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Research Article

Effect on yield and qualitative characteristics of strawberry (*Frageria annanasa*) cv. chandler to foliar application of gibberellic acid and zinc

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Abstract

This research study was conducted to evaluate the effects of gibberellic acid and zinc on quality production of strawberry. The application of plant growth regulator and micro nutrients have a vital role in enhancing productivity and quality of strawberry fruits. This will enhance the productivity and quality of the crop on a large scale which are applied in minute quantity. Strawberry plants were sprayed with different concentrations of GA_3 (0, 50, 100,150, 200 ppm) and Zinc (0, 0.2, 0.4 and 0.6%) after thirty days of transplantation. Results indicated significant variations in all the growth and quality attributes of strawberry fruit. Application of GA_3 @ 200 ppm gibberellic acid increased number of leaves plant^{-1}, plant height, number of fruits plant^{-1}, fruit yield plant^{-1}, leaf area plant^{-1} and total fruit yield. On the other hand, application of GA_3 @ 200 ppm significantly increases days to flowering, days to fruit set and days to fruit maturity. Similarly, maximum plant height, number of leaves plant^{-1}, leaf area plant^{-1}, number of fruits per plant, fruit yield plant^{-1}, total fruit yield, numbers of days to flowering, number of days to fruit set and number of days to fruit maturity were observed in the plants applied with 0.6% zinc as a foliar spray. It is concluded that 200 ppm and 0.6% of GA_3 could be used as foliar spray to obtain quality fruit production of strawberry under the agro climatic condition of Peshawar.

Keywords: Achene; Cell division; Chandler; Flowering; Parthenocarpy; Protein synthesis

Introduction

Strawberry (*Fragaria ananassa*), is a member of the family Rosaceae and belong to sub family rosoideae. It is herbaceous and perennial plant in nature. It produces hermaphroditic flowers in nature, its fruit is commonly called as achenes [1]. It is widely cultivated in almost 73 countries of the world. Largest producer is the United State which contributing about 27% world's total production, with an average of 1312.96 thousand metric tons' ha^{-1}. On an area of 179 hectares it is cultivated in Pakistan with total annual production of 609 tonnes. [2]. In province of Khyber Pakhtunkhwa, it is cultivated in

October to November and its fruit reach to maturity at the end of March and start of April and goes up to June [3]. It is a good source of minerals, iron, sodium, fiber and vitamin C (64 mg). The fruit also consist of 89.9% water [4]. The essential organic acids are malic and citric acids, which contribute to the taste. Greater amount of other non-nutrients substances like flavonoids and phenols are present of strawberries as compared to the fruit of other berries fruit [5]. Strawberry juice is extracted from its fruit which can be used in fresh form and can also preserved to james, jellies and squashes so as to used it in off season time. Strawberry fruit as it is too perishable fruit which could to be transported and handled carefully [6].

Gibberellic acid enhances the growth at most plant species especially rosette plants as well as increased the yield [7]. GA_3 regulates flower initiation, its development and it is very essential for female and male fertility. Zinc are involved in many important processes like protein analysis and synthesis [8]. Zinc has an important role either as a metallic part of many enzymes, as a cofactor and regulatory of a more number of enzymes [9]. This research study is planned to investigate the impact of $GA_3$and Zn as a foliar spray on the yield and quality of strawberry.

Materials and Methods

The research was conducted at Malakandair Research Farm and Hort. laboratory, Department of Horticulture, The University of Agriculture Khyber Pakhtunkhwa Peshawar during the year of 2016-17. Randomized Complete Block Design was used. Different levels of GA_3 (ppm): 0, 50, 100, 150 and 200. Zn Levels (%): 0, 0.2, 0.4, 0.6. Each treatment was replicated three times while total treatments were twenty. Field was well prepared before transplanting strawberry cv. Chandlar plants. Plants in the field were planted on raised beds in double rows [10]. P-P distance was kept 20 cm while R-R distance was 50 cm. These attributes were studied during this research. Number of leaves per plant, plant height (cm), number of days to flowering, days to fruit set, days to fruit maturity, number of fruits per plant, fruit yield per plant and total fruit yield ($kgha^{-1}$).

$$\textbf{Total Yield } (kgha^{-1}) = \frac{\text{Yield plot}^{-1}\text{ (kg)}}{\text{Plot area } (m^2)} \times 10000 m^2$$

The collected data were analyzed and collected through statistical software (8.1) for taking means and analysis of variance were compared at 5% level of significance by applying LSD [11].

Results and discussion

Foliar application of gibberellic acid and zinc concentrations significantly affected all the studied parameters. Plants treated with 200 ppm GA_3 was observed with maximum leaf area $plant^{-1}$ (165.4 cm^2). While less leaf area $plant^{-1}$ (156.7 cm^2) was noted in the control. (Table 1). Plants sprayed with 0.6% zinc, highest leaf area $plant^{-1}$ (163.5 cm^2) was recorded (Table 1). Gibberellic acid helps to improve the cell division [7]. Similar results were obtained by [12]. Zinc play an important role in functional, structural, photosynthesis, protein synthesis, synthesis of auxin, cell division, maintenance of function and structure of membrane of the plants which may enhance leaf area [13]. Similar findings were recorded by [12]. Plants applied with 200 ppm highest number of leaves $plant^{-1}$ (16.0) were noted and with application of plants treated with 0.6% Zn maximum number of leaves $plant^{-1}$ (15.1) was obtained. Whereas less number of leaves $plant^{-1}$ (13.5) were observed in the control (Table1). This may occur due to the sufficient increase of photosynthetic rates. These finding are in line with the results noted with [14]. Zn contribute a lot for essential enzymatic reactions with in the plant like synthesis of cell wall, protein formation, protein metabolism, initiation of flowers and fruit formation [15, 16] obtained similar results.

Strawberry plants treated with 200 ppm GA_3, and 0.6% zinc recorded highest plant height (19.6 cm) and (18.0 cm) respectively. GA_3 improve the cell division

and enlargement which results in increase the plant growth [7]. Zn has a great role in the induction of the growth promoting hormone like IAA, which increases plant height. Similar findings were obtained by [7]. The minimum days to flowering (113.4) and (116.8) of strawberry plants were obtained in the plants applied with 150 ppm GA_3 and 0.4% zinc respectively [17]. Zinc play an essential and vital role in pollination, fruit set and total yield. Our results are similar with [18].

Table 1: Effect of application of GA_3 and zinc leaf area plant^{-1} (cm^2), number of leaves per plant, plant height (cm), days to flowering and days to fruit set of strawberry

GA_3 Levels (ppm)	Leaf area plant^{-1} (cm^2)	Number of leaves plant^{-1}	Plant height (cm)	Days to flowering	Days to fruit set
0	156.7d	12.7e	10.1d	129.2a	8.7a
50	158.2cd	13.6d	12.7c	123.3b	7.5b
100	159.6c	14.2c	15.7b	121.8b	6.9c
150	162.6b	15.2b	18.0a	113.4c	5.7e
200	165.4a	16.0a	19.6a	116.1c	6.4d
LSD at α 0.05	1.617	0.593	2.155	3.761	0.417
Zinc (%)					
0	156.5c	13.5d	12.1c	125.8a	7.9a
0.2	160.6b	14.1c	14.6b	121.1b	7.4b
0.4	161.4b	14.7b	16.0b	116.8c	6.3c
0.6	163.5a	15.1a	18.0a	119.3bc	6.6c
LSD at α 0.05	1.446	0.531	1.927	3.364	0.373
Interactions					
GA x Zn	---	---	---		
Significance Level	N.S	N.S	N.S		

Means followed by same letters in column at 5% probability level do not differ significantly from each other. N.S: Non-significant

Minimum days to fruit set (5.7), (6.3) were obtained with application of 150 ppm GA_3, 0.4% zinc on strawberry plants respectively (Table 2). GA_3 have a great role in pollen tube growth and pollen germination and better results are obtained in fruit set with foliar application of gibberellins [14]. Our results are parallel in line [15]. With foliar application of 150 ppm gibberelic acid minimum days to fruit maturity (19.4) were noted in the plants and with 0.4% Zn application. Less number of days to fruit maturity (20.9) were obtained (Table 2). It might be mainly due to the synthesis of plant hormones which convert shoot to flowers that ultimately lead to early fruit formation as explained by [18, 19]. The Plants treated with 200ppm GA_3, 0.6% Zn highest number of fruits plant^{-1} (10.6) and (10.0) was were recorded (Table 2). GA_3 enhance the differentiation of inflorescence which might be due this reason and similar results were reported by [20]. Zinc and boron have a significant role in successful pollination, fruit set and total yield in plants [15]. Similarly, significant findings were obtained by [21, 22]. Plants treated with 200 ppm GA_3 maximum fruit yield plant^{-1} (212.8g), with 0.6% zinc highest fruit yield plant^{-1} (209.8g) were observed (Table 2). Results are similar with Kazmi, [15]. Zinc influence photosynthesis could be due to the reason of increase in chlorophyll content, change in chloroplasts structure, photosynthesis electron transport systems and fixation of CO_2 fixation. Our findings are similar with Sharma *et al.* [23]. Maximum total fruit yield (21.3 t ha^{-1}) and (21.1 t ha^{-1}) was obtained from the strawberry plants treated 200 ppm GA_3

and 0.6% zinc respectively (Table 2). Role of GA in developing fruit quantity such as, fruit size and fruit weight might be due to its major role in enhancing cell enlargement [16]. Zinc is an important part of many enzyme systems for protein synthesis, energy production, growth development and helps in photosynthesis process by maintain full complement of chloroplast [24]. The present result is similar with the result of [25]. Similar findings were obtained by [26]. Minimum results for all the studied parameters were obtained in control.

Table 2: Impact of foliar application of GA_3 and zinc on days to fruit maturity, number of fruits per plant, number of fruits plant^{-1} (g) and total fruit yield (t ha^{-1}) of strawberry

GA_3 Levels (ppm)	Days to fruit maturity	Number of fruits per plant	Fruit yield plant^{-1} (g)	Total fruit yield (t ha^{-1})
0	26.2a	8.1e	184.7d	18.3d
50	24.5b	8.6d	193.5c	19.4c
100	22.8c	9.1c	201.4b	20.2b
150	19.4d	9.6b	204.2b	20.5b
200	21.8c	10.6a	212.8a	21.3a
LSD at α 0.05	1.329	0.444	5.548	0.612
Zinc (%)				
0	25.0a	8.3d	188.8c	18.9c
0.2	23.5b	9.0c	197.2b	19.7b
0.4	20.9d	9.5b	202.1b	20.2b
0.6	22.3c	10.0a	209.1a	21.1a
LSD at α 0.05	1.188	0.397	4.962	0.547
Interactions				
GA_3 x Zn	---	---	---	
Level of Significance	NS	NS	NS	

Means followed by similar letters do not differ significantly from each other at 5 % probability level. N.S: Non-significant

Conclusions and Recommendations

Foliar application of GA_3 200 ppm and Zinc 0.6% significantly enhanced the fruit yield parameters like number of leaves per plant, leaf area plant^{-1}, plant height (cm), number of fruits plant^{-1}, fruit yield plant^{-1} (g) and total fruit yield (t ha^{-1}). While minimum days to days to flowering, fruit set and fruit maturity were recorded in strawberry plants applied with 150 ppm GA_3 and 0.4% Zn respectively. Higher dose of GA3 and Zn can be used for better yield and quality.

Authors' contributions

Conceived and designed the experiments: M Sajid, Performed experiments: A Ullah, Analyzed the data: Z Shah & Zakirullah. Contributed reagents/ materials/ analysis tools: A Khan. Wrote the paper: Hammad & Z Jan.

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