

Effects of Application Commercial Product Rates and Times on Yield and Fruit Quality of CV. Medjool Date Palms

Esam, A. M. M, N. E. Ashour, Omaima, M. Hafez*, Malaka, A. Saleh

Pomology Research Department, National Research Centre, Dokki, P.O. Box 12622, Cairo, Egypt

Abstract: Inflorescences of Medjool date palms were treated with a commercial product namely (Sword[®]) contains (25% K₂O, 0.5% Mg, 0.5% Zn, 25% Salicylic acid, 0.01% L-ascorbic acid, 0.01% Riboflavin and 48.98% helper's carrier materials) as foliar application. Dates were sprayed with Sword[®] at (1 and 2%) one, two and three times/rate. Once at full bloom, twice at full bloom and one month later and triple at full bloom, one month later and month before harvest time, in addition to the untreated one (control).

In general, results showed that foliar application of Sword[®] had apposite effect on performance of Medjool date palms and obviously there is a direct relation between rises the most parameter contents with increasing rates and times of Sword[®]. The best results obtained with spraying 2% Sword[®] three times is the promising treatment for increasing fruit set, fruit retention, maximize the bunch weight and yield/palm and improving fruit physical characteristics (such as fruit weight, length and diameter) as well as chemical characteristics of date fruits by increasing TSS, total sugars and reducing acidity. Besides, it considered environmentally safe and low cost.

Key words: Medjool date palm, application, nutrients, antioxidants, fruit set, yield and fruit quality.

Introduction

Dates are the most critical conventional crops in Egypt and the Arab countries. Egypt always is considered among the top ten date producers, the total production of date fruits is about 1.3 million tons¹. Medjool cultivar is known semi-soft date fruits. Date can be affected by improper mineral nutrient, whether due to insufficient or incorrect fertilization. Palm trees need sufficient nutrients in proper balance for normal growth and development. Many investigations clearly show the vital role of main elements such as (N, P, K and Mg), minor elements i.e. (Zn, Mn and Fe) and antioxidants like (Salicylic acid, L-ascorbic acid and Riboflavin) as well as their combined effect.

Spraying potassium has a positive effect on fruit setting, retention, yield and fruit quality because it plays an important regulatory role in many physiological and biochemical processes of plant^{2,3,4}.

Zinc is an essential micro-element for plant. It is involved in many enzymes reactions and is necessary for growth and development, as well as protein and carbohydrate metabolism. Foliar application of zinc sulfate is more effective on yield and fruit quality^{5,6,7}.

Spraying macro and micro nutrients had important role in fruit set, fruit retention and development and cause efficient yield and improve quality^{8,9,10}.

Environmental stress causes significant crop losses, its include increased UV-B radiation, water, high salinity, temperature extremes, hypoxia (restricted oxygen supply in waterlogged and compacted soil), mineral nutrient deficiency, metal toxicity, herbicides, fungicides, air pollutants, light, temperature and topography. Most environmental stresses are affecting on the production of active oxygen species in plants, causing oxidative stress^{11,12,13}. The main role of antioxidants is reactive oxygen species (ROS) formation to oxidative stress resistance leading to longevity in plants. In plant tissues many phenolic compounds are potential antioxidants: L-ascorbic acid, flavonoids, tannins and lignin precursors may work as ROS-scavenging compounds. Antioxidants act as a cooperative network, employing a series of redox reactions¹⁴.

From another hand, there are nutrient elements and antioxidants play a great role in increasing fruit set and retention, decreasing fruit drop and improving fruit quality that maximize productivity as well as long life of plant^{15,16}.

Therefore, the target of this study is to assess the effects of foliar application commercial product (Sword[®]) which composed combined nutrient elements (K, Mg & Zn) with antioxidants (Salicylic acid, L-ascorbic acid and riboflavin) on yield, fruit set, retention and quality of Medjool date palm.

Materials and Methods

The present study was carried out during the 2014 and 2015 seasons on 10 years old date palm (*Phoenix dactylifera* L.) cultivar "Medjool" grown on sandy soil with 6x6 meters a part under drip irrigation system at a private orchard located point of 63 kilo meter from Cairo-Alexandria Desert Road. The selected palms were healthy, nearly uniform in growth vigor and fruiting and received regular horticultural practices. Moreover, pruning was performed to maintain bunch/mature leaves ratio to (1:8) respectively. The number of spathes per palm was edited to 10 bunches by removing excess earliest, latest and smallest inflorescence. Pollination was carried out using the same pollen grain source.

Palms were sprayed with freshly prepared aqueous solution commercial product called "Sword[®]" consists of the components (Potassium 25%, Magnesium 0.5%, Zinc 0.5%, Salicylic acid 25%, L-ascorbic acid 0.01%, Riboflavin 0.01% and helper's carrier materials 48.98%) in two concentrations and three times. Seven treatments used including control, on Medjool dates as follows:

- Control (water only).
- 1% Sword[®] once (at full bloom).
- 1% Sword[®] twice (at full bloom then one month later).
- 1% Sword[®] triple times (at full bloom then one month later followed by third one a month before harvest time).
- 2% Sword[®] once (at full bloom).
- 2% Sword[®] twice (at full bloom and one month later).
- 2% Sword[®] triple time (at full bloom, one month later and month before harvest time).

The experiment was set up in a complete randomized block design with ten replicates each of one bunch. Bunches were sprayed using a small hand sprayer until run-off bunches were separated from each side with plastic sheets to avoid any contamination between other treatments.

The number of fruit set was recorded and fruit set (%) calculated with¹⁷.

Fruit retention (%) was determined by using this equation: Total No. of the retained fruits per bunch / Total No. of the nods per bunch¹⁸.

Bunches were harvested at the end of September (in the two seasons) when fruits reached Khalaal stage and their weights were recorded.

Twenty five fruits from each bunch were picked at random to determine the physical fruit characteristics, i. e. fruit weight and dimensions, pulp and seed weight. The chemical constituents like total soluble solid percentage (TSS %) using handy refractometer, reducing, non reducing, total sugars, tannins and total acidity % (as a citric acid /100g pulp) were also determined with ¹⁹.

Statistical analysis was done ²⁰ using LSD at 5% level to compare between different treatments means.

Results and Discussion

Fruit set and retention percentage

It's clear from data presented in Table (1) that all Sword[®] treatments significantly increased fruit set as well as fruit retention. Furthermore, the previous measurements improved progressively by rising rates and times as compare with control. Also, it can be noticed spraying 2% Sword[®] recorded the highest significantly of fruit set and retention compared with spraying 1% and the control. The highest significant percentages of fruit set obtained by 2% Sword[®] triple times (78.6 & 78.0 %), followed by 2% Sword[®] twice times (76.5 & 71.5 %) and 2% Sword[®] once (75.6 & 70.6 %). Meanwhile, the less significant value was obtained by control treatment (66.0 & 67.0 %) consecutively in the two seasons.

Table 1 Effect of application commercial product rates and times on fruit set, retention, bunch weight and yield/palm of Medjool date palms during 2014 and 2015 seasons

Treatments	Fruit set (%)		Fruit retention (%)		Bunch weight (Kg)		Yield/palm (Kg)	
	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd
Control (water only)	66.0	67.0	29.0	29.6	10.9	11.0	109.3	110.0
1% Sword [®] once	70.3	69.6	29.6	32.0	12.5	12.7	121.7	123.3
1% Sword [®] twice	72.0	70.3	31.0	32.3	13.1	13.2	130.0	131.3
1% Sword [®] triple	75.3	70.6	34.0	34.3	14.1	14.3	140.0	141.0
2% Sword [®] once	75.6	70.6	35.0	34.5	15.5	15.8	151.7	155.0
2% Sword [®] twice	76.5	71.5	35.6	34.8	16.3	16.8	159.0	165.0
2% Sword [®] triple	78.6	78.0	42.3	41.0	17.4	18.0	172.7	176.7
LSD _{0.05}	1.7	1.3	1.7	1.00	0.55	0.58	5.50	5.8

The same trend was found as for fruit retention %. It is noteworthy we could say palms sprayed with 2% Sword[®] three times, the means of fruit retention % increased than the control treatment by about (45.9 & 38.5 %) respectively in both seasons. Also, there is no significant differ between 2% Sword[®] once and 1% Sword[®] triple and that is true in the two seasons.

These results are in harmony with those obtained by ²¹ on Sewy date palms, ²² on Barhee date palms ²³ on Amhat date palms and ²⁴ on mango trees.

Bunch weight and yield/palm

Data in Table (1) showed that all sprayed treatments significantly increased both bunch weight and yield/palm of cv. Medjool compared with the control in 1st and 2nd seasons.

In this respect, the best treatments gave the highest significant means of bunch weight were obtained in palms sprayed with 2% Sword[®] triple, twice and one which achieved [(17.4 & 18.0), (16.3 & 16.8) and (15.5 & 15.8) Kg/bunch] respectively, in the two seasons. Whereas, the control palms (untreated check) gave the lowest significant bunch weight, it recorded (10.9 & 11.0 Kg/bunch) in the first and second seasons, consecutively.

On the other side, the same trend was found in yield/palm (Kg) like the previous results. Dates foliar application of high level Sword[®] three times, two and one recorded the maximum yield/palm averages than

untreated dates about by [(58.0 & 60.6), (45.5 & 50.0) and (38.8 & 40.9) %] respectively, in the 1st and the 2nd seasons, with high statistical between them. Otherwise, the control palms (untreated check) gave the minimum significant values of yield/palm, which recorded (109.3 & 110.0 Kg/palm) consecutively, in both seasons.

From the above results might be due to the increase in bunch weight of Medjool date palms was attributed increase in both percentages of fruit set and fruit retention, thus reflected on the yield. Besides, the enhancement effects by application of Sword[®] as a commercial product. This results are going in line with these obtained by ²⁵ who mentioned that the beneficial influence of Sword[®] on the yield might be attributed to their contain combined with mineral nutrition (K, Mg and Zn), antioxidants (Salicylic acid, L-ascorbic acid, and Riboflavin) and helper's carrier materials has positive effect on growth and nutrition status of dates, which could be rendered in increase such biosynthesis and reflected to yield development.

Also, Zinc is one of the micronutrient required of normal plant growth. The role of Zn in plant is due to its requirement in the synthesis of tryptophan which is a precursor of indole acetic acid and the formation of this growth substance is directly influenced by Zn ²⁶.

In addition, antioxidants are essential metabolic functions in the life of plants. This antioxidant activity is associated with resistance to oxidative stress and longevity in plants. Furthermore, the endogenous level of them has recently been suggested to be important in the regulation of developmental senescence and plant defense against oxidative stress ^{27,28}.

In this regard our results are in harmony with those finding by ^{29,30,15,16,24}.

Fruit physical characteristics

Concerning fruit physical properties data in Table (2) revealed that fruit dimensions (cm) (length and diameter) and weight (g), were significantly affected by Sword[®] treatments than the control, especially the high concentrations 2% which gave higher values for all the above mentioned parameters.

Table 2 Effect of application commercial product rates and times on fruit physical characteristics of Medjool date palms during 2014 and 2015 seasons

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit weight (g)		Pulp weight (g)		Seed weight (g)	
	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd
Control (water only)	4.0	3.9	2.3	2.4	15.8	16.0	13.6	13.8	2.2	2.2
1% Sword[®] once	4.4	4.2	2.7	2.6	17.6	17.0	14.8	15.4	2.2	2.2
1% Sword[®] twice	4.6	4.4	3.1	3.0	19.0	18.5	15.9	16.8	2.6	2.2
1% Sword[®] triple	5.0	4.7	3.0	3.1	19.9	19.5	16.8	17.7	2.6	2.2
2% Sword[®] once	5.0	5.3	2.8	3.0	22.5	21.5	18.9	20.2	2.6	2.3
2% Sword[®] twice	5.1	5.4	3.0	3.2	24.8	24.0	21.1	22.4	2.9	2.4
2% Sword[®] triple	5.3	5.5	3.2	3.3	26.0	25.0	21.9	23.6	2.9	2.4
LSD_{0.05}	0.24	0.15	0.13	0.17	0.90	0.73	1.25	0.60	0.21	NS

NS: Not Significant

Regarding fruit dimensions (length and diameter) results showed that spraying Medjool cv. date palms with Sword[®] at 1% or 2% either ones, twice or three times improved fruit dimensions compared with the control in both seasons, since spraying palms with 2% Sword[®] three times recorded the highest value of fruit dimensions followed by the same rate application two times compared with the untreated one. Similar results were obtained in both seasons of the study.

The highest significant value of fruit weight was obtained when Sword[®] sprayed at 2% three times which recorded the heaviest fruit (26.0 and 25.0 g) followed by the same concentration sprayed twice which recorded (24.8 and 24.0 g) during the two seasons, respectively. On the other hand fruit picked from control gave the lowest fruit weight (15.8 & 16.0 g) during the first and second seasons, respectively.

As for flesh and seed weight, it is clear from the recorded data in Table (2) that all used treatments were significantly effective in improving these measurements.

In this respect, the highest value of flesh weight was obtained from palms sprayed with the high rate and time of Sword[®] (2% triple times) compared with the other treatments including control. This was true in both studied seasons.

The above mentioned results are agree with those of ³¹ on Grand Nain banana, ²¹ on Sewy date palm, ²² on Barhee date palms, ³² on Washington navel orange, ²³ on Amhat date palm and ²⁴ on Mango trees.

Fruit chemical characteristics

Generally, all parameters of fruit chemical properties were enhancement gradually by increasing rates and times of Sword[®] applications.

Results in Table (3) revealed that Sword[®] treatments significantly increased TSS% than the control in both seasons of study. In this regard, spraying the high concentration three times gave the highest TSS content (33.2 & 33.0 %) respectively, in the 1st and 2nd seasons. Data clearly that the high concentration of Sword[®] with applications three or two times has no significant differ between them on TSS %, in the first season only.

Table 3 Effect of application commercial product rates and times on fruit chemical characteristics of Medjool date palms during 2014 and 2015 seasons

Treatments	TSS (%)		Acidity (%)		Reducing sugars (%)		Non reducing sugars (%)		Total sugars (%)		Tannins %	
	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd
Control (water only)	28.8	28.3	0.28	0.27	43.0	41.0	11.0	11.7	54.0	52.7	0.13	0.14
1% Sword[®] once	29.7	29.5	0.25	0.26	44.7	45.0	11.0	11.3	55.7	56.3	0.12	0.12
1% Sword[®] twice	30.4	30.3	0.25	0.26	45.7	45.0	10.7	10.7	56.0	55.7	0.11	0.11
1% Sword[®] triple	31.2	31.0	0.24	0.25	46.0	46.0	10.3	11.3	56.7	57.3	0.12	0.12
2% Sword[®] once	31.5	31.8	0.24	0.25	46.3	45.7	11.3	10.7	57.3	56.3	0.11	0.11
2% Sword[®] twice	32.2	32.3	0.24	0.25	47.0	45.7	10.7	10.7	57.3	56.3	0.11	0.11
2% Sword[®] triple	33.2	33.0	0.24	0.25	46.7	48.7	11.0	10.3	59.3	59.0	0.10	0.11
LSD_{0.05}	0.89	0.7	0.001	0.001	N.S	1.43	NS	NS	0.29	1.39	0.001	0.001

NS: Not Significant

As for acidity percentage, it had the opposite trend of the TSS in reducing acidity, which is right in the two seasons. In addition, the results revealed that the high rate of Sword[®] in all applications times showed no significant between them and the low level in spray triple times, which is true in both seasons.

In case reducing sugars, data in Table (3) cleared that there were not affected significantly by different Sword[®] treatments in the first seasons. Meanwhile, reducing sugars were affected significantly by different Sword[®] treatment as compared with the control in the second seasons.

While, non reducing sugars % results indicated that no significant differences were detected due to Sword[®] treatments.

As for total sugars percentage were significantly affected by Sword[®] treatments. However, palms sprayed with high level and time of Sword[®] (2% three times) produced the highest values (59.3 & 59.0 %)

consecutively, in the two seasons compared with other treatments and the control. These hold true for both seasons.

Concerning tannins % all Sword[®] concentration and times reduced total tannins % as compared with the control in 1st and 2nd seasons, with no statistical differences between them except the high level and time of Sword[®] in the first season only. While, the highest significant values of tannins obtained by the untreated palms, that is true in both seasons.

Improvement fruit physical and chemical characteristics due to the benefits of the commercial product their containing some nutrients and antioxidants, it's reflected on all parameters measurements. Such as potassium the role of it in activation enzymes, involved in ATP production, is probably more important for regulating photosynthesis rate that improves plant growth, yield and reduce the influence of adverse weather³³. These processes enhances sugar formation, neutralization of organic acids as well as increasing protein that led to better effect for both cell division and cell elongation.

Moreover, Zinc has also an important role in starch metabolism in plant. It is well known that zinc acts a co-factor of many enzymes and affects many biological processes such as photosynthesis reactions, nucleic acids metabolism, protein and carbohydrate biosynthesis²⁶.

In addition, Antioxidant serves as a co-factor for many enzymes and it contributes to the detoxification of ROS³⁴, also in the biosynthesis of many plant hormones, including ethylene, gibberellic acid, and abscisic acid. In this connection the present results are in agreement with those obtained by^{31, 3, 15, 16, 4}.

Conclusion

From our results it could be concluded that foliar application of Sword[®] had a positive effect on performance of Medjool date palm. Spraying 2% Sword[®] three times (at full bloom, one month later and month before harvest time) is the promising treatment for increasing the most parameters than control like fruit set, fruit retention, maximize the bunch weight and yield/palm by about [(19.0 & 16.4 %)], (45.9 & 38.5 %), (59.6 & 63.6 %) and (58.0 & 60.6 %) consecutively, in both seasons. Furthermore, it is improving fruit physical properties (such as fruit weight, length and diameter) as well as chemical properties of date palms fruits by increasing TSS, total sugars and reducing acidity. Besides, it considered environmentally safe and low cost.

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