RESEARCH ARTICLE

EFFECT OF FOLIAR APPLICATION OF LIQUID ORGANICS ON GROWTH, YIELD AND QUALITY OF STRAWBERRY (*FRAGARIA* × *ANANASA*DUCH.) CV. WINTER DAWN

Nikita Patel[1], D.K. Sharma[2] and B. Chakraborty[3]*

[1]Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari - 396 450,(Gujarat) India
[2]Department of Horticulture, College of Agriculture,Navsari Agricultural University, Bharuch- 392 001 (Gujarat) India
[3]Regional Research Station (Terai Zone), Directorate of Research, Uttar Banga Krishi Viswavidyalaya, Pundibari-736 165, Cooch Behar, West Bengal, India
Email: binayak@ubkv.ac.in

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Abstract: An investigation was carried out under open field condition to study the effect of four different liquid organics (seaweed extract, Novel Plus, *panchagavya* and cow urine) at concentration of 1.0 % and 3.0 % in spray solution on growth, flowering, yield and quality of strawberry. The foliar application of 3.0 % Novel Plus organic liquid nutrient found significantly improved the plant spread, leaves per plant, leaf area, length of petiole, crowns per plant. This foliar treatment also increased the number of flowers, number of fruits, fruit weight and length, percentage of marketable fruits per plant, yield per plant and marketable yield significantly over control plants which received no sprays. However, the best quality fruits in terms of TSS, ascorbic acid and sugar content were harvested from the plant receiving foliar spraying of 1.0 % Novel Plus.

Keywords: Liquid organics, Foliar application, Strawberry, Seaweed extract, Novel Plus

INTRODUCTION

Strawberry (*Fragaria* × *ananassa*Duch.) is a small perennial fruit crop belongs to the family Rosaceae. The fruits are very attractive, juicy, sweetly scented and rich in vitamins (A and C) and minerals (K and Fe). This fruit crop is gaining much more popularity both among the consumers and producers. This is an excellent fruit which can be consumed as fresh and in processed forms (Rathod *et al*., 2021). Among the farmers, strawberry farming is becoming a profitable venture because it offers very high return in the shortest possible time (Singh and Singh, 2009). Therefore, the cultivation of strawberry is expanding towards tropical to subtropical regions of India both under open as well as under protected conditions (Parmar *et al*., 2021).

Strawberry farming requires precious care and attention during entire growing period for harnessing maximum return. Now-a-days, the liquid organic nutrient sources, so-called liquid organics have been used widely in sustainable agricultural farming. Since, liquid organics have a rich source of plant essential nutrients and plant growth promoting substances. Thus, liquid organics bring a quick stimulative effect on plant growth, yield and quality in an ecofriendly manner. Further, these liquid organics are ideally suitable for application as foliar spraying. Several types of liquid organics are available in the markets for application in horticultural crop production like the liquid extract obtained from seaweeds contains growth promoting hormones (IAA and IBA), cytokinins, trace elements (Fe, Cu, Zn, Co and Mn), vitamins and amino acids (Ali *et al*., 2021). Novel Plus organic liquid nutrient has all the benefits of banana pseudostem sap based liquid fertilizers (*i.e*., Novel Organic Nutrient) in addition with insecticidal properties due to incorporation of different botanicals. Hence, Novel Plus organic liquid nutrient provides both plant growth promoting and insecticidal properties (Champaneri*et al*., 2021). Panchagavya (the blend of five products of cow), an organic mixture is reported to have a positive role on plant growth, pests and diseases resistance, hardiness to drought and improvement of soil health status (Kumar *et al.*, 2018). Cow urine has been described as a liquid with innumerable therapeutic value, capable of curing several diseases in plants and can also be used both as bio-fertilizer and bio-pesticide (Pradhan *et al*., 2018). However, the beneficial effects of these liquid organics have not been fully exploited in fruit crops more particularly in strawberries and being a herbaceous plant, strawberry is reported to be responded well to foliar application (Rathod *et al*., 2021). Hence, the present investigation was carried out to find out the effects of foliar application of liquid organics on growth, flowering, yield and quality of strawberry in Southern hilly parts of Gujarat.

MATERIALS AND METHODS

Experimental detail:

*Corresponding Author

The present investigation was carried out at Rambhas Farm (20°77' N and 73°50' E), Hill Millet Research Station, Navsari Agricultural University, Waghai, India during the year 2020- 21. The experimental site was sandy loam and neutral in reaction with pH 6.7. The available N, P and K of the field soil were 315.6, 61.7 and 230.50 kg ha^{-1}, respectively with 1.20 % organic C. The recommended dose of FYM 10 t ha^{-1} and fertilizers [N (as Urea), P_2O_5 (as SSP) and K_2O (as MOP) @ 120:80:100 kg ha^{-1}] were applied at the time of field preparation. Healthy, well developed, almost uniform, pest and disease-free runner plantlets of strawberry cv. Winter Dawn were planted at first week of November at a spacing of 60 cm × 30 cm under paddy straw mulching. Each experimental bed (3.6 m × 1.8 m) comprised of 36 plants with 16 plants in a net plot area (2.4 m × 1.2 m). Foliar spraying of liquid organics [Seaweed extract (1.0 and 3.0 %), Novel Plus (1.0 and 3.0 %), *Panchagavya* (1.0 and 3.0 %) and Cow urine (1.0 and 3.0 %)] was carried out at 45, 60 and 75 days after planting. The plants received no spraying was treated as control. The experiment was laid out in Randomized Block Design (RBD) with nine treatments and replicated thrice.

Five plants from the net plot area were selected randomly and tagged to record the plant growth and ancillary observations. The leaf area was measured using leaf area meter (Biovis PSM-L2000) and expressed in cm^2. Ten berries from the harvested fruit lot of each treatment were randomly selected to record the observations on physico-chemical properties. Digital refractometer (ATAGO Pocket 3810, PAL-1) was used to measure the fruit total soluble solid (TSS) content of the fruits. The fruits having weight < 10 g or malformed (Misshapen) or disease infected were considered as non-marketable fruits. The titratable acidity, sugar content and ascorbic acid of fruits were determined following the standard procedures. The data were analyzed for the variance and least significant differences (LSD) were calculated to compare significant effects at $p \leq 0.05$.

RESULTS AND DISCUSSION

Effect on growth and flowering of strawberry plant

The foliar spraying of liquid organics significantly influenced the vegetative growth of strawberry plants (Table 1). The plant growth in terms of plant spread (28.22 cm) was noted maximum in the plants which received foliar spraying of 3.0 % Novel Plus. The leaf with larger leaf lamina (145.58 cm^2) and maximum length of petiole (11.09 cm) were also recorded from the same set of plants. This treatment had also found to be the best for producing the highest number of leaves (23.67) and crowns (3.40) per plant in strawberry. All the above parameters were recorded minimum in control plants. The exogenous application of liquid organics failed to influence any significant effect on days taken to 50 per cent flowering in strawberry. However, the plants received 3.0 % Novel Plus exhibited earliest flowering with significantly maximum number of flowers (28.93) in strawberry (Table 1).

Novel Plus organic liquid nutrient contains growth promoting substances such as cytokinin and gibberellic acid which are known to be responsible for the cell division and cell elongation in plant system (Champaneri *et al*., 2021). Further, Novel Plus, basically a product that made from banana pseudostem sap which contains a rich source essential elements required for plant growth and development (Modi *et al*., 2021). The combine effect of both plant growth promoters and essential nutrients in Novel Plus organic nutrient might have resulted the maximum plant growth in-terms of plant spread, number of leaves, crowns, length of petiole and leaf area in strawberries. Enhancement of plant growth with the foliar application of banana pseudostem sap based liquid organic fertilizers has been also reported earlier in strawberries (Chakraborty *et al*., 2021). Novel Plus organic liquid nutrient contains GA_3 that might have stimulated the reproductive growth of strawberry plants resulting earliness in flowering with profuse number of flowers per plant (Champaneri*et al*., 2021). Exogenous application of GA_3 promoted the process of flowering with increased number of flower buds have been also reported in strawberry Paroussi*et al.* (2002).

Effect on fruiting and yield of strawberry

Foliar spraying of liquid organics significantly affected the fruiting of strawberry (Table 2). The plants received foliar spraying of 3.0 % Novel Plus produced fruits with maximum weight (16.75 g) and length (4.00 cm). The maximum number of fruits $plant^{-1}$ (17.37) and highest per cent of marketable fruits (90.98 %) were also recorded in the strawberry plants which received foliar spraying of 3.0 % Novel Plus. This treatment also registered the best for producing the highest marketable fruit yield (260.45 g $plant^{-1}$, 144.68 q ha^{-1}) and lowest percentage of non-marketable fruits (9.02 %). The lowest percentage of marketable fruits and yield were recorded in control plants.

The growth promoting substances present in Novel Plus, more particularly the gibberellic acid is known to regulate the process of mobilization of carbohydrate molecules from source (foliage) to sink (developing fruits) (Iqbal *et al*., 2011) and resulting in increased fruit weight and length. Additionally, the Novel Plus organic nutrient (banana pseudostem sap-based product) contains a rich amount of all the plant essential macro and micro elements. Hence, more nutrient supply in Novel Plus treated strawberry plants might have exhibited a higher photosynthetic activity, enhanced utilization of photosynthates and increased allocation of photosynthates towards the economic yield (Singhal *et al*., 2015). Increased fruit

weight with the foliar application of banana pseudostem sap based liquid organic fertilizer is also reported earlier in strawberry (Chakraborty *et al*., 2021). The fruit setting followed by the retention of fruits is depending upon the presence of endogenous level of growth promoters and inhibitors. The foliar spraying of Novel Plus might have regulated this balance in favour of fruit setting as well as retention of those fruits in plants and resulting in the highest number of fruits per plant. Maximum fruit setting and fruits with maximum weight in Novel Plus treated strawberry plants ultimately resulting in maximum number of marketable fruits and marketable fruit yield. Foliar application of banana pseudotsem sap is reported to enhance the yield of several crops like strawberry (Chakraborty *et al*., 2021) and banana (Patil *et al*., 2017). Contributed on effect of foliar spray of growth hormones on nodulation, growth and productivity in *Pisum sativum* (Tomar and Singh, 2005) and effect of foliar spray of Phenylhydrazine hydrochloride, Gibberellic Acid and Maleic hydrazide on stem and flower in *Spilanthesacmella*(Tomar, 2007).

Effect on fruit quality of strawberry

The fruit acidity and non-reducing sugar content in juice of the strawberry were not influenced by the foliar application of liquid organics (Table 3). However, the plants received foliar spraying of 1.0 % Novel Plus produced fruits with the higher TSS (8.95 °Brix) and ascorbic acid (92.96 mg $100g^{-1}$) content whereas, foliar spraying of 3.0 % Novel Plus produced fruits with maximum sugar content [total sugar (9.59 %) and reducing sugar (5.18 %)].The control plants produced fruits with lowest quality. The lowest acidic fruits were harvested from the plants that received foliar spraying of 1.0 % Novel Plus.

Novel Plus organic liquid nutrient contains a higher level of inherent potassium (K). Since, it is prepared through fermentation the sap extracted from the pseudostems of banana plant (Champaneri*et al*., 2021). The fermented liquid of banana pseudostem sap has a higher amount of K (Mahalakshmi and Naveena, 2016). Potassium has a major role in metabolism and translocation of photo-assimilates into the fruits (Marschner, 1995). Further, K nutrition also played significant role in improvement of fruit quality (Asaduzzaman and Asao, 2018). The growth promoting substances present in the Novel Plus organic liquid might have increased the volatile compounds along with hydrolysis of starchy compounds which ultimately raised the TSS level. The enzymatic activity like α-amylase and invertage in the strawberry plants sprayed with the Novel Plus liquid organics might be higher and resulting the sweetest fruit with the highest level of sugar content as well as lowest acidity. Additionally, the fruits with the highest Vitamin C content from the plants treated with Novel Plus might be due the stimulative effect of the inherent compounds present in Novel Plus on the precursor of ascorbic acid biosynthesis. Similar result with the foliar application of Novel organic liquid fertilizer is also reported in mango (Patel *et al*., 2018) and strawberry (Chakraborty *et al*., 2021).

Table 1: Effect of foliar application of liquid organics on growth and flowering of strawberry cv. Winter Dawn

Treatments	plant spread (cm)	Leaves $plant^{-1}$	Leaf area (cm^2)	Length of petiole (cm)	Crowns $plant^{-1}$	Days taken to 50.0% flowering	Flowers $plants^{-1}$
1.0 % Seaweed extract	22.97	21.67	136.59	10.30	2.47	43.33	26.87
3.0 % Seaweed extract	20.62	21.33	130.64	9.88	2.33	41.33	25.60
1.0 % Novel Plus	24.71	21.00	132.71	10.25	2.67	42.33	27.93
3.0 % Novel Plus	28.22	23.67	145.58	11.09	3.40	41.00	28.93
1.0 % *Panchagavya*	22.02	21.33	128.39	9.91	2.73	45.00	25.27
3.0 % *Panchagavya*	24.86	23.00	142.10	10.90	3.07	44.33	25.13
1.0 % Cow urine	21.68	19.00	122.97	9.80	2.47	42.67	24.47
3.0 % Cow urine	23.45	20.33	124.30	9.99	2.60	45.33	24.03
No spray (Control)	19.29	19.07	115.06	8.49	2.07	46.33	22.87
S.Em. ±	1.23	0.94	5.75	0.31	0.20	1.59	1.03
C.D. at 5%	3.68	2.81	17.23	0.93	0.60	NS	3.08

Table 2: Effect of foliar application of biostimulants on fruiting of strawberry cv. Winter Dawn

Treatments	Fruit weight (g)	Length of fruit (cm)	Fruits $plant^{-1}$	Marketable fruits (%)	Non-Marketable fruits (%)	Marketable Fruit yield	
						(g $plant^{-1}$)	(q ha^{-1})
1.0 % Seaweed extract	14.33	3.40	14.37	88.21	11.79	179.87	94.91
3.0 % Seaweed extract	13.14	3.48	14.30	87.16	12.84	164.32	84.49
1.0 % Novel Plus	15.37	3.74	16.27	89.34	10.66	220.88	121.53
3.0 % Novel Plus	16.75	4.00	17.37	90.98	9.02	260.45	144.68
1.0 % *Panchagavya*	12.83	3.33	14.53	84.86	15.14	154.18	79.51
3.0 % *Panchagavya*	14.60	3.64	15.47	87.42	12.58	197.49	105.56

1.0 % Cow urine	11.87	3.20	15.40	81.79	18.21	145.15	82.06
3.0 % Cow urine	12.37	3.33	14.47	81.47	18.53	142.63	74.07
No spray (Control)	11.33	3.19	14.53	79.33	21.01	125.00	66.44
S.Em. ±	0.49	0.15	0.52	1.10	1.09	6.10	3.35
C.D. at 5%	1.47	0.44	1.57	3.30	3.27	18.30	10.05

Table 3: Effect of foliar application of biostimulants on fruit quality of strawberry cv. Winter Dawn

Treatments	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg $100g^{-1}$)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)
1.0 % Seaweed extract	8.63	0.71	87.38	4.81	4.07	8.89
3.0 % Seaweed extract	8.48	0.77	87.24	4.69	4.00	8.69
1.0 % Novel Plus	8.95	0.64	92.96	5.15	4.38	9.53
3.0 % Novel Plus	8.80	0.67	92.16	5.18	4.41	9.59
1.0 % *Panchagavya*	8.39	0.68	84.33	4.50	3.75	8.25
3.0 % *Panchagavya*	8.43	0.78	90.46	4.50	3.93	8.44
1.0 % Cow urine	8.29	0.73	76.07	4.49	3.86	8.35
3.0 % Cow urine	8.22	0.70	76.39	4.56	3.87	8.43
No spray (Control)	7.26	0.83	73.67	4.39	3.83	8.22
S.Em. ±	0.21	0.04	1.35	0.11	0.22	0.22
C.D. at 5%	0.63	NS	4.04	0.32	NS	0.67

CONCLUSION

This study was focused to improve the fruit yield and quality of strawberry with the foliar application liquid organics that were prepared from the farm waste materials as a component of sustainable strawberry farming. The findings of the experiment suggested that the yield and quality strawberry could be improved with foliar application of 1.0-3.0 % Novel Plus at 45, 60 and 75 DAT of strawberry runners.

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