EFFECT OF CALCIUM AND ZINC SPRAYS ON FRUIT DROPPING NATURE OF HAYANY DATE CULTIVAR. I. YIELD AND FRUIT QUALITY

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ABSTRACT

The present study was carried out on Hayany date palm grown at Dammitta Governorate. Spraying with calcium (3000 ppm Ca^{++}) and zinc sulphate (150 ppm Zn^{++}) solutions either alone or in combination were conducted during 1999-2000 seasons, to evaluate their efficiency in reducing the incidence of date fruit drop, by increasing the fruit retention. Applications were done on both the leaves and bunches at the fifth week after complete pollination; the beginning of Kimiri stage, and also repeated after binding process of bunches. The obtained results revealed that both treatments increased significantly the force required to removing fruits, reduced the excessive fruit drop and increased yield especially in the off-year of bearing. Also a significant increase in fruit weight and size was observed in on-year of bearing, however the differences were not significant in the off-year, whereas flesh weight of fruits showed a significant increase as affected by application of calcium plus zinc. Moreover, pronounced effects of applications at the binding process were apparent on fruit characters when compared with those at the fifth week after complete pollination. With respect to the chemical characteristics of Hayany date fruits at the end of Khalal stage, it was found that total sugar, reducing sugars, total proteins, and soluble proteins of date fruits were significantly increased as affected by spraying with both calcium and zinc, whereas the tannins contents were reduced. Consequently, we recommend with using these applications at the same condition, especially on date palm grown on sandy soil.

Additional Index Words: Date palm, Cultivar, Khalal, Kimiri, Fruit drop, Yield, Fruit quality, Total and soluble proteins, Total and reducing sugars, Tannins, Removal force.

INTRODUCTION

The date palm tree is one of the ancient domesticated fruit trees in the Middle East countries, and their fruit still occupy an important place in the dietary pattern of people even to day. In Egypt many cultivars were located at different districts, according to the diversity of their climatic requirement, especially average temperature and relative humidity which affect fruit maturation processes (Hussein *et al.*, 1979; Ibrahim & Hagag,1993). Demmitta governorate is considered one of main producers of soft date "Hayany" where about of 490000 female adult palms are existed (Ministry of Agriculture, 1998). Their fruits attain maturation at the end of September till the end of November and directly consumed as a fresh fruits on seasons after harvest; at the Rutab stage when the fruits precipitates nearly all astringent components and acquires a softer texture, and a darker, less attractive color (Hussein *et al*., 1979; Suad Al-Hooti *et al.*,1995).

Effect of fertilization with some major elements on the productivity and fruit quality of date palm has been widely reported by many workers (Furr & Brown 1963, Hussein & Hussein 1972, Kalifa *et al.*, 1975, Abdalla *et al*. 1987, Melouk *et al.*, 1999, Atalla *et al*.,1999, and Shawky *et al*.,1999).Up till now, little attention have been paid towards another nutrient elements in particular Ca^{2+} and Zn^{2+}, for palm nutrition, especially grown on sandy soil, except the addition of little manures at winter, as a source of trace elements. Despite, minor elements affect greatly the physiological processes and play an important role in fruit retention of many fruit trees, as well as, improving the yield and fruit quality (Singh & Sant Ram, 1983, Babu *et al*., 1984, Khan *et al*.,1993).

High concentrations of calcium are known to inhibit and sometimes prevent fruit ripening Ferguson, (1984). While calcium undoubtedly has subtle effects on all membrane, on membrane proteins Paliyath and Poovaiah, (1985), and as a second messenger Hepler and Wayne, (1985), the high concentrations of calcium required to delay ripening or inhibit senescence suggest a gross effect, perhaps in the wall.

The main aim of this study is to evaluate the role of calcium and zinc in minimizing the dropped fruits after complete pollination by increasing fruit retention, especially at the off-year of bearing, which results an increase in yield per palm and improve their fruit quality.

MATERIALS AND METHODS

The present investigation was carried out during the growing seasons of 1999 (on-year) and 2000 (off-year). Thirty-five old date palm trees of "Hayany" cultivar (*Phoenix dactylifera*, L.) grown on a sandy soil at OM-El-Reda Village in a Private Orchard 20 Km west Demmitta city were selected for this study.

All trees received the common orchard management, pruning, pollination, and thinning bunches, usually practiced at the Demmitta governorate. Four replicates each one palm tree were used, in a complete randomized block design, in the following treatments:

Tc =Spraying the bunches and leaves with water only.

T_1 =Spraying the bunches and leaves at the fifth week after complete pollination with calcium nitrate solution at (3000ppm, calcium).

T_2 =Spraying the bunches and leaves at the fifth week after complete pollination with zinc sulphate solution at (150ppm, zinc).

T_3 =Spraying the bunches and leaves at the fifth week after complete pollination with $Ca(NO_3)_2$ + $ZnSO_4$ at the previous concentrations of T_1& T_2

T_4 =Spraying the bunches and leaves at the binding process of bunches with $Ca(NO_3)_2$ at (3000ppm, calcium).

T_5 =Spraying the bunches and leaves at the binding process of bunches with zinc sulphate (150ppm, zinc).

T_6 =Spraying the bunches and leaves at the binding process of bunches with $Ca(NO_3)_2$ (3000ppm, calcium) + $ZnSO_4$ (150ppm, zinc).

T_7 =Spraying the bunches and leaves with $Ca(NO_3)_2$ at the fifth week after complete pollination and then repeated after binding process of the bunches with the same solution at (3000ppm, calcium).

T_8 =Spraying the bunches and leaves with $ZnSO_4$ (150ppm, zinc) at the fifth week after complete pollination and then repeated after binding process of the bunches with the same solution.

T_9 = Spraying the bunches and leaves with both $Ca(NO_3)_2$ (3000ppm, calcium) and zinc sulphate $ZnSO_4$ (150ppm, zinc) at the fifth week after complete pollination and then repeated at binding process of the bunches with the same solutions and concentrations.

The bunches and leaves had been sprayed, till their entire surfaces became thoroughly wet.

Fifteen spikelets on each four bunches of nearly equal size were chosen and their fruits were recorded to estimate the dropped fruit percentage per treatments on each palm at harvest time.

At the beginning of harvest time, fruit removal force was determined by using push-pull dynamometer (Model DT 101 (Kg 1×10 gm/Lb2 × 0.02Lb) from Effegi, Italy).

Palm fruit yields were calculated according to the average number of retained fruits at the end of Khalal stage on each bunch were multiplied by the average fruit weight by the number of commercial bunches per palm.

At the end of Khalal stage, 20 full-matured fruits were detached at random from each bunch per palm to determine their physical and chemical properties.

Chemical analysis of fruit samples included determination of total soluble solids percentage by using refractometer, tannins were carried out according to method of Ranganna, (1979) as mg/100gm flesh weight. Sugars were determined spectrophotometrically at 700 mμ using spekol II (Carlzesis Jena) as described by Naguib (1964) and El-Shaht (1980) on dry weight basis.

Total protein (T.P.) extraction was prepared according to Dure III & Chilan, (1981) and Oster *et al.*, (1992). Soluble protein extraction (SP) was carried out according to Dure III & Chilan, (1981) and Mahhou & Dennis, Jr. (1994) on fresh weight basis. The T.P. and S.P. contents were determined spectrophotometrically at 595 mμ by the Coomassie assay of Bradford (1976).

The statistical analysis of the obtained results was carried out according to Norusis (1993) using the new least significant difference (N.L.S.D.).

RESULTS AND DISCUSSION

1- Effect of calcium and zinc sprays on fruit removal force, fruit drop percentage and yield per palm:

Results in Table (1) show that spraying with calcium either alone or combined with zinc caused a significant increase in the force required for separating the fruits from its stalks. Zinc alone did not realize the same effect, except spraying it at both first period and second one of applications. Similar responses on fruit drop percentage were observed, especially at the off-year of bearing, subsequently yield per palm increased significantly at the same year.

The above mentioned results are in agreement with those findings of Singh & Saut Ram, (1983), Babu *et al.*, (1984), and Khan *et al.*,(1993), where fruit retention of many other fruit trees have been improved under similar applications with calcium and zinc. A tentative explanation for the increased fruit removal force, fruit drop percentage and yield per palm Table (1) due to calcium and zinc sprays may be due to improve the formation of cellulose and lignin. These materials are required for building plant structure or preventing the abscission layer formation and consequently, the reduction in pre-harvest fruit dropping Nijjar, (1985).

Table (1) Effect of Calcium and Zinc Sprays on fruit removal force, fruit drop Percentage and yield per palm of Hayany cultivar.

Treatments	Fruit removal force (Ibs.)			Fruit drop %			Yield / Palm(Kg)		
	1999 *	2000 **	Average	1999	2000	Average	1999	2000	Average
Control	1.06	1.33	1.20	30.37	41.53	35.95	98.80	60.36	79.58
T_1	1.89	1.81	1.85	20.34	21.35	20.85	107.31	107.07	107.19
T_2	0.90	0.94	0.92	27.94	27.46	27.70	95.31	67.92	81.62
T_3	1.87	1.96	1.92	23.97	21.24	22.61	85.67	107.22	96.45
T_4	1.56	1.78	1.67	26.10	29.05	27.58	110.60	85.19	97.80
T_5	1.15	1.21	1.18	26.84	21.31	24.07	104.35	93.31	98.83
T_6	1.56	1.60	1.58	22.47	14.33	18.40	106.61	96.82	101.72
T_7	1.54	1.83	1.69	21.16	28.08	24.62	113.23	91.70	102.47
T_8	1.52	1.69	1.61	25.16	25.74	25.45	107.40	103.97	105.68
T_9	1.92	2.00	1.96	21.03	15.81	18.42	98.93	106.90	102.92
L.S.D at 5%	0.136	0.30	0.157	N.S.	11.40	8.72	N.S.	23.07	22.08

T_1 = Ca at 5th week after pollination. **T_2** = Zn at 5th week after pollination.
T_3 = Ca +Zn at 5th week after pollination. **T_4** = Ca at binding process.
T_5 = Zn at binding process. **T_6** = Ca +Zn at binding process.
T_7 = Ca at 5th week after pollination + Ca at binding process.
T_8 = Zn at 5th week after pollination + Zn at binding process.
T_9 = (Ca +Zn at 5th week after pollination) + (Ca +Zn at binding process).
***** On-year ****** Off-year

2- Effect of calcium and zinc sprays on fruit weight, size and flesh weight:

Results in Table (2) reveal that average of fruit weight and flesh weight significantly increased during both seasons of the study, whereas the same trend was observed in the on-year of bearing, however the differences were not significant in the off-year of bearing. The different treatments of both Ca and Zn alone or combined at different time of applications showed similar effects on fruit physical properties. These results reflect, in general, the need of palm trees during both on-year and off-year of bearing to more nutrients to regulate their biennial bearing and to compensate the additional requirements to some fertilizers. Various workers in different fruit trees have also reported similar findings, El-Naggar *et al*.,(1973), on Valencia Orange, who mentioned that spraying trees with zinc sulphate reduced the alternate bearing, El-Gazzar *et al*.,(1979), on Washington Navel Orange, Samra (1985) on Mandarin.

The increase in growth criteria of date palm fruit due to calcium and zinc sprays in addition to the reduction in the pre-harvest fruit dropping surely reflected on improving the yield. The improvement occurred in the fruit quality due to supplying trees via leaves with calcium and zinc could be attributed to their effects on enhancing formation and translocation of carbohydrates and carbohydrate enzymes, Yogeratnam & Greenham (1982).

Table (2) Effect of Calcium and Zinc Sprays on some physical characters of Hayany date Fruits at the end of khalal stage.

Treatments	Fruit weight (gm)			Fruit size (cm^3)			Flesh weight (gm)		
	1999	2000	Average	1999	2000	Average	1999	2000	Average
Control	17.94	19.19	18.57	18.27	19.83	19.05	14.77	15.36	15.06
T_1	21.13	19.94	20.54	21.59	21.25	21.42	17.48	16.77	17.13
T_2	18.51	21.39	19.95	19.15	23.29	21.22	14.89	19.26	17.08
T_3	20.46	22.33	21.40	19.64	22.83	21.23	16.77	20.75	18.76
T_4	21.31	21.24	21.28	23.57	22.06	22.82	18.66	19.20	18.93
T_5	20.48	22.51	21.50	20.40	21.69	21.04	16.06	19.64	17.85
T_6	21.66	20.35	21.00	23.15	20.47	21.81	19.53	17.83	18.68
T_7	19.57	19.69	19.63	21.37	19.42	20.40	17.81	16.58	17.20
T_8	20.91	20.92	20.91	19.36	20.09	19.72	17.97	18.23	17.96
T_9	21.23	19.91	20.57	19.71	21.03	20.37	17.67	17.37	17.52
L.S.D at 5%	2.7	N.S.	2.62	1.81	N.S.	N.S.	1.74	3.37	2.25

3- Effect of calcium and zinc sprays on chemical characteristics of date fruit:

The results in Table (3&4) clearly indicate that the effect of treatments included Ca alone or Ca plus zinc were apparent at the first season of the study on T.S.S., where the increase was significant, but the increase in the second one was not significant. An average trend of two seasons of T.S.S was significant. Also, total sugars soluble proteins and total proteins contents exhibited a significant increase at both seasons of study. A reverse trend was observed on tannin contents that were reduced significantly as affected with treatments. Samra, (1985), reported similar results on mandarin, spraying trees with zinc increased the levels of nitrogen in the leaves.

In the present study, understanding of the changes that occur during maturation and ripening of date palm fruits as influenced by both Ca^{2+} and Zn^{2+} application is limited because knowledge of the structure of the walls in mature date palm fruits and of enzymes that modify the walls is very limited. Softening is accompanied by an increase in the content of soluble pectic substances Huber, (1983). The increase in soluble uronic acid residues is often correlated with an increase in the polyuronide hydrolyzing enzymes Brady, (1987).

When one consider the potential activity of the polygalactouronase and pectin methyl esterase in fruit tissues, that attack on polyuronide appears to be very limited and, in tomatoes, there is evidence that calcium limits wall hydrolysis Brady *et al.*, (1985), claims that calcium is "solublized" or otherwise redistributed in ripening fruit have been made, but these claims are built on inadequate techniques Brady,(1987), and there is a need to evaluate calcium distribution between the vacuole and the wall.

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Table (3) Effect of Calcium and Zinc Sprays on Total Soluble Soilds and Sugars of Hayany date fruits, at the end of Khalal stage.

Treatments	T.S.S. %			Reducing Sugars %			Non – reducing Sugars %			Total Sugars %		
	1999	2000	Average	1999	2000	Average	1999	2000	Average	1999	2000	Average
Control	30.5	30.0	30.25	70.39	68.67	69.53	8.09	4.34	6.22	78.48	73.31	75.90
T_1	32.3	31.0	31.66	76.74	80.46	78.6	11.94	6.66	9.30	88.68	87.12	87.9
T_2	32.67	29.0	30.8	71.79	74.51	73.15	7.46	5.57	6.52	79.25	80.08	79.67
T_3	33.33	28.0	30.66	72.51	74.59	73.53	12.66	6.01	9.34	87.98	80.60	84.29
T_4	32.5	31.0	31.75	78.39	76.78	77.59	10.43	7.55	8.99	88.82	84.33	86.58
T_5	32.0	28.0	30.0	70.72	65.23	67.97	6.05	4.16	5.12	76.77	69.39	73.08
T_6	35.33	29.0	32.16	77.07	78.62	77.85	7.0	5.03	6.02	84.07	83.69	83.86
T_7	32.33	31.0	31.66	78.89	79.14	79.02	9.61	7.17	8.39	88.50	86.31	87.31
T_8	30.0	29.0	29.5	70.83	77.80	74.32	6.78	5.64	6.21	77.51	83.44	80.48
T_9	29.83	29.0	29.41	72.29	76.42	74.36	7.55	4.92	6.24	79.84	81.34	80.59
L.S.D at 5%	4.20	N.S.	2.73	N.S.	7.60	7.56	N.S.	N.S.	N.S.	4.12	5.48	3.73

Table (4) Effect of Calcium and Zinc Sprays on Tannins and Protein fractions of Hayany date fruits, at the end of Khalal stage.

Treatments	Tannins (mg/100 gm flesh)			*Soluble Protein %			*Insoluble Protein %			Total Protein %		
	1999	2000	Average	1999	2000	Average	1999	2000	Average	1999	2000	Average
Control	303.4	296.47	299.9	0.80	0.97	0.89	0.42	0.34	0.38	1.22	1.31	1.27
T_1	224.5	192.77	208.6	0.82	0.89	0.87	0.38	0.35	0.37	1.20	1.24	1.22
T_2	228.4	221.47	224.9	1.42	1.48	1.45	0.38	0.36	0.37	1.78	1.86	1.82
T_3	231.97	228.60	230.2	0.92	1.16	1.04	0.40	0.39	0.40	1.32	1.55	1.44
T_4	242.3	287.30	264.5	1.47	1.59	1.53	0.39	0.39	0.39	1.86	1.98	1.92
T_5	275.1	286.4	280.7	0.91	1.01	0.96	0.38	0.37	0.38	1.29	1.38	1.34
T_6	232.0	282.0	257.0	1.23	1.47	1.35	0.38	0.37	0.38	1.61	1.84	1.73
T_7	249.97	274.9	262.4	0.73	0.94	0.84	0.38	0.37	0.38	1.11	1.31	1.21
T_8	231.97	265.9	248.9	1.33	1.56	1.45	0.38	0.36	0.37	1.71	1.92	1.82
T_9	264.07	276.47	270.3	1.18	1.54	1.36	0.36	0.37	0.37	1.54	1.91	1.73
L.S.D at 5%	54.71	45.62	34.92	0.137	0.621	0.166	N.S.	N.S.	N.S.	0.219	0.271	0.218

* fresh weight.