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EFFECT OF FOLIAR APPLICATION OF DIFFERENT NUTRIENTS AND GA_3 ON YIELD AND QUALITY OF STRAWBERRY

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ABSTRACT

The investigation entitled "effect of foliar application of different nutrients and GA_3 on yield and quality of strawberry" was carried out during 2022-23 at Regional Horticultural Research Station, Department of Fruit Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari. The experiment was laid out in randomized block design with three replications and eight treatments of different nutrients and GA_3, *viz*., Control (T_1), $CaNO_3$ @ 0.5 % + GA_3 100 ppm (T_2), Boron @ 0.5 % + GA_3 100 ppm (T_3), $ZnSO_4$ @ 0.5 % + GA_3 100 ppm (T_4), $FeSO_4$ @ 0.2 % + GA_3 100 ppm (T_5), Novel Organic Liquid Nutrients (NOLN) @ 1 % + GA_3 100 ppm (T_6), Nano urea @ 0.1% + GA_3 100 ppm (T_7) and 19:19:19 @ 1% + GA_3 100 ppm (T_8) sprayed at 30, 45 and 60 days after planting. Observed data clearly revealed that foliar application of Novel Organic Liquid Nutrients @ 1 % + GA_3 100 ppm increases number of flowers, number of fruits, fruit weight, fruit length, fruit diameter and quality parameters like maximum TSS, total sugar, anthocyanin and minimum acidity.

Keywords: Foliar application, Novel Organic Liquid Nutrients, GA_3, Strawberry, Yield, Quality

Introduction

Strawberry (*Fragaria* x *ananassa* Duch.) is one of the most important delicious, attractive soft fruit of the world belongs to the family Rosaceae and cultivated varieties are octaploid (2n=56) in nature. Most of the cultivated varieties originated from (*Fragaria* x *ananassa* Duch.) a hybrid between Virginia strawberries (*Fragaria* x *virginiana* Duch.) of Eastern North America and the widespread beach strawberry (*Fragaria* x *chiloensis* Duch.) of North and South America (Childers *et al.*, 1995). It is a herbaceous perennial temperate fruit crop, but can be successfully cultivated under sub-tropical and tropical areas of the world (Riyaphan *et al.*, 2005). Strawberry is a non-climacteric fruit, widely appreciated for its bright red colour, juicy texture, tantalizing flavour and delicious taste. It contains 18 different amino acid and also contains antioxidant. Strawberries are highly sensitive plants and also perishable in nature. Deficiency of nutrients has an adverse effect on crop productivity, stability and sustainability. Nutrients play a vital role in plant growth and developmental processes. Foliar feeding is proved to be the best method in respect of cost effectiveness and effortlessness operation. It is the rapid and efficient method as it supplies nutrients directly to a place wherever, it is required (Murtić *et al*., 2017). Calcium plays a prominent role in fruit production enhancing the shelf life and maintaining the quality of fruits (Lodhi and Tiwari, 2017). The role of boron in reproductive growth especially in pollen tube formation and its elongation inside the style (Singh *et al.*, 2022). It also reduces the incidence of fruit cracking. Zn has a pivotal role as a cofactor in enzyme activities in starch metabolism (Alloway, 2008). The metabolism of carbohydrates and proteins is also controlled by zinc. It also plays an important role in

photosynthesis and related enzymes resulting in increasing sugar and decreasing acidity (Abedy, 2001). Iron act as catalyst in synthesis of chlorophyll molecule and helps on the absorption of other elements (Zende, 1996). Iron plays an important role in chloroplast development and maintenance, plant metabolism and involved in the process of nitrogen fixation (Meena *et al.*, 2008). Novel organic liquid nutrient is a patented product of Navsari Agricultural University, Navsari, Gujarat, India made from banana pseudostem sap and other organics. NAUROJI Novel Organic Liquid Nutrient formulation is good source of plant nutrients contained macro elements in the range of 1.00 to 1.12 % N, 0.50 to 0.71 % P, 2.39 to 20.2 % K and micro nutrients in the range of 259 to 323.2 mg/kg Fe, 47.3 to 241.3 mg/kg Mn, 10.1 to 107.4 mg/kg Zn and 13.4 to 83.6 mg/kg Cu along with growth promoting substances like cytokinin, gibberellic acid *etc.* (Gurjar *et al.*, 2022). IFFCO released a new nano fertilizer called nano urea, which has manifold benefits over conventional urea. It reduces the requirement of conventional urea by 50 percent or more, environment friendly, improve soil, air and water quality thus, helps in reducing the global warming. It is cheaper than conventional urea and reduce input cost to farmers and leads to increase in farmer's income (Prem Babu, 2021). Nano urea is more efficacious in terms of nutrient absorption owing to lesser losses (Kumar *et al.*, 2021). Water soluble fertilizer (19:19:19) is contributing nitrogen 19 %, phosphorus 19 % and potassium 19 %. It is free of chloride and contains high-quality macronutrients and essential nutrients (Raj *et al.*, 2019). Recently, plant growth regulators have become an effective tool in the cultivation of fruit plants. Gibberellic acid is most effective in promoting cell elongation and cell division through boosting amylase activity and counteracting the apical dominance phenomenon (Rustam *et al.*, 2017). GA_3 has a positive effect on fruit set and increases fruit size, total yield and quality. The role of these different nutrients and GA_3 has been investigated in several fruits. Hence, the present investigation was carried out to find out the effect of foliar application of different nutrients and GA_3 on growth, yield and quality of strawberry.

Materials and Methods

Experimental site and planting material: The present investigation, titled "effect of foliar application of different nutrients and GA_3 on yield and quality of strawberry" was conducted during 2022-23 growing season at the Regional Horticultural Research Station, Department of Fruit Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari. The experimental site had heavy black soil, rich in organic matter and potash, moderately drained with good water holding capacity. Healthy, well-developed, uniform, insect-pest and disease-free runner plantlets at two-three leaf stage of strawberry cv. Winter Dawn were planted at a spacing of 30 cm × 30 cm under silver plastic mulch during the first week of November. The recommended dose of FYM (10 t ha^{-1}) and fertilizers [N (as Urea), P_2O_5 (as DAP) and K_2O (as MOP) @ 120:80:100 kg ha^{-1}] were applied at the time of field preparation.

Experimental Design and Treatments: The experiment was laid out in Randomized Block Design (RBD) with eight treatments and three replications. Each experimental raised bed (3.3 m × 0 .9 m) comprised 32 plants with 8 plants in a net plot area (2.4 m × 0.3 m). Foliar application of different nutrients and GA_3 was carried out at 30, 45 and 60 days after planting. The treatments were as follows: T_1 = Control, T_2 = $CaNO_3$ @ 0.5 % + GA_3 100 ppm, T_3 = Boron @ 0.5 % + GA_3 100 ppm, T_4 = $ZnSO_4$ @ 0.5 % + GA_3 100 ppm, T_5 = $FeSO_4$ @ 0.2 % + GA_3 100 ppm, T_6 = Novel Organic Liquid Nutrients (NOLN) @ 1 % + GA_3 100 ppm, T_7 = Nano urea @ 0.1% + GA_3 100 ppm, T_8 = 19:19:19 @ 1% + GA_3 100 ppm.

Flowering analysis: Days taken to 50 % flowering were counted by number of days from the date of planting to when 50% of the plants have flowering while, number of flowers per plant were recorded during weekly by observing fully opened flowers in each treatment.

Fruit yield analysis: Number of fruits per plant was recorded at each picking. Fruit length and diameter were measured in centimeters using vernier calliper and fruit weight was recorded in gram with help of high precision. Fruit yield was recorded from first picking to the end of the experiment and converted into kg/ha. Fruit weighing less than 10 g or Diseased or misshapen fruits were considered as non-marketable.

Quality analysis: Digital refractometer was used to measure the total soluble solid (°B) content of the fruits. Titratable acidity, total sugar content and anthocyanin content were determined following the standard procedures (AOAC, 1980).

Statistical analysis: Data were analysed by standard method of analysis of variance technique appropriate for the randomized block design (RBD) as described by Panse and Sukhatme (1985). The treatment differences were tested by using 'F' test at 5% level of significance based on null hypothesis.

Results and Discussion

Effect on flowering of strawberry plant

Table 1 presents the mean data for flowering parameters. The exogenous application of different nutrients and GA_3 do not show any significant effect on days taken to 50 per cent flowering in strawberry. However, the plants received NOLN @ 1 % + GA_3 100 ppm exhibited earliest flowering with significantly maximum number of flowers (28.73) in strawberry. It might be due to novel organic liquid nutrients contains all essential elements which boost more vegetative growth that resulted in formation of more metabolites to stimulate the flowering. Additionally, the presence of GA_3 promoted more inflorescence growth, leading to the production of additional flowers. The research results are in conformity with the earlier findings of Kumar and Tripathi (2009) and Khushbu *et al.* (2021) in strawberry.

Effect on fruiting and yield of strawberry

The data regarding yield parameters influenced by different nutrients and GA_3 spray are tabulated in Table 2. The plants treated with foliar application of NOLN @ 1 % + GA_3 100 ppm produced maximum number of fruits plant^{-1} (16.53), fruit weight (16.57 g), fruit length (4.13 cm) and fruit diameter (3.87 cm). Highest fruit yield (14209 kg/ha) with maximum marketable fruit yield (12630 kg/ha) were also recorded in the strawberry plants which received foliar spraying of NOLN @ 1 % + GA_3 100 ppm. This treatment also registered the best for producing the lowest percentage of Diseased or Misshapen Fruits (11.27 %). The lowest marketable fruit yield was recorded in control plants. The enhancement in number of fruits per plant, fruit weight, fruit length, fruit diameter and fruit yield might be due to novel organic liquid nutrients contains all the essential elements that required by the plant that promote more vegetative growth, increased flowering and more fruit set. Additional application of GA_3 improved the better supply of nutrients and other compounds to the fruits that are vital for their proper growth and development, which resulted in improved fruit size and ultimately high yield. These results are in conformity with the findings of Nikita *et al.* (2022) in strawberry and Gurjar *et al.* (2023) in mango and sapota. Moreover, novel organic liquid nutrient contains ample amount of macro and micro nutrients that promote more vegetative growth, while application of GA_3 stimulates the development of ovaries and enhances the production of hormones responsible for fruit growth and development which leads to increase in number of fruit set. The similar results were also found by Khushbu *et al.* (2021) in strawberry and Champaneri *et al.* (2021) in Indian bean.

Effect on fruit quality of strawberry

The effect of different treatments on fruit qualitative parameters are presented in Table 3. Plant treated with NOLN @ 1 % + GA_3 100 ppm produce fruits which have higher TSS (9.41°B), total sugar (9.63 %) and anthocyanin content (41.29 mg 100 g^{-1}). The lowest acidic (0.63 %) fruits were harvested from the plants that received foliar spraying of NOLN@ 1 % + GA_3 100 ppm. The control plants produced fruits with lowest quality. It might be due to the influence of a higher concentration of GA_3 might have been rapidly converted into sugar and novel organic liquid nutrient contains macro, micro elements and plant growth regulators which increase respirational demand and adequate supply of nutrients, synthesis of invertase and starch splitting enzymes decrease the acidity in fruit and also affect the physiological processes such as respiration and photosynthesis, which improved the supply of dry matter, minerals and carbohydrates towards the developing fruits. Similar results were reported earlier by Tulsi *et al.* (2017) in banana, Patel *et al.* (2018) in mango, Khushbu *et al.* (2021) and Abdullah *et al.* (2023) in strawberry.

Table 1: Effect of different nutrients and GA3 on growth and flowering of strawberry

Treatments	Days taken to 50% flowering	Flowers plant^{-1}
T_1 : Control	48.80	21.67
T_2 : $CaNO_3$ @ 0.5 % + GA_3 100 ppm	42.77	27.93
T_3 : Boron @ 0.5 % + GA_3 100 ppm	42.37	28.27
T_4 : $ZnSO_4$ @ 0.5 % + GA_3 100 ppm	45.30	24.60
T_5 : $FeSO_4$ @ 0.2 % + GA_3 100 ppm	43.93	25.00
T_6 : NOLN @ 1 % + GA_3 100 ppm	42.03	28.73
T_7 : Nano urea @ 0.1% + GA_3 100 ppm	46.70	23.73
T_8 : 19:19:19 @ 1% + GA_3 100 ppm	45.93	24.33
S.Em. ±	2.21	1.20
C.D. at 5 %	NS	3.69

Table 2: Effect of different nutrients and GA_3 on fruiting and yield of strawberry

Treatments	Fruits plant^{-1}	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit yield (kg/ha)	Marketable fruit yield (kg/ha)	Diseased or Misshapen Fruits
T_1 : Control	11.80	11.30	2.79	2.59	9428	7984	15.22
T_2 : $CaNO_3$ @ 0.5 % + GA_3 100 ppm	15.17	14.87	3.60	3.52	12264	10802	11.86
T_3 : Boron @ 0.5 % + GA_3 100 ppm	16.27	15.93	3.89	3.63	12944	11435	11.74
T_4 : $ZnSO_4$ @ 0.5 % + GA_3 100 ppm	13.97	12.87	3.55	3.21	11547	9976	13.66
T_5 : $FeSO_4$ @ 0.2 % + GA_3 100 ppm	14.47	13.73	3.58	3.37	11644	10084	13.45
T_6 : NOLN @ 1 % + GA_3 100 ppm	16.53	16.57	4.13	3.87	14209	12630	11.27
T_7 : Nano urea @ 0.1% + GA_3 100 ppm	12.67	11.90	3.29	2.82	10363	8883	14.45
T_8 : 19:19:19 @ 1% + GA_3 100 ppm	13.33	12.13	3.44	3.02	11053	9559	13.47
S.Em. ±	0.66	0.67	0.18	0.16	827	725	0.76
C.D. at 5 %	2.04	2.05	0.54	0.49	2534	2222	2.34

Table 3: Effect of different nutrients and GA_3 on quality of strawberry

Treatments	TSS (°B)	Acidity (%)	Total sugar (%)	Anthocyanin (mg 100 g-1)
T_1 : Control	8.07	0.83	8.21	31.80
T_2 : $CaNO_3$ @ 0.5 % + GA_3 100 ppm	9.21	0.69	9.31	38.57
T_3 : Boron @ 0.5 % + GA_3 100 ppm	9.27	0.67	9.52	40.55
T_4 : $ZnSO_4$ @ 0.5 % + GA_3 100 ppm	8.62	0.73	8.98	36.33
T_5 : $FeSO_4$ @ 0.2 % + GA_3 100 ppm	8.85	0.72	9.05	37.38
T_6 : NOLN @ 1 % + GA_3 100 ppm	9.41	0.63	9.63	41.29
T_7 : Nano urea @ 0.1% + GA_3 100 ppm	8.37	0.79	8.49	33.87
T_8 : 19:19:19 @ 1% + GA_3 100 ppm	8.57	0.77	8.69	37.74
S.Em. ±	0.18	0.02	0.18	0.93
C.D. at 5 %	0.57	0.05	0.55	2.85

Conclusions

On the basis of the result obtained from the present investigation that the foliar application of different nutrients and GA_3 at 30, 45 and 60 DAP give good response to growth, flowering, yield and quality parameters. The findings suggest that Novel Organic Liquid Nutrients @ 1 % + GA_3 is a promising treatment for enhancing flowering, fruiting, yield and quality.

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