EFFECT OF ALA ON FRUIT YIELD AND QUALITY OF DATE PALM "CV. KHALAS"

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ABSTARACT

5-Amino levnulinic acid (ALA) is a precursor of tetrapyrrole compounds such as chlorophyll. Effects of ALA in plants have been reported in relation to chlorophyll biosynthesis, photosynthesis activity and suppression of respiration. Fruits of Khalas CV were sprayed with ALA aqueous solutions of 0, 50, and 100 ppm two weeks after fruit setting. Spraying was applied biweekly for a duration of six weeks. Chlorophyll content in Khalal stage was significantly increased with ALA treatment. Fruit weight, fruit volume and fruit flesh percentage on rutab stage were significantly increased with increasing concentration of ALA. On tamer stage, fruit volume was significantly increased with ALA treatment, while fruit weight was not. Total and reducing sugars were significantly increased with ALA treatment in Rutab stage, but not in Tamer stage.

INTRODUCTION

Date Palm (*Phoenix dactylifera*, L.) is a major fruit tree of Saudi Arabia. The total production of date fruits was about 686000 tons (Economics of Date Production in Kingdom of Saudi Arabia, 1998). Cultivation of Khalas date palm cultivar has tremendously increased in Saudi Arabia in recent years. This cultivar is well known for its high quality fruit. However, with the recent increase in its cultivation, several fruit quality problems have surfaced. Fruit size is considered one of the major factors that determine the income of the producers. Chemical spraying (Ethrel, GA_3, Ethephon, Naphthalene Acetic Acid) has been reported to improve date palm fruit size and quality (Riuhani and Basin, 1977; El-Hamady et al., 1983; El-Hamdy *et al.*, 1992; Elgamdi et al., 1993; Hussein *et al.*, 1996; Moustafa and Seif, 1996 and Moustafa *et al.*, 1996;). However, chemical treatment particularly GA_3 delayed fruit ripening and decreased total soluble solid and total sugar (Hussein *et al.*, 1996 and Moustafa and Seif, 1996)

5-Amino levulinic acid (ALA) is a precursor of tetrapyrrole compounds such as chlorophyll, phycobilin, heme and vitamin B12 which are found in plants. Foliar spraying of ALA at low concentration improved the growth and yield of crops and vegetables by 10 – 60 % over the control as reported on radish, kidney beans, barley, potatoes, garlic, rice and corn (Hotta et al., 1997 a, b and c). Effects of ALA in plants have been reported in relation to chlorophyll

biosynthesis, photosynthesis activity and suppression of respiration (Hotta et al., 1997a and Bingshan *et al.*, 1998)

Treating fruit of date at khalal stage (green stage) is expected to show some of the previously mentioned effects. If this assumption is true, the contribution of the treated fruits to photosynthetic activity could be higher than untreated ones. Therefore, accumulation of assimilates due to the increased activity of photosynthesis of treated fruits might positively affect the fruit size and chemical properties.

MATERIALS AND METHODS

The study was carried out in 1998/1999 in Al-Hassa. Twelve uniform 25 years old vigorous palm trees "cv. Khalas" were selected. They were subjected to the normal agricultural practices and thinned to eight bunches each. Pollination was conduced using the same male parent for all experimental palm trees. Fruits were sprayed with ALA aqueous solutions of 0, 50 and 100 ppm containing Tween 20 (0.1%). The spraying treatments were started two weeks after fruit setting with approximately 240 ml/tree of aqueous solution (approximately, 30 ml / bunch). Spraying was applied biweekly in the early morning for a duration of six weeks. Samples from each tree (replicate) were randomly collected at Khalal, rutab and tamer stages.

Chlorophyll was determined in khalal stage. Fruits skin (coat) was taken by a cork borer and then homogenized in cold ($4^{o}C$) 80 % v/v acetone in water. The homogenate was kept in the dark and centrifuged for 3.0 minutes to remove the fruit debris. The absorbency of the extract at 647 and 664 mm was taken using a spectrophotometer. For the accurate determination of chlorophyll a, b and the total, the extinction coefficients of Graan and Ort (1984) were used. Physical properties of rutab and tamer were obtained, i.e. fruit length and diameter (cm), fruit weight (g), fruit size (cm^3), fruit flesh (%), and fruit seed (%). Chemical properties including moisture (%), ash content, total sugars and reducing sugars were measured according to AOAC(1989).

RESULTS AND DISCUSSION

Total chlorophyll content and chlorophyll a and b in khalal stage were significantly increased with ALA treatment. There was no marked increase in chlorophyll a with increasing ALA concentration from 50 to 100 ppm. However, 50 ppm ALA treatment yielded significantly the highest total chlorophyll and chlorophyll b concentrations. Since a slight drop in all chlorophyll types was noticed with the 100 ppm ALA application, the 50 ppm ALA concentration might have represented a physiological threshold level beyond which

chlorophyll deteriorates. The increase in chlorophyll content has been reported in horse radish treated with low concentration of ALA (Hotta et al, 1997a), while respiration was suppressed in certain crops with higher levels of ALA (Bingshan *et al.,* 1998).

Table (1) shows that ALA treatment had no significant effects on rutab fruit dimensions. Fruit weight, fruit volume and fruit flesh % were significantly increased with increasing concentrations of ALA, while the seed fruit % was significantly reduced. The significant increase in rutab fruit weight with 5ALA treatments may be attributed to the increase in flesh fraction under the same treatments. The fruit volume was positively affected with increasing ALA concentrations, while both fruit diameter and length were not. Under this situation, it is not possible to establish a clear positive correlation between fruit volume and the two dimensions. However, we can continuously assume that other unobserved factors may have affected the volume parameter in addition to the slight non significant increases in fruit diameter and length. The increase in fruit weight and volume was approximately similar, i.e. 30 % more than control. Fruit dimensions of tamer were not significantly affected by ALA treatments Fruit volume was significantly increased with ALA treatment, while fruit weight was not. Seed and fruit flesh % were not significantly affected by ALA treatment (Table 1). It is quite possible that fruits at this stage may have reached an stable physiological maturation that can not be changed by ALA or any other hormonal treatments. Moreover, the ALA positive or negative effects are possible more pronounced at the rutab stage of the fruit. Hussein et al., (1996) reported that GA3 treatment significantly increased fruit weight, volume, length and thickness, but there was no definite trend for seed weight in Zaghlolo date cv. Similar effects had been reported by Moustafa and Seif, (1996). The proper time of chemical application during fruit or flower development to obtain certain desirable characters of fruits have been well investigated over the years (Rouhani and Bassiri, 1977; El-Hammady *et al.,* and Elgamdi *et al.,* 1993).

Total and reducing sugars were significantly increased in rutab stage with the application of ALA, but there was no significant difference in non reducing sugar content. As was the case in chlorophyll, 50 ppm ALA yielded significantly the highest total and reducing sugars. This possibly indicates an active photosynthesis rate with this concentration. Ash content was significantly reduced with increasing ALA concentration. Moisture content was significantly lower with 50 ppm ALA, but there was no significant difference between control and 100 ppm ALA. The reduction on moisture content with ALA treatment indicates an increase on dry matter of fruits which raise the possibility of higher photosynthetic activity of fruits at khalal stage. The improved photosynthesis efficiency of khalal stage might possibly led to the accumulation of assimilates which might explain the increase in dry matter content of fruits.

Total and non-reducing sugars in tamer stage were not much altered with ALA, but there was an increase in reducing sugars with ALA treatment and this increase was significant and best with 50 ppm ALA. Similar to rutab stage, ash content significantly decreased with ALA treatment. Moisture content was not significantly changed with ALA treatment. However, there was a clear trend of an increase in moisture content. This increase in moisture content may explain the significant increase in fruit volume of tamer. Although, there was no significant effect of ALA on fruit weight, a 20 % increase in fruit weight might with ALA was obtained compared to 22 % in fruit volume. It worth mentioning that an increase in fruit volume and weight on tamer might be obtained due to the flesh fraction. Mustafa and Seif (1996) and Hussein et al., (1996) reported that total sugars % has been reduced with GA3 treatment. However, Hussein et al., (1996) reported an increase in total and reducing sugars in Zaghlol date treated with cycocel.

Despite the consistent increasing trend, fruit yield (kg/tree) was not significantly affected (Fig. 2). Yield is a combined factor of fruit number, size, weight and other related variables (Abdulla et al., 1983; Bacha and Shaheen, 1986). The parameters of this factor are often inversely proportional. In our study, ALA has improved fruit weight and volume at rutab stage. It is quite probable that increasing of fruit size or weight reduces fruit number as has often been shown in certain fruit crops. Improvement of fruit size is becoming detrimental in marketing of date fruits and highly preferred by consumers.

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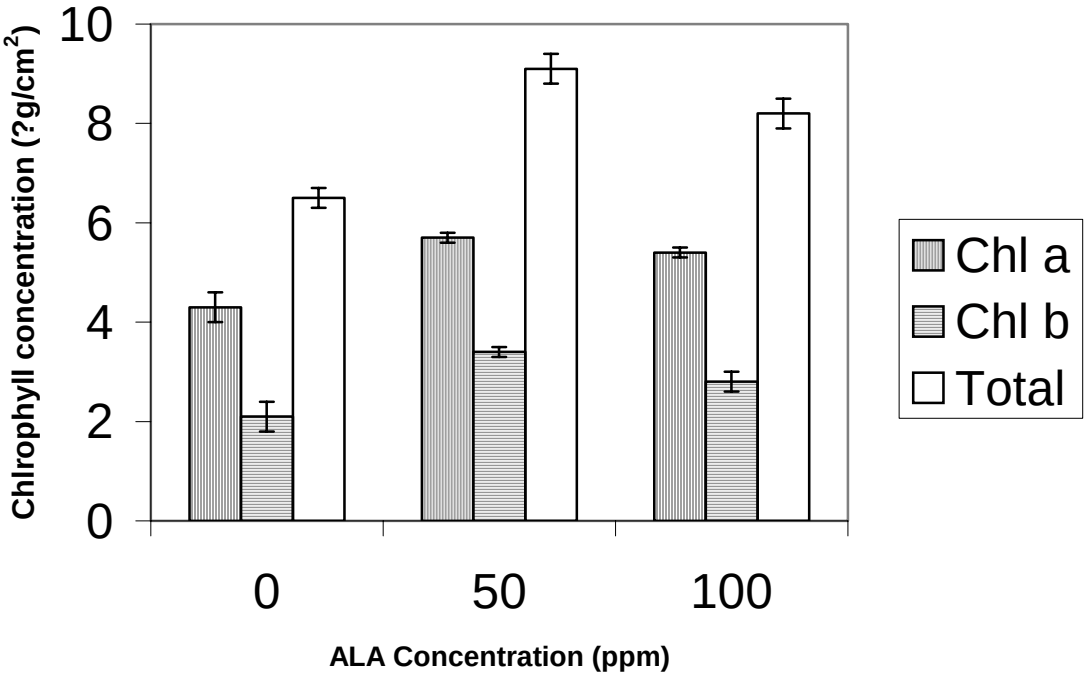
Chlrophyll concentration (?g/cm2)
10
8
6
4
2
0
0
50
100
ALA Concentration (ppm)
Chl a
Chl b
Total

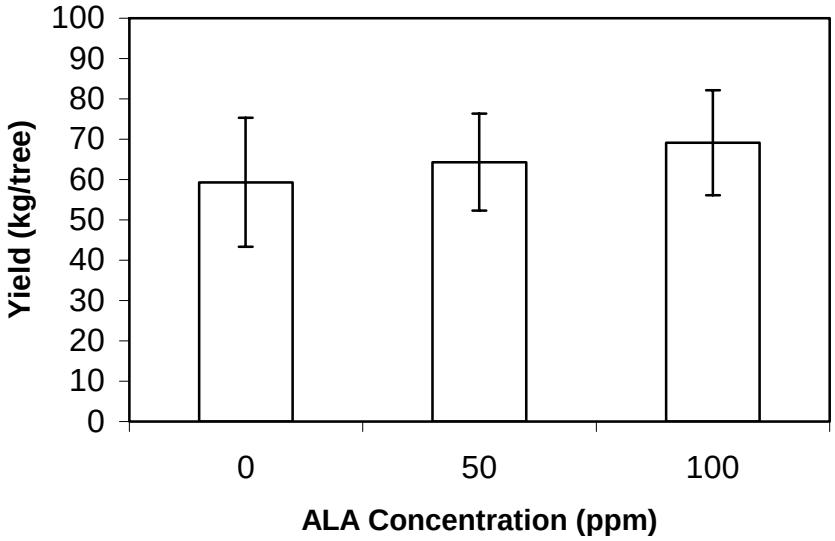
Yield (kg/tree)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
ALA Concentration (ppm)

Table 1. Fruit and seed physical properties of Khalas " Rutab and Tamer" as affected by ALA treatments.

ALA Concentration (ppm)	Weight (g)	Volume (cm^3)	Flesh : fruit (%)	Seed : fruit (%)	Diameter (Cm)	Length (Cm)
Rutab						
0	8.81	8.5	88.2	11.8	2.13	3.18
50	10.10	9.9	89.8	10.2	2.19	3.33
100	11.49	11.1	90.1	9.9	2.24	3.42
F.Test	*	*	*	*	N.S	N.S
LSD (5%)	2.27	2.58	1.7	1.7	---	---
Tamer						
0	5.88	5.9	87.7	12.3	1.91	3.1
50	6.33	6.4	88.7	11.1	1.91	3.1
100	6.75	7.2	89.2	10.8	1.93	3.2
F.Test	N.S	*	N.S	N.S	N.S	N.S
LSD (5%)	---	0.9	---	---	---	---

Table 2. Chemical properties of Khalas "Rutab and Tamer" as affected by ALA treatments.

ALA concentration (ppm)	Moisture (%)	Ash (%)	Reducing sugars (%)	Non red. sugars (%)	Total sugars (%)
Rutab					
0	64.0	0.98	24.3	1.6	25.9
50	58.3	0.93	30.6	2.0	32.6
100	62.8	0.82	26.9	1.5	28.4
F-Test	*	*	*	N.S	*
LSD (5%)	5.2	0.09	4.1	---	4.2
Tamer					
0	6.9	1.78	70.1	4.3	74.4
50	7.7	1.57	71.6	4.2	75.8
100	8.3	1.58	70.5	4.2	74.7
F-Test	N.S	*	*	N.S	N.S
LSD (5%)	---	0.17	1.3	---	---