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Effects of Gibberellin on Fruit of Date Palm: A Review

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Gibberellin (GA) is one of the important plant growth regulators involved in various physiological processes of growth and development. Many kinds of plants have been found to be affected in various ways by gibberellin. Most commonly vegetative growth has been stimulated causing increases in the length of stems and the height of plants. Early flowering and improved fruit set have been reported. In a few instances seedless (unpollinated) fruit has been produced and in some cases size and shape of the fruit change.

Role of Endogenous GA

Plants, including the date palm (*Phoenix dactylifera* L.), synthesize natural gibberellin for the regulation of various developmental activities. Leshem and Ophir (1977) studied the differences in the endogenous level of gibberellin activity in male and female partner of date palm. The female partner invariably manifested higher endogenous GA-like activity. This trend was consistent but marked seasonal fluctuations in both free and glycosidic bound GA were observed and declined with anthesis. While a clear correlation exists between female growth and high GA activity in this species the switch from vegetative to generative growth in both male and female may be associated with a lower relative proportion of endogenous GA in a specific multi-hormonal complex, presumably required for flower induction.

Exogenous Application of GA

Exploratory experiments were begun in 1958 to find out what gibberellin would do to dates if applied exogenously (Table 1). Several possibilities were considered by Nixon (1959) and other researchers when GA_3 was applied to fruit of different date palm cultivars at different flowering and fruiting stages and at various concentrations. A seedless date, approaching the pollinated one in quality, would be highly desirable. Increase in size and change in time of ripening without sacrifice of quality might be beneficial under some conditions. The fruit stalks of some cultivars are too short, thick and stiff to permit proper handling of the bunches; this is particularly true of the late bunches of *Medjool* cultivar. Interesting results were obtained by Nixon (1959) and several other researchers (Ketchie 1967, 1968, Abd-Elrahman 1974, Bandok 1975, Clor et al. 1975, Samara 1978, Mohammed et al. 1983) from the studies concerning exogenous application of GA_3 and its influence on various physical characteristics and chemical constituents of date palm fruit (Tables 2 and 3). This paper reviews the research which has been carried out by different researchers to study the effects of GA_3 on fruit of date palm.

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Effects of GA on Physical Characteristics of Fruits and Seeds

Size. Nixon (1959) reported that at the time of ripening, treated fruit was longer than untreated fruit of the *Deglet Noor* variety, but the effect on length of other varieties was variable. The breadth of treated fruit was less than that of untreated fruit except in the *Deglet Noor* variety at the lower range of concentrations. Applications of gibberellic acid within a few weeks after the opening of the spathe had more effect on size of fruit than those made later. In both fruit and seed of *Deglet Noor* dates gibberellin in the higher concentrations produced an increase in length at the expense of breadth.

Shabana et al. (1975) and Mohammed et al. (1983) found no significant change in the size of GA-treated fruits except for *Zahdi* fruits treated with GA at 50 ppm, whereas Mawlood (1980) obtained significant increases in the length and diameter of *Samani* and *Zaghloul* cultivars as a result of GA_3 treatment at 50 ppm. Differential effect of GA_3 on size of fruit could be due to varying response of cultivars and difference in the time of application of GA_3.

Weight. GA_3 at suitable concentration on pollinated bunches produced larger fruit than on controls and unpollinated bunches produced fruit equal in size to that of the controls (Ketchie 1967). Furthermore, Ketchie (1968) found that the application of 50 and 100 ppm GA_3 at the time of pollination thinned the fruit without decreasing the weight per bunch below that of the hand thinned. Shabana et al. (1975) and Mohammed et al. (1983) failed to find any significant increase in the weight of GA_3-treated *Zahdi* and *Sayer* fruits except in *Zahdi* at 150 ppm, and Hussein et al. (1976) even recorded a decline in the dry weight of GA_3-treated fruit of *Barhee* cultivar.

Color. Gibberellic acid applied to the fruit when it was about half size had more effect on coloring. Fruit treated at this stage never acquired a pronounced *Khalal* color and application of GA_3 (500 and 1,000 ppm) within a few weeks after the pollination partially inhibited the acquisition of *Khalal* color in *Deglet Noor* and *Medjool* fruit (Nixon 1959). Delay in the coloration of *Samani* dates was noticed by Marie and Bandok (1974) after GA_3 treatment at 400 ppm. Furthermore delay in the loss of green color was greater when GA_3 was applied at the early stage of fruit development. Similarly, Hussein et al. (1976) observed that in untreated *Barhee* fruits coloring commenced 7–15 days earlier than GA_3-treated fruits. However, GA_3 had no effect on color development of *Samani* and *Zaghloul* dates (El-Azzouni et al. 1975) and Mawlood (1980) even recorded retardation in the color development of both *Samani* and *Zaghloul.*

Unpollinated *Deglet Noor* dates when treated with GA_3 within a few weeks after the opening of the spathe, did not acquire as much pink color as untreated ones. *Deglet Noor* fruit treated when about two months old and about ½ inch long acquired still less pink color, instead much of it retained a greenish cast.

Ripening. The effect on ripening of unpollinated dates of gibberellin applied to the fruit within a few weeks after the opening of the prophyll was not pronounced (Nixon 1959). There was a tendency for the treated fruit of the *Deglet Noor* to shrivel prior to ripening and was especially noticeable at the higher concentrations. In some instances this gave a final appearance of slightly earlier ripening. Gibberellin applied to the fruit when it was about half size had more effect on ripening than that applied earlier. Unpollinated *Deglet Noor* fruit treated when half-grown ripened earlier than untreated fruit, but the behavior of the former was somewhat abnormal because of premature shrivelling. Pollinated fruit treated when half-grown ripened slightly later than

Table 1. Exogenous application of GA_3 to fruit of several date palm cultivars at different flowering and fruiting stages and at varying concentrations.

	GA_3 Application				
Cultivar	Investigator	Plant Part	Time	Concentration	Form
Deglet Noor *Halawy*	Nixon (1959)	Flower, fruit and fruit-stalk	Before and just after pollination	10–1,000 ppm	Liquid spray and lanolin paste
Khadrawy	Nixon (1959)	Flower, fruit and fruit-stalk	Half-size fruit	10–1,000 ppm	Liquid spray and lanolin paste
Medjoor	Nixon (1959) Ketchie (1967, 1968)	Flower, fruit and fruit-stalk	Half-size fruit	10–1,000 ppm	Liquid spray and lanolin paste
Barhee	Nixon (1959), Hussein et al. (1976)	Flower, fruit and fruit-stalk	Half-size fruit	10–1,000 ppm	Liquid spray and lanolin paste
Samani	Marie and Bandok (1974), El-Azzouni et al. (1975), Mawlood (1980)	Flower, fruit	Before and just after pollination	25–200 ppm	Liquid spray
Zaghloul	Marie and Bandok (1974), El-Azzouni et al. (1975), Mawlood (1980)	Flower, fruit	Before and just after pollination	25–200 ppm	Liquid spray
Sayer	Benjamin et al. (1975), Shabana et al. (1975), Mohammed et al. (1983)	Fruit	During slow period of fruit development	50–150 ppm	Liquid spray
Zahdi	Benjamin et al. (1975), Shabana et al. (1975), Mohammed et al. (1983)	Fruit	During slow period of fruit development	50–150 ppm	Liquid spray
Sewy	Samara (1978)	Flower, fruit	Full bloom and 60 days later	50–100 ppm	Liquid spray

untreated fruit of the *Deglet Noor*, *Medjool* and *Barhee* cultivars.

Ketchie (1968) reported that fruit bunches of *Medjool* when sprayed with 100 ppm GA_3 at the time of pollination matured earlier than the fruit on hand-thinned bunches. Application of GA_3 to the fruit of *Samani* and *Zaghloul* cultivars delayed maturity and ripening (Marie and Bandok 1974, El-Azzouni et al. 1975). Hussein et al. (1976) in *Barhee* and Samara (1978) in *Sewy* also reported delayed maturity and ripening of GA_3-treated fruits.

Parthenocarpy. A female date inflorescence which receives no pollen normally develops some parthenocarpic or seedless fruit. When pollinated, only one of the three carpels of a date flower normally develops but when unpollinated, one or all three carpels may develop; differences in this respect are apparently largely a matter of cultivar. Fruit without seed is usually smaller and narrower than fruit

Table 2. Effects of exogenous application of GA_3 on various physical characteristics of date palm fruit.

Investigator	Physical Characteristic					
	Size (Length, Diam.)	Weight	Color	Ripening	Parthenocarpy	Thinning
Nixon 1959	Fruit length increased	—	Inhibited color change	Unpollinated fruits ripened early and shrivelled, pollinated fruits ripened late	Induced single seedless carpel development	—
Ketchie 1967, 1968	—	Large fruit no reduction in weight	—	Unpollinated fruits ripened early and shrivelled, pollinated fruits ripened late	Produced seedless dates	Fruits thinned
Marie and Bandok 1974	—	—	Delayed loss of green color	Delayed maturity	—	—
El-Azzouni et al. 1975	—	—	Retarded color change	Delayed maturity	—	—
Shabana et al. 1975	Unaffected	Unchanged	—	—	—	—
Hussein et al. 1976	—	Decline in wt.	No effect on color development	Delayed maturity and ripening	—	—
Samara 1978	—	—	—	—	Seedless dates	—
Mawlood 1980	Increase in length and diameter	—	Retarded color development	—	—	—
Mohammed *et al.* 1983	Unaffected	Unchanged	—	—	—	—
Clor et al. 1975	—	—	—	—	Seedless dates	—

Table 3. Effects of exogenous application of GA_3 on various chemical constituents of date palm fruit.

	Chemical Constituent							
Investigator	Moisture	Soluble Solids	Sugars	Acidity	Amino Acid	Tannin	Protein and Indole	Enzymes
Abd-Elrahman 1974	Not affected	Not influenced	—	Not influenced	—	—	—	—
Bandok 1975	—	—	Unaffected/ declined	—	Reduction	Unaffected	—	—
Benjamin et al. 1975	Not affected	Not influenced	Increased	—	—	—	—	—
Clor et al. 1975	Reduction	Decreased	—	—	—	—	—	—
Hussein et al. 1976	Significantly increased	Decreased	Unaffected/ decreased	Increased	—	—	—	—
Samara 1978	—	Decreased	Reduction	Increased	—	—	—	—
Mawlood 1980	Not affected	Decreased	Reduction	Increased	Increased	Increased	Increased	Decreased
Mohammed 1983	Not affected/ slightly increased	Not influenced	Increased	—	—	—	—	—

with seed, and when three carpels develop each is smaller than one that develops by itself.

Nixon (1959) reported that aqueous sprays of gibberellin applied to unpollinated *Deglet Noor* flowers within a few days of the opening of the prophyll stimulated the development of all three carpels in a large proportion of the flowers instead of the single carpel that normally develops in this cultivar either with or without pollination. But only a single carpel developed when gibberellin was applied five weeks later to *Deglet Noor* inflorescences. In some instances the three carpels that developed from one *Deglet Noor* flower shrivelled before reaching full development, but a large proportion of them attained a size almost equal to that of the single unpollinated carpels, although they differed in shape. Multicarpel development did not occur in the *Medjool* in which single seedless carpels develop somewhat as in *Deglet Noor*. In the *Barhee*, *Halawy* and *Khadrawy* cultivars, the development of all three carpels of unpollinated flowers is common, but when gibberellin was applied during the period of receptivity to pollen, a large percentage of single seedless carpels developed.

Application of GA_3 at 25, 50 and 100 ppm to unpollinated and pollinated flowers produced seedless dates, but application to unpollinated bunches produced significantly higher numbers of seedless dates than when applied to pollinated bunches (Ketchie 1967). Seedless dates were induced by Clor et al. (1975) when non-viable pollen and GA_3 were applied to the inflorescences. Samara (1978) found that application of GA_3 at 50 or 100 ppm at full bloom and/or 60 days later induced seedless *Sewy* dates.

Thinning. Effect of GA_3 as a chemical thinning agent on date palm was tested by Ketchie (1967, 1968). Application of 50 and 100 ppm GA_3 to *Medjool* date bunches at the time of pollination thinned the fruit without decreasing weight per bunch below that of the hand-thinned.

In addition to the beneficial effects of GA mentioned above there were some adverse effects on fruit and fruitstalk of date palm. Nixon (1959) reported that the application of gibberellin increased the normal curvature of fruitstalks but also resulted in so much undesirable spiral twisting that there was a complete turn of 360° in several instances. Furthermore, gibberellin appeared to increase the susceptibility of *Deglet Noor* dates not only to shrivel as previously mentioned but also to checking and blacknose.

Effect of GA on Chemical Constituents of Fruit

Moisture. GA does not seem to enhance the moisture content of dates. Abd-Elrahman (1974) noticed that the treatment with GA_3 at 25 and 100 ppm had no significant effect on the moisture content of *Samani* and *Zaghloul* dates. Clor et al. (1975) also recorded a reduction in the moisture content of *Zahdi* dates from 17.33% to 14.77% as a result of GA_3 treatment at 50 ppm. In another experiment (Benjamin et al. 1975, Mohammed et al. 1983) fruits of both *Zahdi* and *Sayer* cultivars, when treated with GA_3 at 50, 100 and 150 ppm showed a pattern of moisture content quite similar to that of control at different developmental stages. At harvest time only some GA_3-treatments increased moisture in both *Zahdi* and *Sayer* dates.

On the contrary, Hussein et al. (1976) obtained significant increases in *Barhee* dates by applying GA_3 at 100, 250, 500 and 1,000 ppm. However, Mawlood (1980) did not find any difference due to GA_3 treatment in moisture content of fruits of *Samani* and *Zaghloul* cultivars.

Sugar. Bandok (1975) reported that the GA_3 at 200 ppm lowered total sugars while no major differences occurred either in reducing or non-reducing sugars in *Samani* cultivar. Although GA_3 at 50, 100, 150 ppm had no influence on the sugar accumulation pattern at different developmental stages in both *Zahdi* and *Sayer* cultivars, the total and reducing sugar contents in *Zahdi* were appreciably higher in GA_3-treated fruits than control (Benjamin et al. 1975, Mohammed et al. 1983). The maximum sucrose contents of GA-treated fruits of both *Zahdi* and *Sayer* cultivars was lower than control except for treatment at 50 ppm in *Zahdi*. Hussein et al. (1976) on the contrary, recorded a decrease in the percentage of reducing and total sugars, while sucrose remained unaffected by the treatment of GA_3 at 100, 250, 500 and 1,000 ppm. The reduction in total sugars owing to the application of GA_3 (50 and 100 ppm) is also confirmed by Samara (1978) and Mawlood (1980).

Soluble solids. In general, GA (50, 100, 150 ppm) does not have pronounced influence on the total soluble solids (TSS) of *Zahdi* and *Sayer* dates at different developmental stages (Abd-Elrahman, 1974, Benjamin et al. 1975, Mohammed et al. 1983) except for low TSS value at 150 ppm treatment at harvest time. It appears that GA exerts a negative effect on TSS content of dates. Clor et al. (1975) and Samara (1978) reported that GA_3 at 50 ppm decreased TSS in fruits of *Zahdi* and *Sewy*. Likewise low percentage of TSS in unpollinated dates has been obtained by Samara (1978) and Mawlood (1980) after GA_3 treatment at 50 ppm. With the increase in GA_3 concentration, there is a corresponding decrease in the TSS content of dates (Hussein et al. 1976).

Acidity. GA_3 seems to promote acidity in dates. Abd-Elrahman (1974) failed to obtain any significant influence of GA_3 treatments at 25 and 100 ppm in fruits of *Samani* and *Zaghloul* cultivars. On the contrary, Hussein et al. (1976) found enhancement in the acidity of dates due to GA_3 application at 500 and 1,000 ppm. This is in agreement with the results of Samara (1978) who recorded higher acid-

ity value when GA_3 at 50 or 100 ppm was applied to the seedless dates. Mawlood (1980) also confirmed that GA_3 increases the acidity of both seedy and seedless dates.

Amino acid. Not much is known about the effect of GA_3 on the amount of amino acids in dates except for few reports. Bandok (1975) stated that GA_3 at 200 and 400 ppm reduces the total free amino nitrogen in *Samani* fruit either during the growth and development or at harvest time whereas Mawlood (1980) found that GA_3 (50 ppm) increases the amino acids of both *Samani* and *Zaghloul* cultivars.

Tannin. No major differences in tannin content could be observed between fruits treated with GA_3 at 50–400 ppm at different intervals from pollination and untreated ones (Bandok, 1975). But Mawlood (1980) obtained increases in the tannin contents of both *Samani* and *Zaghloul* after GA_3 treatment.

Information on the influence of GA_3 on protein, indole contents and enzymatic activity is meager. Mawlood (1980) reported that GA_3 increases protein content and indole contents of both *Samani* and *Zaghloul* dates and decreases the invertase and PG enzymes activity.

Conclusion

An account of results of the various investigations presented in the paper leads to the conclusion that the effect of gibberellin on date palm fruit varies with different cultivars, time, form, and concentration of GA_3 application. Although GA_3 does not show promotive influence on fruit size and weight, it could be used to delay ripening, to induce thinning, and to produce seedless fruit, if needed. The general influence of GA_3 application on various chemical constituents such as moisture, TSS, and sugar is non-promotive, however, acidity seems to be promoted by GA_3 application. Information on the effect of GA_3 application on other chemical constituents, for instance, amino acid, tannin, protein, indole content and enzymatic activity is rather scanty and needs further research. Also, there is a need for research on the mechanism of gibberellin action in the fruit of the date palm. Analysis of endogenous gibberellin at various fruit developmental stages is an interesting area for future research.

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Literature Cited

Abd-Elrahman, M. H. 1974. Studies on physiological and physical changes in the fruit of some date varieties after maturity. M.Sc. Thesis, Cairo Univ. (in English with Arabic summary).

Bandok, A. Z. 1975. Physiological studies on artificial ripening of some date fruits. Ph.D. Thesis, Ain Shams Univ., Cairo (in English with Arabic summary).

Benjamin, N. D., H. R. Shabana, B. A. Al-Ani, M. A. Clor, K. S. Jawad, and A. M. H. Shaibani. 1975. Effects of some growth regulators on the depressed period of development and physico-chemical changes during different stages of ripening in date fruit. I. A-Chemical changes (soluble solids, sugars), and moisture content in fruits of *Zahdi* and *Sayer* cultivars. Palm and Date Res. Tech. Bull. No. 1/75. 20 pp. (Arabic Summary).

Clor, M. A., N. D. Benjamin, H. R. Shabana, and B. A. Al-Ani. 1975. Seed and fruit development of *Phoenix dactylifera* as influenced by type of pollination and some growth substances. In the Third International Palm and Dates Conf., Baghdad, 30 Nov.–4 Dec., 1975 (in Arabic with English summary).

El-Azzouni, M. H., M. T. Kabeel, E. T. Bakr, E. I. Bakr, and M. H. Abd-Elrahman. 1975. Effect of pre- and post-harvest application of some growth regulators on two date palm varieties *Samani*, and *Zaghloul*. Annals. Agri. Sci. Moshtohor. 4: 213–220.

HUSSEIN, F., S. MOUSTAFA, AND F. EL-SAMARAIE. 1976. Effect of gibberellic acid on yield, ripening and fruit quality of "Barhee" dates grown in Saudi Arabia. Egyptian J. Hort. 3(2): 197–207.

KETCHIE, D. O. 1967. Tests of chemicals for thinning and producing seedless "Medjool" dates. Date Growers Inst. Ann. Rept. 44: 5–6.

———. 1968. Chemical tests for thinning Medjool dates. Date Growers Inst. Ann. Rept. 45: 19–20.

LESHEM, Y. AND D. OPHIR. 1977. Differences in endogenous levels of gibberellin activity in male and female partners of two dioecious tree species. Annals of Bot. 41(172): 375–379.

MARIE, N. AND A. Z. BANDOK. 1974. Date fruit response to gibberellic acid and ethephon. Egyptian Hort. 1(1): 89–90.

MAWLOOD, E. A. 1980. Physiological studies on fruits development of *Samani* and *Zaghloul* date palm cultivars. Ph.D. Thesis, Cairo Univ. (in English with Arabic summary).

MOHAMMED, S., H. R. SHABANA, AND N. D. BENJAMIN. 1983. Response of date fruit to gibberellic acid application during slow period of fruit development. Principes, submitted for publication.

NIXON, R. W. 1959. Effects of gibberellin on fruitstalks and fruit of date palm. Date Growers Inst. Ann. Rept. 36: 5–7.

SAMARA, N. R. E. 1978. Physiological studies on date fruits, M.Sc. Thesis, Ain Shams Univ., Cairo (in English with Arabic summary).

SHABANA, H. R., K. S. JAWAD, N. D. BENJAMIN, AND B. A. AL-ANI. 1975. Effect of some growth regulators at depressed period of development on the physical properties of *Zahdi* and *Sayer* cultivars. *In* Second Scientific Conf. Baghdad, 6–11 Dec. (in Arabic with English summary) 16 pp.

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