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Effect of foliar application of different chemicals and humic acid on fruit yield and quality of custard apple (A*nnona squamosa* L.) cv. local

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Abstract
An experiment was carried out to study the "Effect of foliar application of different chemicals and humic acid on fruit yield and quality of custard apple (*Annona squamosa* L.) cv. Local" at Horticultural Research Farm, and P.G. Laboratory, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, during August- October, 2017. Treatments comprised foliar application (At marble stage and 15 days after first spray) of different chemicals *viz.* Potassium sulphate (K_2SO_4 @ 1 and 1.5%), Potassium nitrate (KNO_3 @ 1 and 1.5%), Calcium chloride ($CaCl_2$ @ 1 and 1.5%) and humic acid (1 and 1.5%) along with control. The experiment was laid out in completely randomized design with three repetitions. Among all the treatments T_7 (Humic acid @ 1%) treatment was found most effective treatment and recorded significantly maximum fruit yield/plant, fruit weight, fruit diameter, total soluble solids, total sugar, reducing sugar, non-reducing sugar, ascorbic acid shelf life whereas, there was no any significant effect on acidity.

Keywords: Chemicals, humic acid, fruit yield, quality

1. Introduction
Custard apple (*Annona squamosa* L.) is a crop of tropical and sub-tropical region of India. Being climacteric in nature, the biochemical changes in the fruit after harvest occurs at a faster rate and shows very short storage life at room temperature due to its fast ripening, high respiration rate and ethylene production (Prasana *et al*., 2000) [17]. Therefore, increase in shelf life of custard apple fruit will be an advantage to the growers (Gohlani and Bisen, 2012) [10]. Chemicals and humic acid are very essential substances for improved yield and quality of fruit. Among various chemicals, calcium is known essential plant nutrient involved in a number of physiological processes concerning membrane structure, function and enzyme activity (Jones and Lunt, 1970) [11]. Calcium delay softening and improve the fruit quality. The preharvest application of calcium salts has been used successfully in many fresh fruits to reduce loss of firmness and to slow down the ripening process. Potassium is important for cell growth due to its role in cell expansion and development of thick epidermal cell walls (Salisbury and Ross, 1992) [19]. The quality of fruits, especially colouration of the skin, size aroma and shelf life, is improved when adequate potassium. Humic acid is one of the bio-stimulants which promote plant growth and stimulate plant enzymes and increase production. It is known to thicken the cell wall in fruit and prolong the storage or shelf life. Humic acid also stimulate plant growth (higher biomass production) by accelerating cell division, increasing the rate of development in root systems and increasing the yield.

Material and Methods
An experiment was framed with nine treatments *viz*, Potassium sulphate (K_2SO_4 @ 1 and 1.5%), Potassium nitrate (KNO_3 @ 1 and 1.5%), Calcium chloride ($CaCl_2$ @ 1 and 1.5%) and humic acid (1 and 1.5%) along with control. A completely randomized design was used with three replication. An experiment was conducted during *kharif-rabi*, 2017 at Horticulture Research Farm, and P.G. Laboratory, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Twenty seven uniform size tree sprayed twice i.e at marble stage and fifteen days after first spray. The mature fruits were harvested and sum up to record yield/plant. Five uniform size fruits from each treatments were selected and kept in laboratory at ambient condition. Quality parameters like TSS, total sugar, acidity,

ascorbic acid were analyzed at ripening stage. Fruits were observed up to edible storage and days were recorded as shelf life.

Results and Discussion

Significantly, maximum fruit yield (23.25 kg/plant) was recorded with the treatment T_7 (humic acid @ 1%) which remained at par with treatment T_6, T_8, T_3 and T_1. While, the lowest fruit yield (16.70 kg) was recorded under treatment T_9 (Table 1). Increase in fruit yield might be due to humic acid which enhanced uptake of mineral nutrients and increased cation exchange in soil as well as plant hormone like activity (Serenella *et al.*, 2002) [20]. Similar results were also reported by El-Razek *et al.* (2012) [6] in peach, Asgharzade *et al.* (2012) [3] in grape, Khattab *et al.* (2012) [13] in pomegranate and Ngullie *et al.* (2014) [16] in mango.

The highest total soluble solids (25.35 ºBrix) was recorded with treatment T_7 (humic acid @ 1%) and it remained at par with all the treatment except T_9 (Table 1). Increase in TSS might be due to positive effect of humic acid on nutrient availability and stimulation of pigment accumulation resulting in greener leaves with greater photosynthetic efficiency which produce more assimilates, that assimilates depicted in terms of total soluble solids (Abdel-Mwgoud *et al.*, 2007) [2] in tomato. Similar results were also reported by Giuseppe *et al*. (2005) [9] in grape and El-Razek *et al*. (2012) [6] in peach.

Data revealed (Table 1) that maximum shelf life of fruits (6.57 days) was recorded with treatment T_7 (humic acid @ 1%) followed by treatments T_8 and T_6. While, minimum shelf life (4.83 days) was observed in treatment T_9. Increase in shelf life of fruits might be due to humic acid which stimulate plant enzymes activity and firmness of cell wall in fruit which prolong the shelf life (El-Nemr *et al.* 2012) [5]. Similar findings were also reported by Mohamadineia *et al*. (2015) [14] in grape and Farahi *et al.* (2013) [7] in strawberry. Foliar application of different chemicals and humic acid were found non-significant effect on acidity (%) of fruit.

Table 1: Influence of foliar application of different chemicals and humic acid on fruit yield, TSS, shelf life and acidity

Sr No	Treatments	Fruit yield (kg/plant)	TSS (ºBrix)	Shelf life (Days)	Acidity (%)
T_1	Potassium sulphate (K_2SO_4) @ 1 %	20.37	23.90	5.10	0.23
T_2	Potassium sulphate (K_2SO_4) @ 1.5 %	18.80	24.70	5.23	0.22
T_3	Potassium nitrate (KNO_3) @ 1 %	20.50	23.93	5.20	0.23
T_4	Potassium nitrate (KNO_3) @ 1.5 %	17.87	24.33	4.90	0.21
T_5	Calcium chloride @ 1 %	19.67	24.80	5.37	0.22
T_6	Calcium chloride @ 1.5 %	22.10	24.61	6.07	0.21
T_7	Humic acid @ 1 %	23.25	25.35	6.57	0.20
T_8	Humic acid @ 1.5 %	21.50	24.92	6.20	0.21
T_9	Control	16.70	22.48	4.83	0.25
	S.Em. ±	1.11	0.49	0.23	0.01
	C.D. at 5 %	3.29	1.47	0.67	NS
	C.V. %	9.56	3.51	7.14	9.16

The highest total sugar (26.06%) was recorded with treatment T_7 (humic acid @ 1%) which remained at par with treatments T_8, T_5, and T_6. While, minimum total sugar (21.33%) was recorded under T_9 (Table 2). The increase in total sugar in response to humic acid might be due to formation of maximum amount of carbohydrate within the leaf and fruit tissues, which than converted to the specific sugar like glucose and sucrose (Abbas *et al.*, 2013) [1]. Similar finding was also reported by Zachariakis *et al.* (2001) [22] in grape.

Data revealed (Table 2) that significantly, maximum reducing sugar (20.46%) was recorded with treatment T_7 (humic acid @ 1%) and it remained statistically at par with treatments T_8 and T_5. While, minimum reducing sugar (16.74%) was recorded under treatment T_9 (Control). The accumulation of more reducing sugar by the foliar application of humic acid might be due to increased translocation of more photosynthetic assimilates to the fruit and breakdown of starch during ripening (Abbas *et al.*, 2013) [1]. Similar result was also reported by Karakurt *et al.* (2009) [12] in pepper.

The maximum non-reducing sugar (5.58%) was recorded with treatment T_7 (humic acid @ 1%) which remained at par with all the treatment except T_8 and T_9 (Table 2). It can be hypothesized that foliar application of humic acid had positive effects on nutrient availability. This favourable nutritional status, induced by foliar applications of humic acid could be the indirect cause of the accumulation of sugar in fruit. Similar finding was also reported by Neri *et al*. (2002) [15] in strawberry.

The maximum ascorbic acid (24.18 mg/100 g pulp was recorded with treatment T_7 (humic acid @ 1 %) which remained statistically at par with all the treatment except T_9 ((Table 2)). It might be due to humic acid increase the permeability of bio membranes for electrolytes accounted for increased uptake of phosphorus and potassium which increase the ascorbic acid percentage of the fruit (Reuther, 1973) [18]. Similar results were also reported by Carvajal *et al.* (1995) in paprika, Yildrim (2007) [21] in tomato and Abbas *et al.* (2013) [1] in Kinnow mandarin.

Table 2: Influence of foliar application of different chemicals and humic acid on total sugar, reducing sugar, non-reducing sugar and ascorbic acid

S. No	Treatments	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Ascorbic acid (mg/100 g pulp)
T_1	Potassium sulphate (K_2SO_4) @ 1 %	23.5	18.30	5.19	22.15
T_2	Potassium sulphate (K_2SO_4) @ 1.5 %	23.5	18.23	5.29	22.01
T_3	Potassium nitrate (KNO_3) @ 1 %	23.73	18.34	5.36	21.13
T_4	Potassium nitrate (KNO_3) @ 1.5 %	23.8	18.47	5.33	21.66
T_5	Calcium chloride @ 1 %	24.66	19.44	5.19	22.28
T_6	Calcium chloride @ 1.5 %	24.26	18.82	5.44	22.81
T_7	Humic acid @ 1 %	26.06	20.46	5.58	24.18
T_8	Humic acid @ 1.5 %	25.23	20.19	5.03	23.18
T_9	Control	21.33	16.74	4.59	20.02
	S.Em. ±	0.64	0.41	0.15	0.70
	C.D. at 5 %	1.89	1.22	0.46	2.08
	C.V. %	4.59	3.78	5.12	5.45

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