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The Impact of Foliar Application of Urea, Zinc and Canada Humex on Yield and Fruit Properties of Jujube "C.V Puyin" Under Saudi Arabia Conditions

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ABSTRACT

The effect of foliar applications with urea, zinc sulphat and Canada Humex at 1 and 2% on yield and fruit quality of Jujube trees 'Puyun' was determined through 2012 and 2013 seasons. All treatments were applied twice (after 15 days of fruit set and one month after first spray). Fruit yield and its components were improved at all treatments during both seasons. Canada Humex applications enhanced physical and chemical characteristics but did not affect acidity content in first season only, as compared with other treatments and the control. Spraying with 2% level was more effective than spray 1% in all treatments. Canada Humex (2%) increased yield, fruit weight, flesh weight and fruit volume, SSC and reducing and total sugars. Also, urea and zinc sulphate 2% enhanced yield and quality of jujube fruit. Canada Humex improved fruit yield and quality compared to urea and ZnSO4. Canada Humex as a natural product is more favorable to the consumer than other chemical compounds.

Keywords: Zizyphus jujoba, Canada Humex, safe products, Saudi Arabia, urea, Zn SO_4.

INTRODUCTION

Jujube tree (*Ziziphus jujuba* Mill.), Rhamnaceae, is known in the Arab countries as Sider, Nabk or Ber (Liu and Zhao, 2009). The jujube is one of the ancient and popular fruit crops due to its wider adaptability under adverse soil and climatic conditions. It is also one of the world's most nutritious plants rich in P, K, Fe, vitamin C and amino acids (Jin-Wei, *et al*., 2007 and Boora and Bal, 2008). *Zizyphus* species are commonly used in traditional medicine for the treatment of various diseases such as digestive disorders, weakness, liver complaints, obesity, urinary troubles, diabetes, skin infections loss of appetite, fever, pharyngitis, bronchitis anemia, diarrhea and insomnia (Kirtikar and Basu 1984). Fruit quality factors are very important to fetch higher price from the marketing point of view. It includes size, shape, color, gloss and free of defects and decay (Mitra and Dhaliwal 2009). However one of the main constraints in jujube fruit production is the

production of small size fruits and the natural high fruit drop (about 70%), which adversely affects fruit productivity and quality and subsequently the growers profit (Ghosh *et al*., 2009 and Kassem *et al*., 2011).

Fertilizers are the important input factor which is essential for better quality production (Omar and Belal 2007). The rising prices, timely availability, adequate doses and purity of fertilizers are the important considerations. For adequate plant growth and production, micronutrients are needed in small quantities; however, their deficiencies cause a great disturbance in the physiological and metabolic processes in the plant (Bacha *et al*., 1997). A balanced fertilization program with macro and micronutrients in plant nutrition is very important in the production of high yield with high quality products (Sawan *et al*., 2001).

Plants normally take up nutrients from soils through their roots although nutrients can be supplied to plants as fertilizers by foliar sprays. Foliar feeding is a relatively new and controversial technique of feeding plants by applying liquid fertilizer directly to their leaves (Bernal *et al*., 2007; Baloch *et al*., 2008). Throughout the world, microelements such as Fe, Zn, Mn and Cu are added to foliar fertilizers, in order to compensate their deficiency especially in arid and semi-arid regions (Kaya *et al*., 2005). Foliar application with Zn and urea alone or in combination had a significant effect on yield and its components under sandy soil conditions (Gobarah *et al*., 2006; Salama *et al*., 2009). Thus, they are associated with saccharide metabolism, photosynthesis and protein synthesis (Marschner, 1995).

Humic acid is particularly used to decrease the negative effects of chemical fertilizers and could have beneficial effect on the nutrition of the plant (Martinez *et al*., 1983). Humic substances are identified as beneficial source for supplying humic acid and fulvic acid. Humic substances are organic in nature with significant distribution in soil, fresh water, sewage, compost, oceans, lignite and brown coals. The commercial humic acids were found to improve growth, yield production, quality and increased significantly the accumulation of P, K, Ca, Mg, Fe, Zn and Mn in tissues of some horticulture crops (David *et al*.,1994; Erik *et al*., 2000). Therefore, the present study aimed to investigate the effect of urea, zinc sulphate and Canada Humex as a foliar spray on the growth, yield and chemical contents of jujube trees 'Puyin'.

MATERIALS AND METHODS

Plant Materials, Treatments and Experimental Design

This study was conducted during 2012-2013 seasons, at Research and Agriculture Experimental Station, King Saud University, Saudi Arabia. Jujube trees 'Puyun' of 10 years old and 3 m height were treated with urea, zinc sulphat, Canada Humex (Table 1) at 1 and 2%. The treatments were applied twice (after 15 days of fruit set and one month after first spray). The trees were planted at 4 × 5 m spacing and pruned in April.

Table (1): Chemical composition of Canada Humex

Composition	%
Nitrogen	12
Phosphorus	12
Potassium	12
Calcium	1
Magnesium	0.1
Iron	1.5
Manages	0.6
Zanic	0.14
Cupper	0.06
Boron	0.13
Molybdenum	0.06
Amino acids	10
Folic acid	3
Humic acid	10
Simulative growth	10

Produce by Egyptian Canadian for Humate Technology & Agricultural Consultancy, Egypt

All primary branches were removed leaving 60 cm from base of the trunk. Trees were subjected to the same cultural practices usually done in the orchard. During May of both seasons, trees were fertilized with organic manure and calcium superphosphate (15% P_2O) at a rate of 12 and 1.5 kg/tree, respectively. Twenty one trees were selected as uniform as possible and were subjected to foliar spray during two successive seasons. The experiment was designed as randomized complete design (RCD) with three replicates per treatment and each replicate was represented by one tree. The following seven foliar spray treatments were applied:

Urea 1 and 2% (T_1 and T_2)
Zinc sulphate 1 and 2% (T_3 and T_4)
Canada Humex 1 and 2% (T_5 and T_6)
Water only (control) (T_7)

All treatments were applied when fruitlet diameter was 3.0 - 4.0 mm (about 15 - 20 days after fruit set). The foliar applications were applied directly to tree canopy with a handheld spray until runoff in the early morning.

Fruit Measurements

In both seasons, fruits from each tree (replicate) were harvested when fruit color turned to light green (ovary green). Only commercially acceptable fruits were harvested on any date and each treatment was harvested two or more times during the harvest period. At harvest, all harvest fruits were weighed to record total yield (kg/tree). At harvest, a sample of 4kg fruits from each replicate was randomly collected in both seasons to determine physical and chemical characteristics. The dimensions (length and diameter) were measured using a digital caliper. Fruit and flesh weight were measured using a digital balance. Fruit volume was measured using the water displacement method, when each fruit was submerged in a container (250 cm^3 graduated cylinder) filled with water to a known volume. The soluble solids content (SSC), titratable acidity, total soluble sugars, reducing sugars and fruit moisture content were measured to determine fruit quality. All measurements were determined according to A.O.A.C. (1995).

Statistical Analysis

One way ANOVA was applied using SAS program (SAS, 2000). Means were compared using least significant differences (LSD) at $P \leq 0.05$ (Snedecor and Cochran 1977).

RESULTS

Yield and Fruit Components

The highest significant values in fruit yield (52.58 kg/tree), fruit weight (24.05 g) and flesh weight (21.89 g) were recorded with 2% Canada Humex (T_6) as compared with other treatments during both seasons (Table 2). T_5 (1% Canada Humex) was followed by T_2 (2% urea) in terms of improving yield and the other fruit characteristics, as compared to other treatments, while control treatment recorded the lowest values during both seasons.

Fruit Physical Properties

Fruit length and diameter increased significantly with all spraying treatments in both seasons (Table 3). Spraying 2% of Canada Humex resulted in the maximum fruit length (3.93 and 4.09 cm) and diameter (3.60 and 3.24 cm) in 2012 and 2013 seasons, respectively. Control showed the lowest values of fruit length during both seasons.

Fruit volume (cm^3) had the same trend as fruit dimensions. The highest values (25.00 and 22.33cm3) were obtained when 2% of Canada Humex was sprayed in both the 2012 and 2013 seasons; respectively (Table 2).

Fruit Chemical Properties

Soluble solids concentration (SSC) increased significantly with all spraying treatments compared to the control in both seasons (Table 4). The highest SSC was recorded when 2% of Canada Humex were sprayed; 17.47% and 14.73% in the 2012 and 2013 seasons, respectively.

Total and reducing sugars (%) also increased significantly with all spraying treatments compared to the control in both seasons (Table 4), but the difference in reducing sugars was insignificant between 1 and 2% Canada humex during both seasons. T6 (2% of Canada Humex) showed the highest total sugars (14.32 and 13.79%; Table 3) in the 2012 and 2013 seasons, respectively. On the other hand, T_7 (control) resulted the lowest significant values in SSC, Total and reducing sugars in both seasons.

Acidity (%) was reduced with all spraying treatments compared to the control in both seasons, but the differences were insignificant in 2012 only, fruit acidity was the lowest significant; 0.36% in 2013.

DISCUSSIONS

Sustainability in agriculture is an important goal, which can be gained through the effective and economic utilization of natural resources as well as careful management of agricultural inputs (Cervantes-Godoy and Dewbre , 2010; OECD 2010). In the present study, yield and quality of Jujube fruit 'Puyin'was positively affected by foliar application of urea, ZnSO4 (as macro and micronutrients) and Canada Humex compared with unsprayed (Table 2 and 4). The promotion on yield and fruit quality due to applications of these materials appeared in terms of increasing fruit dimensions, fruit weight, flesh weight, SSC, reducing and total sugar content and in decreasing total acidity. The promotion on fruit quality was related with increasing Canada Humex concentration. Application at concentration of 2% was beneficial in enhancing fruit quality than using 1% in most of tested parameters during both seasons. Previous reports on application of humic acid on tomato improved yield and fruit quality (Padem and Ocal 1999; Yildirim, 2007).

Table 2: Effect of foliar application of urea, zinc sulphate and Canada Humex on yield (kg/tree); fruit and flesh weight (g) of " Puyun cv." jujube during 2012 and 2013 seasons

Treatments	Yield (kg/tree)		Fruit weight (g)		Flesh weight(g)	
	2012	2013	2012	2013	2012	2013
Urea 1%	37.18bcd	32.34cd	18.65bc	16.97c	16.72b	14.79b
Urea 2%	50.70b	51.10ab	17.47bc	17.27c	15.43b	15.60b
Zn SO_4 1%	31.67cd	37.55bcd	16.83c	15.40d	14.90b	13.53c
Zn SO_4 2%	46.20abc	46.47abc	16.36c	17.71c	14.62b	15.42b
Canada Humex 1%	51.97ab	52.53a	20.79b	19.81b	18.41b	18.45a
Canada Humex 2%	52.34a	52.58a	24.05a	21.07a	21.89a	18.86a
Control	28.66d	29.30d	13.28d	15.36d	11.65c	12.97c
LSD5%	18.12	18.23	2.78	1.02	2.66	1.12

Means not sharing any letter differ significantly at p≤0.05.

Table 3: Effect of foliar application of urea, zinc sulphate and Canada Humex on fruit length (cm); fruit diameter (cm) and fruit volume (cm^3) of "Puyun cv." jujube trees during 2012 and 2013 seasons

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit volume (cm^3)	
	2012	2013	2012	2013	2012	2013
Urea 1%	3.70b	3.75a	3.27bc	3.18a	19.5bc	17.67b
Urea 2%	3.70b	3.76a	3.17bc	3.09a	18.0c	17.03b
Zn SO_4 1%	3.67b	3.68a	3.07cd	2.97a	17.33c	19.0ab
Zn SO_4 2%	3.5c	3.82a	3.07cd	3.12a	17.0c	19.0ab
Canada Humex 1%	3.72b	3.96a	3.37b	3.19a	22.0b	20.67ab
Canada Humex 2%	3.93a	4.09a	3.60a	3.24a	25.0a	22.33a
Control	3.3d	2.72b	2.9d	2.7b	13.0d	19.83ab
LSD5%	0.16	0.41	0.18	0.23	2.76	2.86

Means not sharing any letter differ significantly at p≤0.05.

Table 4: Effect of foliar application of urea, zinc sulphate and Canada Humex on SSC (%); acidity (%); reducing and total sugars (%) of " Puyun cv." jujube trees during 2012 and 2013 seasons

Treatments	SSC (%)		Acidity (%)		Reducing Sugars (%)		Total Sugars (%)	
	2012	2013	2012	2013	2012	2013	2012	2013
Urea 1%	15.07b	13.47b	0.65a	0.51b	6.32ab	4.70c	12.49b	11.88bc
Urea 2%	15.67b	13.76b	0.68a	0.43c	6.27ab	5.44b	12.01b	12.56b
Zn SO_4 1%	14.2bc	12.57c	0.57a	0.48b	6.12ab	4.73c	12.56b	12.15bc
Zn SO_4 2%	13.87c	13.20bc	0.58a	0.42cd	6.43ab	5.38b	11.97b	11.56c
Canada Humex 1%	14.67bc	13.43b	0.60a	0.41d	6.97a	5.87a	12.82b	12.65b
Canada Humex 2%	17.47a	14.73a	0.54a	0.36e	7.21a	5.89a	14.32a	13.79a
Control	12.47d	11.09d	0.75a	0.59a	4.72c	4.43c	10.3c	10.57d
LSD 5%	*1.38*	*0.68*	*0.18*	*0.04*	*0.82*	*0.28*	*1.29*	*0.6*

Means not sharing any letter differ significantly at p≤0.05.

The stimulating effect of humic substances on growth, yield of horticulture crops could be related to enhanced uptake of mineral nutrients and the plant hormone-like activity of humic substances (Dursun *et al*., 2002; Serenella *et al*., 2002; Fathy *et al*, 2013). Humic acid has been reported to improve plant growth and development (Bohme and Lua 1997; Hartwigsen and Evans 2000; Liu and Cooper 2002). Furthermore, humic acid substances increased dry matter of foliage and roots, promoted N uptake and accumulation of nutrients and enhanced photosynthesis of apple trees (Tatini *et al*., 1991; Jianguo *et al*., 1998). Humates markedly increased cell membrane permeability and exhibit hormone like activity (Chen *et al*., 1994; Fathy *et al*., 2013).

In light of humic acid induced bioassay, it could be explained humic acid has cytokinins-like and gibberellins-like activities. Moreover, it increases water uptake of trees (Honay and Tich, 1976), possibly as a result of increasing root surface area or increasing cell permeability (Webb and Biggs, 1988).

CONCLUSION

Spraying Canada Humex twice (after 15 days of fruit set and one month after first spray) at 2% followed by 1% concentration, have a highest effect than urea and zinc sulphate on yield and fruit quality of Jujube fruit 'Puyun' grown under Saudi Arabia conditions. In addition, Canada Humex is safe for human, animal and the environment in terms of less pollution and low soil salinity.

Moreover, the reduction of fertilization and decreasing the total production cost could be achieved.

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