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Influence of fertigation on growth and yield of strawberry (*Fragaria* X *ananassa* Duch.) cv. Sabrina

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Abstract
Significance of fertigation on growth and yield components of strawberry was studied. The experiment was laid out in Completely Randomized Design with four replications and eight treatments. Application of 100 or 75% RDF through fertigation or 25 % RDF through soil + 75 % RDF through fertigation recorded higher plant height (27-29 cm), number of trifoliate leaves (27-30), plant spread (>50 cm in both east-west and north-south direction), maximum leaf area (>175 cm^2), number of runners per plant (1.75-1.85), plant dry weight (28-30 g). These treatments also recorded higher fruit characteristics viz., maximum fruit weight (17-18 g), fruit volume (18-19 cc), fruit length (4.00-4.14 cm) and fruit diameter (4.08-4.14 cm). By virtue of this, fruit yield per plant was also found highest (384-391 g), giving 31- 33 per cent higher than 100% RDF through soil application (295.95 g/plant). However, application of 75% RDF through fertigation stands best among them. Application of 50% RDF through soil application and 50% RDF through fertigation found alternative to these treatments and thus fertigation ensures best solution for intensive and economical crop production.

Keywords: Strawberry, Sabrina, Fertigation, Growth, Yield

Introduction
Strawberry (*Fragaria x ananassa* Duch.) belongs to the family Rosaceae with basic chromosome number of X=7. The cultivated strawberry is an octoploid, obtained by the hybridization of two North American species *Fragaria chiloensis* and *F. virginiana* developed in France during seventeenth century (Staudt, 1999). The fresh ripe fruit of strawberry is a rich source of vitamins, minerals and also possess anticancer compound called ellagic acid. Crop is of temperate in origin but trained under sub tropical conditions in poly houses due to varietal evaluations and adaptability.

A proper nutrition management for the crop is important in terms of increasing yield and improvement in quality of the produce (Kessel, 2003). Fertigation allows an accurate and uniform application of nutrients to the wetted area, where the active roots are concentrated. Further, it gives flexibility of fertilization which enables the specific nutritional requirements of the crop to be met at different stages of growth. As the crop is being trained under controlled environment, adoption of the fertigation system becomes easy to manage and also helpful to exploit the potentiality of the crop with desired quality. By considering these points, an experiment was conducted to study the influence of fertigation on growth and yield of strawberry under naturally ventilated poly house conditions.

Materials and Methods
The experiment was carried out in a low cost naturally ventilated polyhouse of the Department of Fruit Science, College of Horticulture, Mudigere, situated in the Western Ghats and represents the Hill zone (Zone-9 and Region-V) of Karnataka. It is located at 13^0 25' North latitude and 75^0 25' East longitude with an altitude of 982 m above mean sea level. The experiment was conducted by adopting Completely Randomized Design with four replications and eight treatments (T_1-100 % RDF through soil application, T_2-75 % RDF through soil application, T_3-50 % RDF through soil + 25 % RDF through fertigation, T_4-50 % RDF through soil + 50 % RDF through fertigation, T_5-25 % RDF through soil + 50 % RDF through fertigation, T_6-25 % RDF through soil + 75 % RDF through fertigation, T_7-75 % RDF through fertigation and T_8-100 % RDF through fertigation). Farm yard manure @ 20 t/ha was applied common to all the treatments. The recommended fertilizer dosage used in the study was 150:100:120 kg/ha. Fertigation was done at seven intervals of 25, 32, 39, 46, 53, 60 and 67 DAT. Tissue cultured plants of Sabrina variety of strawberry was planted at a spacing of 30 cm x 30 cm on raised beds with 14 plants per plot *viz.*, 7 plants of 2 rows. Transplanting was

done in the month of November 2016. Enough care is exercised for rising the crops like timely weed control, taking care of damages etc. The growth and yield components were taken and subjected for statistical analysis.

Results and Discussion

Morphological parameters: Morphological parameters of Strawberry (Table 1) were found to differ significantly due to the treatments. In general, fertilizer application as fertigation than soil application resulted in better growth. Comparison between application of 75% RDF through soil to that of 50% RDF through soil + 25% RDF through fertigation improved the growth marginally. Further, improvement of growth was significant in treatment 25% RDF through soil + 50% RDF through fertigation over the earlier mentioned treatments, giving positive response for fertigation with higher doses of RDF. However, these treatments together did not match the growth attained by 100% RDF as soil application.

The plant is of spreading type and attained tallness of 25-30 cm. Among the treatments, maximum plant height (around 27-29 cm), higher number of trifoliate leaves (27-30), plant spread (>50 cm in both east-west and north-south direction), maximum leaf area (>175 cm^2) was achieved by application of 100% or 75% RDF through fertigation or 25 % RDF through soil + 75 % RDF through fertigation which were on par to each other. The well accomplished sustained vegetative growth might be due to prolonged sustained nutrient availability resulting in increased rate of various physiological and metabolic processes such as synthesis of proteins, nucleic acids, coenzymes, secondary metabolism products, enzyme activation, osmotic regulation, energy transfer, respiration and photosynthesis in the plant system. These results are in accordance with the findings of Martinsson *et al*. (2006) and Kachwaya and Chandel (2015) who also recorded that the maximum vegetative growth in the plants fertigated with full nutrient package compared to control in strawberry plants. The highest number of runners per plant (1.85) was seen in 100% RDF through fertigation due to earlier reasons which has accumulated more photosynthates and thereby helped to increase runners per plant. Maximum plant dry weight (around 29-30 g) was recorded in treatments with application of 100% or 75% RDF through fertigation and 25 % RDF through soil + 75 % RDF through fertigation which were on par to each other. The earlier growth in the plants as supported by equal distribution of nutrients and their uptake resulted in increased fresh weight and focussed on plant dry weight. Similar results were obtained in the studies of Gariglio *et al*. (2000) and Sonsteby *et al*. (2009) in strawberry. It is clear from these results that the piece meal application of nutrients through fertigation (at least 75% RDF) at intervals paved way for plant demand at right time resulting in positive growth than other treatments. Further, 50% RDF dose as fertigation along with 50% basal application resulted as an alternative and succeeded to get next best results for growth (tallness of 26.8 cm, trifoliate leaves of 24.4, plant spread of 46-47 cm in both directions, leaf area of 169.49 cm^2 and 1.65 runners/plant) compared to above said top three treatments but clearly exceeded statistically the other treatments in test.

Reproductive parameters: Flowering duration significantly varied from 57 to 72 days in different treatments. Soil applied plots resulted in early cessation of flowering period where as fertigated plots prolonged the event. Though maximum duration of flowering (71.95 days) was recorded in treatment with application of 100% RDF through fertigation, it was closely followed by application of 75% RDF through fertigation with or without 25% basal RDF application (70.95 and 68.40 days). The extension of duration of flowering might be due to frequent irrigation and fertilization causing high C/N ratio which promoted the extension of flowering period. These results of present investigation are in confirmation with those of Sonsteby *et al*. (2009) in strawberry and Valji (2011) in papaya. Different fruit characters were also influenced by fertigation treatments. Comparison among application of 75% RDF through soil and to that of either 50% or 25% RDF through soil + 25 or 50% RDF through fertigation, resulted in betterment of fruit characters in later fertigated treatments. It is clear that split applications of fertilizers through fertigation had an advantage over soil application. However, these treatments did not mark the success to that of application of 100% RDF through soil either for berry characteristics or to that of fruit yield per plant (292.95 g).

The maximum fruit weight (around 17 to 18 g) was recorded in treatments with applications of 100% or 75% RDF through fertigation and 25 % RDF through soil + 75 % RDF through fertigation which were on par to each other. These three treatments again recorded maximum fruit volume (18-19 cc), fruit length (4.00-4.14 cm) and fruit diameter (4.08-4.14 cm). The better growth and sustained period of flowering due to congenial plant growing atmosphere advocated by timely availability of nutrients in these treatments paved way for better yield components (Table 2). As a result, these treatments recorded higher fruit yield (384-391 g/plant) *viz*., treatment receiving 100 % RDF through fertigation recorded maximum fruit yield per plant (390.42 g) which was on par with treatments 75% RDF through fertigation (385.96 g) and 25 % RDF through soil + 75 % RDF through fertigation (384.75 g). Significantly higher yields under maximum dose of fertilizers applied through fertigation is attributed to improved vegetative growth, better water and nutrient utilization, fractioned supply of nutrients through split applications might have met the nutrients requirement of strawberry at different growth stages thus leading to increase in fruit characteristics and as a result it gave higher fruit yield. These results are in line with those of Reddy *et al*. (2002), Gutal *et al*. (2005), Martinsson *et al*. (2006) and Pervin *et al*. (2014) who observed significant increase in yield of strawberry with full nutrient package through fertigation as compared to low doses through fertigation or basal fertilizer applications. On the other hand, reduction in quantity of fertilizers through fertigation resulted in slightly lower yield components in terms of fruit characteristics. In the treatment 50% RDF as basal and 50% RDF through fertigation recorded reasonably good yield components (weight of 16.42g,volume of 16.44 cc, length of 3.84 cm and diameter of 3.33 cm) and yield (328.45 g/plant), yet did not succeed to reach statistical significance to that of earlier mentioned treatments and ended up with next best.

In conclusion, results envisage application of 75% RDF through fertigation under naturally ventilated poly house situations is found better for getting good growth and yield of straw berry.

Table 1: Effect of fertigation treatments on morphological parameters of strawberry

Treatments	Plant height (cm)	Number of trifoliate leaves	Plant spread (cm)		Leaf area (cm^2)	Number of runners per plant	Plant dry weight (g)
			East-West	North-South			
T_1	26.30	20.75	44.25	43.24	161.79	1.45	24.33
T_2	25.25	19.60	42.38	41.69	160.12	1.15	20.53
T_3	26.05	21.85	45.62	44.87	164.49	1.35	22.83
T_4	26.80	24.40	46.97	46.15	168.46	1.65	25.50
T_5	26.50	23.20	46.76	46.21	167.74	1.30	24.28
T_6	27.84	28.70	51.13	49.60	176.10	1.80	29.13
T_7	28.10	28.65	52.94	51.65	176.52	1.75	29.08
T_8	28.56	29.95	53.92	52.63	177.23	1.85	29.40
S. Em ±	0.11	0.19	0.59	0.46	0.27	0.09	0.42
C. D. (P = 0.05)	0.32	0.55	1.73	1.35	0.80	0.28	1.21

Table 2: Effect of fertigation treatments on reproductive parameters of strawberry

Treatments	Duration of flowering (days)	Fruit weight (g)	Fruit volume (cc)	Fruit length (cm)	Fruit diameter (cm)	Fruit yield/plant (g)
T_1	58.40	15.07	16.74	3.84	3.33	292.95
T_2	57.15	13.40	14.56	2.86	2.68	221.28
T_3	60.20	13.83	15.39	3.11	2.83	232.90
T_4	61.70	16.42	16.95	3.84	3.37	328.45
T_5	62.50	14.16	15.41	3.15	2.87	250.33
T_6	68.40	17.95	18.25	4.00	4.08	384.75
T_7	70.95	17.96	18.38	4.02	4.10	385.96
T_8	71.95	17.97	18.50	4.14	4.14	390.42
S. Em ±	0.37	0.16	0.10	0.04	0.05	2.25
C. D. (P = 0.05)	1.09	0.47	0.29	0.13	0.14	6.57

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