%)		Yield/ tree (kg)		Firmness (Ib/in^2)	
	2021	2022	2021	2022	2021	2022
*T1	7.00f	7.70f	31.33c	28.67e	11.60e	11.10g
T2	10.33e	10.33e	33.00c	32.33d	12.03d	11.50f
T3	14.67d	14.00d	43.33b	40.67c	15.07c	14.03e
T4	19.33b	19.00b	49.33a	47.33b	16.07b	15.03d
T5	16.00c	16.00c	45.67b	42.00c	15.20c	15.16c
T6	21.00a	19.00b	50.33a	49.00b	16.23ab	15.50b
T7	22.00a	21.33a	51.67a	51.67a	16.60a	15.83a
LSD	1.09	1.73	3.41	1.74	0.37	0.11

T1: control. T2: nitrophenolate sodium (NPS) at 200 ppm. T3: GA_{4+7} at 10ppm. T4: thidiazuron (TDZ) at 5ppm. T5: NPS plus GA_{4+7}. T6; NPS plus TDZ and T7; NPS plus GA_{4+7} and TDZ . Means within columns with the same letter are not significantly different using least significant difference (LSD) at $P \leq 0.05$ levels.*

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Average fruit weight of LeConte pear data was reported in Table 3. The data proved that fruit weight was increased by treatments contained GA_{4+7} and TDZ .Fruit length of LeConte pear trees as influenced by preharvest foliar treatments was reported in Table 2. The data indicated that

the maximum fruit length was recorded by GA_{4+7} treatments. Whereas, minimum fruit length was recorded in control treatment .The data of fruit diameter of LeConte pear trees was reported in Table 3. The data proved that TDZ treatments have a significant increase in fruit diameter as compared with other individual treatments and control especially in the first season.

Table 3. Effect of foliar spray of nitrophenolate sodium, GA_{4+7} and thidiazuron on some physical characteristics of LeConte pear trees during 2021 and 2022 seasons.

Treatments	Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)	
	2021	2022	2021	2022	2021	2022
*T1	169.00e	167.67c	7.53e	7.23c	5.93c	5.70e
T2	173.00d	170.00c	7.77c	7.67b	6.03c	5.93d
T3	188.67c	187.67b	8.27b	8.50a	6.87b	6.90c
T4	190.33bc	189.67ab	7.50e	7.20c	7.07a	7.03ab
T5	191.33abc	192.33a	8.43a	8.60a	6.90b	6.97bc
T6	192.67ab	191.67ab	7.63d	7.23c	7.10a	7.07ab
T7	193.67a	193.00a	8.47a	8.63a	7.17a	7.13a
LSD	2.92	4.39	0.09	0.14	0.104	0.111

**T1: control. T2: nitrophenolate sodium (NPS) at 200 ppm. T3: GA_{4+7} at 10ppm. T4: thidiazuron (TDZ) at 5ppm. T5: NPS plus GA_{4+7}. T6; NPS plus TDZ and T7; NPS plus GA_{4+7} and TDZ. **Means within columns with the same letter are not significantly different using least significant difference (LSD) at P ≤ 0.05 levels.*

The data in Table 4 showed that all preharvest treatments reduced fruit TSS percentage except nitrophenolate sodium and control. Data in Table 4 illustrated that all preharvest treatments increased fruit acidity percentage except nitrophenolate sodium and control. Peel carotene content of LeConte pear as influenced by preharvest treatments were discussed in Table 4. The data showed that nitrophenolate sodium at 200 ppm increased peel carotene content as compared with GA_{4+7} or TDZ treatments. The data also showed there was no difference between nitrophenolate sodium and control treatment.

Table 4. Effect of foliar spray of nitrophenolate sodium, GA_{4+7} and thidiazuron on some chemical characteristics of LeConte pear trees during 2021 and 2022 seasons.

Treatments	Fruit TSS (%)		Fruit titratable acidity (%)		Carotenes (µg/ g)	
	2021	2022	2021	2022	2021	2022
*T1	15.07a	14.07a	0.697b	0.67d	55.36a	56.78a
T2	15.03a	14.07a	0.693b	0.67d	55.17a	57.87a
T3	14.03b	13.5b	0.817a	0.77c	48.29b	50.54b
T4	13.47c	13.1c	0.817a	0.80ab	46.62d	46.49c
T5	14.07b	13.53b	0.810a	0.79bc	47.71c	50.09b
T6	13.37c	13.13c	0.803a	0.79bc	46.55d	47.07c
T7	13.23d	13.07c	0.827a	0.81a	45.65e	45.85c
LSD	0.129	0.187	0.027	0.019	0.431	1.293

T1: control. T2: nitrophenolate sodium (NPS) at 200 ppm. T3: GA_{4+7} at 10ppm. T4: thidiazuron (TDZ) at 5ppm. T5: NPS plus GA_{4+7}. T6; NPS plus TDZ and T7; NPS plus GA_{4+7} and TDZ . Means within columns with the same letter are not significantly different using least significant difference (LSD) at P ≤ 0.05 levels.*

4. Discussion

The results Poor fruit set and low yield of LeConte cultivar are the major problem which facing pear growers at local or worldwide level (Carra *et al*., 2018). The data in Table 1 showed that gibberellic acid treatments enhanced vegetative characteristics of LeConte pear such as shoot length, pedicel length and pedicel diameter

as compared with control and other individual treatments. The positive role of GA on such properties might be due to its influence on cell division and elongation, photosynthesis, chlorophyll content, carbohydrate biosynthesis (Ferguson *et al*., 1999). Preharvest foliar spray of gibberellic acid on pomegranate trees increased shoot length (Attia, 2017). The data in Table 1 also indicated that TDZ treatment increased pedicel diameter of pear fruit. Such increase was attributed to enhance cell division (Guo *et al*., 2011). Data in Table 2 indicated that preharvest foliar application of all treatments such as nitrophenolate sodium, gibberellic acid, TDZ or its combination increased fruit set and yield as compared with control treatment. The positive effect of nitrophenolate on fruit set and yield was attributed to its influence on increasing auxin concentration, inhibition of IAA oxidase, increased tolerant to stress and total carbohydrates (Djanaguiraman *et al*., 2005; Przybysz *et al*., 2014; Kocira *et al*., 2015). The positive effect on fruit firmness might be attributed to its influence on stress tolerant (Calvo *et al*., 2014). TDZ enhanced pear fruit set as a result of increasing the rate of parthenocarpy Pasa *et al*. (2017). The positive effect of GA_{4+7} on fruit set and yield might be attributed to induce pear parthenocarpy and repressed accumulation of ABA (Liu *et al*., 2018). The results of this study are in harmony with (Sabir *et al*., 2021; Watanable *et al*., 2008; Sharma *et al*., 2018). Finally, plant growth regulators controls the continuity of the flow of assimilates and nutrients required for fruit growth (Treharne *et al*., 1985).

Preharvest foliar application of gibberellic acid, TDZ and nitrophenolate enhanced physical properties of pear fruits such as fruit weight, fruit length and fruit diameter. The positive impact of gibberellic acid on physical characteristics could be due to increase photosynthesis process, sugar formation, chlorophyll content, and cell elongation (Zhang *et al*., 2007; Richard, 2006; Ferguson *et al*., 1999 and Attia, 2017). Moreover, TDZ application protects chlorophyll degradation, promotes cell division and elongation (Guo *et al*., 2011) which reflects on physical fruit quality. The positive role of TDZ on physical properties was previously reported (Carra *et al*., 2021; Li *et al*., 2019; Yang *et al*., 2019). Furthermore, preharvest application of nitrophenolate sodium enhanced physical characteristics of pear fruits. The positive role of nitrophenolate might be attributed to increase plant tolerant to stress resulting from improving the growth and productivity of plant species (Calvo *et al*., 2014). Preharvest application of nitrophenolate at 630ppm as a foliar spray improved fruit weight, size of "Valencia" orange (Hamed, 2018).

The data in Table 4 illustrated that preharvest application of TDZ and GA_{4+7} increased juice acidity and decreased fruit TSS and carotenes of pear fruits. On the other hand, nitrophenolate sodium increased peel color of pear fruits. Such findings for GA, TDZ or nitrophenolate are in agreement with (Li *et al*., 2019; Yang *et al*., 2019; Attia, 2017; Hamed, 2018).

5. Conclusion

The present study recommended pear growers to use the formulation containing nitrophenolate plus GA_{4+7} and thidiazuron for enhancing fruit set, yield and quality of LeConte pear cultivar.

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Institutional Review Board Statement
All Institutional Review Board Statement are confirmed and approved.

Data Availability Statement
Data presented in this study are available on fair request from the respective author.

Ethics Approval and Consent to Participate
This work carried out at Department of Horticulture, Faculty of Agriculture, Damanhour University.

Consent for Publication
Not applicable.

Conflicts of Interest
Declare no conflict of interest.

5. References

A O A C. (1985). *'Official Methods of Analysis. Association of Official Analytical Chemists'*, Washington D C, USA, 14 Th Ed.

Ali, M., Abbasi, B.H. (2014). 'Thidiazuron-induced changes in biomass parameters, total phenolic content, and antioxidant activity in callus cultures of *Artemisia absinthium* L.', *Appl. Biochem. Biotechnol*. 172, pp. 2363–2376.

Arteca, R. N. (1996). *'Plant growth substances and principles and applications'*, Chapman and Hall Dept. BC. 115 Fifth Avenue, New York, NY10003.

Attia, S. M. (2017). 'Manipulation of splitting, sunburn and enhancing coloration of Wonderful pomegranates by preharvest foliar applications', IJRDO-*Journal of Agriculture and Research*, 3(5), pp. 01-09. https://doi.org/10.53555/ar.v3i5.24.

Bynum, J.B., Cothren, J.T., Lemon, R.G., Fromme, D.D., Boman, R.K. (2007). 'Field evaluation of nitrophenolate plant growth regulator (Chaperone) for the effect on cotton lint yield', *J. Cotton Sci*., 11, pp. 20–25.

Calvo, P., Nelson, L., Kloepper, J.W. (2014). 'Agricultural uses of plant bio-stimulants'. *Plant Soil*, 383, pp. 3–41.

Carra, B., Pasa, M.S., Abreu, E.S., Dini, M., Pasa, C.P., Ciotta, M.N., Herter, F.G., Mello-Farias, P. (2021). 'Plant growth regulators to increase fruit set and yield of 'Rocha' pear trees in Southern Brazil', *An. Acad. Bras. Cienc.*, 93, e20180680. DOI 10.1590/0001-3765202120180860.

Carra, B., Pasa, M.S., Silva, C.P., Amarante, C.V.T., Steffens, C.A., Bartnicki, V.A., Ciotta, M.N., Mello-Farias, P.C., Einhorn, T. (2018). 'Early spring inhibition of ethylene synthesis increases fruit set and yield of 'Rocha' pear trees in Southern Brazil', *Sci. Hortic.*, 232, pp. 92-96.

Djanaguiraman, M., Sheeba, J.A., Devi, D.D., Bangarusamy, U. (2005). 'Response of cotton to Atonik and TIBA for growth, enzymes and yield', *J. Biol. Sci*., 5, pp. 158-162.

El-Fakharani, E.M.M., Wally, A.S., Saied, I.A. (1990). 'Effect of some growth regulators on persimmon. 1-Effect of Alar and GA_3 on retained fruits and fruit quality of persimmon', *Annals, Agric. Sci. Moshtohor*, 28 (3), pp. 1699 – 1710.

Ferguson, L., Michailides, T.J., Shorey, H.H. (1999). *'The California Fig Industry'.* Univ. California. U.S.A.

Guo, B., Abbasi, B.H., Zeb, A., Xu, L.L., Wei, Y. H. (2011). 'Thidiazuron: a multi-dimensional plant growth regulator'. *Afr. J. Biotechnol*. 10, pp. 8984–9000.

Guoqiang Yang, a,b Shan Zhao, a,b Jin Gong, a,b Min Huang, a,b Weiwei Yu, a,b Kankan Zhanga, b., Deyu Hua, b. (2019). 'Dissipation and the effects of thidiazuron on antioxidant enzyme activity and malondialdehyde content in strawberry', *J. Sci. Food Agric*., 99, pp. 4331–4337.

Hamed, N. A. M. (2018). 'Response of valencia orange trees to some treatments during blooming, fruit set and fruit maturation', *Journal of Horticultural Science and Ornamental Plants*, 10 (3), pp. 167-178.

Sabir, I. A., Xunju Liu, Songtao Jiu. (2021). 'Plant growth regulators modify fruit set, fruit quality, and return bloom in sweet cherry'. *HORTSCIENCE*, 56(8), pp. 922–931.https://doi.org/10.21273/HORTSCI15835-21.

Jackson, J. E. (2003). *'Biology of apples and pears'*, 1st ed., Cambridge, 488p.

Kocira, A., Kocira, S., Stryjecka, M. (2015). 'Effect of Asahi SL application on common bean yield', *Agric. Agric. Sci. Proc*., 7, pp. 103–107.

Li, M. F., Feng, S., Li, S. P., Wu, F., Wang, F., Li, C. L., Wang, L. J. (2019). 'Preharvest promotion or inhibition of colouration: Which is the more conducive to improving

litchi postharvest quality?', *Scientia Horticulturae*, 254, pp. 124-132.

Liu, L., Wang, Z., Liu, J., Liu, F., Zhai, R., Zhu, C., Xu, L. (2018). 'Histological, hormonal and transcriptomic reveal the changes upon gibberellin-induced parthenocarpy in pear fruit', *Horticulture research*, *5*.

Mustapha, Y., Babura, S. R. (2009). 'Determination of carbohydrate and β-carotene content of some vegetables consumed in Kano metropolis, Nigeria. Bayero', *Journal of Pure and Applied Sciences*, 2(1), pp. 119-121.

Pasa, M.S., Silva, C.P., Carra, B., Brighenti, A.F., Souza, Alk, Petri, J.L. (2017). 'Thidiazuron (TDZ) increases fruit set and yield of 'Hosui' and 'Packham's triumph' pear trees', *An. Acad. Bras. Cienc*., 89: pp. 3103-3110. *Press, Ames, Iowa*. USA.

Przybysz, A., Gawronska, H., Gajc-Wolska, J. (2014). 'Biological mode of action of a nitrophenolate–based biostimulant'. *Journal Frontiers in Plant Science*, (5) 713, pp. 1 -15.

Richard, M. (2006). *'How to grow big peaches'*, Dept. of Hort. Virginia Tech. Blacksburg, VA 24061. www. Rce. Rutgers. Edu.

Sanzol, J., Herrero, M. (2001). 'The "effective pollination period" in fruit trees', *Scientia Horticulturae*, *90*(1-2), pp. 1-17.

SAS Institute Inc. (1999). *'The SAS System for Windows*, Version 8.0, SAS Institute Inc., Cary, NC, USA.

Schmidt, C.S., Mrnka, L., Frantik, T., Motyka, V., Dobrev, P.I., Vosatka, M. (2017). 'Combined effects of fungal inoculants and the cytokinin-like growth regulator thidiazuron on growth, phytohormone contents and endophytic root fungi in Miscanthus x giganteus', *Plant Physiol. Biochem*., 120, pp. 120–131.

Shan, T., Wei, J., Wang, Y. (2021). 'Effects of different pesticides treatments on the nutritional quality of kiwifruit', *J. Food Sci*., 86, pp. 2346–2357. https://doi.org/10.1111/1750-3841.15763.

Sharma, S., Sharma, N., Sharma, D. P., Chauhan, N. (2018). 'Effect of plant growth regulators on fruit set, yield efficiency, fruit size and russet formation in apple cv. Scarlet Spur II', *Int. J. Pure App. Biosci. SPI*, 6(3), pp. 692-698.

Singh, G. (2008). *'Effect of irrigation, foliar fertilization and plant bioregulators on growth yield and quality of pomegranate cv. G-137'*, Ph.D. Thesis, Dr. Y.S. Parmar University of *Horticulture and Forestry*, Nauni, Solan, H.P. (INDIA).

Snedecor, G. W., Cochran, W. G. (1980). *'Statistical Methods'*, 6th Ed. Iowa State Univ.

Treharne, K. J., Quinlan, J. D., Knight, J. N., Ward, D. A. (1985). 'Hormonal regulation of fruit development in apple', A mini review. *Plant Growth Reg*., 3, pp. 125–132.

Watanabe, M., Segawa, H., Murakami, M., Sagawa, S., Komori, S. (2008). 'Effects of plant growth regulators on fruit set and fruit shape of parthenocarpic apple fruits', *Journal of the Japanese society for Horticultural Science*, 77(4), pp. 350-357.

Westwood, M. N. (1978). 'Plant efficiency; growth and yield measurements', *Temperate Zone Pomology*. WH Freeman and company, San Fransisco, pp. 119-120.

Zhang, C. K., Tanabe, H., Tani, H., Nakajima, M., Mori, A., Itai, Sakuno, E. (2007). 'Biologically active gibberellins and abscisic acid in fruit of two late-maturing Japanese pear cultivars with contrasting fruit size', *J. Amer. Soc. Hort. Sci*., 132, pp. 452- 458.