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Effect of Foliar Spray of Chemicals on Flowering and Fruiting in Litchi

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A B S T R A C T

A field experiment was conducted to induce the flowering in litchi through pre-flowering spray of different potassium forms application i.e. di-potassium hydrogen-ortho-phosphate (dibasic), potassium di-hydrogen orthophosphate (monobasic), potassium nitrate and a PGR i.e. 2-Chloroethyl phosphonic acid (ethrel) in 9-10 years old litchi orchard consecutively for 2 years. The four spraying of each chemical was applied during October – January at monthly interval. These chemicals significantly influenced the flowering and fruiting characters. The 'Shahi' litchi trees sprayed with 1% mono-potassium phosphate and 400 ppm ethrel increased flowering percentage. Ethrel (400 ppm) sprayed not only advanced flowering and harvesting by 6-7 days but also recorded maximum yield (70.48 kg per tree) due to highest record of number of female flower per panicle and improved the fruit quality in terms of total soluble solids (20.47 0B) and TSS/Acid ratio. Combined spray of 1% mono-potassium phosphate and 1 % potassium nitrate led to highest fruit weight, pulp recovery, female flower per panicle and sex ratio (1.03). Spray of 1 % potassium nitrate led to largest fruit and seed weight and most of the fruits were >21 g in weight which is most desirable characters to fetch premium price by the litchi growers. Untreated trees merely had fruit weight <18.0 g and fruit yield per tree only upto 33.70 kg per tree also had least acidity percentage. In this investigation, it is indicated that, foliar spray of different forms of potassium and ethrel improved flowering and final fruit yield in litchi trees.

Introduction

Bihar is known as hub of litchi production not only in India but also in the world due to its quality fruit. Entire country people desire to taste this fascinating fruit having unique fragrance and high demand during the season. The plant is highly specific to climatic condition and soil requirement and probably due to which its cultivation is restricted to the few countries in the world. Fruit yield of litchi in different production belts is irregular and below the potential bearing capacity of the trees. Usually, litchi plants take longer gestation period (> 15 years) to reach at consistent and regular bearing stage. In the juvenile stage of plant growths (7-14 years tree age), trees showed erratic and irregular behavior of bearing due to continuous growth flushes after harvest and changing environment conditions and thus farmers suffers for a long period in order to get regular fruiting (Kumar *et al*., 2015). As the litchi tree require low temperature to induce flowering and subsequently fruiting (Menzel and Simpson, 1995). This is possible only by maintaining a balance between continuous vegetative growth in juvenile litchi trees and

degree of dormancy to initiate flower bud formation and subsequently initiation of flowering panicle. Dormancy in litchi is apparently influenced by dry weather or recurring period of relatively cold weather. The main objectives of litchi growers are to harvest maximum quantity of marketable fruits as the lowest investment cost.

Potassium, is an essential macro-element required in large amounts for normal plant growth and development involved in many physiological processes, water relations, photosynthesis, assimilate transport and enzyme activation which have direct consequences on crop productivity. When potassium uptake is lower than demand, foliar potassium is mobilized to the fruit, which is detrimental for plant growth and fruit set and quality (Besford and Maw, 1975). Pre-harvest sprays of potassium and growth regulators are one of the most important practices of the new strategies applied in the integrated fruit production systems, improving fruit quality (Mandal *et al.*, 2012). Application of ethrel @ 1,000 ppm, which could not only remove winter flushes but also dropped mature leaves, thereby affecting plant growth and development and sometimes bring flowering in coming season. Many investigations reported the use of potassium salts (K_2HPO_4 or KNO_3) as a chemical agent for induction of plant resistance and induction of flowering. This [K+] cation plays a major role in: enzyme activation, protein synthesis, stomatal function, stabilization of internal pH, photosynthesis, turgor-related processes and transport of metabolites (Abd El Rahman and Hoda, 2016).

Response of various growth promoting chemicals and regulators on regulation of flowering and fruiting have been studied by various workers in litchi (Mishra *et al.*, 2012; Zhang *et al.*, 2002). The foliar spray of KH_2PO_4 (1%) + KNO_3 (1%) seems to be beneficial for increasing the flowering, fruit set and improving the fruit size and weight of mango cv. Keshar (Garad *et al.*, 2013). The information on use of growth regulators and their influence on shoot behavior, flowering panicle induction, fruit yield and their inter relation is lacking particularly in juvenile litchi orchard. The aim of the present study was to test the effects of foliar spraying of KNO3, ethrel, potassium di-hidrogen phosphate, di-potassium hydrogen phosphate either alone or in combination of two or more on the flowering, yield, fruit quality characteristics of litchi fruits.

Materials and Methods

The experiment was conducted in 10-12 years old litchi orchard during 2014-2016 consecutively for 2 years at Research Farm of ICAR-NRC on Litchi Muzaffarpur, Bihar located at 210 m MSL. The litchi cv. Shahi was planted at a spacing of 8.25 m x 8.25 m which accommodates 144 plants per ha. The experiment was laid out in randomized block design (RBD) comprising of 9 treatments T1: KNO_3 (1%); T2: K_2HPO_4 (1%); T3:KH_2PO_4 (1%); T4:K_2HPO_4 (2%); T5:KH2PO4 (2%); T6:K_2HPO_4 (1%)+ KNO3 (1%), T7: KH_2PO_4 (1%)+ KNO_3 (1%); T8:Ethrel (400 ppm) and T9: Control (water spray) with three replication. A back-held spray pump was used for foliar application of the chemicals. After each treatment, the pump was washed thoroughly.

A teaspoon of commercial washing powder was added as a wetting agent for effective result and for improvement in absorption. Distilled water containing a comparable amount of wetting agent was sprayed on the plants in the controlled treatment. All foliar spraying was carried out early in the morning. Four spray of each chemical was applied during 1st week of every month starting from October to January (at 30 days interval). Standard cultural practices were followed to grow the litchi crops. The experimental field was sandy loam in texture, alkaline in

reaction with low to medium in fertility status.

The observation on per cent shoot flowered was recorded on the basis of shoot flowered divided by total shoots tagged and multiplied by 100. Deviation in flowering was assessed through flowering time of control tree taken as bench mark and any delay or early flowering was indicated with prefix (– and +, respectively) sign before numerals. Total number of flower per panicle was estimated by counting floral shoots of tagged branches in individual trees. Sex ratio was calculated by number of female flower divided by number of male flowers per panicle counted from randomly selected flowering shoot in each direction. Fruit maturity (harvest date) was determined on the basis of fruit colour developed (a bright pinkish red blush with flattened tubercles) and pulp TSS reached 18 °Brix.. The average fruit weight was estimated by weighing 10 fruits in each treatment, with the help of an electronic balance measuring in grams to the third decimal place, and then converting to average fruit weight. Pulp recovery, seed weight was obtained by weighing of pulp, seed and whole fruit separately. For determination of TSS, sub-samples (10 g) were pressed through cheese cloth to extract the juice. Total soluble solids were determined with Erma Hand Refractometer (0-32o Brix) with necessary temperature correction. The titratable acidity percentage of juice was estimated as per AOAC (2000). TSS/acid ratio was calculated by dividing the TSS value with acidity. The data were subjected to statistical analysis as per the method of Gomez and Gomez (1984). Least significant of difference at 5% level was used for finding the significance of differences if any, among the treatment means.

Results and Discussion

The results in table 1 clearly showed that foliar spray of various chemical had pronounced effect on shoot panicle emergence percentage and in terms of delay or advancement in flowering period, number of flowers (total, male and female) per panicle and sex ratio. More than 75 % shoots showed flowering due to spray of K_2HPO_4 (1%) and ethrel (400 ppm). Untreated trees had only 56.17 % shoot flowered during the same season. Flowering in litchi was advanced by 5.17 days in tree sprayed with ethrel (400 ppm) than normal time of panicle emergence observed (12-16 March) in control trees. Increase in number of flowers per panicle is an indicator of plants yield and ethrel (400 ppm) spray also led to rapid jump in total number of flower per panicle (182.26) followed by trees sprayed with KH_2PO_4 (1%). Control tree was observed to be half of total flowers per panicle recorded in tree receiving 1 % KH_2PO_4. KNO_3 (1%) and combined spray of K_2HPO_4 (1%) + KNO_3 (1%) showed delayed flowering by 4.66 days and 3.66 days, respectively than normal flowering time.

The more numbers of shoot expressing panicle emergence may be attributed to suppression of vegetative growth which resulted into the fast maturation of twigs and stress due to application of potassium that led to more accumulation of photosynthates in twigs and leaves. K_2HPO_4 (1% or 2 %) had least deviation in flowering time with control trees, means it doesn't have much effect on flowering time. Delay in panicle emergence under KNO_3 (1%) spray might be due to changes in carbohydrate and mineral metabolism in the shoots. Delay in flowering in KNO_3 treated plants might be due to its effect in supplementing the nitrogen to the leaves. The KNO_3 treatment has been effective for stimulating flowering of mango trees that had remained vegetative well beyond normal bearing ages, for advancing the flowering and fruiting periods, and for breaking the biennial bearing habits of trees.

Table.1 Flowering attributes affected by foliar spray of K+ ions and ethrel in litchi cv. Shahi

Treatments	% shoot flowered			*Flowering (days)			Total Flowers/ panicle			Male flowers/ panicle			Female flowers / panicle			Sex ratio		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
KNO_3 (1%)	68.33	80.00	74.17	+4.33	+4.66	4.50	149.33	154.67	152.00	98.33	86.00	92.17	51.00	68.67	59.83	0.54	0.80	0.67
K_2HPO_4 (1%)	68.33	83.33	75.83	+1.00	+1.33	1.17	140.00	140.00	140.00	75.00	82.00	78.50	65.00	58.00	61.50	0.92	0.71	0.82
KH_2PO_4 (1%)	70.00	86.67	78.34	+2.00	+2.33	2.17	168.18	186.33	177.26	92.18	89.67	90.92	76.00	96.67	86.33	0.81	1.08	0.95
K_2HPO_4 (2%)	66.67	83.33	75.00	+1.00	+1.66	1.33	118.60	120.60	119.60	71.27	73.27	72.27	47.33	47.33	47.33	0.67	0.65	0.66
KH_2PO_4 (2%)	66.67	78.33	72.50	+3.00	+3.00	3.00	166.87	160.87	163.87	93.20	84.87	89.03	73.67	76.00	74.84	0.86	0.97	0.92
K_2HPO_4 (1%) + KNO_3 (1%)	65.00	75.00	70.00	+2.66	+3.00	2.83	176.27	162.00	169.14	111.60	94.67	103.13	64.67	67.33	66.00	0.59	0.73	0.66
KH_2PO_4 (1%) + KNO_3 (1%)	68.33	71.67	70.00	+3.33	+3.66	3.50	163.00	156.00	159.50	84.00	75.67	79.83	79.00	80.33	79.67	0.97	1.09	1.03
Ethrel (400ppm)	73.33	78.33	75.83	-5.33	-5.00	-5.17	181.72	182.80	182.26	119.38	117.80	118.59	62.33	65.00	63.67	0.53	0.55	0.54
Control	55.67	56.67	56.17	0.00	0.00	0.00	80.00	106.33	93.17	42.67	70.67	56.67	37.33	35.67	36.50	0.89	0.51	0.70
C D (*P*=0.05)	8.97	14.23	7.93	--	--	-	30.40	30.86	17.65	26.92	24.90	14.28	17.44	10.00	7.94	NS	0.25	0.14

Table.2 Fruit yield and harvesting period affected by foliar spray of K+ ions and ethrel in litchi cv. Shahi

Treatments	Fruit yield/ plant (kg)			Fruit wt (g)			Seed wt. (g)			*Harvesting**		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
KNO_3 (1%)	65.17	70.86	68.02	20.54	22.79	21.67	3.92	4.16	4.04	+3.5	+3.5	+3.5
K_2HPO_4 (1%)	63.28	66.75	65.02	18.37	20.59	19.48	3.31	3.89	3.60	+5.0	+ 6.5	+5.75
KH_2PO_4 (1%)	52.65	55.60	54.13	17.62	21.85	19.74	3.46	3.94	3.70	+2.5	+ 2.5	+2.5
K_2HPO_4 (2%)	54.63	56.65	55.64	16.96	21.04	19.00	3.59	3.70	3.65	+6.5	+ 7.5	+7.0
KH_2PO_4 (2%)	58.63	70.65	64.64	19.61	18.78	19.20	3.79	3.80	3.80	+8.0	+ 3.0	+5.5
K_2HPO_4 (1%) + KNO_3 (1%)	67.86	65.05	66.46	18.82	20.18	19.50	3.77	4.00	3.89	+2.0	+ 1.0	+1.5
KH_2PO_4 (1%) + KNO_3 (1%)	66.17	63.25	64.71	19.68	23.55	21.62	3.56	3.83	3.70	+6.0	+6.0	+6.0
Ethrel (400ppm)	68.33	72.62	70.48	19.79	20.79	20.29	3.88	3.67	3.78	-7.0	- 8.0	-7.5
Control	35.16	32.24	33.70	17.28	18.50	17.89	3.67	4.08	3.88	0.00	0.00	0.00
C D (*P*=0.05)	6.79	2.44	4.96	1.35	3.80	0.64	0.26	0.20	0.21	--	--	--

*- sign indicate (early) and + sign indicate (delay);

**Harvest advancement/delay was counted by considering the date of harvest of control plants.

Table.3 Physico-chemical fruit quality parameters affected by foliar spray of K+ ions and ethrel in litchi cv. Shahi

Treatments	**Pulp recovery**			**TSS ^{0}Brix**			**Acidity**			**TSS/Acidity ratio**		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
KNO_3 (1%)	60.90	66.55	63.73	18.75	18.64	18.70	0.60	0.70	0.65	27.77	26.76	27.27
K_2HPO_4 (1%)	58.16	61.00	59.58	19.38	19.32	19.35	0.73	0.70	0.72	26.51	27.88	27.20
KH_2PO_4 (1%)	63.33	69.44	66.39	19.57	19.59	19.58	0.64	0.67	0.66	30.79	29.57	30.18
K_2HPO_4 (2%)	60.05	65.45	62.75	19.92	19.82	19.87	0.71	0.71	0.71	28.07	27.91	27.99
KH_2PO_4 (2%)	61.47	62.20	61.84	18.91	19.72	19.32	0.75	0.69	0.72	25.19	28.75	26.97
K_2HPO_4 (1%) + KNO_3 (1%)	60.75	62.41	61.58	20.20	20.48	20.34	0.65	0.58	0.62	31.76	36.03	33.90
KH_2PO_4 (1%) + KNO_3 (1%)	65.35	65.88	65.62	20.18	20.32	20.25	0.51	0.56	0.54	36.85	38.09	37.47
Ethrel (400ppm)	62.33	63.44	62.89	20.42	20.51	20.47	0.74	0.44	0.59	39.94	46.67	43.31
Control	59.62	62.37	61.00	19.60	18.54	19.07	0.55	0.68	0.62	31.68	29.37	30.53
C D (*P*=0.05)	2.12	3.74	2.73	NS	0.57	0.97	0.07	0.06	0.16	8.25	9.86	6.63

Kumar *et al.*, (2015) also got advanced fruit maturity in litchi by 7 days by spray of 400 ppm ethrel and 4 days by spray of 1 % KNO_3. The sex ratio, number of flower per panicle (male and female flowers both) of litchi increased significantly with foliar application of various chemicals either alone or in combination. The sex ratio in trees sprayed with KH_2PO_4 (1%) + KNO_3 (1%) improved by almost 50 percent over control trees (1.03 and 0.70, respectively) due to less number of male flower per panicles (79.83) in former treatment. Control trees not only had least number of male flowers per panicle (56.67) but also had less number of female flowers per panicle (36.50). Spray of ethrel (400 ppm) has least sex ratio due to very large no. of male flower per panicle (118.59) while control trees had lowest number of female flowers per panicles (36.50). However, number of female flower/ panicle was maximum (86.33) trees sprayed with KH_2PO_4 (1%) and at par with K_2HPO_4 (1%) + KNO_3 (1%) (Table 1).

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