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ORIGINAL RESEARCH

Effect of $CaCl_2$, $ZnSo_4$ and gibberellic acid spray on growth, development and propagative characteristics of strawberry cv. Camarosa

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ABSTRACT:

Spraying has a main effect on the increasing of fruits elements. In the present study held at 2015, pre-harvest characteristic was investigated after spraying $CaCl_2$, $ZnSO_4$ and Gibberellic Acid (GA) and then growth, development and propagative characteristics of strawberry cv. Camarosa were analysed. The experiment was performed in Complementary Randomized Design (CRD) with four replications. $CaCl_2$, $ZnSO_4$ and gibberellic acid were sprayed and Total Acidity (TA) and Total Soluble Solids (TSS) were analyzed for studying the fruit quality. The results showed that GA, $CaCl_2$ and $ZnSO_4$ treatments increased the leaf area and root length of strawberry. The application of 150 mg/l $ZnSO_4$, 100 mg/l GA and 10 mM $CaCl_2$ increased the number of flowers and weight of primary and secondary fruit. Higher percentage of total soluble solids and ascorbic acid were obtained in fruits at the concentration of 150 mg/l of $ZnSO_4$ and lowest values was recorded in control. In general, 150 mg/l $ZnSO_4$, 100 mg/l GA and 10 mM $CaCl_2$ spray were proposed for increasing strawberry production.

Keywords:
Gibberellic acid, $CaCl_2$, $ZnSo_4$, strawberry, total acidity and total soluble solids

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INTRODUCTION

Fargarya is one of the most commercial strawberries that are produced from hybridization between Clinisius Netherlands and Aragarya Virjinia strawberries. The study species i.e., strawberry is a small fruit and a hybrid product of two varities with low to high variable for Acta-ploide species created at different environmental conditions. Since, strawberry fruit is high tolerant to short-term moisture and has deep root system, light and water management are essential to achieve the high efficiency and high quality of strawberry fruits (Oszmianski and Wojdylo, 2009; Poovaiah and Leopold, 1973; Poovaiah, 1979).

Some factors such as total acidity and total soluble solids are very important in strawberry fruit quality determination. Foliar nutrition may play an important role in strawberry quality and productions (Sturm *et al*., 2003). Foliar nutrition in appropriate stage has increased quality and quantity details of strawberry. Since, zince in one of the enzymes component, it is a more essential metal for normal plant growth and development. Also, zince is essential for the production of tryptophan. In some research reports, it is given that flowers production Zinc treatment are interrelated (Laugale and Bite, 2006; Rutkowski *et al*., 2006; Testoni *et al*., 2006). It is well know that calcium plays an important role in fruits and vegetables for maintainance and quality. The use of calcium maintain goodness to fruits, increase of vitamin C content and decrease of damage and browning in apples (Abadia *et al*., 2011; Orowski and Michalek, 2011; Fernandez *et al*., 2006 ; Nasiri *et al*., 2010). Some researchers have obtained positive effect of calcium application in the fruit quality (Phun *et al*., 1997). Calcium application before and after harvest had an effect on fruit quality, delay in decay, fruit ageing and improvement in physiological properties of many fruits and vegetables. Gibberellic acid is one of the biological indicators and can increase strawberry growth (Kazemi *et al*., 2011). Strawberry response to application of gibberellic acid was similar to environmental factors such as long photoperiod and low temperature (Chéour *et al*., 1984).

The aim of this experiment is to study the effect of $CaCl_2$, $ZnSO_4$ and gibberellic acid spray on growth, development and propagative characteristics of strawberry cv. Camarosa.

MATERIALS AND METHODS

Plant material

This study was conducted on strawberry plants in greenhouse of Ilam Agricultural and Natural Resource Center, Ilam, Iran during 2015. Strawberry was grown at natural light condition. The temperature conditions were 24 ± 5°C and 15 ± 4°C, during days and nights respectively; with relative humidity of 70%. Daughter plants of Camarosa were potted in 3 plastic pots filled with 2:1 sandy loam soil and compost. After 2 weeks of establishment, in the beginning of November, the

Table1. Effect of $CaCl_2$, $ZnSO_4$ and gibberellic acid spray on dry weight, leaf area, number of flowers and total root length in strawberry

Treatments	Concentration	Plant dry weight (g)	Leaf area (cm^3)	Root length (cm)	Number of flowers
Control	0	9.5^{j}	18.14^{fg}	12.44^{g}	7.4^{bc}
$ZnSO_4$ (mg/l)	50	11.7^{i}	$30.1d^{e}$	16.2^{f}	7.1^{c}
	100	13.4^{ef}	32.65^{c}	28.7^{b}	7.23^{bc}
	150	17.98^{a}	44.5^{a}	34.2^{a}	15.8^{a}
Gibberellic acid	25	13.7^{e}	24.3^{f}	18.3^{e}	10.1^{b}
(mg/l)	50	13.9^{d}	32.5^{c}	20.3^{d}	10.2^{b}
	100	17.3^{b}	44.2^{a}	31.2^{b}	15.3^{a}
$CaCl_2$ (mM)	5	12.3^{f}	24.6^{ef}	18.1^{e}	6.8^{bc}
	10	15.7^{c}	43.32^{a}	18.8^{e}	14.9^{a}

Table 2. Effect of $CaCl_2$, $ZnSO_4$ and gibberellic acid spray on length of flowering period, primary and secondary fruit weight and number of primary and secondary grains in strawberry

Treatment	Concentration	Length of flowering period (days)	Primary fruit weight (g)	Secondary fruit weight (g)	Number of primary grains	Number of secondary grains
Control	0	15.7^{c}	8.98^{c}	7.6^{c}	136^{c}	110^{c}
$ZnSO_4$	50	16.2^{c}	12.6^{b}	8.77^{b}	157^{bc}	116^{bc}
(mg/l)	100	21.7^{b}	12.2^{b}	9.4^{b}	178^{b}	163^{b}
	150	35.1^{a}	18.8^{a}	16.55^{a}	222^{a}	211^{a}
Gibberellic	25	14.2^{c}	11.96^{b}	11.5^{b}	138^{c}	102^{c}
acid (mg/l)	50	21.6^{b}	12.7^{b}	9.2^{b}	190^{b}	165^{b}
	100	33.3^{a}	18.3^{a}	16.3^{a}	220.5^{a}	210^{a}
$CaCl_2$ (mM)	5	21.5^{b}	15.2^{ab}	11.6^{ab}	160^{bc}	139^{bc}
	10	28.4^{ab}	18.3^{a}	15.4^{a}	225^{a}	211^{a}

treatments, included: $ZnSO_4$ in three levels [50, 100 and 150 mg/l], gibberellic acid in three levels [20, 50, 100 mg/l], $CaCl_2$ in two levels [5 and 10 mM] and distilled water as control.

Measurements

In the end of experiment, plants were carefully taken out of their pots, roots were washed with distilled water, and the whole plants were oven dried for 72 h at 70°C. The following quality parameters of harvested fruits were determined: dry weight, number of runners, leaf area, number of flowers, length of the roots, length of flowering period, weight of primary and secondary fruits and number of their achene's, Total Acidity (TA), Total Soluble Solids (TSS) and vitamin C of 'Camarosa' strawberry. Dry weights were expressed as gram. Length of roots was measure by using a ruler and was expressed as 'cm'. Number of runners and flowers were counted throughout the experimental period. Leaf area was measured using a- leaf area meter and expressed as 'cm'.

Ascorbic acid content

Ascorbic Acid (AA) content in strawberry was analyzed using 2, 6-dichlorophenolindophenol method (Fernandez *et al.,* 2006). An aliquot of 10 ml strawberry squash extract was diluted to 50 ml with 3% metaphosphoric acid in a 50 ml volumetric flask. The aliquot was filtered and titrated with the standard dye to a pink endpoint (persisting for 15 sec).

Statistical Analysis

The research was lead as a factorial experiment in an absolutely randomized plan with 4 duplications, all consisting of three pots with one plant per plot. Data were investigated by SPSS 16 software and judgments of averages were predicted by Duncan's test with a probability value of 5%.

RESULTS AND DISCUSSION

The results showed that foliar application of $ZnSO_4$ significantly affected plant dry weight [$p \leq 0.05$].

Table 3. Effect of $CaCl_2$, $ZnSO_4$ and gibberellic acid spray on pH, TSS, TA and vitamin C in strawberry

Treatments	Concentration	pH	TSS	TA	Vitamin C
Control	0	3.41^{abc}	$5.6f^{g}$	4.32^{g}	24^{j}
$ZnSO_4$ (mg/l)	50	3.39^{bc}	6.67^{de}	5^{f}	30.1^{i}
	100	3.36^{bcd}	7.53^{c}	8.11^{c}	55.39^{c}
	150	3.61^{a}	10.12^{a}	10^{a}	69.12^{a}
Gibberellic acid (mg/l)	25	3.1^{cd}	5.56^{f}	7.2^{e}	46.31^{e}
	50	3.39^{abc}	7.3^{d}	7.3^{d}	47.8^{d}
	100	3.49^{ab}	8.94^{b}	9.2^{b}	57.2^{b}
$CaCl_2$ (mM)	5	3.32^{d}	6.2^{ef}	6.9^{e}	44.12^{f}
	10	3.35^{bc}	10.11^{a}	9.9^{a}	65.7^{a}

Maximum plant dry weight and root length was recorded at 150 mg/l $ZnSO_4$. Gibberellic acid and $CaCl_2$ had no significant effect on number of runners and root length. Zinc is part of carbonic anhydrase, as well as dirogenesis and auxin, which promotes growth and helps to increase dry and fresh fruit weight (Moraes *et al*., 2012). Norvell and Welch (1993) reported that sufficient Zn nutrient is very important in root absorption, Na complementation and plant growth. $CaCl_2$ and $ZnSO_4$ increased leaf area significantly [$p \leq 0.05$]. Highest leaf area was recorded at 150 mg/l $ZnSO_4$, 100 mg/l gibberellic acid and 10 mM $CaCl_2$ treatments. Leaf area increased due to Zn and Ca accumulation. Gibberellic acid reduced leaf growth, cell number, size and division of cells and proteins, chlorophyll, sugar content and elasticity (Moraes *et al*., 2012).

Tables 1 and 2 showed that gibberellic acid and $ZnSO_4$ resulted in increased duration of flowering length, primary and secondary weight of fruits and number of achenes [$p \leq 0.05$]. However, $CaCl_2$ treatment increased number of fruits while decreased flowering duration length. Some researchers showed positive effect of $ZnSO_4$ on number of fruits (Norvell *et al*., 1993). Achene's synthesis auxin that increases primary growth, and so, $ZnSO_4$ was used to increase fruit quality and number of fruits (Brittenham *et al*., 1994). Gibberellic acid increases photosynthesis, acid transport to sinks and finally resulting on increased grain production. Nazarpour *et al*. (2005) showed that gibberellic acid spray increased number of fruits in strawberry. Calcium is one of the nutrients that play a key role in cell membrane structure, cell organelles, fruit growth and quality.

CONCLUSION

In general, $CaCl_2$, $ZnSO_4$ and gibberellic acid increases plant root length, dry weight and number of fruits. Zinc is part of carbonic anhydrase and other dehydrogenases and auxins, which promotes plant elongation and therefore, increases dry and fresh weight of fruits. Useful effect of calcium is increase in number of fruits which is due to photosynthesis activity and these chemical agents are related to hormone metabolism that increase primary synthesis of auxin as an essential factor for fruit growth. In general, based on results of the present study application of 150 mg/l $ZnSO_4$ was proposed for increasing of strawberry production.

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