Indian J. Hort. 67(Special Issue), November 2010: 426-428

Short communication

Physiological response of strawberry plants to graded levels of nitrogen and potassium under polyhouse

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Strawberry is essentially a temperate fruit crop, which has adapted well in Kashmir valley owing to fact that the fruits of strawberry come into market when no other fruit is available (Ahmad, 2). The main drawback of its cultivation of is the under sized fruit resulting in less returns to the growers. Nutrition is one of the important aspects of crop production and accounts for about 30% of the total cost of production. Studies with strawberry have shown the diversity of responses to changing N rates and time of application (Santose and Chandler, 10). Hence, the determination of nutritional needs for efficient production of high quality fruit is an important aspect of nutrient management for the growers. Several fertilizer experiments with strawberry have been conducted from time to time and results on response of strawberry to N nutrition are conflicting (Patrik and Martin, 9) and high yielding strawberry crop can remove K @ 40-70 kg/ha through fruits and calyx tissue (Albregts and Howard, 3). As no information is available on the nutrient requirement of the fruit under the Kashmir conditions, hence the experiment was conducted to optimize the dose of nitrogen and potassium with regard to yield and quality of strawberry fruit.

The investigation was carried out in the Division of Pomology, SKUAST-K, Shalimar during 2003-2004 in pots under polyhouse conditions. Earthen pots of 30 cm diameters and 5 kg capacity were filled with 4 parts of well decomposed FYM and 6 parts of soil. Initial nutrient status of the pot mixture was determined and which revealed that the soil was slightly acidic in pH (6.0), medium in organic carbon (0.6%), available N (244.0 kg ha^{-1}), available K (155 kg ha^{-1}) and low in available phosphorous (9.23 kg ha^{-1}) and micronutrients viz., Fe, Zn, Mn and Cu were of the order of 55.0, 10.25, 5.75 and 1.75 ppm, respectively. One healthy and sound runners of strawberry cv. *Confutura* having 2-3 full (compound) open leaves were transplanted in the each experimental pots during the second week of October and pots were placed under poly house during first fortnight of November. The treatments consisted of 4 levels of nitrogen (0, 100, 150 and 200 kg ha^{-1}) applied as urea and three potassium levels (0, 75 and 150 kg ha^{-1}) applied as MOP and there were twelve treatments comprising T_0-control; T_1-100 kg/ha N; T_2-150 kg/ha N; T_3-200 kg/ha N; T_4-75 kg/ha K; T_5-150 kg/ha K; T_6-100kg N + 75 kg/ha K; T_7 - 100 kg/ha N + 150 kg/ha K; T_8–100 kg/ha N + 150 kg/ha K; T_9–200 kg/ha N + 75 kg/ha K; T_{10}-150 kg/ha N + 150 kg/ha K and T_{11}-200 kg/ha N + 150 kg/ha K. Phosphorus was applied to the pots @75 kg ha^{-1} uniformly after one week of transplanting through single super phosphate (SSP). The experiment was laid out in randomized block design (factorial) with four replication and the obtained data were statistically analyzed as suggested by Gomez and Gomez (5) applying the least significant differences (LSD) at 5% for comparison among the treatment means. Morphological characters viz, no of leaves, plant height, plant spread and physical parameters of fruit viz., no of fruits, fruit length, width, fruit weight and yield per plant were recorded as per recommended methods (Atogo-Japan). TSS was determined from freshly strained and thoroughly stirred juice using hand refrectometer. The readings were corrected at 20^0C and results were expressed in ^{o}Brix. Total sugars and acidity were estimated by following as per A.O.A.C. (1) method . Organoleptic ratings of fruits were determined by a panel of trained judges using 1-5 point scale. Fruits scoring 5 points were rated as excellent and those with 4, 3, 2 and 1 rated as very good, good, fair and poor in quality respectively. Leaf samples were collected for leaf analysis as per the procedure outlined by Chapman (3). For macro and micro nutrient estimation, well ground leaf tissue was digested in diacid mixture containing $HN0_3$ and $HClO_4$ (9: 4 ratio) for P, K and micronutrients (Jackson, 6). The phosphorous content was determined by using ammonium molybdate: ammonium metavenadate using double beam UV-Vis spectrophotometer (ECIL, India) while as the potassium was determined by using flame photometer (Jackson, 6) and micronutrients were

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Table 1. Effect of N and K on vegetative growth, yield and qualitative attributes of strawberry cv. Confutura.

Treatments	Vegetative growth attributes			Yield attributes			Qualitative attributes			
	Plant height (cm)	Plant spread (cm^2)	No. of leaves/ plant	No.of fruit/ plant	Fruit wt. (cm)	Yield /plant (g)	TSS (^0B)	Acidity (%)	Total sugar (%)	Organo-lepticrating (1-5 scale)
T_0	18.62	459.13	7.00	11.62	6.10	71.07	7.82	0.91	6.62	2.46
T_1	24.12	572.50	8.50	13.12	6.81	89.37	8.31	0.80	7.10	2.96
T_2	27.15	686.63	10.25	14.37	7.81	112.41	8.85	0.65	7.37	3.36
T_3	25.87	663.75	9.37	13.37	7.56	101.22	8.53	0.64	7.23	3.67
T_4	18.50	485.00	6.37	11.87	6.26	74.37	7.97	0.92	6.89	2.71
T_5	18.56	521.87	7.75	12.12	6.37	77.28	8.13	0.96	6.97	2.92
T_6	23.12	600.88	7.87	13.25	7.04	93.19	8.47	0.81	7.20	3.16
T_7	27.15	726.25	9.25	14.62	8.10	118.45	8.89	0.66	7.43	3.55
T_8	23.09	693.25	8.12	13.87	7.40	102.77	8.55	0.83	7.25	3.31
T_9	26.60	713.13	9.00	14.25	7.82	111.54	8.65	0.65	7.28	3.97
T_{10}	27.43	864.50	10.00	15.37	8.41	129.41	9.04	0.70	7.63	3.97
T_{11}	26.00	818.13	9.25	14.37	8.16	117.28	8.78	0.67	7.33	3.97
LSD(P=0.05)	NS	20.27	NS	NS	0.04	3.87	0.02	NS	0.02	0.15

estimated by using atomic absorption spectrophotometer (ECIL 4141, India).

Data revealed that the increase in the number of leaves/plant and plant height was not significantly influenced by either of the treatments, although T_{10} treatment attributed to the maximum increase followed by T_9 treatment. The better vegetative growth attributes of strawberry plant with both N and K might be due to the high quantity of carbohydrate formation inside the plant cell resulted from more chlorophyll due to optimum dose of N and K. Santosh and Chandler (10) also reported that the increased rate of nitrogen increased green foliage. Increased in vegetative growth may also be attributed due to the fact that the K is most abundant cation found in the cytoplasm which play an important role in osmoregulation enzyme activation, protein synthesis and photosynthesis.

Fruit weight was were significantly influenced by different levels of N and K. Maximum weight (8.41 g) and yield/plant (129.41 g) were recorded with T_{10} treatment with lowest fruit weight (6.10 g) and yield in control (71.07g/plant). However, the number of fruits/plant did not increase significantly with any of the treatment. The significant differences in yield/plant were due to variation in fruit weight. The increase in fruit weight might be due to the stimulation of growth and concomitant translocation of assimilates to sustain the growth. Similar observations were also noted by Neuweiler *et al*. (7). The optimum doses of K also helps in the enlargement of fruit as it was established that cell extension is the consequence of the accumulation of K in the cells and in vacuoles thus increase in fruit size and weight resulted in higher yield with N and K application. Ozaki and Illey (8) have also reported beneficial effects of N and K application in strawberry. However, a decrease in the berry production was recorded with the highest dose of N (200 kg ha^{-1}) i.e. T_3. The reduction in growth and yield might be due to higher rates of N alone caused marked reduction in both growth and yield attributes with high nitrogen rates accumulation resulted in high levels of ammonium and soluble salts in the soil inhibited plant growth. The maximum TSS (9.04^{o}B) and total sugar (7.63%) was recorded with T_{10} treatment. Similarly, the combined effect of N and K significantly influenced organoleptic score, recording a maximum of 3.97 with T_{10} treatment that was statistically at par with T_9 and T_{11} treatment.

The results thus indicated that both N and K applied each @ 150 kg ha^{-1} (i.e. T_{10} treatment) was the best treatment in producing better quality berries. The decrease in TSS and total sugar with highest dose of N may be attributed to the fact that at higher doses excessive growth consumed most of the metabolites and a little were left for storage in the berries.

An increase in the level of N and K increased leaf N and K content (Table 2). The maximum leaf N content (2.79%) and K content (1.35%) was recorded with T_3 and T_5 treatment respectively indicating that sole application of N and K increased leaf N and K content. However, the combined effect of N and K did not significantly improved leaf P content. T_3 treatment also resulted in highest micronutrient content. The highest leaf Fe content (101.87 ppm), Zn (40.50 ppm), Mn (64.62 ppm) and Cu (9.25 ppm) was recorded with highest dose of nitrogen (Table 2) indicating that sole application of N and K increased leaf N and K content. Haynes and Goh

Table 2. Effect of N and K on leaf nutrient content in strawberry cv. Confitura.

Treatments	Leaf macro-nutrient content (%)			Leaf micro-nutrient content(ppm)			
	N	P	K	Zn	Fe	Mn	Cu
T_0	1.76	0.24	0.74	15.25	41.37	17.0	3.87
T_1	1.99	0.23	0.73	29.75	63.25	42.00	7.37
T_2	2.49	0.22	0.72	32.75	83.12	55.12	8.00
T_3	2.79	0.24	0.72	40.50	101.87	64.62	9.25
T_4	1.46	0.22	0.91	17.37	40.50	16.75	4.50
T_5	1.73	0.24	1.35	15.50	42.75	18.62	4.75
T_6	1.99	0.25	0.90	25.00	60.75	45.62	6.87
T_7	2.58	0.24	0.89	28.62	77.37	55.25	7.62
T_8	1.85	0.21	1.32	25.00	57.88	37.00	6.62
T_9	2.76	0.22	0.85	35.75	94.87	62.00	8.62
T_{10}	2.41	0.25	1.28	28.87	81.87	50.62	7.62
T_{11}	2.61	0.23	1.23	36.12	91.00	60.12	8.50
LSD (P = 0.05)	0.17	NS	0.03	3.58	8.68	6.17	1.12

(4) also observed that an increasing rates of N raised concentration of leaf Fe, Mn, Zn and Cu while increasing rates of K had no significant influence on concentration of micronutrient which confirmed present findings.

It is therefore obvious that different levels of N and K influenced growth, yield and quality parameters of strawberry and hence, it can be concluded that the application of N @ 150 kg/ha in combination with K @ 150 kg/ha proved to be the most effective treatment for improving the plant growth, yield, fruit quality and maintaining the optimum leaf macro and micronutrient content of strawberry.

References

1. AOAC. 1998. *Official Methods of Analysis*. Association of Official Analytical chemists, Washington, D.C.
2. Ahmad, M. F. 2009. Effect of planting density on growth and yield of strawberry. *Indian J. Hort.* **66**: 132-34.
3. Albregts, E.E. and Howard, C.M. 1987. Fertilizer rate and method of application on fruiting strawberry. *Proc. Florida State Hort. Soc.* **100**: 198-200.
4. Chapman, H.D. 1964. Suggested foliar sampling and handling techniques for better determining the nutrient status of field and horticultural and plantation crops. *Indian J. Hort.* **21**: 77-119.
5. Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for Agricultural Research* (2nd Edn.), John Wiley and Sons Inc., New York.
6. Jackon, M.L. 1973. *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd; N. Delhi, p. 32.
7. Neuweiler, R. and Scheer, H.V.D. 1997. Nitrogen fertilization in integrated out door strawberry production. *Acta Hort.* **439**: 747-51.
8. Ozaki, H.Y. and Illey, J H. 1964. Effect of different levels of nitrogen and potassium on growth and yield of strawberry. *Proc. Soil Crop Sci. Soci. Florida* **25**: 344-51.
9. Patrick, J.B. and Martin, L.W. 1981. Vegetative and reproductive growth responses of three strawberry cultivars to nitrogen. *J. Ameri. Soc. Hort. Sci.* **106**: 266-72.
10. Santos, B. M and Chandler C. K. 2009. Influence of nitrogen fertilization rates on the performance of strawberry cultivers. *International Journal of Fruit Sci.* **9**: 126-35.

Received: March, 2009; Revised: February, 2010
Accepted: June, 2010