Indian J. Hort. 69(4), December 2012: 512-516

Effect of foliar sprays of potassium on fruit size and quality of 'Patharnakh' pear

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ABSTRACT

The investigation was conducted to improve size and quality of Patharnakh pear fruits through foliar sprays of potassium fertilizers at Punjab Agricultural University, Ludhiana. The sixteen-year-old plants were sprayed with KNO_3 and K_2SO_4 @ 1.0, 1.5 and 2.0% in three sets, *i.e.*, one, two and three sprays. First spray was given at 15 days after full bloom (DAFB), second at 30 DAFB and third was applied at 45 DAFB. Results showed that foliar potassium application significantly improved the fruit size as compared to control. Similarly, the number of K sprays had a positive effect on final fruit size. Maximum fruit size was recorded with three sprays of KNO_3 at 1.5 per cent. Fruit colour as measured by '*l*', '*a*' & '*b*' values, improved with various K treatments, however, K_2SO_4 treatments were found more effective than KNO_3 treatments. Fruit firmness increased with both higher dose of K as well as number of sprays given and the trees sprayed with K_2SO_4 thrice produced fruits with highest firmness. Soluble solids were increased with various potassium K treatments and number of applications and highest value was recorded with K_2SO_4 at 2.0%. Same treatment significantly improved total sugars of fruits also. A non-significant decrease in acid content of juice was observed with increase in number of sprays of K fertilizers.

Key words: Pear, potassium spray, fruit size, fruit quality.

INTRODUCTION

Under sub-tropical conditions of north-western India, pear cultivation is primarily focused to a single variety 'Patharnakh' (*Pyrus pyrifolia* Burm.) due to its wider adaptability, low chilling requirement and high yield potential (Gill *et al.*, 5). However, this cultivar has tendency to bear small sized fruits with inferior quality particularly when plants are bearing profusely and these fruits fetches low price in market. Improving marketable yield of good quality pear fruits has always been a challenge for scientists and pear growers. Practices such as pruning of tree, fruit thinning, foliar application of nutrients (Josan *et al.*, 11) are commonly followed to improve fruit size and quality of horticultural plants. Among various nutrients, potassium is considered to be of most importance and is known to have profound effect on fruit quality by influencing size, colour, soluble solids, acidity and vitamin content (Bhargava *et al.*, 1). Potassium uptake is proportional to vegetative growth, reaching its maximum in early summer and accumulates subsequently in fruit tissue (Johnson and Uriu, 10). The competition between developing fruits and vegetative organs for photoassimilates can limit root growth/activity and K uptake (Lester *et al.*, 12). Under such conditions, increasing soil K fertilization may not be enough to alleviate this developmentally-induced deficiency because of competition from other cations for binding sites on roots (Marschner, 13). Earlier studies showed that foliar sprays of K improved fruit quality in pear (Hudina and Stampar, 9) and Kinnow mandarin (Gill *et al.*, 6). Although foliar K application has been practiced widespread, but no information is available on its effect on sub-tropical pears.

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MATERIALS AND METHODS

The present study was carried out during 2009 and 2010 at New Orchard of Department of Horticulture, Punjab Agricultural University, and Ludhiana, situated at 30° 54' N latitude and 75° 47´ E longitudes with an altitude of 247 m above mean sea level. To evaluate the effect of foliar application of potassium on fruit size and quality, the Patharnakh trees were sprayed with laboratory grade KNO_3 and K_2SO_4. The soils orchard tested sandy loam in texture, medium in organic carbon 0.55%, pH 7.9, EC 0.11 dS m^{-1} with available P and K were 16.5 and 141.8 kg/ha, respectively. The experimental block was 16-year-old grafted on *Pyrus pashia* rootstock and spaced at 7.4 m × 7.4 m in a square system of planting. Trees were maintained under uniform management practices and supplied with good quality tubewell water for irrigation. The soils (0-15 cm) of site were analyzed for salient physic-chemical properties. Experimental plots were fertilized with mineral nitrogen (1.0 kg $tree^{-1}$ urea), phosphorus (2.0 kg $tree^{-1}$ single super phosphate) and potassium (1.5 kg $tree^{-1}$ muriate of potash), through soil application. Half dose of N and full dose of P and K fertilizers were

applied in February and remaining N was given in April by broadcasting. Application of KNO_3 and K_2SO_4 was carried out through foliar sprays at 1.0, 1.5 and 2.0% during different stages of fruit development. Each treatment was applied in three sets; as single spray (15 days after full bloom); as two sprays (15 & 30 days after full bloom) and as three sprays (15, 30 & 45 days after full bloom). Control plants received only water sprays. Applications were made with foot pump using 10 litres of water per plant. The layout of the experiment was a randomized block design with three replications for each of the treatments tested. A random sample of 20 fruits from each replication was taken for physico-chemical analysis. Fruit size in terms of length and breadth was measured with the help of digital Vernier callipers (Mitutoyo, Japan). Peel color of the fruits was measured using Color Flex spectrophotometer (Hunter Lab, USA). Total soluble solids were determined digital refractometer (ERMA, Japan). For acidity, fruit juice was titrated with 0.1 N NaOH and the results were expressed in terms of percentage of malic acid. Fruit firmness was determined with hand held penetrometer (FT-327, USA) by taking readings on opposite sides along the fruit equatorial region using 8 mm stainless steel probe. The skin of the fruit was removed at reading spot. Sugars were estimated as per standard method. Data obtained from experiment were pooled and subjected to analysis of variance using statistical analysis software package CPCS1.

RESULTS AND DISCUSSION

Fruit size is considered to be one of the important external factors in determining fruit quality in sub-tropical pear as it greatly influences consumers appeal. The effect of both foliar application of different potassium fertilizers and number of sprays on fruit size in terms of fruit breadth and fruit length is presented in Table 1. Data clearly indicate that various treatments significantly improved fruit length as compared to control. The greatest mean fruit length (6.65 cm) was recorded with KNO_3 @ 1.5 per cent which was at par with KNO_3 @ 2.0 per cent and significantly higher from rest of treatments. However, smallest mean fruit length (6.31 cm) was observed from water sprayed plants. Fruit length also varied significantly with number of sprays, plants sprayed thrice produced quite longer fruits (6.67 cm) followed by sprayed twice and once with values of 6.59 cm and 6.38 cm, respectively. The interaction between sprays and treatments was found to be significant. Maximum fruit length (6.85 cm) was noticed with the application of KNO_3 @ 1.5 per cent sprayed thrice during cropping season.

Likewise, fruit breadth was significantly influenced with foliar applied potassium. The highest average fruit breadth (6.53 cm) was recorded with potassium nitrate @ 1.5 % followed by KNO_3 @ 2.0%. Meanwhile control treatment produced lowest mean fruit breadth (6.25 cm). Similarly, mean fruit breadth improved with increase in number of K applications and maximum fruit breadth (6.56 cm) was recorded with three sprays. In addition, the interaction between the effect of treatments and number of applications indicated that three sprays of potassium nitrate at 1.5 per cent gave the maximum fruit breadth of 6.72 cm. Similar, increase in fruit size with potassium applications

Table 1. Effect of foliar applications of potassium fertilizers on fruit size in pear cv. Patharnakh.

Treatment	Fruit length (cm)				Fruit breadth (cm)			
	One spray	Two sprays	Three sprays	Mean	One spray	Two sprays	Three sprays	Mean
KNO_3 (1.0%)	6.38	6.63	6.72	6.58	6.31	6.43	6.60	6.45
KNO_3 (1.5%)	6.42	6.66	6.86	6.65	6.33	6.55	6.72	6.53
KNO_3 (2.0%)	6.45	6.69	6.66	6.60	6.36	6.56	6.59	6.50
K_2SO_4 (1.0%)	6.31	6.57	6.67	6.52	6.25	6.42	6.54	6.40
K_2SO_4 (1.5%)	6.38	6.62	6.73	6.58	6.28	6.48	6.59	6.45
K_2SO_4 (2.0%)	6.40	6.64	6.73	6.59	6.29	6.55	6.61	6.48
Control	6.30	6.31	6.32	6.31	6.24	6.25	6.25	6.25
Mean	6.38	6.59	6.67		6.29	6.46	6.56	
CD (p = 0.05)								
No. of spray (A)		0.03				0.03		
Treatment (B)		0.05				0.04		
A × B		0.07				0.06		

was earlier reported in pear (Gobara, 7) and cherry (Bhat, 2).

The fruit skin colour was determined with Hunter Lab scale, i.e. '*l', 'a'* and '*b'* value. At this scale, *'l'* measures luminosity that varies from zero (black) to 100 (pure white); 'a' and 'b' values represent the levels of tonality and saturation; with +*a* (indicating red); -*a* (indicating green); +*b* (indicating yellow) and -*b* (indicating blue). The highest '*l'* value of fruit peel was noticed with application of K_2SO_4 at 2.0 per cent (65.1) and was at par with K_2SO_4 at 1.5 per cent, while the lowest *'l'* value (58.1) was found in water sprayed plants (Table 2). The effect of number of applications of K was non-significant. The interaction of number of sprays and treatments was also non-significant but maximum value of '*l'* (65.8) was recorded with three sprays of K_2SO_4 at 2.0 per cent. Results also indicated that K_2SO_4 treatments were more effective in improving the brightness of the fruits than KNO_3 treatments.

The 'a' value for pear fruits was recorded negative irrespective of treatments. The K_2SO_4 treatments had higher (-) '*a*' value as compared to KNO_3 sprays. However, the minimum mean value of '*a'* (-1.68) was recorded in fruits of control plants and the maximum value (-3.43) was noted in K_2SO_4 (2.0 %) sprayed plants. The '*a'* value of fruits was increased with the increase in number of foliar applications of potassium fertilizers. The interaction of treatments and number of applications was significant and maximum 'a' value (-3.63) was found with three sprays of K_2SO_4 (2.0%). These results are in conformity with El-Gazzar (4) who reported improvement in apple fruit colour with K fertilization. Application of K fertilizers had a positive effect on '*b'* value of fruits, which indicated change in fruit colour from greenish to greenish yellow. The maximum mean '*b'* value (29.0) was recorded with applications of K_2SO_4 at 2.0 per cent. However, the number of K applications had non significant effect on '*b'* value of the fruit skin. Regarding interaction, significant effect was noticed for '*b'* value with K application and maximum '*b'* value (29.2) was noted with three sprays of K_2SO_4 at 2.0 per cent. Hence, the applications of K_2SO_4 gave better colouration to the fruits as compared to other treatments. Similar observations have been reported by Chanana and Gill (3) in Perlette grape.

Fruit firmness was increased significantly with different potassium treatments (Table 3). The highest average fruit firmness was recorded with K_2SO_4 at 2.0 per cent (13.98 lbf), it was significantly higher as compared to firmness of control fruits which also showed the minimum value of 13.5 lbf. In general, K_2SO_4 treatments resulted in greater fruit firmness as compared to corresponding doses of KNO_3. With regard to number of applications, significantly higher fruit firmness (13.8 lbf) was observed in plants sprayed thrice. The interaction of potassium fertilizer treatments and number of applications was found non-significant. However, maximum value of fruit firmness (14.1 lbf) was observed with three sprays of K_2SO_4 at 2.0 per cent. Potassium applications increased osmoregulation of cell vacuoles and maintained the equlibra, resulting in firm fruits (Wani and Khajwall, 15).

Table 2. Effect of foliar applications of potassium fertilizers on fruit colour (Color flex®) in pear cv. Patharnakh.

Treatment	'l'				'a'				'b'			
	One spray	Two sprays	Three sprays	Mean	One spray	Two sprays	Three sprays	Mean	One spray	Two sprays	Three sprays	Mean
KNO_3 (1.0%)	57.4	58.9	59.2	58.5	-1.69	-1.70	-3.10	-2.16	26.6	26.9	27.2	26.9
KNO_3 (1.5%)	58.5	60.4	60.3	59.7	-1.73	-2.21	-3.11	-2.35	26.9	27.9	27.5	27.4
KNO_3 (2.0%)	62.5	62.4	62.7	62.5	-2.34	-3.13	-3.30	-2.92	27.2	28.0	28.0	27.7
K_2SO_4 (1.0%)	62.7	62.2	62.0	62.3	-2.66	-3.40	-3.15	-3.07	27.3	27.3	28.1	27.6
K_2SO_4 (1.5%)	64.2	63.5	62.9	63.5	-2.69	-3.59	-3.25	-3.18	28.2	28.4	28.3	28.3
K_2SO_4 (2.0%)	65.0	64.6	65.8	65.1	-3.12	-3.55	-3.63	-3.43	28.7	29.0	29.2	29.0
Control	58.8	57.0	58.4	58.1	-1.68	-1.68	-1.67	-1.68	26.2	25.9	26.3	26.1
Mean	61.30	61.3	61.6		-2.27	-2.76	-3.02		27.3	27.6	27.8	
CD (p = 0.05)												
No. of spray (A)		NS				0.03				NS		
Treatment (B)		2.31				0.03				0.39		
A × B		NS				0.05				0.62		

Table 3. Effect of foliar applications of potassium fertilizers on fruit firmness and total soluble solids in pear cv. Patharnakh.

Treatment	Fruit firmness (lbf)				Total soluble solids (°Brix)			
	One spray	Two sprays	Three sprays	Mean	One spray	Two sprays	Three sprays	Mean
KNO_3 (1.0%)	13.7	13.6	13.6	13.6	11.8	12.1	12.4	12.1
KNO_3 (1.5%)	13.7	13.7	13.7	13.7	11.9	12.1	12.5	12.2
KNO_3 (2.0%)	13.8	13.9	13.9	13.9	12.1	12.3	12.4	12.3
K_2SO_4 (1.0%)	13.5	13.7	13.8	13.7	12.0	12.3	12.3	12.2
K_2SO_4 (1.5%)	13.8	13.8	14.0	13.9	12.2	12.4	12.6	12.4
K_2SO_4 (2.0%)	13.9	14.0	14.1	14.0	12.4	12.6	13.0	12.7
Control	13.5	13.5	13.5	13.5	11.7	11.7	11.8	11.7
Mean	13.7	13.7	13.8		12.0	12.2	12.4	
CD (p = 0.05)								
No. of spray (A)		0.06				0.20		
Treatment (B)		0.10				0.35		
A × B		NS				0.55		

Various potassium treatments and number of applications significantly affected the total soluble solids content of fruits as compared to control (Table 3). The highest mean TSS (12.6%) were recorded with K_2SO_4 (2%) treatment followed by K_2SO_4 (1.5%) treatment. Meanwhile, the lowest mean TSS contents (11.7 %) were noted in fruits from water sprayed tree. A positive relationship was noted between concentration of K applications and TSS contents of fruits and the effects of K_2SO_4 were more reasonable than that of KNO_3. Similarly, soluble solid contents significantly increased with number of potassium sprays. Regarding the interaction effects, highest total soluble solids content (13.0%) were recorded in plants sprayed thrice with K_2SO_4 at 2.0 per cent. The increase in TSS content with foliar application of K is related with role of potassium in translocation of sugars from leaves to fruits (Havlin *et al.*, 8).

The total titratable acid content was not affected significantly by any potassium treatment (Table 4). However, the maximum total titratable acids content (0.35%) was noticed in control, whereas the lowest value of total titratable acid content (0.30%) was found with K_2SO_4 at 2.0 per cent. Among different sprays maximum acidity (0.33%) was observed in trees sprayed once. The amount of total sugars was found to be increased significantly by foliar fertilization of potassium at varying concentrations as compared to control (Table 4). With the increase in dose of K_2SO_4 treatments, the total sugars content improved linearly and maximum mean value of 7.84 per cent was recorded in 2.0 per cent K_2SO_4 treatment and minimum in control fruits. Overall, potassium sulphate treatments recorded higher total sugars content as compared to potassium nitrate treatments. The maximum mean total sugars content was noted in plants sprayed thrice and minimum was recorded in plant applied single application of fertilizers. With regard to interaction, significant effects were observed in percentage of total sugars. The highest total sugars (7.97%) were noticed with three sprays of K_2SO_4 at 2.0 per cent, while the lowest (7.62 %) were recorded in fruits harvested from control plants. Similar observations have been made by Pandey *et al.* (14) in guava fruits. The results of present investigations revealed that three foliar sprays of K_2SO_4 at 2.0 % were highly effective in improving fruit size, colour, firmness, TSS and total sugars in Patharnakh pear.

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Table 4. Effect of foliar applications of potassium fertilizers on fruit acidity and total sugars in pear cv. Patharnakh.

Treatment	Acidity (%)				Total sugars (%)			
	One spray	Two sprays	Three sprays	Mean	One spray	Two sprays	Three sprays	Mean
KNO_3 (1.0%)	0.33	0.34	0.35	0.34	7.67	7.65	7.73	7.68
KNO_3 (1.5%)	0.33	0.34	0.32	0.33	7.69	7.73	7.84	7.75
KNO_3 (2.0%)	0.31	0.30	0.30	0.30	7.69	7.74	7.80	7.74
K_2SO_4 (1.0%)	0.35	0.32	0.31	0.33	7.67	7.74	7.83	7.75
K_2SO_4 (1.5%)	0.33	0.30	0.31	0.31	7.70	7.75	7.92	7.79
K_2SO_4 (2.0%)	0.30	0.31	0.30	0.30	7.72	7.82	7.97	7.84
Control	0.36	0.35	0.34	0.35	7.63	7.62	7.62	7.62
Mean	0.33	0.32	0.32		7.68	7.72	7.82	
CD (p = 0.05)								
No. of spray (A)		NS				0.03		
Treatment (B)		NS				0.05		
A × B		NS				0.08		

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Received : October, 2011; Revised : July, 2012;
Accepted : September, 2012