International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 2110-2113
© 2018 IJCS
Received: 12-01-2018
Accepted: 15-02-2018

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Influence of nitrogen, phosphorus and potassium and their relationship with yield and quality parameters in high density apple Cv. silver spur under temperate conditions of Kashmir

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Abstract
Field trial was conducted during 2015-16 to study the effect of different levels of NPK on yield and quality parameters (tree height, trunk girth, fruit length, fruit diameter and fruit weight) of High Density Apple cv. Silver Spur. Soil samples were taken randomly at two stages viz., before fertilizer application and after fertilizer application and were subsequently analysed. The investigation consisted of 10 treatment combinations with different levels of nitrogen, phosphorus and potassium. The results revealed that the highest tree height (194.3 cm), trunk girth (17.0 cm), fruit length (6.98 cm), fruit diameter (7.38 cm), fruit weight (198.6 g) and fruit yield (4.0 kg/tree) was recorded in treatment with 105 g N/tree, 35 g P/tree and 150 g K/tree. Available nitrogen exhibited significant and positive coefficient of correlation with tree height (r=0.805), annual extension growth (r=0.873), tree girth (r=0.654), fruit length (r=0.749), fruit weight (r= 0.783) and fruit yield (r=0.888). The relationship between available phosphorus with tree girth was positive and significant (r=0.759). The available potassium had significant and positive correlation with tree height (r=0.606). Available calcium had significant and positive correlation with fruit diameter (r=0.710). Available sulphur had significant and positive correlation with fruit length (r=0.680), fruit diameter (r=0.659) and fruit weight (r=0.794). Available zinc revealed a positive and significant correlation with fruit weight (r=0.695). Available copper had positive and significant correlation with fruit length (r=0.768), fruit diameter (r= 0.707) and fruit weight (r=0.633). The relationship between available iron with annual shoot extension growth (r=0.611), fruit length (r=0.742) and fruit diameter (r=0.748) was positive and significant. Available manganese had positive and significant correlation with fruit weight (r=0.681). All other correlation coefficients observed were non-significant.

Keywords: Influence of nitrogen, phosphorus, potassium, relationship, yield and quality

Introduction
Apple is considered as an important temperate fruit of Kashmir valley. The fruit belongs to family Rosaceae and sub family Pomoidae. It is grown throughout the world but the major apple producing country being China. In India it is majorly grown in the states of Jammu and Kashmir, Uttrakhand and Himachal Pradesh. Apple production of Jammu and Kashmir was recorded to be 1726834 metric tonnes on 162971 hectares of land (Anonymous, 2017) [2]. High density plantation involves planting of more number of trees compared to the commercial orchard. High density apple plantation has gained popularity during recent times due to manifold increase in productivity. Nutrient management is very critical for optimum productivity of high density apple as it plays an important role in enhancing good tree growth, cropping and fruit quality as compared to the vigorous trees as high-density apple trees fruit earlier, have good yield and smaller root system. There has been a greater attention today in order to improve the nutrition of the trees due to high density planting, old orchards need to be replanted due to shortage of new land, higher production should be ensured from younger plantings (Bright, 2005) [5]. Nitrogen plays a very important role in vegetative growth, cell division, cell elongation and thereby improves the yield of the crop. Phosphorus is an element which is essential in maintaining the fruit size, fruit firmness, and has direct effect on the yield. However, the high-density apple plantation in Kashmir conditions is practiced without any proper recommendations for nutrient management. Keeping in view the fact the present study was conducted to ascertain the effect of different levels of nitrogen phosphorous and potassium on growth, yield and quality of apple cv.

Silver Spur under temperate conditions of Kashmir.

Materials and Methods

The experiment was conducted at Sher-e-Kashmir University of Agricultural Sciences and Technology Shalimar Kashmir in the high-density apple block. The experiment was laid in randomised complete block design with ten treatments and three replications, consisting of four levels of nitrogen viz., 0, 65, 85 and 105 g N/tree and three levels of phosphorus viz., 0, 25 and 45 g P/tree and three levels of potassium viz., 0, 120 and 180 g K/tree. The soil of the experimental area was silty clay loam in texture, medium in nitrogen, phosphorus and potassium respectively with neutral (6.93) soil reaction. The nutrients N, P and K were applied through urea, DAP, MOP and SSP. Half dose of nitrogen, full dose of phosphorus and half dose of potassium were applied 21 days before expected bloom and remaining half dose of nitrogen and potassium were applied after fruit set (about 21 days after petal fall). The height of each tree was recorded before the start and after the completion of the experiment with the help of graduated staff and was expressed in cm. Four shoots were randomly selected from each quadrant of the experimental tree and average annual shoot extension growth of the current season was recorded. The girth of the tree was measured at 30 cm above the ground level. The trunk girth was measured before the start and after the completion of the experiment with the help of measuring tape and total increment in girth was expressed in cm. Fruit length and diameter of ten fruits per tree in each treatment was measured at the longest position with the longest and widest position respectively with the help of digital vernier calliper and average fruit length and diameter was expressed in cm. The weight of each fruit was recorded with the help of electronic balance and measured in grams. The average weight was determined by dividing the total weight obtained (g) by the number of fruits. Fruit yield was calculated by weighing the total fruits harvested from each tree and expressed in kgs.

Statistical Analysis

Relationship between growth, yield and quality with available nutrients was carried as per procedures outlined by Gomez and Gomez (1984) [11]\. Treatment means were compared by using critical difference.

Results and Discussion

Data in Table 1 revealed highest tree height (194.3 cm) was recorded in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O and the lowest (180.6 cm) was recorded in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. Increase in tree height may be attributed to the effect of nitrogen on cell division and cell elongation leading to the development of large surface area, and nitrogen is thought to be a strong promoter of vegetative growth because of being component of chlorophyll. Also, nitrogen nutrition is directly related with plant growth, therefore its increased dose may have improved plant growth especially leaf size. Increased leaf size may be responsible for improvement in the rate of photosynthesis and thereby faster growth of plants. This is accordance with the findings of Ehsan Fedhel (2007) and Tripathi *et al.* (1990) [22]. Highest annual shoot extension growth (65.6 cm) (Table 1) was seen in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O whereas; lowest (56.2 cm) was seen in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. This may be attributed to the fact that nitrogen activates both cell division and elongation in the meristematic tissues. Nitrogen is a strong promoter of vegetative growth because of being component of chlorophyll. Also, nitrogen nutrition is directly related with plant growth, therefore its increased dose may have improved the plants growth especially leaf size. Increased leaf size might be responsible for improvement in the rate of photosynthesis and thereby faster growth of plants. This is in accordance with the findings of Sharma (2016) [21]. Highest trunk girth (17.0 cm) (Table 1) was recorded in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O and lowest was recorded in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. This is due to the effect of nitrogen in improving the growth of the tissues. Nitrogen is a strong promoter of vegetative growth. This is in accordance with the findings of Sharma (2016) and Kumar *et al.* (2008) [18].

Table 1: Effect of nitrogen, phosphorus and potassium on tree height, annual shoot extension growth and trunk girth in high density apple orchard cv. Silver Spur

Treatments	Tree height (cm)	Annual shoot extension growth (cm)	Trunk girth (cm)
T_1	180.6	56.2	15
T_2	187.3	59.6	15.6
T_3	193.9	64.4	16.8
T_4	194.3	65.6	17
T_5	191	58	15.6
T_6	190.6	60.6	15.4
T_7	191.3	61.8	15.2
T_8	189.6	61.4	15.8
T_9	188.9	61.6	15.6
T_{10}	191	61.4	16
C.D($P \leq 0.05$)	0.15	0.99	0.08

Highest fruit length (6.98 cm) (Table 2) was recorded in fruits treated with T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O and the lowest reading (5.91 cm) was recorded in treatment with 0g N, 35g P_2O_5 and 150g K_2O. Increased fruit length may be attributed to increase in cell size and number due to increased nitrogen application. This may also be due to translocation and accumulation of photosynthates from source to sink owing to high supply of synthates. The reason expressed for greater fruit weight may also hold good for greater fruit length. These findings are in agreement with those of Iqbal *et al.* (2012) and Racsko *et al.* (2005) [13, 20]. Highest fruit diameter (7.38 cm) (Table 2) was recorded in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O while as, the lowest fruit diameter (6.95 cm) was recorded in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. This may be attributed to the fact that higher doses of nitrogen increase vegetative growth and greater fruit weight may also hold good for greater fruit diameter. These findings are in agreement with

Iqbal *et al.* (2012) [13] and Racsko *et al.* (2005) [20]. Highest fruit weight (168.6 g) (Table 2) was recorded with 105g N, 35g P_2O_5, 150g K_2O in T_4 treatment and lowest fruit weight (148.0 g) was recorded with 0g N, 35g P_2O_5 and 150g K_2O in T_1 treatment. The increase in fruit weight with the application of nitrogen, phosphorus and potassium may be due to the fact that nitrogen, phosphorus and potassium sufficient plants have better capability for CO_2 assimilation, which leads to higher rate of synthesis and supply of carbohydrates in the plants. The fruits are very strong sink for carbohydrates etc. therefore more carbohydrates would be transported to the fruits in case of trees well supplied with nitrogen. This is in conformity with the findings of Khan *et al.* (2016) and Kashyap *et al.* (2012). Highest fruit yield (4.0 kg tree^{-1}) (Table 2) was recorded in T_4 treatment with 105g N, 35g and 150g K_2O and lowest fruit yield (3.0 kg tree^{-1}) was recorded in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. The increase in fruit yield may be due to increased application of nitrogen, phosphorus and potassium especially nitrogen. This is in conformity with findings of Khan *et al.* (2016) and Kashyap *et al.* (2012) [15, 16]. The increase in yield may be due to promotion of vegetative growth and increase in net assimilation rate and accelerating the photosynthates in storage organs of fruits resulting in an increased diameter and weight of fruits hence improving the fruit yield. These are in accordance with the findings of Kamble and Kathmale (2015) [14].

Table 2: Effect of nitrogen, phosphorus and potassium on fruit length, fruit diameter, fruit weight and fruit yield in high density apple orchard cv. Silver Spur

Treatments	Fruit length (cm)	Fruit (diameter cm)	Fruit weight (g)	Fruit yield (kg tree^{-1})
T_1	5.91	6.95	148	3
T_2	6.35	7.11	151	3.2
T_3	6.93	7.23	157.6	3.9
T_4	6.98	7.38	168.6	4
T_5	6.34	7.12	156	3.2
T_6	6.38	7.32	149	3.4
T_7	6.32	7.15	152	3.3
T_8	6.36	7.25	155.8	3.2
T_9	6.32	6.99	157	3.5
T_{10}	6.84	7.03	154.2	3.4
C.D($P \leq 0.05$)	0.02	0.02	4.85	0.03

The relationship between available nutrients with growth, yield and quality attributes (Table 3) showed that available nitrogen revealed positive and significant correlation with tree height, annual extension growth, trunk girth, fruit length, fruit weight and fruit yield. This may be attributed to the fact that nitrogen plays an active role in cell division and cell elongation thus improves the growth parameters and yield. These results are in agreement with the findings of Kumar and Chandel (2004) [17]. The relationship of available phosphorus with trunk girth was positive and significant. This could be attributed to the role of phosphorus as an essential constituent of cell and its organelles and in plant metabolism. These are in line with the findings of Kumar and Chandel (2004) [17]. The available potassium had significant and positive correlation with tree height. This is because of its role in plant metabolism and enzyme system of plants. Similar results were found by Afzal *et al.* (2015) [1]. Available calcium was positively and significantly correlated with fruit diameter. It could be due to role of calcium as structural component of cell and enzyme activity (Bhat *et al.*, 2009) [5]. Available sulphur was positively and significantly correlated with fruit length, fruit diameter and fruit weight. This could be attributed to the role of sulphur in activation of enzymes, constituent of amino acids etc. and in cell division thereby improving the growth and yield (Mansour *et al.*, 2008) [19]. DTPA extractable zinc revealed a positive and significant correlation with fruit weight. This could be due to its role in plant metabolism especially as activator of enzyme system leading to quality production and since zinc is essential co-factor for number of enzymes like peptidase, protienase, enolase and is required for formation of amino acids tryptophan which consists of hormone indole acetic acid (IAA) and is essential for cell elongation. (Barker and Pilbeam, 2007) [3]. The relationship between DTPA extractable iron with annual shoot extension growth, fruit length and fruit diameter was positive and significant. Iron plays a key role in carbohydrate metabolism and fruit quality (Dongre*et al.*, 2000). Iron has an important role in photosynthesis that causes higher photosynthetic rate thereby improving the quality parameters and yield (Houimli*et al.*, 2015 and Davarpanah*et al.*, 2013). DTPA extractable copper was significantly and positively correlated with fruit length, fruit diameter and fruit weight. The possible reason could be that copper is essential for photosynthesis due to its involvement in the electron transport chain (Bergmann, 1992) [4]. Copper rich plants have higher enzyme activities resulting in higher carbon fixation rates. This results in more carbohydrates for plant growth and development, which increases the yield (Brown *et al.*, 1994) [7]. DTPA extractable manganese was positively and significantly correlated with fruit weight. This result might be owing to the role of manganese in the oxygen evolving step of photosynthesis and membrane function as well as serving as an important activator of numerous enzymes in the cell, thereby increasing cell size and hence increases in diameter (Wiedenhoeft, 2006) [23].

Table 3: Coefficient of correlation between available nutrients and growth, quality and yield parameters of high density apple cv. Silver Spur

Nutrients	Tree height	Annual shoot extension growth	Tree girth	Fruit length	Fruit diameter	Fruit weight	Fruit yield
N	0.805*	0.873*	0.654*	0.749*	0.318	0.783*	0.888*
P	0.596	0.464	0.759*	0.258	0.411	0.059	0.574
K	0.606*	0.587	0.372	0.238	0.23	0.043	0.484
Ca	0.294	0.112	-0.018	0.32	0.710*	0.398	-0.017
Mg	-0.192	-0.118	-0.048	0.217	0.595	0.195	-0.035

S	-0.109	-0.193	0.168	0.680*	0.659*	0.794*	0.025
Zn	0.392	0.305	0.354	0.46	0.18	0.800*	0.174
Cu	0.586	0.479	0.165	0.768*	0.707*	0.633*	0.359
Fe	0.525	0.611*	0.201	0.742*	0.748*	0.622	0.503
Mn	0.024	0.217	0.481	0.632	0.377	0.681*	0.284

Conclusion

Therefore, it is concluded that nutrients play an important role as far as plant growth and development is concerned which efficiently increase the yield of crop. Our results showed that application of urea, DAP, MOP and SSP had significant effects on growth, yield and quality parameters. However, the most propitious treatment is T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O

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