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Influences of PGR and nutrient on leaf, soil and berry nutrient status of strawberry fruit cv. Chandler

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Abstract
The present investigation was carried out to study the influences of PGR and nutrient on leaf, soil and berries of strawberry fruit were significantly influence by various plant growth regulators. Among different Growth regulators. GA_3 (100ppm) recorded the significantly highest leaf nitrogen content (2.52%) and leaf potassium content (1.51%) was recorded at 25 ppm GA_3.The nitrogen content in berry (242.08mg/100g), and potassium content in berry (165.19 mg/100g) was recorded with GA_3 100 ppm. The leaf, soil and berry N and K content were found maximum in the plant supplied with N_3K_2+50 ppm GA_3. (2.61%) leaf potassium (1.51%) N_3K_3 + 50 ppmGA_3, soil nitrogen (276.78 kgha^{-1}) N_3K_2+50 ppm GA_3 As per the soil nutrient study is concerned, N_3K_2+50 ppm GA_3, soil potassium (259.34 kgha^{-1}) and berry nitrogen were recorded (226.92 mg/100g) N_3K_3 + 50 ppmGA_3 respectively. The treatment GA_3 (100 ppm) was the best plant growth regulators treatment for improving leaf nitrogen content. However respect, with respect to leaf nitrogen, soil potassium and berry nitrogen, N_3K_3 + 50 ppmGA_3 was found best.

Keywords: PGR, berry nutrient, strawberry fruit

Introduction
Strawberry (*Fragaria x ananassa* Duch.), a herbaceous perennial plant, belongs to family Rosaceae. It occupies significant place in fruit growing areas of the world, since it can be cultivated in plains as well as in the hills up to an elevation of 3000 meter MSL in humid or dry regions (Darrow and Waldo, 1935) [1]. Strawberry has gained the status of being one of the most important soft fruit of the world after grapes. Among the fruits, it gives quickest return in shortest possible time. Strawberry is an attractive fruit with distinct, pleasant aroma and delicate flavour. It isa rich source of vitamin C (40-120 mg/100g of berries), vitamin B_1, proteins and minerals like phosphorus, potassium, calcium and iron. In India, Maharastra is the leading state in the production of strawberry. It is also grown in Dehradun and Nainital (Uttrakhand), Srinagar (J&K) and hills of Darjeeling (W.B.). Recently its area has considerably increased in Haryana and Punjab. In Uttar Pradesh, growing area are Saharanpur, Muzaffarnagar, Ghaziabad and Allahabad districts. The most commonly grown cultivar is Chandler which is short day plant with excellent fruit quality and suitable for fresh marketing and processing. Among the various cultural practices, plant growth regulators and nutrients have the potential of increasing the plant productivity by influencing various metabolic processes thus altering the growth and development processes of plant (Mikhtelva and Petrovaskya, 1974) [2]. Like above, use of nutrients also play a dominant role in improving the plant growth, runner production, fruit yield and quality of berries. Several reports indicate that nitrogen fertilization increases fruit firmness, increase supply of nitrogen and acid contents of fruits (Rayaml *et al*. 1999) [8]. A judicious use of fertilizer would therefore, be of a great help in regulating the vegetative growth, fruit yield and quality of strawberries. Foliar spray of regulators along with fertilizer application of major nutrients (N, and K) influences the plant growth, enhance the flowering, increase berry yield and improve the berry quality in strawberry.

Material Method
The field experiment was conducted at Main experimental station of horticulture, Department of Horticulture, Narendra Deva University of Agriculture and Technology, Kumarganj,

Faizabad (U.P.). The uniform runners of strawberry cv. Chandler were collected from Dr. Y.S. Parmar University of Horticulture & Forestry, Solan, H.P., for planting. Nine runners planted in 1x1 m raised bed at a distance of 30 x 30 cm and out of which nine plants per treatment were randomly recorded for the data. The planting was done in the first week of October 2010-11 and 2011-12. The foliar application of 50 ppm GA_3 and 300 ppm PP333 was given ten days before the flowering (third week of January 2010-11 and 2011-12 respectively). In experiment-II the recommended fertilizer doses of NPK (40, 60and 100 Kg ha^{-1}) in the form of urea, SSP, MOP and FYM (50 t ha^{-1}) were given at the time of field preparation, the graded doses of N (40, 60 and 100 Kg ha^{-1}) and K (20, 40 and 60 kg ha^{-1}) in the form of urea and MOP were applied before planting (i.e. at the time of preparation of raised experimental beds). While recommended quantity of P_2O_5 (40 kg ha^{-1}) through SSP and FYM (50 t ha^{-1}) were applied as a basal dose in all the treatment combinations. The PGR were sprayed uniformly with the help of pneumatic volume sprayer, till the leaves were wet and droplets of solution started trickling down. One of solution was required for each replication. October 2010-11 and 2011-12. Leaf nutrients twenty fully mature leaves all around the plants were collected from each treatment, washing, cleaning, drying, grinding and storing of the samples were carried before digestion (Chapman, 1964) [3]. Digestion of leaf sample was followed as per the method given by Piper (1966) [4]. One gram of leaf sample was digested in di-acid (HNO_3 and $HClO_4$ in 4:1 ratio v/v) for P and K estimation. However for N estimation one gram leaf sample was digested using concentrated H_2SO_4 and digestion mixture (Jackson, 1973) [5]. Fruit nutrients Ten gram of fresh berry pulp was digested in concentrated H_2SO_4 and digestion mixture for N estimation as described by Jackson (1973) [5]. Separate digestion was carried out for estimation of other nutrients in di-acid (HNO_3 and $HClO_4$ in 4:1 ratio v/v) as suggested by Piper (1966) [4]. Total nitrogen in leaves was estimated by micro-Kjeldhal's method as suggested by Jackson (1973) [5] and results were expressed in per cent N dry weight basis. Total phosphorus was determined by Vanadomolybdo-phoshoric acid yellow colour method as suggested by Jackson (1973) [5] while potassium content was estimated by Flame photometer and results were expressed in per cent.

Result

Different plant growth regulators and nutrients exhibit significant influence on leaf, soil and berry nutrient status of plant (Table 1). Maximum leaf N content (2.52%) was recorded in 100 ppm GA_3 treatment., maximum leaf K content (1.51%) was observed in 25 ppm GA_3, maximum berry N content (242.08 mg/100g) in 100 ppm GA_3 treatments, the maximum berry K content (165.19 mg/100g) was recorded under 100 ppm GA_3 treatments, by application of PGR and nutrient with combination (Table 2). Maximum leaf nitrogen (2.61%) was observed with the treatment of N_3K_2+50 ppm GA_3. Highest leaf K content (1.51%) was found in leaves treated with N_3K_3+50 ppm GA_3, maximum Soil N was recorded with the treatment of N_3K_2+50 ppm GA_3 (276.78 kg ha^{-1}).

An inquisition of data presented in Table 3 revealed that different PGR and nutrient have significant role on soil potassium and berry nitrogen of strawberry. Maximum increase in Soil K (259.34 kg ha^{-1}) was observed with the treatment of N_3K_3+50ppm GA_3, the Berry N influenced by various treatments of nutrients with the combination of PGRs was recorded with the treatment of N_3K_3+ 50 ppm GA_3 (226.92 mg/100).

Table 1: Effect of PGR on leaf and berry N, and K (%)

Treatments	Leaf N (%)	Leaf K (%)	Berry N (mg/100 g)	Berry K (mg/100 g)
T_1:Control (water spray)	2.11	1.31	218.51	153.32
T_2:25 ppm GA_3	2.33	1.51	234.31	159.40
T_3: 50 ppm GA_3	2.42	1.45	237.40	160.47
T_4: 100 ppm GA_3	2.52	1.42	242.08	165.19
T_5: 200 ppm PP333	2.27	1.42	225.3	156.40
T_6: 300 ppm PP333	2.22	1.40	223.99	155.32
T_7: 400 ppm PP333	2.21	1.39	221.21	154.25
T_8: 2 ppmTriacontanol	2.41	1.48	237.81	156.63
T_9: 4 ppm Triacontanol	2.48	1.44	238.22	156.88
T_{10}: 6 ppm Triacontanol	2.45	1.41	233.59	157.73
T_{11}: 100 ppm Ethephon	2.28	1.38	224.25	156.07
T_{12}: 200 ppm Ethephon	2.21	1.38	222.53	155.88
T_{13}: 300 ppm Ethephon	2.18	1.37	221.48	155.30
SE±	0.03	0.02	0.18	1.15
CD at 5%	0.07	0.07	0.54	0.15

Table 2: Effect of nutrients and PGR on leaf N, K (%), soil N and K (kg ha^{-1}) and Berry N (mg/100g)

Treatments	Leaf N (%)	Leaf K (%)	Soil N (kg ha^{-1})	Soil K (kg ha^{-1})	Berry N (mg/100g)
T_1 : Control	2.15	1.36	217.32	249.45	218.40
T_2 : N_1K_1 + 50 ppm GA_3	2.34	1.44	255.12	251.34	223.16
T_3 : N_1K_2 + 50 ppm GA_3	2.30	1.42	250.12	252.18	224.58
T_4 : N_1K_3 + 50 ppm GA_3	2.25	1.44	263.65	252.45	224.11
T_5 : N_2K_1 + 50 ppm GA_3	2.43	1.46	267.88	253.35	226.17
T_6 : N_2K_2 + 50 ppm GA_3	2.40	1.46	266.34	255.45	226.48
T_7 : N_2K_3 + 50 ppm GA_3	2.43	1.47	271.34	255.34	226.16
T_8 : N_3K_1 + 50 ppm GA_3	2.47	1.41	271.13	257.67	226.71
T_9 : N_3K_2 + 50 ppm GA_3	2.61	1.48	276.78	259.13	226.84
T_{10} : N_3K_3 + 50 ppm GA_3	2.21	1.51	259.78	259.34	226.92
T_{11} : N_1K_1 + 300 ppm PP_{333}	2.23	1.41	259.67	254.45	219.49

T_{12} : $N_1 K_2$ + 300 ppm PP_{333}	2.24	1.41	254.12	254.88	219.41
T_{13} : $N_1 K_3$ + 300 ppm PP_{333}	2.24	1.43	249.14	253.67	219.32
T_{14} : $N_2 K_1$ + 300 ppm PP_{333}	2.28	1.44	249.13	253.88	219.50
T_{15} : $N_2 K_2$ + 300 ppm PP_{333}	2.19	1.44	251.13	255.56	219.74
T_{16} : $N_2 K_3$ + 300 ppm PP_{333}	2.25	1.42	254.15	254.67	220.16
T_{17} : $N_3 K_1$ + 300 ppm PP_{333}	2.29	1.41	253.12	254.67	220.47
T_{18} : $N_3 K_2$ + 300 ppm PP_{333}	2.29	1.41	254.26	253.88	220.32
T_{19} : $N_3 K_3$ + 300 ppm PP_{333}	2.28	1.41	252.17	253.88	220.42
SE±	0.03	0.01	0.12	0.37	0.02
CD at 5 %	0.06	0.03	0.23	0.86	0.05

N_1 = 40 Kg ha^{-1} K_1 =20 Kg ha^{-1}
N_2 = 60 Kg ha^{-1} K_2 =40 Kg ha^{-1}
N_3 = 100 Kg ha^{-1} K_3 = 60 Kg ha^{-1}

Discussion

It was observed from the present investigations that the plant which were treated with GA_3 (100 and 50 and ppm) recorded more nitrogen content in leaf, whereas maximum K content in leaf was recorded in 25 ppm GA_3 treatment. This might be attributed to the fact that growth regulators control the translocation and distribution of nutrients in plant and foliar applied plant regulators restrict the movement of mineral element out of the leaf which might have resulted in the higher concentration of these elements. The present finding are in close agreements with the finding of Dwivedi (1987) [6] who recorded higher leaf N content when plants were treated with 50 ppm GA_3 under long day conditions in Senga cultivar of strawberry. The maximum K content was recorded with the application of 25 ppm GA_3. This might be due to higher uptake of N and the nitrogen status of the plant affects the absorption and distribution of other elements in plants (Smith, 1962) [7].

In berries highest N and K content were recorded with 100 ppm GA_3 treatment. This may be due to higher concentration of nutrient element in the leaves. These findings are in conformity with the findings of Rana (2001) [10] who reported maximum fruit N and K content with the application of 100 ppm GA_3 in strawberry cv. Chandler. Various nutrients in combinations with GA_3 pronounced significant effect on the nutrients contents of leaves and fruits in strawberry. The N content in leaves was increased with increase in nitrogen in combination withN_3K_2+ 50 ppm GA_3. Further, it is widely accepted that growth regulators control the translocation and distribution of nutrients in plants. This may be due to the fact that foliar applied PGR regulate the mineral element movement which resulted into higher level of this element in leaf and fruit of strawberry (Dwivedi, 1987 and Nestby, 2002) [6]. The maximum leaves K content was recorded in N_3K_3 + 50 ppm GA_3 treatment. This might be due to higher application of K fertilizer (Smith, 1962 and Mishra, 1983) [7]. In the present investigation the maximum soil was recorded in N_3K_2+50 ppmGA_3 and Potassium content in soil was increases in potassium in combination with N_3K_3+50GA_3. Havelka (1970), Rom and Arrington (1974) and increase in the available N, and K contents in the soil of peach orchard with combined application of N and K. The maximum berry N content in berry was recorded in combination with N_3K_3+50ppm GA_3 these findings are in conformity with the findings Singh (1982) [9]

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