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Effect of Foliar Application of Potassium Nitrate and Ethephon on Yield Characters of Papaya (*Carica papaya* L.) cv. Red Lady

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ABSTRACT

An investigation was carried out to study the effect of foliar application of potassium nitrate and ethephon on yield characters of papaya (*Carica papaya* L.) cv. Red lady at a farmer's field, Idappadi, Salem district, Tamil Nadu during 2018-2020. The prime objective of the study was to identify the best treatment that improved the yield characters of papaya. The experiment was laid out in a Randomized Block Design (RBD) with nine treatments replicated thrice. The treatments comprised of different concentrations and combinations of KNO_3 and ethephon. The results revealed that foliar application of KNO_3 @ 2% + Ethephon @ 800 ppm significantly reduced the time taken to first flowering, time taken to first fruiting and time taken from flowering to fruit maturity, peel weight and increased number of fruits per plant, fruit length, fruit diameter, fruit weight, pulp weight, pulp - peel ratio and yield per plant followed by KNO_3 @ 1.5% + Ethephon @ 800 ppm.

***Key words*:** Papaya, Foliar spray, Potassium nitrate, Ethephon, Yield characters

Papaya (*Carica papaya* L.), referred as fruit of angels by Christopher Columbus, is the most economically important species in the Caricaceae family [8]. It is cultivated for its fruit, papain, pectin, and antibacterial substances [27]. It is believed to have originated in the lowlands of eastern Central America, from Mexico to Panama [25]. It is now cultivated in 66 countries of the world and India ranks first in production followed by Dominican Republic, Brazil, Mexico and Indonesia [14]. It was introduced to India from Philippines through Malaysia in the early part of 16th century [32]. In India, it is grown in an area of 0.14 million ha with production of 5.99 million tonnes [5]. Andhra Pradesh is the leading producer of papaya followed by Gujarat, Karnataka, Madhya Pradesh and Maharashtra.

Papaya has gained more importance owing to its high palatability, fruiting ability throughout the year, early fruiting, highest productivity per unit area and multifarious uses like food, medicine and industrial inputs [30]. Red Lady is a gynodioecious variety of papaya tolerant to papaya ringspot virus and is very popular in south India. Fruits are short-oblong on female plants and rather long-shaped on bisexual plants, weighing about 1.5 - 2 kg. The flesh is thick, red, and 13% in sugar content and aromatic. More popularly grown in India due to its suitability to all the environmental conditions. Plants begin to bear fruits at 80 cm height and normally have over 30 fruits per plant in each fruit setting season. Foliar feeding of nutrients directly to the site of metabolism as a substitute or supplement to soil application considerably enhanced fruit yield and quality attributes [35]. It is observed that yield response curves are strongly modulated by interactions between nutrients and other growth factors [22]. The application of foliar sprays can help to preserve crop yields and quality, with low environmental impact [13] and [15]. The important criterion of the effectiveness of the nutrient spray is the rate at which the foliar-applied nutrients are absorbed by the leaves and translocated within the plant [3]. Secondly, foliar sprays are normally more rapid than to soil application of nutrients, especially in the reproductive phase as it compensates the root decline with the onset of the reproductive stage [42].

KNO_3 is used in India, Mexico, Hawaii (United States) and Malaysia [28]. Potassium nitrate is used to induce off-season flowering and to synchronous flowering in mango. The effective spray concentration ranges from 1 to 10 % KNO_3 with the optimum concentration varying with the age of the trees and climatic conditions [20] and [11]. [31] hypothesized that, once gibberellins levels fall below a threshold level, starch can start to accumulate, allowing the tree to flower. After sufficient starch has accumulated, floral initiation will ensue. However, the buds will remain quiescent until conditions are favourable for flowering. KNO_3 may activate those quiescent buds for floral initiation.

Ethephon, invented in 1965, is a liquid that is converted into ethylene and acts as a plant hormone after it

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is sprayed on plants [18]. The phytohormone ethylene is well known to influence many physiological and developmental processes in plants including, but not limited to seed germination, seedling growth, and formation of the apical hook, senescence, fruit ripening, abscission and gravitropism [2]. It can be speculated that the ethylene generated when ethephon is sprayed plays a critical role in flower induction. The ethylene-generating agent, Ethephon, has been used successfully to induce and increase flowering in various mango varieties in the Philippines and India [9]. Studies on effects of potassium nitrate and ethephon on flowering, yield and quality characters are limited in fruits crops in general and papaya in particular. Hence, the present investigation was carried out with the objective to study the effect of potassium nitrate and ethephon on yield characters of papaya (*Carica papaya* L.) cv. Red lady.

MATERIALS AND METHODS

The present study was carried out at a farmer's field, Idappadi, Salem district, Tamil Nadu during 2018-2020. The experiment was carried in Randomized Block Design with nine treatments replicated thrice. Seeds of papaya cv. Red Lady were sown in a polybag (12×10 cm) and 60 days old seedlings were transplanted to research plots at a spacing of 1.8 × 1.8 m. Four plants were maintained for each treatment. The treatment details are as follows T_1- Control; T_2- KNO_3 @ 1.5%; T_3- KNO_3 @ 2.0%; T_4- Ethephon @ 800 ppm; T_5- Ethephon @ 1000 ppm; T_6- KNO_3 @ 1.5% + Ethephon @ 800 ppm; T_7- KNO_3 @ 1.5% + Ethephon @ 1000 ppm; T_8- KNO_3 @ 2% + Ethephon @ 800 ppm; T_9- KNO_3 @ 2% + Ethephon @ 1000 ppm. The observations were recorded on days taken for first flowering, days taken for first fruiting, days taken from flowering to fruit maturity, number of fruits per plant, fruit length, fruit diameter, fruit weight, peel weight, pulp weight, pulp peel ratio, yield per plant. The data generated during the study were statistically analyzed [29].

RESULTS AND DISCUSSION

Yield attributing characters

The data related to effect of foliar application of potassium nitrate and ethephon on yield attributing characters of papaya cv. Red lady is presented in (Table 1). The days taken for first flowering was the lowest (75.39 days) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (79.18 days) whereas it was the highest (108.97 days) in T_1 (control). The reduced flowering duration could be attributed to the effect of applications of nitrogenous compounds containing NO_3^- or NH_4, + increased levels of arginine, a compound which can promote flowering [15]. The fraction of K in the KNO_3 also could stimulate photosynthesis and transport of photoassimilates, among others, which is very important for the formation of flowers [40].

Table 1 Effect of foliar application of potassium nitrate and ethephon on yield attributing characters of papaya cv. Red lady

Treatments	Days taken for first flowering	Days taken for first fruiting	Days taken from flowering to fruiting
T_1 (Control)	121.96	211.45	108.97
T_2 (KNO_3 @ 1.5%)	114.19	199.55	102.12
T_3 (KNO_3 @ 2.0%)	109.91	193.25	98.27
T_4 (Ethephon @ 800 ppm)	101.32	180.70	90.65
T_5 (Ethephon @ 1000 ppm)	105.60	186.70	94.48
T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm)	88.56	161.88	79.18
T_7 (KNO_3 @ 1.5% + Ethephon @ 1000 ppm)	92.79	168.15	83.03
T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm)	84.31	155.63	75.39
T_9 (KNO_3 @ 2% + Ethephon @ 1000 ppm)	97.06	174.44	86.85
S.Ed.	1.74	1.98	2.92
CD (P=0.5)	3.69	4.21	6.20

The days taken for first fruiting was the minimum (84.31 days) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (88.56 days) while it was maximum (121.96 days) in control. Potassium nitrate increased fruit set and fruit retention as reported by [35]. Similar findings reported by [7] in mango, [41] in citrus, [24] in mango and longan, [39] in mango and [37] in ber, are in agreement with the present investigation.

The days taken from flowering to maturity was the lowest (155.63 days) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (161.88 days) whereas it was the highest (211.45 days) in control. Nitrogen regulates the uptake of other nutrients and enhances the plant's biological processes including growth, absorption, transportation, and excretion. Reduction in number of days taken to maturity might be due to the better source-sink relationship of translocation of carbohydrates efficiency to the developing fruits. This might be due to the faster rate of translocation of assimilates from source to sink, aided by additional potassium because it is a general metabolic activator increasing the respiration and photosynthetic rate [17]. All these reduce metabolites and water stress caused by competition among fruits and fruit set which leads to increased fruit set percentage and reduced fruit drop percentage. Similar findings were observed by [23] in pineapple and [6] in Citrus.

Yield characters

The data pertaining to effect of foliar application of potassium nitrate and ethephon on yield characters of papaya cv. Red lady is presented in (Table 2). The number of fruits per plant was the highest (52.63) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (49.92) whereas it was the lowest (29.42) in control. Early flowering, fruiting and better retention of fruits would have facilitated the better utilization of nutritional resources within the tree resulting in maximum yields [21]. According to [26], K might have acted as activators for some complex enzymes catalyze metabolic reactions related to the carbohydrates, nucleic acid, nucleotides, amino acids, protein and folic acid. This might be due to foliar application of K enhanced carbohydrate reserves, which ensured a better fruit set [12].

Table 2 Effect of foliar application of potassium nitrate and ethephon on yield characters of papaya cv. Red lady

Treatments	Number of fruits	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Pulp weight (g)	Peel weight (g)	Pulp-Peel ratio	Yield / plant (kg)
T_1: Control	29.42	14.12	10.32	1342.35	1249.23	240.63	5.19	27.77
T_2: KNO_3 @ 1.5%	33.62	16.44	11.73	1543.33	1406.44	227.92	6.17	31.25
T_3: KNO_3 @ 2.0%	36.36	17.82	12.67	1681.56	1548.89	213.28	7.26	34.09
T_4: Ethephon @ 800 ppm)	41.72	20.71	14.55	1942.86	1806.81	185.02	9.76	39.39
T_5: Ethephon @ 1000 ppm)	39.04	19.26	13.61	1813.51	1687.57	198.99	8.48	36.82
T_6: KNO_3 @ 1.5 % + Ethephon @ 800 ppm)	49.92	24.92	17.38	2317.70	2156.75	145.23	14.85	47.16
T_7: KNO_3 @ 1.5% + Ethephon @ 1000 ppm)	47.18	23.53	16.44	2194.05	2040.37	158.18	12.89	44.57
T_8: KNO_3 @ 2% + Ethephon @ 800 ppm)	52.63	26.29	18.65	2440.65	2271.34	132.34	17.16	49.67
T_9: KNO_3 @ 2% + Ethephon @ 1000 ppm)	44.48	22.11	15.49	2069.43	1942.05	171.44	11.22	42.02
S. Ed.	1.08	0.54	0.43	61.05	56.78	6.015	0.06	1.08
CD (P=0.5)	2.30	1.15	0.92	122.03	113.56	12.03	0.858	2.30

The fruit length was the highest (26.29 cm) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (24.92 cm) whereas it was the lowest (14.12 cm) in control. The increase in length of fruits may be due to the fact that mineral nutrients appear to have indirect role in hastening the process of cell division and cell elongation due to which the size of fruit might have improved. Potassium being a major nutrient is essential for reduction of nitrate in plants. It is essentially required for the production of best quality fruits. It is also involved in the opening and closing of stomata and such finding have also been reported by [33]. The fruit diameter was the highest (18.65 cm) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (79.18 cm) while it was the minimum (10.32 cm) in control. KNO_3 treatments, especially at higher concentrations, increased fruit size compared to the control in Washington navel orange [1].

The fruit weight was the highest (2440.65 g) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (2317.70 g) whereas it was the lowest (1342.35 g) in control. The fruit weight (2440.65 g), pulp weight (2271.34 g), pulp - peel ratio (17.16) were maximum and peel weight (132.34 g) was minimum when the plants were applied with KNO_3 @ 2% + Ethephon @ 800 ppm. Nitrogen is an essential element of chlorophyll and chlorophyll is essential for carbohydrate synthesis by photosynthesis. Nitrogen increased arginine synthesis and produced more types of poly-amines, which is leading to the development of primary flowering and enhancement of growth rate of the ovary and increasing cell division consequently fruit set per cent and yield are increased. These results are in conformity to the findings of [19] in papaya. This might be due to higher potassium levels was mainly due to the increase in pulp weight which was the consequence of the satisfactory activity of the enzymes involved in starch and protein synthesis under an adequate supply of K. Similar findings were also observed earlier by [34] in mango.

The pulp weight was the highest (2274.34 g) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (2156.75 g) while it was the lowest (1249.23 g) in control. The increase in pulp weight could be due to more absorption of water and greater accumulation of food substances in elongated cells and inter cellular space of mesocarp [4]. The peel weight was the lowest (132.34 g) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (145.23 g) whereas it was the highest (240.63 g) in control. The peel looses water both by transpiration to the atmosphere and also to the pulp by osmosis [38] thereby contributing to an increase in the fresh weight of the pulp as the fruit ripens.

The pulp to peel ratio was the highest (17.16) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (14.85) while it was the lowest (5.19) in control. The increase in pulp to peel ratio is due to rapid increase in the sugar concentration in the pulp compared to the peel thus contributing to a differential change in osmotic pressure [10]. The fruit yield was the highest (42.02 kg/plant) in T_8 (KNO_3 @ 2% + Ethephon @ 800 ppm) followed by T_6 (KNO_3 @ 1.5% + Ethephon @ 800 ppm) (47.16 kg/plant) whereas it was the lowest (27.77 kg/plant) in control. The increase in fruit yield could be attributed to increased size, diameter and weight of fruits. Moreover, probably there was a greater diversion of photosynthates to sink (fruit), which ultimately added to the fruit yield. Early flowering, fruiting and better retention of fruits would have facilitated the better utilization of nutritional resources within the tree resulting in maximum yields [21].

CONCLUSION

It is concluded from the present investigation that the foliar application of KNO_3 @ 2% + Ethephon @ 800 ppm is found to be the best treatment for boosting yield and quality characters of papaya cv. Red Lady.

LITERATURE CITED

1. Abd El-Rahman GF, Hoda MM, Ensherah AHT. 2012. Effect of GA_3 and potassium nitrate in different dates on fruit set, yield and splitting of Washington navel orange. *Nature and Science* 10(1): 148-157.
2. Abeles FB, Morgan PW, Saltveit ME. 1992. *Ethylene in Plant Biology*. San Diego, CA: Academic press.
3. Alexander A. 1986. *Foliar Fertilization*. Dordrecht. The Netherlands: Martinus Nijhoff Publishers.
4. Amarcholi JJ, Singh V, Sharma KM, Patel RJ, Chaudhari GV, Momin SK. 2016. Influence of various chemicals on flowering and fruiting characteristics of 'Kesar' Mango. *Research Journal of Agricultural Science* 7(1): 53-54.
5. Anonymous. 2018. Horticultural Statistics at a Glance 2018. Ministry of Agriculture and farmers welfare, Government of India.
6. Ashraf YM, Ashraf M, Akhtar M, Mahmood K, Muhammad S. 2013. Improvement in yield, quality and reduction in fruit drop in kinnow (*Citrus reticulata* Blanco.) by exogenous application of plant growth regulators, potassium and zinc. *Pakistan Jr. Botany* 45: 433-440.
7. Barun. 2006. Effect of paclobutrazol, potassium nitrate and Urea on bearing of mango. *Ph. D. Thesis,* Submitted to Rajendra Agricultural University, Bihar.
8. Carvalho FA, Renner SS. 2012. A dated phylogeny of the papaya family Caricaceae reveals the crop's closest relatives and the family's biogeographic history. *Mol. Phylogenet. Evol*. 65: 46-53**.**
9. Chanda KL, Pal RN. 1986. *Mangifera indica*. *In*: (Eds) A. C. Halevy. CRC Handbook of flowering 5. CRC Press, Boca Raton, Florida, USA. pp 211-30.
10. Dadzie BK, Orchard JE. 1997. Routine Post Harvest Screening of Banana/Plantain Hybrids: Criteria and Methods. INIBAP Technical Guidelines 2. International Plant Genetic Resources Institute, Rome, Italy; International Network for the Improvement of Banana and Plantain, Montpellier, France; ACP-EU Technical Centre for Agricultural and Rural Cooperation, Wageningen, The Netherlands.
11. Davenport TL. 2009. Reproductive physiology. *In*: (Eds) R. E. Litz. The Mango: Botany, Production and Uses (2nd ed). CAB International, Wallingford, UK. https://doi.org/10.1079/9781845934897.0097. pp 97-169.
12. Dutta P, Ahmed B, Kundu S. 2011. Effect of different sources of potassium on yield, quality and leaf mineral content of mango in West Bengal. *Better Crops-South Asia*. pp 16-18.
13. Fageria NK, Barbosa Filho MP, Moreira A, Guimaraes CM. 2009. Foliar fertilization of crop plants. *Journal of Plant Nutrition* 32: 1044-1064.
14. FAO. 2019. FAOSTAT (online). Rome. http://www.fao.org/faostat/en/#data/QC
15. Fernandez-Escobar R, Marin L, Sanchez-Zamora MA, Garcia-Novelo JM, Molina-Soria C, Parra MA. 2009. Long-term effects of N fertilization on cropping and growth of olive trees and on N accumulation in soil profile. *European Journal of Agronomy* 31: 223-232.
16. George AP, Broadley RH, Nissen RJ, Ward G. 2003. Effects of chemicals on breaking new rest flowering shoot production and yield of subtropical tree crops. *Acta Hort*. 575: 835-840.
17. Ghanem M, Mimoun MB. 2010. Effects of potassium foliar sprays on Royal Glory peach trees. *Acta Horticulturea* 868: 261-265.
18. Henny RJ. 2001. Tips on regulating growth of floricultural crops in foliage plants. Edited by M. Gastson, Columbus Ohio Florists Association. pp 83-87.
19. Kavitha M, Kumar N, Jeyakumar P. 2000. Role of zinc and boron on fruit yield and associated characters in papaya cv. Co.5. *South Indian Horticulture* 48(1/6): 6-10.
20. Kulkarni VJ. 2004. The tri-factor hypothesis of flowering in mango. *Acta Horticulturea* 645: 61-70. https://doi.org/10.17660/ActaHortic.2004.645.3
21. Kumar MA, Reddy Y. 2008. Preliminary investigations on the effect of foliar spray of chemicals on flowering and fruiting characters of mango Cv. Baneshan. *Ind. Jr. Agric. Research* 42(3): 164-170.
22. Marschner P. 2012. *Marschner's Mineral Nutrition of Higher Plants* (3rd Edition). Waltham, USA: Academic Press.
23. Mellis EV, Teixeira LAJ, Quajjio JA, Cantarella A. 2011. Potassium fertilization for pineapple: Effects on plant growth and fruit yield. *Rev. Bras. Frutic. Jaboticabal* - SP 33(2): 618-626.
24. Nahar N, Choudhary MSH, Rahim MA. 2010. Effect of $KClO_3$, KNO_3 and urea on the flowering and fruiting of mango and longan. *Jr. Agroforestry and Environment* 4(1): 31-34.
25. Nakasone HY, Paull RE. 1998. *Tropical Fruits*. CAB International, Wallingford.
26. Nijjar GS. 2000. *Nutrition of Fruit Trees*. Kalyani Publishers, 2nd Ed. New Delhi. pp 156-157.
27. Niklas KJ, Marler TE. 2007. *Carica papaya* (Caricaceae): a case study into the effects of domestication on plant vegetative growth and reproduction. *Am. Jr. Botany* 94: 999-1002.
28. Nulit A, Afiqah AN, Hawa ZEJ, Kusnan M. 2014. Improving the yield of 'Chok Anan' mango with potassium nitrate foliar sprays. *International Journal of Fruit Science* 14: 416-423.
29. Panse VG, Sukhatme PV. 1995. *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi. pp 347.
30. Parkash J, Singh K, Goswami AK, Singh AK. 2015. Comparison of plant growth, yield, fruit quality and biotic stress incidence in papaya var. Pusa Nanha under polyhouse and open field conditions. *Indian Journal of Horticulture* 72: 183-186.
31. Protacio CM. 2000. A model for potassium nitrate-induced flowering in mango. *Acta Horticulturea* 509: 545-552.
32. Schroeder CA. 1958. The origin, spread and improvement of Avocado, Sapodilla and papaya. *Indian Journal of Horticulturea* 15(3/4): 263-26.
33. Sharma A, Wali VK, Bakshi P, Jasrotia A. 2013. Effect of integrated nutrient management strategies on nutrient status, yield and quality of guava. *Indian Journal of Horticulturea* 70: 333-339.

34. Shinde AK, Jadhav BB, Dabke DJ, Kandalkar MP. 2009. Effect of potassium on yield and quality of 'Alphonso' mango (*Mangifera indica* L.). *Indian Jr. Agril. Sciences* 79(12): 1007-1009.
35. Singh JN, Singh DK, Chakravarthy D. 1994. Effect of urea and NAA on fruit retention and physicochemical composition of mango (*Mangifera indica* L.) cv. Langra. *Orissa Jr. Horticulture* 22: 26-30.
36. Singh NP, Malhi CS, Sharma RC. 2005. Effect of foliar feeding on N, P and K on vegetative and fruiting characters of mango cv. Dashehari. *In*: Proceedings: *International Conference on Mango and Date Palm: Culture and Export.* University of Agriculture, Faisalabad.
37. Srivastava A, Singh SP, Kumar A. 2013. Effect of foliar spray of different sources of potassium on fruiting, yield and shelf- life of ber (*Ziziphus maurtiana* Lam.) fruits cv. "Banarasi Karaka". *International Journal of Agricultural Sciences and Technology* 2(1): 19-21.
38. Stover RH, Simmonds NW. 1987. *Banana* (3rd Edition). John Wiley and Sons, Inc. New York. pp 468.
39. Sudha R, Balamohan TN, Soorianatha SK. 2012. Effect of foliar spray of nitrogenous chemicals on flowering, fruit set and yield in mango (*Mangifera indica* L.) cv. Alphonso. *Journal of Horticultural Sciences* 7(2): 190-193.
40. Swietlik D. 2003. *Plant Nutrition*. *In*: (Eds) Baugher T.A. and Singha S. Concise Encyclopedia of temperate tree fruit. Food Products Press, New York. pp 387.
41. Thirugnanavel A, Amutha R, Baby Rani W, Indira K, Mareeswari P, Muthulaksmi S, Parthiban S. 2007. Studies on regulation of flowering in acid lime (*Citrus aurantifolia* Swingle.). *Res. Jr. Agric. and Bio. Sciences* 3(4): 239-241.
42. Weinbaum SA. 1988. *Foliar Nutrition of Fruit Trees*. *In*: (Eds) P. M. Neumann. In Plant Growth and Leaf-applied Chemicals. Boca Raton, Florida: CRC Press.