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Original Research Paper

Effect of N and K Fertilizers on Growth, Yield and Quality of Pear (*Pyrus pyrifolia*)

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ABSTRACT

The effect of different combined doses of N and K fertilizers on plant growth, fruit quality and foliar elemental composition of pear *cv.* Patharnakh was investigated. Experimental plants were supplied with different levels of N (460, 690 and 920 g N /plant) and K (600, 900, 1200 and 1500 g K_2O/plant) in the form of Urea and Muriate of Potash (MOP) fertilizers. From the results, it was found that nitrogen application increased number of fruits/plant, trunk cross-sectional area (TCSA), shoot length and leaf N content, whereas, K application improved fruit firmness, total soluble solids (TSS), and leaf K content. Fruits harvested from T_4 (460 g N:1500 g K_2O /plant) treatment recorded maximum firmness. Plants under T_9 (920 g N: 600 g K_2O /plant) treatment showed the maximum increase in shoot length, and TCSA, whereas, T_6 (690 g N : 900 g K_2O /plant) resulted in maximum fruit yield. Leaf N and K concentrations improved with applications of the respective fertilizer.

Keywords: Pear, fertilization, growth, fruit quality, leaf nutrient content

INTRODUCTION

Among temperate fruits grown in North Western sub-tropics of India, pear occupies maximum acreage with 'Patharnakh' as the leading cultivar due to its high yield potential. However, fully grown-up plants of this cultivar show variability in fruit yield with small sized fruits which fetch poor market price. Improving the marketable yield of good quality fruits has always been a challenge for growers. Balanced nutrition of plants along with good cultural practices can help in improving quality fruit with high yields. Nitrogen is one of the most important elements for high productivity and growth of fruit plants (Titus and Kang, 1982) and also promotes fruit and seed development (Marschner, 1995). Similarly, potassium is considered as a quality improving element in fruit crops. Imbalanced use of nutrients or widespread use of N fertilizers alone leads to poor quality of fruits (Ganeshamurthy *et al,* 2011). High rates of N can be utilized by plant only in the presence of required K levels. Similarly, potassium (K) is the most aboundant nutrient in the fruit, where it influences the size, firmness, skin color, TSS and acidity (Brunetto *et al*, 2015). However, little information is available on the effect of combined application of nitrogen and potassium fertilizers on yield and quality in sub-tropical pears (Gill *et al,* 2012). Keeping in view the above, the present experiment was designed to study the effect of different combined doses of N and K fertilizers on growth, fruit yield and fruit quality and leaf nutrient content of Patharnakh pear plants.

MATERIAL AND METHODS

The present research was carried out at Fruit Research Farm and Leaf Analysis Laboratory of the Department of Fruit Science, Punjab Agricultural University, Ludhiana during the year 2013-14. The study was conducted on commercially bearing Patharnakh pear plants grafted on *Kainth (Pyrus pashia),* spaced at a distance of 7x7 m. The experiment was laid out in Randomized Block Design (RBD) and all the treatments were replicated thrice. Plants were applied with different combined doses of N (Urea) as N_1- 460, N_2- 690 and N_3-920 g/plant and K (MOP) , as K_1-600, K_2-900, K_3- 1200 and K_4-1500 g K_2O/plant. Twelve fertilizers combinations include: T_1- N_1K_1, T_2-N_1K_2,

T_3-N_1K_3, T_4-N_1K_4, T_5-N_2K_1, T_6-N_2K_2, T_7-N_2K_3, T_8-N_2K_4, T_9-N_3K_1, T_{10}-N_3K_2, T_{11}-N_3K_3 and T_{12}-N_3K_4. Potash fertilizer was applied in December while nitrogen was applied in two split doses; before and after fruit set. A uniform dose of 320 g of P_2O_5 using single super phosphate (SSP) was applied to all experimental trees. Fruit yield per plant was calculated as the average weight of fruits multiplied by the number of fruits and expressed in kg per plant. Number of fruits per plant at harvest time were manually counted. The annual increase in TCSA (cm) was recorded with the help of measuring tape at the height of 15 cm above the graft union. For determination of an increase in shoot length, four shoots were tagged around the plant in the dormant season. The increase in shoot length was measured using a measuring tape in the following dormant season and expressed in cm. At harvest, ten randomly selected fruits from each treatment were weighed on the electronic balance and expressed as mean fruit weight in 'g'. TSS (^{0}Brix) was estimated with hand held digital refractometer (*ATAGO, PAL -1*, Japan). Titratable Acidity (TA) (%) of juice was determined by titrating against 0.1 N NaOH using phenolphthalein as an indicator. Fruit firmness (lbf) was measured with stand mounted penetrometer (model FT-327, USA) as the maximum force required to plunge a spherical tip into the peeled skin of fruit. For estimation of nutrient content, leaf samples were collected in the month of July, washed with tap water and 0.1 N HCl, rinsed with distilled water, and dried in an oven at 60^{o}C for 72 hours. The dried samples were ground and stored in butter paper bags for further analysis of nutrients. For nitrogen estimation Kel Plus Nitrogen Estimation System (*Pelican Equipments*, India) was used. Phosphorus was estimated by Vanado-molybdo phosphoric yellow colour method as described by Chapman and Pratt (1961) and expressed as %. For determination of leaf K%, the flame photometer method (AOAC, 1990) was followed.

Statistical analysis of the experimental data was done using statistical package SAS 9.3 (The SAS system for Windows, Version 9.3, SAS Institute, Cary, NC). Data was analyzed for analysis of Variance (ANOVA) using the Fischer LSD ($p<0.05$) for significant difference test.

RESULTS AND DISCUSSION

Different combined doses of N and K significantly affected the fruit yield of pear plants (Table 1). The highest fruit yield was recorded in the T_6 (N_2K_2) treatment which registered a value of 94.5 and 101.2 kg/plant during the years 2013 and 2014, respectively. At higher levels of N, the high yield might be due to increased availability and uptake of nutrients

Table 1. Effect of different combined doses of N and K fertilization on fruit yield, number of fruits, increase in TCSA and increase in shoot length of pear *cv.* Patharnakh

Treatment	Fruit yield (kg/plant)		Number of fruits/plant		Increase in TCSA (cm)	Increase in shoot length (cm)
	2013	2014	2013	2014		
T_1-N_1K_1	76.2	78.9	548	578	1.44	12.17
T_2-N_1K_2	80.1	85.8	561	612	1.42	11.89
T_3-N_1K_3	83.5	88.4	579	614	1.36	11.48
T_4-N_1K_4	83.7	90.1	593	651	1.29	11.17
T_5-N_2K_1	89.5	94.9	604	660	1.81	13.60
T_6-N_2K_2	94.5	101.2	618	689	1.78	13.50
T_7-N_2K_3	90.0	92.4	578	615	1.75	12.79
T_8-N_2K_4	82.1	83.7	547	560	1.64	12.23
T_9-N_3K_1	84.7	85.7	635	651	2.25	14.58
T_{10}-N_3K_2	83.5	92.2	643	691	2.20	14.17
T_{11}-N_3K_3	80.9	85.1	583	621	2.10	13.78
T_{12}-N_3K_4	75.3	79.5	549	570	2.00	13.70
LSD *(P=0.05)*	4.30	4.90	13.98	14.12	0.18	1.12

Table 2. Effect of different combined doses of N and K fertilization on fruit weight, TSS, TA and fruit firmness of pear *cv.* Patharnakh

Treatment	Fruit weight (g)		TSS (%)		TA (%)		Fruit firmness (lbf)	
	2013	2014	2013	2014	2013	2014	2013	2014
T_1-N_1K_1	139.0	136.5	13.28	12.45	0.352	0.360	15.75	16.1
T_2-N_1K_2	142.7	140.2	13.36	12.46	0.345	0.320	15.92	16.2
T_3-N_1K_3	144.1	143.9	13.42	12.77	0.324	0.340	16.38	16.2
T_4-N_1K_4	141.2	138.3	13.48	12.36	0.322	0.330	17.14	16.8
T_5-N_2K_1	148.1	143.8	12.86	12.14	0.314	0.350	14.96	15.0
T_6-N_2K_2	152.8	146.9	12.97	12.25	0.310	0.330	15.58	15.3
T_7-N_2K_3	155.7	150.2	13.06	12.19	0.301	0.290	15.67	15.8
T_8-N_2K_4	150.2	149.5	13.19	12.75	0.300	0.290	15.74	15.9
T_9-N_3K_1	137.7	131.7	11.14	11.23	0.298	0.310	14.83	15.4
T_{10}-N_3K_2	133.7	133.4	11.98	11.54	0.295	0.330	15.10	15.5
T_{11}-N_3K_3	138.8	137.0	12.21	12.12	0.283	0.280	15.14	15.6
T_{12}-N_3K_4	137.1	139.4	12.44	12.34	0.281	0.280	15.38	15.6
LSD *(P=0.05)*	5.16	1.65	0.33	0.52	0.022	NS	0.52	0.10

Table 3. Effect of different combined doses of N and K fertilization on leaf nitrogen, phosphorus and potassium content of pear *cv.* Patharnakh

Treatment	Nitrogen (%)	Phosphorus (%)	Potassium (%)
T_1-N_1K_1	1.85	0.103	0.91
T_2-N_1K_2	1.88	0.116	0.96
T_3-N_1K_3	1.91	0.124	1.05
T_4-N_1K_4	1.83	0.130	1.11
T_5-N_2K_1	1.97	0.119	1.15
T_6-N_2K_2	1.98	0.117	1.16
T_7-N_2K_3	2.05	0.126	1.23
T_8-N_2K_4	2.00	0.125	1.31
T_9-N_3K_1	2.14	0.117	1.17
T_{10}-N_3K_2	2.10	0.122	1.20
T_{11}-N_3K_3	2.13	0.128	1.22
T_{12}-N_3K_4	2.10	0.120	1.23
LSD *(P=0.05)*	0.11	0.009	0.04

(Dhillon *et al,* 2011). The minimum fruit yield of 75.3 kg/plant during the year 2013 was recorded from plants under T_{12} treatment, while, for the year 2014, it was 78.9 kg /plant in T_1 (N_1K_1) treatment. The intermediate levels of N and K dose resulted in better fruit yield of pear plants as compared to lower and higher levels of N and K fertilizers. Number of fruits per plant varied with different combined doses of N and K. Treatment T_{10} (N_3K_2) recorded the maximum of 643 and 691 fruits per plant, whereas, a minimum of 547 and 560 fruits/plant was registered for treatment T_8 (N_2K_4) during the year 2013 and 2014, respectively (Table 1). Higher dose of N contributes to the greater number of fruits per plant (Dhillon *et al,* 2011). The effect of N and K applications on TCSA is presented in Table 1. The maximum increase in TCSA (2.25 cm) of plants was registered in fertilizer combination of the highest dose of N and the lowest dose of K, whereas, minimum TCSA (1.29 cm) was observed for T_4 treatment. The maximum increase in shoot length (14.58 cm) during

the year 2013 was observed for T_9 (N_3K_1) and was statistically at par with treatments T_{10}, T_{11} and T_{12} (Table 1). Similarly, Bennewitz *et al* (2011) reported that potassium application did not have a significant effect on the trunk cross-sectional area of apple trees. However, Kumar and Chandel (2004) reported that the girth of pear tree cv. Red Bartlet was significantly increased by both nitrogen and potassium application. Higher doses of N resulted in an increase in shoot length, whereas, with the higher dose of K, a slow increment in shoot length was recorded. Similar observation of an increase in lateral and terminal shoots of pear was reported by Yadav and Bist, 2003. Fruit weight was significantly affected by dosage of applied N and K fertilizers (Table 2). Maximum fruit weight of 155.7g and 150.2g was recorded for treatment T_7 (N_2K_3) during the year 2013 and 2014, respectively. Increased fruit size in guava fruits with potassium applications was also reported by Gill and Bal (2010). Plants applied with N_3K_2 fertilizer combination registered minimum fruit weight of 133.7 g during 2013, whereas, for the year 2014, the minimum fruit weight (131.7 g) was observed for T_9. Different nutrient levels of N and K significantly affected TSS content with the maximum of 13.48% registered for treatment T_4 (N_1K_4) during the year 2013, while during following year, fruits from treatment T_3 (N_1K_3) registered maximum (12.77%) TSS content (Table 2). Similar increase in TSS with potassium application was observed in Patharnakh pear fruit (Prasad *et al,* 2015). Minimum TSS content of 11.14% and 11.23% was recorded in T_9 (N_3K_1) treatment during the year 2013 and 2014, respectively. Maximum TSS was recorded in the fruits of plants applied with the lowest dose of N and higher dose of K. Fruits from higher N dose rate had lower soluble solids content in apple *cv.* 'Golden Delicious' (Raese *et al,* 2007). During the year 2013, TA of fruit juice showed a declining trend with an increase in levels of N and K fertilizers (Table 2). Raese *et al* (2007) reported similar results of decreased acid content with increasing N dose in apple. Maximum fruit juice acidity recorded for the year 2013 and 2014 was 0.352% and 0.360%, respectively for T_1 (N_1K_1) treatment wherein the applied dosage of N and K was minimum. During 2013, minimum fruit firmness of 14.83 lbf was recorded in plants with the highest dose of N and the lowest dose of K while, during the year 2014 it was recorded as 15 lbf for treatment T_5 (N_2K_1) treatment. Similar decrease in fruit firmness with higher doses of N was reported by Okamoto *et al* (2001). In contrast, maximum fruit firmness of 17.14 lbf and 16.8 lbf, during 2013 and 2014 respectively, was retained by fruits harvested from T_4 (N_1K_4) treatment. A linear increase in fruit firmness with increase in dose of K in combination with different N doses was observed (Table 2). A similar increase was observed by Gill *et al* (2012).

The effect of N and K fertilizer combinations on leaf nitrogen, phosphorus and potassium content of pear *cv.* Patharnakh is presented in Table 3. It was observed that the highest dose of N in combination with the lowest dose of K resulted in maximum leaf N content (2.14%). The minimum content of leaf N (1.83%) was recorded for treatment T_4 (N_1K_4) which is a combination of lowest N and highest K dose. Higher rates of N fertilizer frequently increased concentrations of leaf N in 'Fuji' apples (Raese and Drake, 1997). Maximum leaf phosphorus content (0.130%) was observed in the leaf of plants treated with T_4 (N_1K_4) treatment. The highest dose of K result in high potassium content (1.31%) of leaf in treatment T_8 (N_2K_4) and the minimum (0.91%) was recorded in T_1 (N_1K_1) treated plant leaves, where K dosage applied was lowest. The higher leaf N and K contents may be due to enhanced accumulation and translocation of nitrogen (Walsch *et al*, 1989) and potassium (Smith, 1962) under higher supply from roots to leaves.

Thus, it can be concluded that application of 690g of nitrogen and 900g of K_2O was effective in improving fruit yield and quality of pear *cv.* Patharnakh.

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