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Effect of Different Levels of PGRs with Organic Manure on Growth Characters and Economics of Strawberry (*Fragaria x ananassa* Duch.) *cv.* Chandler in Northern region

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A B S T R A C T

A field experiment was conducted at the Crop Research Farm, Department of Horticulture, Allahabad School of Agriculture, SHIATS, Allahabad (U.P.) entitled "Effect of different levels of PGRs with Organic Manure on growth characters and Economics of Strawberry (*Fragaria x ananassa* Duch.) *cv.* Chandler in Northern region." PGRs namely NAA (100, 150 and 200 ppm), GA_3 (100, 150 and 200 ppm), Triacontanol (100, 150 and 200 ppm) and CCC (400, 800 and 1200 ppm) were applied as foliar spray and poultry manure (2.50, 5.50 and 8.50 tones ha^{-1}) was mixed in soil during field preparation. The plant growth parameters like plant height, plant spread and petiole length increased with application of poultry manure and GA_3 at all successive stage of plant growth. The treatment combination 8.50 tones poultry manure + 200 ppm GA_3showed the maximum plant height, plant spread and petiole length. The minimum plant height, plant spread and petiole length was observed with 8.50 tones poultry manure + 1200 ppm CCC and the maximum number of leaves per plant was recorded with 5.50 tones poultry manure + 150 ppm GA_3treated plants. The highest benefit cost ratio was recorded with 5.50 tones poultry manure + 150 ppm Triacontanol treated plants.

Introduction

The common cultivated strawberry *(Fragaria x ananassa* Duch.) is considered as a hybrid between *F. virginiana* and *F. chilonensis. F.* species belongs to rosaceae family with basic chromosome number X=7. Genus *Fragaria* includes atleast 17 other species (diploid, tetraploid, hexaploid and octoploid). The cultivated strawberry is an octoploid (2n=8x=56). Strawberry is also nutritious and beneficial for anemic patients. Strawberry

consumption can reduce the risk of cancer by 50% due to high level of vitamin - C (30 - 100 mg/100 g) foliate and photochemical compound such as the ellagic acid present in the fruit. Besides this, it is also a fairly good source of vitamin - A (60 IU/100 g) Kumar *et al.* (2011).

In 2012, (1,312,960 MT) 30.4 % of the total production came from the United States of America. The other major strawberry producing countries are Turkey (302,416 MT) 7.0 %, Spain (262,730 MT) 6.0%, Egypt (240,284 MT) 5.5% and Mexico (228,900 MT) 5.3% of world (Sources: FAOSTAT data, January 2014). In India it is grown in Dehradun, Nainital (Uttarakhand), Solan, Kullu and Palampur (H.P.), Srinagar (J&K) and hills of Darjeeling (W.B.). Now it's cultivation is gaining popularity in the tropical and sub-tropical areas of Gurgaon (Haryana), Muzaffer Nagar, Saharanpur and Meerut (U.P.), Jalandhar, Patiala, Ludhiana and Gurdaspur (Punjab) and Pune (Maharastra).

The fresh ripe fruit of strawberry are rich source of vitamins, minerals and among vitamins it is fairly good source of vitamin A and vitamin C. It has high pectin, available in the form of calcium pectate, which serves as an excellent ingredient for jelly making. Besides it also has abundance of minerals, like potassium, calcium and phosphorus. In strawberry the ellagic acid (naturally occurring plant phenol) has been found to inhibit cancer disease. The regular consumption of strawberry fruits also controls asthma.

Most strawberry cultivars produce hermaphrodite flowers and are self-fertile. However, some also produce male or staminate, imperfect and female or pistillate flowers. Hermaphrodite flowers are self-fertile and pistillate flowers requires cross pollination for fruit production. The inflorescence is really a modified stem and at each node of the inflorescence a bract replaces the leaf while the bud in the axil of the bract develops into a branch of the inflorescence. Strawberry is an aggregate fruit and non-climateric fruit which develops by simultaneous ripening of the number of separate berries of a single flower, adhering as the common unit on the common receptacle, botanically called as "etaerio of achenes". Strawberry is usually propagated through runners. Now a day, large scale propagation by tissue culture has been used widely in strawberry industry.

Strawberry can be grown in wide climatic conditions, ranging from temperate to tropical climate. Since its cultivation is greatly influenced by specific regional adaptation due to photoperiodic and temperature requirement, hence cultural practices are highly variable. Among the different climatic factors, temperature and day length affect considerably the growth and yield of strawberry. Its flowering is strongly influenced by photoperiod, temperature and its interactions. Photoperiod has a marked effect on strawberry vegetative growth, plant morphology and yield. Growth and development of strawberry is highly sensitive to variations in air and soil temperature. An optimum growing season temperature of 15^0C has been reported for most of the strawberry cultivars and species and range between 20 to 26^0C, the ambient temperature for proper growth. Plants grow very fast in plains and its starts bearing within three months of planting and in hills, it takes 9-12 months to come to bearing. However, the fruit quality is very good in hills as compared to plains. Similarly, the colour and flavor development is not proper in plains. Triacontanol treated plants increased number of root which causes plants to take up more nutrients from soil and increased production per plants (Blarke and Lenz, 1983). Fruit set, early flowering, yield and fruit quality (i.e. berry size, weight and

volume) was increased with Azotobacter and Azospirillum in combination with 60 kg nitrogen/ha and 100 ppm GA_3 in strawberry *cv.*sweet Charlie (Singh and Singh, 2006). NAA treated plant increased juice content of fruit (Kumar *et al*., 2012).

Organic manures in soil have been associated with increases in water-holding capacity, cation-exchange capacity, aeration and root depth as well as decrease in soil crusting and erosion. Poultry manure, Compost, Farm yard manure and vermi-compost have been utilized in agriculture as a significant source of organic manure. Manures supply plant nutrients including micronutrients, provide food for soil micro-organisms and buffering action in soil reaction. 3.03 % N, 2.63 % P_2O_5 and 1.4 % K_2O nutrient composition of poultry manure (Katyayan, A., 2008).

Continuous and indiscriminate use of chemical fertilizers has caused serious damage to the soil ecosystem and physico-chemical characteristics so there is need to use the organic manure in place chemical fertilizers to maintain the soil ecosystem. Plant growth regulators (PGR's) are plant hormones enhancers or disruptors. They can be manmade or naturally derived. Plant hormones play many roles in plants growth, as root or shoot growth, leaf drop, flower development and fruiting. They have the potential of increasing plant productivity and quality through influence on various metabolic processes.

Effect of Plant Growth Regulators in Strawberry

Gibberallic acid (GA_3)

Khokhar *et al*. (2004) reported that GA_3 at 75 ppm produced the tallest plants, the highest leaf area, number of leaves per plant, cumulative fruit yield, fruit weight and fruit volume while fruit anthocyanin content in strawberry was highest with GA_3 at 50 ppm. Tripathi and Shukla (2006) reported that GA_3 at 100 ppm concentration produced tallest plants (20.39 cm) with higher number of leaves (18.09) and number of flowers (16.23). Further this treatment extended the duration of flowering (72.66 days) and resulted in higher yield (112.95 g.) per plant with maximum length (3.09 cm) and weight (8.02 g.) of berries of strawberry. Kaur *et al.* (2009) reported that vegetative growth, yield and fruity quality was improved with 100 ppm GA_3 while reduced acidity and higher ascorbic acid of fruit was also found with early planting treatment in strawberry.

Sharma and Singh (2009) reported that 75 ppm GA_3 spray either during November or February or both has increased the leaf petiole, leaf area and leaf number significantly. Fruit size decreased, and fruit number increased but there was no remarkable effect on fruit quality parameters of strawberry. Kumar *et al.* (2012) reported that the best result in terms of vegetative growth, runner production and ascorbic acid with 90 ppm GA_3 treated strawberry (*Fragaria x ananassa* Duch.) *cv.* Sweet Charlie.

Kumar *et al.* (2013) reported that the highest juice content of fruits (86.70/86.46%), TSS (7.56/7.43^{0}Brix), sugar content (4.33/4.26%), pH of fruit (3.87/3.86) were recorded in 50 ppm GA_3 treated strawberry (*Fragaria x ananassa* Duch.) *cv*. Belrubi. The plant growth parameters like plant height, plant spread and petiole length increased with application of poultry manure and GA_3 at all successive stage of plant growth. The treatment combination 8.50 tones poultry manure + 200 ppm GA_3 showed the maximum plant height, plant spread and petiole length.

Chloro Choline Chloride (CCC)

Dwivedi *(*1987) observed that the maximum

days taken to produce first of flower strawberry from date after transplanting with 1000 ppm cycocel under long day conditions. the crown height, number of leaves and leaf area were reduced of strawberry *cv*. Teoga. Pankov (1992) reported that increased fruit yield (1.6 and 1.9 t/ha respectively) with 2.4% a.i. CCC treated of strawberry mother plants cv. Yasna and Senga Sengana.

Tripathi and Shukla (2007) reported that the maximum berry width was recorded with 1000 ppm CCC treated plants of strawberry *cv*. Chandler. Kumar and Saravanan (2010) reported that highest plant height (24.13cm) obtained with GA_3 125 ppm treated plants and highest length diameter ratio of fruits (2.10) recorded with treatment T_{10} (GA_3 75ppm + CCC 500 ppm) treated strawberry plants. Kumar *et al.* (2012) reported that the highest values for fruit yield (330.7 g/plant and 20.15 t/ha) and cost benefit ratio (1:2.70) were recorded with 500 ppm cycocel.

Triacontanol

Thakur *et al*. (1991) reported that highest number of leaves per plant (7.2) and leaf area (149.4 cm) of strawberry *cv*. Teoga were obtained with 50 ppm triacontanol. Kumar *et al.* (2011) the results revealed that highest number of fruits (23.31), yield per hectare (27.90 tones), length diameter (1.50) and cost benefit ratio (1:3.1) were recorded with triacontanol 5 ppm treated strawberry (*Fragaria* x *ananassa* Duch.) *cv*. Sweet Charlie plants.

The maximum weight of fruit, maximum length diameter ratio of fruits, maximum specific gravity was recorded with poultry manure + 100 ppm triacontanol treated plant and the maximum fruit yield per plot (3301.83 g) and fruit yield per ha. was recorded with treatment T_7 (5.50 tones poultry manure + 150 ppm triacontanol).

Naphthalene Acetic Acid (NAA)

Techawongstein (1989) reported that spraying with 400 ppm NAA resulted in the highest fruit diameter, weight, volume, acidity per cent (as citric acid equivalent) and the lowest sugar: acid ratio in strawberry cv. Tioga. Mir *et al*. (2004) recorded that plant height, plant spread, number of leaves per plant, petiole length, leaf area index, days to first flowering and days to fruit bud development, fruit yield per plant, highest fruit yield per hectare and improved fruit quality of strawberry *cv*. Sweet Charlie with NAA at 0, 10, 15, 20, 25, 30 and 35 ppm. Asrey *et al.* (2004) reported that the pre-harvest treatment with NAA 25 ppm favoured the higher vitamin C (49.30 mg/100 g pulp) content of strawberry *cv.* Chandler during storage. Villarreal *et al.* (2009) reported that the treatment with naphthalene acetic acid (NAA) delayed ripening and anthocyanin accumulation of strawberry fruits.

Effect of organic manure in Strawberry

Poultry manure

Turemis (2002) reported that the fruit yield was 490.2 g/plant with wheat straw + poultry manure while with poultry manure fruit yield was 436.6 g/plant in strawberry. Singh *et al.* (2006) reported that the highest values for plant height (23.39 cm), plant spread (24.21 cm), runners per plant (13.03) and yield (238.95 g/plant) as well as the earliest blooming (10.33 days) along with better quality of strawberry *cv*. Senga Sengana with treatment combination poultry manure + *Azotobacter* + wood ash + phosphate solubilizing bacteria + oil cake. Umar Iqbal *et al.* (2008) reported that the maximum plant height 20.29 cm, plant spread 27.65 cm and leaf area 69.05 cm^2ofstrawberry *cv.* Chandler with the application of 50 per cent nitrogen through poultry manure and remaining quantity in the form of urea in combination with *Azotobacter*. Ngodup and Sarvanan

(2010) reported that highest plant height, plant spread, petiole length, no. of leaves, fruit per plant and the highest yield of strawberry (*Fragaria* × *Ananassa* Duch). *cv.* Chandler was obtain from T_7 (vermicompost @2tonnes /ha + poultry manure @ 2tonnes /ha). Subhajith and Prasad (2010) the results revealed that the application of 50% NPK+ 50% poultry manure of recommended dose noticed 15.31 tones yield per hectare and 0.81 % acidity and 50.80 mg/100 g ascorbic acid of strawberry (*Fragaria* × *ananassa* Duch). *cv.* Chandler. Ayesha *et al.* (2011) reported that improvement in the fruit weight of strawberry observed (10.0 g) with T_3: Soil+ Silt+ Poultry Manure (1: 1: 1). Nowsheen *et al*. (2012) reported that maximum plant growth and fruit yield (132.75q/ha) of strawberry obtained with treatment Poultry manure + *Azotobacter*+ Wood ash+ PSB+ Oil Cake (T_2).

The present investigation at the Experimental Field of the Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed to-be University), Allahabad U.P. It was concluded that the maximum plant height, plant spread and petiole length, maximum number of leaves per plant was recorded with poultry manure and GA_3 treated plants. The highest benefit cost ratio was recorded Poultry manure and triacontanol treated plants. The application of poultry manure, GA_3, and triacontanon is recommended for better vegetative growth and economics of strawberry under northern region. Hence, overall use of plant growth regulators (PGR's) and poultry manure not only increases plant growth and yield but also results in the improvement in fruit quality of strawberry.

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