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Response of nitrogen, phosphorus and potassium on available nutrients in high density apple cv. silver spur under temperate conditions of Kashmir

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Abstract
A field trial was conducted during 2015-16 at the experimental field of Division of Fruit Science Sher-e-Kashmir University of Agricultural Sciences and Technology. The trail was conducted to observe the effects of Nitrogen, Phosphorus and Potassium on available nutrients, which consisted of 10 treatment combinations with different levels of Nitrogen, Phosphorus and Potassium. Investigation revealed that highest available nitrogen (311.6 kg ha^{-1}) was recorded in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O. Highest available phosphorus (21.08 kg ha^{-1}) was recorded in T_7 treatment with 85g N, 45g P_2O_5 and 150g K_2O. Highest available potassium (248.44 kg ha^{-1}) was recorded in T_{10} treatment with 85g N, 35g P_2O_5 and 180g K_2O. Highest exchangeable calcium (588.33 ppm) was recorded in T_4 treatment with 105% N, 35g P_2O_5 and 150g K_2O. Highest exchangeable magnesium (131.88 ppm) was recorded with 85g N, 35g P_2O_5 and 150g K_2O (T_3 treatment). Highest available sulphur (10.99 ppm), highest available zinc (0.76 ppm), highest soil copper (1.24 ppm), highest available manganese (19.99 ppm), highest available iron (36.81 ppm) was recorded in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O.

Keywords: Nitrogen, phosphorus, potassium, magnesium, calcium, zinc, copper.

Introduction
Apple belongs to the family Rosaceae and sub-family Pomoidae. It is very important temperate fruit of Kashmir valley. More recently orchardists are now shifting to high density plantation as it offers them and more productivity and hence more returns. In order to maintain the productivity and health of high density plants it is very important to maintain the soil health through proper management of nutrients. Nutrients play a very important role in the proper development of plants. Nitrogen plays an important role in the vegetative growth, cell division, cell elongation and thereby improves both the quality and yield of the crop. Phosphorus plays an important role in maintaining the fruit size, fruit firmness and has a direct effect on the yield of the crop. Potassium provides an ionic environment for metabolic processes in the cytosol, and as such functions as a regulator of various processes including growth regulation, plants require potassium ions for protein synthesis and for opening and closing of stomata therefor potassium is very important as far as the growth and development of the crop is considered. Therefore, mineral elements are essential for plants as they play an important role in growth and development. The importance of minerals as nutrients for sustaining plant growth and development was realized several centuries earlier. The production of quality fruit is also influenced by nutritional status of soil, fruit and mineral composition, harvesting at maturity stage and leaf fruit ratio (Hansein and Ryugo, 1979) [4]. The importance of nitrogen, phosphorus and potassium in cultivation of high density is of great importance. Keeping in view the change of trend to shifting to high density and the importance of nutrients the study was taken to understand the role of nutrients in enhancing the available nutrient content.

Materials and Methods
The experiment was conducted at the high density apple block of Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir. The trees were 3 years of age and the

rootstock was MM-106. The design used was Randomized complete block design (RCBD). There were a total of 10 treatments with 03 replications, number of plants per replicate were 02 and number of plants were 60. 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 the remaining half dose of nitrogen and potassium were applied after fruit set about 21 days after petal fall. Soil samples were collected from different sites of the experimental plot under the canopy of the apple plants and the initial samples were collected 21 days before expected bloom whereas, the final samples were collected at commercial harvesting stage during 2015-16. Soil samples after collection were air dried, crushed, and sieved through 2mm sieve. The processed soil samples were then labeled and stored in cloth bags for analysis of various available nutrients. Available nitrogen was determined by alkaline permanganate method given by Subbiah and Asija (1956) [15]. Available phosphorus was extracted with 0.5 N sodium bicarbonate at pH 8.5 (Olsen *et al.*, 1954) [12] and estimated by ammonium molybdate method (Jackson, 1973) [5]. The available potassium was extracted with neutral normal ammonium acetate solution and determination was carried out with the help of Flame photo meter as described by Jackson (1973) [5]. The available calcium was extracted with neutral normal ammonium acetate and determined by Versenate titration method as described by Black (1965) [2]. The available magnesium was extracted with neutral normal ammonium acetate and determined by Versanate titration method as described by Black (1965) [2]. The available sulphur was estimated by turbidity method outlined by Chesnin and Yien (1951) [3]. The micro-nutrient cations were estimated by extracting soil with DTPA solution (Lindsay and Norvell, 1978) [9] and determined with the help of atomic absorption spectrophotometer.

Statistical Analysis

The experimental design used was RCBD and the treatment means were compared by using critical difference.

Results and Discussion

The data presented in (Table 1) indicated that highest available nitrogen (311.6 kg ha^{-1}) was recorded in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O and the lowest available nitrogen (306.9 kg ha^{-1}) was recorded in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. The treatments showed significant effect on available N. The increase in available nitrogen with increasing level of nitrogen could be due to organic matter decomposition as well as NH_4^+ on exchange complex. These finding are in agreement with those of Marks *et al.* (1995) [11]. The increase in available nitrogen in soil also resulted from the higher soil biomass production, which is an indirect store house of nitrogen after it is mineralized (Perur *et al.*, 1973) [13]. Highest available phosphorus (21.08 kg ha^{-1}) (Table 1) was recorded in T_7 treatment with 85g N, 45g P_2O_5 and 150g K_2O and the lowest available phosphorus (19.89 kg ha^{-1}) was recorded in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. Phosphorus content differed significantly among all the treatments. This could be due to high organic carbon and accumulation of phosphorus in the surface soils and hence results in higher content of available phosphorus. Similar results were obtained by Awasthi (1993) [1]. Highest available potassium (248.44 kg ha^{-1}) (Table 1) was recorded in T_{10} treatment with 85g N, 35g P_2O_5 and 180g K_2O and the lowest available potassium (244.89 kg ha^{-1}) was recorded in T_8 treatment with 85g N, 35g P_2O_5 and 0g K_2O. The treatments differed significantly with respect to available potassium. It is due to the fact that higher levels of soil potassium application increases potassium ion concentration in soil solution and are held on the surface of clay particles, thus increasing the potassium reserves near the root zone. This is in accordance with the findings of Kumar (1984) [8] in plum orchard.

Table 1: Primary nutrient status of high density apple cv. Silver Spur at commercial harvesting stage

Treatments	Nitrogen (kg ha^{-1})	Phosphorous (kg ha^{-1})	Potassium (kg ha^{-1})
T_1	306.9	19.89	245.66
T_2	309.6	20.14	245.82
T_3	308.9	20.08	245.99
T_4	311.6	20.48	246.34
T_5	308.9	20.02	246.37
T_6	307.9	20.87	246.81
T_7	309.3	21.08	247.95
T_8	308.3	20.47	244.89
T_9	308.6	20.09	247.28
T_{10}	309.6	20.87	248.44
C.D ($P \leq 0.05$)	0.3	0.09	0.25

Highest calcium (588.33 ppm) (Table 2) was recorded in T_4 treatment with 105% N, 35g P_2O_5 and 150g K_2O and the lowest exchangeable calcium (584.66 ppm) was recorded in T_{10} treatment with 85g N, 35g P_2O_5 and 180g K_2O. The treatments revealed significant effect on calcium. This might be attributed to the fact that nitrogen is taken as nitrate form by higher plants including apple and is thus having synergistic relationship with calcium. These results are in conformity with the findings of Suklabaidya (2012) [16]. Highest exchangeable magnesium (131.88 ppm) (Table 2) was recorded with 85g N, 35g P_2O_5 and 150g K_2O in T_3 treatment and lowest available magnesium (130.16 ppm) was recorded with 0g N, 35g P_2O_5 and 150g K_2O in T_1 treatment. The treatments showed significant effect on available magnesium. Nitrogen and phosphorus have synergistic relationship with available magnesium as a result there is increase in exchangeable magnesium. The results are in agreement with those of Malvi (2011) [10]. Highest available sulphur (10.99 ppm) (Table 2) was recorded in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O and the lowest available sulphur (10.65 ppm) was recorded in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. Treatments showed significant effect on available sulphur. This may be due to high content of organic matter and also due to synergetic effect of nitrogen with sulphur. Similar reports were given by Kow and Nabwami (2015) [7] and Singh and Bhandari (1992) [14].

Table 2: Secondary nutrient status of high density apple cv. Silver Spur

Treatment	Calcium (ppm)	Magnesium (ppm)	Sulphur (ppm)
T_1	585.80	130.16	10.65
T_2	586.08	130.99	10.82
T_3	587.83	131.88	10.91
T_4	588.33	130.21	10.99
T_5	587.33	130.44	10.88
T_6	587.33	131.49	10.82
T_7	587.66	130.64	10.70
T_8	586.00	130.92	10.88
T_9	585.20	130.23	10.80
T_{10}	584.66	130.20	10.76
C.D ($P \leq 0.05$)	0.35	0.15	NS

Lowest DTPA extractable zinc (0.71 ppm) (Table 3) was recorded with 0g N, 35g P_2O_5 and 150g K_2O in T_1 treatment while as highest zinc (0.76 ppm) was observed in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O. The treatments had non-significant effect on soil zinc. These results are in agreement with the findings of Kamble and Kathmale (2015) [6]. Lowest DTPA extractable copper (1.20 ppm) (Table 3) was recorded with 0g N, 35g P_2O_5 and 150g K_2O in T_1 treatment while highest DTPA extractable copper was found in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O. The treatments exhibited non-significant effect on available copper. This may be due to the synergetic effect of nitrogen with copper. This is in conformity with the findings of Malvi (2011) [10]. Highest DTPA extractable manganese (19.99 ppm) (Table 3) was recorded in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O and the lowest DTPA extractable manganese (18.77 ppm) was recorded in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. Manganese content differed significantly among all the treatments. This may be due to the synergetic effect of nitrogen with manganese. This is in conformity with the findings of Malvi (2011) [10]. Highest DTPA extractable iron (36.81 ppm) (Table 3) was recorded in T_4 treatment with 105g N, 35g P_2O_5 and 150g K_2O and the lowest DTPA extractable iron (34.33 ppm) was recorded in T_1 treatment with 0g N, 35g P_2O_5 and 150g K_2O. The available iron showed significant difference among the treatments. This may be due to the synergetic effect of nitrogen with iron. Similar results were observed by Malvi (2011) [10].

Table 3: Micronutrients status of soils of high density apple cv. Silver Spur

Treatment	Zinc (ppm)	Copper (ppm)	Manganese (ppm)	Iron (ppm)
T_1	0.71	1.20	18.77	34.33
T_2	0.73	1.21	19.82	34.64
T_3	0.73	1.23	19.66	36.37
T_4	0.76	1.24	19.99	36.81
T_5	0.75	1.22	19.33	34.66
T_6	0.72	1.23	19.00	35.72
T_7	0.74	1.23	19.00	35.66
T_8	0.75	1.23	19.93	34.93
T_9	0.75	1.22	19.29	34.66
T_{10}	0.74	1.23	19.46	34.90
C.D ($P \leq 0.05$)	NS	NS	0.01	0.25

Conclusion

It may be concluded that nutrients play a crucial role in growth and development of plants and increase the soil health and fertility conditions. Highest available nitrogen was reported in T_4 treatment. Maximum available phosphorus was recorded in T_7 treatment and maximum available potassium was found in T_{10} treatment. Highest available calcium and sulphur were recorded in T_4 treatment. Maximum DTPA extractable micronutrients viz; zinc, copper, manganese and iron were observed in T_4 treatment.

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