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Research Article

EVALUATING THE EFFECTS OF FOLIAR APPLICATION OF NITROGEN AND ZINC ON YIELD INCREASING AND QUALITY IMPROVEMENT OF APPLE CV. 'GOLAB KOHANZ'

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ABSTRACT

In order to evaluate the effects of foliar application of nitrogen and zinc on fruit set percent and quality of apple c.v 'Golab Kohanz' was conducted an experiment as factorial arrangement in randomized complete block design with three replications and one tree in each plot in one of the apple gardens placed in Kamfirouz region, Fars province, Iran, in autumn season. The first factor was foliar application of zinc (0, 3 and 6 gL^{-1}) and the second factor was foliar application of urea (0, 3 and 5 gL^{-1}). Based on the obtained results, the highest fruit set percent, fruit length, fruit diameter, Zn amount in shoot and root and chlorophyll index significantly ($p<0.05$) was observed in foliar application of 6 gL^{-1} Zn. Also the greatest fruit set percent, fruit length, fruit diameter, N amount in the root and leaf area was relative to foliar application of 5 gL^{-1} urea. Regards to the interaction between N and Zn, the highest fruit set percent, fruit length, fruit diameter, N amount in the root, leaf area and chlorophyll index significantly ($p<0.05$) was observed in treatment of 5 gL^{-1} urea and 6 gL^{-1} zinc.

***Keywords**: Foliar Application, 'Golab' Apple, Zinc, Urea, Fruit Ser Percent*

INTRODUCTION

Tree bearing is divided to the components such as flower number, the number of flowers that convert to the fruit and also fruit quality in harvest time. Enhancement of nitrogen in the flower buds is leading to increasing of ovule life, pollination and fertilization period and leaf area. Consequently fruit set become rather and bigger in relation to size and the yield become rather (Albrigo, 2002). Nitrogen requirement is maximum amount in during flowering and fruit set period, so influence the foliar application of nitrogen on plant nutrition is higher than soil application. Nutrition foliar application often is used in the spring an din the some cases in the summer (Morgan *et al.*, 2006; Cheng *et al.*, 2004). Foliar application is supplementary for soil application of an alternative method for soil application. Foliar application of urea is causing to increase plant adaptation against stress and its absorption percent is 70%. Foliar application of nitrogen in spring season is the more effective than soil application and is causing to increase seed and fruit set and yield (Andrews, 2002). Also foliar application of nitrogen and micro nutrients in the fruit trees such as 'Golab' apple has been led increasing yield and reduction of fruit drop. According to the report of some researchers, there is positive and sever linear correlation between nitrogen and chlorophyll, photosynthesis, protein synthesis and leaf nitrogen amount (Meziane and Shipley, 2001; Vos *et al.*, 2005; Boussadia *et al.*, 2010). When senescence process is beginning, amount of protein, carbohydrate, chlorophyll and total nitrogen in the leaf tissue is decreasing (Spencer and Titus, 1972). Therefore, can be expected application of nitrogen fertilizer during postharvest period could be affect on the some stages of senescence process (DeAngelis *et al.*, 2012). Zinc is one of the micro nutrients that are necessary for fruit set and proper production. This element there is in the part of carbonic an-hydras enzyme in all photosynthetic tissues that is necessary for chlorophyll bio-synthesis. Zinc also plays role in tryptophane synthesis, which is a pre-material for auxin synthesis (Castr and Sotomayor, 1997; Hewitt, 1993; Marschener, 1995). In the peach trees, zinc deficiency is leading to production of small, deformed and very low quality fruits (William, 1991). Application of zinc in mango has been increased fruit and stone weight (Bahadur *et al.*, 1998). Foliar application of sweet orange trees having zinc deficiency in April and May has been enhanced TSS and fruit juice (Dixi and Gamdagin, 1978). It has been showed that foliar application of zinc on apple had no distinct influence on the yield, fruit weight, acidity and soluble sugars (Wojcik *et al.*, 1995). The present study was performed with aim of evaluation the effects of nitrogen and zinc via foliar application on increasing yield and improvement quality of apple c.v 'Golab Kohanz'.

MATERIALS AND METHODS

This experiment was performed in one of the apple gardens in 'Kamfirouz' region on 14-years-old apple trees c.v 'Golab Kohanz'. The apple trees were treated in autumn season about four weeks before leaves abscission. In this investigation was used urea fertilizer with 46% nitrogen made of Shiraz petrochemical company and zinc sulphate fertilizer with 21% Zn made of French country. This study was conducted by using factorial experiment (3×3) in randomized complete block design with three replications and one tree in each plot. The first factor was foliar application of zinc sulfate (0, 3 and 6 gL^{-1}) and the second factor was foliar application of urea (0, 3 and 5 gL^{-1}). Spraying was done by using a 12 liters atomizer sprayer. Spraying time was selected early morning before rising of the sun, to prevent undesirable effects of sunlight. To reduce adhesion and better absorption of elements was used 5 mlL^{-1} washer dish liquid. Sampling from spurs (small shoots) was done in April before beginning of spring growth. For flower counting, 4 spurs on each shoot and finally 16 spurs on each tree were selected and in order to determine amount of nitrogen and zinc the spurs were sent to laboratory. The flowers were counted by using the four marked shoots around the tree during 9 days. Two weeks after entire dropping of petals, the set fruits were counted and this operation was replicated every 15 days once until harvesting time (1 July 2012). To calculate fruit set percentage was used below formula. Fruit set in the pome-fruit trees usually is explained by the number of fruit that is setting in lieu of each 100 flower buds (Rasoolzadegan and Kalbasi, 1999).

$$Fruit.set.percetage = \frac{The.set.fruit.number}{the.number.of.flower.bud}$$

The fruit length and diameter was randomly measured in five fruits by caliper. Leaf area was measured by using leaf area meter in five leaves from each spurs. Chlorophyll index was measured by using SPAD 502 in five leaves. After fruit harvesting, total acid (TA) and TSS were measured by using titration method and manual Refractometer respectively.

RESULTS

Influence of zinc on the evaluated characteristics

Analysis of variance results indicated that foliar application of zinc in autumn season had significant influence ($p<0.01$) on fruit set percentage, fruit diameter and length, amount of zinc in the spurs and nitrogen in the root and had significant effects ($p<0.05$) on root zinc and chlorophyll index (Table 1). The highest fruit set percent, fruit length and diameter, amount of zinc in the spurs and root and chlorophyll index significantly ($p<0.05$) was observed in foliar application of 6 gL^{-1} Zn. There was no significant difference between various concentrations of zinc in viewpoint of nitrogen amount in the spurs. Also amount of nitrogen in the root was not significant in Zn 3 and 6 gL^{-1}. There was no significant difference between various levels of zinc in relation to spur nitrogen, leaf area, total acid and TSS (Table 2).

Influence of urea on the evaluated characteristics

According to the results of analysis of variance, effect of foliar application by urea in autumn season had significant ($p<0.01$) on fruit set percentage, fruit diameter and length, amount of zinc in the spurs and nitrogen in the root and leaf area and had no significant influence on the other characteristics (Table 1). The greatest fruit set percent, fruit length and diameter, amount of nitrogen in the root and leaf area was observed in foliar application of 5 gL^{-1} urea. Although foliar application of urea increased amount of nitrogen in the spurs by this enhancement was not significant. Amount of zinc in the spur was not significant in urea 3 and 5 gL^{-1}. The highest zinc in the root was observed in control treatment. There was no significant difference between various levels of nitrogen in relation to chlorophyll index and TSS (Table 3).

Interaction between urea and zinc on the evaluated characteristics

Analysis of variance table showed that there was significant interaction ($p<0.01$)between two factors in viewpoint of fruit set percentage, fruit diameter and length, amount of zinc in the spurs and root, leaf area, chlorophyll index and total acid (Table 1). The highest fruit set percent, fruit length and diameter, amount of nitrogen and zinc in the root, leaf area and chlorophyll index was significantly ($p<0.05$) observed in foliar application of 5 gL^{-1} urea and 6 gL^{-1} Zn. Amount of zinc in the spurs significantly was higher in the application of 3 or 5 gL-1 urea + 6 gL^{-1} zinc than control treatment. Application of 3 gL-1 zinc without urea significantly increased total acid than control and other treatments. Interaction between urea and zinc was not significant in relation to TSS (Table 4).

DISCUSSION

The obtained results of this investigation show that foliar application of zinc has been influence on fruit length and diameter, which is according to the findings of Dixi and Gamdagin (1978) on Kinnow mandarin. They observed foliar application of zinc on Kinnow mandarin increased fruit size and TSS. It has been showed that application of zinc on sweet orange affects fruit size (Hewitt, 1993). Castr and Sotomayor (1997) reported that zinc is necessary for production of good fruit. Zinc plays role in synthesis of auxin that can be important factor on increasing fruit size (Janik, 1984). It has been showed that zinc increases cell division in apricot, peach, avocado and sweet orange and delays tissue differentiation. Also zinc has effect on carbohydrates and proteins synthesis that can be increases fruit growth (Emami, 2006). The results of the present study showed the highest fruit length and diameter was relative to 5 gL-1 urea and 6 gL-1 zinc treatment, which is represent the distinct effect of zinc and nitrogen on fruit size. Regards to role of nitrogen in fruit set, supplying this element will increase fruit set when nitrogen absorption from soil is limiting due to low temperature of soil and low activity of root and leaves. Increasing nitrogen concentration in the flower buds via foliar application of urea increase ovule long life and duration of pollination and fertility as well as leaf area consequently the fruits become larger. Nitrogen supply necessary carbohydrate for growth of flower bud and will increase yield. Supplying nitrogen for the plant is necessary when plant need to it. Regards to physiologic and metabolic role of nitrogen element, increasing nitrogen concentration in the leaf and flower buds, even there is not any deficiency, increases fruit set and improves qualitative properties of fruit. Foliar application of nitrogen on Washington navel orange in California significantly increased fruit yield for three successive years in lieu of each tree equivalent 17 kg, without change in the fruit size, than control treatment (Albrigo, 2002). Also application of urea on Washington navel orange increased ammonium production and Argenin synthesis and is producing more types of poly-amines, which is leading to development of primary flowering and enhancement growth rate of ovary and increasing cell division consequently fruit set percent and yield is increased (Dixi and Gamdagin, 1978). Foliar application of nitrogen in late of autumn increases leaf photosynthesis and they will keep longer green but this phenomenon will increase possible loss of leaves by winter frost before transfer of nitrogen to the tree (Castr and Sotomayor, 1997). Foliar application of nitrogen decreases C/N ration in the leaf consequently amount of amino acids and protein significantly increase. The sprayed urea on the leaf, contrast to the other nitrogen fertilizers, after uptake by plant directly can be used in amino acids synthesis. Urea because of physiologic properties such as non-polarity, chemical properties, rapid absorption and solubility in water and oil is one of the common and accessible resources for the growers. However, due to the rapid increase in absorption by foliar application of nitrogen fertilizers should be paid particular attention to the used concentration because the error in the application of solutions containing high concentrations, may will be cause unforeseen damage in the garden.

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Table 1: Analysis of variance in relation to the evaluated characteristics

S.V	D.F	Mean Square (MS)										
		TSS %	TA (mg/g)	Chlorophyll index	Leaf area (Cm^2)	Zn root (ppm)	N root (%)	Zn spur (ppm)	N spur (%)	Fruit diameter (cm)	Fruit length (cm)	Fruit set percent
Replication	2	0.44^{ns}	0.09^{ns}	0.98^{ns}	3.04^{ns}	20.60^{ns}	0.00^{ns}	34.7^{ns}	0.09^{ns}	0.06^{ns}	0.08^{ns}	1.03^{ns}
Zinc (A)	2	4.10^{ns}	0.17^{ns}	31.93^{*}	2.67^{ns}	27.74^{*}	0.10^{**}	23945.7^{**}	0.08^{ns}	0.19^{**}	0.35^{**}	890.70^{**}
Urea (B)	2	1.25^{ns}	0.24^{ns}	0.19^{ns}	34.45^{**}	32.21^{**}	0.16^{**}	327.6^{**}	0.03^{ns}	1.93^{**}	1.28^{**}	449.14^{**}
Interaction AB	4	1.77^{ns}	0.38^{**}	89.18^{**}	40.97^{**}	95.00^{**}	0.14^{**}	441.8^{**}	0.08^{ns}	0.21^{**}	0.14^{**}	44.12^{**}
Error	16	2.81	0.84	11.07	8.15	7.18	0.00	24.43	0.06	0.02	0.04	12.17
C.V %		11.43	18.95	6.22	11.8	7.60	1.62	5.56	18.73	2.59	3.79	10.42

^{ns} not significant, $^{*, **}$ significant at 5 and 1% respectively

Table 2: Evaluation the effect of zinc foliar application on different characteristics of apple cv. 'Golab Kohanz'

Zn concentration \ Characteristics	TSS %	TA (mg/g)	Chlorophyll index	Leaf area (Cm^2)	Zn root (ppm)	N root (%)	Zn spur (ppm)	N spur (%)	Fruit diameter (cm)	Fruit length (cm)	Fruit set percent
0.0	14.9a	0.15a	48.37b	25.62a	34.81b	1.16b	59.11c	1.32a	6.03b	5.26b	29.33b
3.0 gL^{-1}	14.2a	0.15a	49.51ab	26.11a	34.54b	1.27a	88.60b	1.35a	6.08b	5.25b	31.07b
6.0 gL^{-1}	14.85a	0.14a	50.54a	25.51a	36.41a	1.27a	118.67a	1.43a	6.20a	5.46a	40.03a

The means in each column, having same letter, are not significant different according to DMRT(5%)

Table 3: Evaluation the effect of urea foliar application on different characteristics of apple cv. 'Golab Kohanz'

Urea concentration \ Characteristics	TSS %	TA (mg/g)	Chlorophyll index	Leaf area (Cm^2)	Zn root (ppm)	N root (%)	Zn spur (ppm)	N spur (%)	Fruit diameter (cm)	Fruit length (cm)	Fruit set percent
0.0	14.58a	0.16a	49.55a	24.62b	26.51a	1.16c	84.78b	1.33a	5.80c	5.11c	29.51c
3.0 gL^{-1}	14.48a	0.14b	49.38a	25.74ab	34.56b	1.22b	91.01a	1.35a	6.19b	5.32b	33.25b
5.0 gL^{-1}	14.90a	0.15a	49.48a	26.88a	34.68b	1.32a	90.59a	1.40a	6.32a	5.54a	37.66a

The means in each column, having same letter, are not significant different according to DMRT(5%)

Table 4: Evaluation the interaction between zinc and urea foliar application on different characteristics of apple cv. 'Golab Kohanz'

Interaction Zn×Urea	Characteristics	TSS %	TA (mg/g)	Chlorophyll index	Leaf area (Cm^2)	Zn root (ppm)	N root (%)	Zn spur (ppm)	N spur (%)	Fruit diameter (cm)	Fruit length (cm)	Fruit set percent
	0.0	14.40a	0.14bc	44.74c	23.33c	35.92bc	1.26d	56.29f	1.27a	5.37d	4.97e	23.11f
0.0	3.0 gL^{-1}	14.82a	0.15bc	49.66ab	24.77c	35.92bc	1.21e	67.38e	1.38a	6.14b	5.29cd	30.22de
	5.0 gL^{-1}	15.50a	0.17ab	50.70ab	28.77a	32.90de	0.93f	53.66f	1.30a	6.23ab	5.52ab	34.66c
	0.0	14.06a	0.19a	50.84ab	24.11bc	37.70ab	1.28d	85.82d	1.38a	5.76d	5.09de	29.44e
3.0 gL^{-1}	3.0 gL^{-1}	14.00a	0.13c	50.66ab	26.44ab	34.44cd	1.23e	83.32d	1.38a	6.14b	5.25cd	30.66de
	5.0 gL^{-1}	14.55a	0.15bc	50.12ab	24.11ab	31.48e	1.30c	96.65c	1.37a	6.15b	5.41bc	33.11cd
	0.0	15.27a	0.15bc	47.63bc	26.44ab	35.92bc	1.33b	112.22b	1.43a	5.92c	5.26cd	36.00bc
6.0 gL^{-1}	3.0 gL^{-1}	14.64a	0.14bc	47.83bc	26.00abc	33.33cde	1.33b	122.33a	1.40a	6.29ab	5.42bc	38.88b
	5.0 gL^{-1}	14.64a	0.13c	53.08a	27.77a	39.19a	1.35a	121.46a	1.45a	6.38a	5.69a	45.22a

The means in each column, having same letter, are not significant different according to DMRT(5%)

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