Effect of Hormones on the Development of Date Fruit

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Single and repeated applications of CLPA and 2, 4-D on the date palm inflorescences and the developing fruits showed marked differences on the development of various physical characters of the fruit as well as the rate of development. CLPA increased setting and enhanced the maturity of dates by more than 20 days, while 2, 4-D decreased the setting and delayed the ripening by more than a week. Both the growth regulators increased fruit weight and size; 2 4-D being more effective than CLPA.

INTRODUCTION

The date palm, *Phoenix dactylifera* Linn. requires dry season at the time of flowering and fruit ripening. Unfortunately, monsoon rains synchonise with the ripening time of dates in many parts of West Pakistan, which results in heavy shedding of the fruit. Partly softened dates are spoiled by fermentation on plants. In fact, this is a very serious handicap to the date industry in the province.

There can be two solutions to the problem. Firstly, to breed varieties which would ripen their fruit either before the onset of monsoon or after the rainy season is over. Secondly, application of such cultural practices which would either hasten the fruit maturity or delay it so as to prevent the spoilage due to rains. Breeding of date palm is a fairly long process and would be of no immediate advantage to the date growers. Breeding programmes should, however, be planned and taken up for future improvements.

By the time the monsoons approach, the berries have attained their full size and ripening processes have started. Hastening of these processes would be more desirable than delaying them. It was thought desirable to use some of the growth regulators for accelerating the developmental processes in date fruit so that the fruit matures before the onset of the monsoons.

REVIEW OF LITERATURE

Luckwill (1948) reported that levels of naturally occurring auxins were important in fruit set and enlargement of apples. Zielinski and Garden (1957) treated Royal Ann sweet cherries with parachlorophenoxyacetic acid (CLPA), NOA, 2, 4, 5-trichlorophonoxyacetic acid (2, 4, 5-T) and obtained increased

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fruit set. Harris (1961) reported that for fruit setting in Zante currants 20 ppm CLPA was better than girdling and 2, 4-D, respectively. Weaver *et al.* (1961) reported that CLPA increased and GA decreased the setting in some of the seeded and seedless grapes. Takahashi and Nakayama (1961) reported that 50 ppm CLPA gave the highest percentage fruit set in tomatoes.

Mosolov and Mosolova (1959) noted increased uptake and assimilation of nutrients in gibberellin treated crops. Stewart (1952) concluded that water sprays of 2, 4, 5-TP and 2, 4-D on Washington Navel and Valencia oranges applied at floweing resulted in increased fruit size. Nixon (1959) noted an increase in the length and decrease in the diameter of date fruits treated with GA. Bradley and Crane (1955) reported that increase in the fruit size of apricots was due to enlargement of cells. Nucleus size was also increased. Zielinski *et al.* (1954) reported that 25 ppm CLPA plus 100 ppm NOA resulted in 25 per cent increase in fruit size of thornless evergreen black berries while NOA alone reduced the fruit size. Bringhurst *et al.* (1956) noted an increase in the fruit size of Boysen blackberries when treated with BOA combined with CLPA. Weaver (1953) reported that 5 to 15 ppm CLPA resulted in the production of larger berries than girdled plants of Thompson seedless and Black Corinth grapes.

Moore and Thomas (1952) found that time from flowering to harvest was reduced by nine days by subjecting the tomato fruits to CLPA treatment. Erickson and Hass (1956) found that 2, 4-D delayed the maturity and slightly increased the yield of lemons. Similarly, Steward and Hield (1950) found that 2, 4-D had increased the size but delayed the maturity in case of oranges. Zielinski and Garden (1951) observed 4 to 6 weeks delay in maturity of Montmorency cherries treated with 2, 4-D and 2, 4, 5-T. Nixon and Carden (1939) concluded that attempts to produce seedless dates with chemical stimulation had failed.

MATERIALS AND METHODS

These studies were carried out in the Experimental Fruit Garden of the West Pakistan Agricultural University, Lyallpur on Hillawi dates. Nine palms of uniform age were selected. The experiment was laid out in a split plot design.

Two growth regulators, parachlorophenoxy acetic acid (CLPA) and dichlorophenoxy acetic acid in three concentrations of 0, 25 and 100 ppm were applied by spray at (1) 15 day intervals from pollination to 'soft brown' stage, (2) pollination (only once), (3) one month after pollination (only once). Data on fruit set, maturity period, yield and various physical characters of the fruit were recorded.

RESULTS

Average values for the fruit set, yield, maturity period, size and weight of individual berries and seeds for each treatment are presented in Table 1.

Percentage of Fruit Set

The differences in the fruit set due to the time and frequency of applications were non-significant. CLPA was significantly better than 2, 4-D as 70.88 per cent setting was recorded for the spathes treated with CLPA as against 63.37 per cent for those treated with 2, 4-D. For the concentrations of the chemicals used, 100 ppm was significantly better than 25 ppm. The percentage for the former was 68.61 against 65.3 for the latter concentration. Fortnightly application of 100 ppm CLPA was the best. Application of 100 ppm 2, 4-D at fortnightly intervals gave the least percentage of setting. Fruit setting increased with the increase in the concentration of CLPA applied at fortnightly intervals while the reverse was true for the 2, 4-D.

Percentage of Fruit Matured

The percentage of fruit matured was significantly affected by the time of application. The highest percentage of 56.88 was recorded for fortnightly applications of the hormones. The differences due to various treatments applied once only were non-significant. 56.03 per cent fruit matured on the spathes treated with CLPA as compared to 43.22 per cent on those treated with 2, 4-D. Although there was no difference between 100 and 25 ppm concentrations but these were significantly better than the control. Fortnightly applications of 100 ppm CLPA was the best followed by 25 ppm CLPA, 25 ppm and 100 ppm 2, 4-D respectively.

Days Required for Maturity

Fortnightly applications were effective to reduce the ripening period. CLPA treated fruits took 135.93 days to mature as compared to 142.67 by 2, 4-D. Among the concentrations tried 100 ppm was better than 25 ppm and the control to reduce the ripening period, which were non-significant among themselves.

100 ppm CLPA applied at fortnightly intervals was the best for reducing the ripening period, followed by 25 ppm CLPA. 2, 4-D tended to delay the ripening and this effect was accentuated with increase in the concentration.

Fruit Yield

Fortnightly applications significantly increased the yield as compared to single application. CLPA was better than 2, 4-D. 100 ppm was the best concentration followed by 25 ppm and the control respectively. The increase in concentration had direct effect on the fruit yield. Fortnightly applications of 100 ppm CLPA were more effective than 25 ppm CLPA, 100 ppm and 25 ppm 2, 4-D in order of merit.

TABLE 1. *Effect of Application of CLPA and 2, 4-D on fruit setting, maturity, size and weight of dates.*

Growth regulator	Concentration (ppm)	Fruit set (per cent)	Fruit maturied (per cent)	Days required for maturity.	Yield in grams.	Length of fruit (cms).	Diameter of the fruit (cms).	Weight per fruit (grams).	Weight of pulp per fruit (gms).	Weight per seed (gms).
Applied at fortnighly intervals.										
CLPA ..	0	67.0	48	140.3	6186.6	3.5	1.91	7.67	6.06	1.61
	25	75.3	71	127.6	13051	3.53	1.92	8.17	7.01	1.16
	100	87.0	81	115	14580.6	3.69	2.06	8.77	7.64	1.13
2, 4-D ..	0	66.6	47.3	141	6375.6	3.46	1.91	7.76	6.18	1.58
	25	60.0	50	148	10269	4.09	2.17	8.85	7.13	1.72
	100	54.0	44	148.6	10383.3	4.69	2.52	10.32	8.09	2.23
Applied at pollination time only.										
CLPA ..	0	68	48	140.6	6207.6	3.52	1.9	7.71	6.11	1.60
	25	70	49	140	7754.6	3.53	1.9	7.66	6.07	1.59
	100	76	53.3	140	7902.6	3.54	1.91	7.75	6.12	1.63
2, 4-D ..	0	70	47.6	142.3	6013	3.55	1.91	7.63	6.05	1.58
	25	59.3	49	141.6	7018	3.6	1.91	7.73	6.14	1.59
	100	58.6	48.6	141	7296	3.57	1.89	7.59	6.02	1.57
Applied 30 days after pollination (Once).										
CLPA ..	0	67.3	48.3	139.3	5911	3.56	1.91	7.61	6.06	1.55
	25	59.3	49.3	148.3	7167	3.6	1.90	7.62	6.08	1.54
	100	68	56.3	140	7802.3	3.61	1.91	7.66	6.14	1.52
2, 4-D ..	0	66	46.6	139	5729.3	3.51	1.91	7.62	6.04	1.58
	25	64.6	54.6	141.3	6680.6	3.57	1.91	7.69	6.10	1.59
	100	68	46	141	6432.3	3.6	1.92	7.63	6.07	1.56

Fruit Size

Fortnightly applications of 2, 4-D and CLPA markedly increased the rate of growth in size. CLPA had greater rate of development in size than 2, 4-D as fruits treated with CLPA took less number of days to develop fully. It took 117 days to reach the maximum size in case of CLPA treated fruits as compared to 132 days for the fruits subjected to 2, 4-D treatments.

Fruit Weight and Pulp Weight

Fortnightly application of 100 ppm 2, 4-D had the maximum effect on fruit and pulp weight, followed by 25 ppm 2, 4-D and 100, and 25 ppm CLPA. Rate of increase was the maximum in the fruits treated with CLPA and followed by 2, 4-D, both applied at 15 day intervals. It took more than 133 days to reach a constant weight of fruit and pulp in fruits treated fortnightly in size than 2, 4-D as fruits treated with CLPA took less number of days to develop fully. It took 117 days to reach the maximum size in case of CLPA treated fruits as compared to 132 days for the fruits subjected to 2, 4-D treatments.

Fruit Weight and Pulp Weight

Fortnightly application of 100 ppm 2, 4-D had the maximum effect on fruit and pulp weight, followed by 25 ppm 2, 4-D and 100, 25 ppm CLPA. Rate of increase was the maximum in the fruits treated with CLPA, followed by 2, 4-D both applied at 15 day intervals. It took more than 133 days to reach a constant weight of fruit and pulp in fruits treated fortnightly with 2, 4-D, while the maximum weight limit was reached after 118 days with 100 and 25 ppm CLPA treatments. The increase in fruit and pulp weight continued even after 133 days in case of 2, 4-D treated fruits. Maximum gains in the weight of fruits treated with CLPA were recorded during 58th to 103rd day, there was slight increase afterwards. In case of 2, 4-D treated fruits greatest increase occurred during the 58th to 118th days. Single applications of the hormones had the similar effect as the control.

Weight of Seed

100 ppm 2, 4-D applied at fortnightly intervals increased the seed weight to the maximum, while the same concentration of CLPA applied accordingly produced seed with the minimum weight. Development in seed was constant after 103 days in CLPA treated fruits, while this condition was reached after 118 days in 2, 4-D and the control. With bimonthly treatments of CLPA, the seed weight became constant after 103 days.

DISCUSSION

Fruit Setting

The two growth regulators had different effects on fruit setting; fortnightly applications of CLPA increased the setting and 2, 4-D decreased it. The increased fruit set as a result of CLPA applications at bloom period may

have been due in part to the stimulatory effect of CLPA on the increased pollen germination and pollen tube growth, which should have affected better fertilization. Furthermore, faster tube growth would also contribute to fertilization of large number of ovules especially those which may not remain receptive for the slow growing pollens. Luckwill (1948) pointed out that levels of naturally occurring hormones are of importance in fruit set as is evident from the results that maximum setting was obtained with higher doses. Harris (1953) found 20 ppm CLPA better for fruit setting of stone fruits. It seems that auxin levels for proper setting differ with the species of the plants.

Results with regard to the effect of 2, 4-D on fruit setting are in contrast to the findings of Takahashi and Nakayama (1961), who got increased setting percentage by using 10 ppm 2, 4-D on tomatoes, while Stewart (1952) observed no effect of 5 and 100 ppm 2, 4-D on fruit setting of citrus. It is possible that 2, 4-D at such higher concentrations as 25 and 100 ppm either had caused injury to the essential floral organs or upset the physiological balance and thus a lower concentration could be found which would increase the setting percentage. Takahashi and Nakayama (1961) obtained increased setting by using 10 ppm 2, 4-D.

The effect of 2, 4-D in reducing setting was, to some extent, counterbalanced by the increase in yield because of increase in fruit weight and size. The yield obtained from 2, 4-D treatment was greater than the control. Higher concentrations had higher thinning effect and also higher yields. 2, 4-D therefore, can equally be beneficial for increasing yield and producing fruit of good size.

Regular applications of the growth regulators were superior to single applications at either pollination time alone or 30 days after that. In fact, 2, 4-D or CLPA had no effect when applied one month after pollination. It seems that hormones are needed once to stimulate the growth of ovary wall and then these are needed continuously throughout the whole developmental period.

Fruit Development

It was observed that fortnightly applications of 2, 4-D and CLPA resulted in larger and heavier fruits, the effect being greater with increase in the concentration in each case. Since increase in fruit weight was mostly due to increase in flesh weight, it may be concluded that growth regulators applied accelerated the growth of ovary wall. It may be possible that application of growth regulators increased the uptake and assimilation of nutrients so as to increase the pulp weight as has been reported by Mosolov and Mosolova (1959) that gibberallin treated crops had increased uptake and assimilation of

nutrients.

A fruit may develop good size in two ways; firstly, by an increase in the number of cells, and secondly, by increase in size of cells. Bradley and Crane (1955) determined that the increase in fruit size of apricots was due to enlargement of cells and observed larger nuclear size. There seems to be a definite relationship between the development of fruit and presence of auxins as has been reported by Yum (1962) in peaches. He found that early varieties produced more auxins, therefore, they developed earlier or attained proper values essential for maturity earlier than other varieties. Increase in weight and size by 2, 4-D may be attributed to its thinning and hormonal effect combined together.

The observation that no single application of either chemical increased the size and weight suggest that the fruit needed a continued supply of growth regulators throughout their development from setting to maturity. It is obvious that the fruits on the same tree and branch would compete for the hormones as they would for better nourishment from the tree sources. Only those which are in a better position to have required supplies would stay on the tree, others would drop, hence a continuous supply of hormones will be advantageous. The continuous need of the growth regulators by the date fruits also suggest that the growth regulators applied are soon used up and that they are not stored in the fruit.

The two hormones differed in their effect on the weight of seed. Regular applications of CLPA reduced the weight of seed while 2, 4-D increased it. Nixon and Gardner (1939) concluded that attempts to produce seedless dates with chemical stimulation had failed. It is probable that the chemicals are selective in their effect on the different types of tissues, CLPA accelerating the growth of ovary wall and inhibiting the development of seed and 2, 4-D acting *vice versa* on the seed.

Growth rate of CLPA treated berries was higher than those treated with 2, 4-D which were better than the control. It was because of this greater growth rate that CLPA treated fruits matured earlier by more than 15 days, having attained the maximum values for weight and size earlier than 2, 4-D and the control.

It may be speculated that hormones increased the activity of the cells resulting in increased development of processes leading to increased size and weight. Influence of auxin on cell elongation is exerted through an effect on the plasticiy of the cell wall. This all may be the end of the general and basic effects of hormones on celluar metablolism. Since growth is a continuous process, auxins are continuously needed.

In view of the fact that life process within the cell is a highly systematic aggregate of complex biochemical and physiological phenomenon, a little

chemical change would cause a chain of reactions which might manifest in morophological modifications. Physiological reactions are accelerated, retarded or inhibited by the enzymes, auxins and hormones (besides other environmental factors) and these effects result into several morophological modifications such as an increase or decrease in the size or even a modification of the normal shape.

Fruit Maturity

Maturity is the preceding stage of ripening when the development of cells is completed so as to render good colour, texture, taste, aroma and other qualities to the fruit.

The periodical observations have indicated that fortnightly applications of 100 ppm and 25 ppm CLPA enhanced the maturity while 100 and 25 ppm 2, 4-D delayed it, the effect of each being greater with increase in the concentration.

Hastening the maturity by CLPA was as a result of early accomplishment of the developmental process such as fruit growth and accelerating the physiological changes in the fruit. The effect on the ripening was well marked after '*doka*' formation. CLPA accelerated those processes which lead to ripening of the fruit, while 2, 4-D applications retarded the processes leading to ripening and counter-balanced the effect of already existing hormones in the fruit. The late ripening of these large size fruits resulting by 2, 4-D applications might be due to prolonged cell division or cell elongation. Delayed ripening of large size fruits has also been reported by Nixon (1928), who observed that large and small sized fruits produced as a result of pollination of *Phoenix dactylifera* with different species of *Phoenix*, differed in their ripening time, the larger ones maturing late and small ones earlier.

The hormonal influence of the chemicals, used in these studies remained localised, for adjacent berries showed no response to the application of these hormones. It shows that effect of these growth regulators applied to one part is not translocated to other parts.

From a physiological standpoint, the pronounced effect of CLPA to enhance and that of 2, 4-D to retard the ripening process offer possibilities in fascinating studies on fruit maturation. The ripening effect of the growth regulators depend on many factors such as the time of application, growth regulator, concentration used.

Fortnightly applications of both growth regulators increased the yield. There could be three reasons for increase in the yield, better fruit setting, reduced pre-harvest drop and better fruit size and weight. Increase in CLPA treated fruits was due to all the three factors while in 2, 4-D it was due to greater size and weight.

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