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Effect of growth regulators on growth and harvest maturity in kiwifruit (*Actinidia deliciosa*)

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ABSTRACT

The present study was conducted in the experimental farm of Department of Pomology, UHF, Solan. Three plant growth regulators, viz., NAA, 2,4,5-T and Ethrel were sprayed at different concentrations at stage II of fruit growth to study their effect on growth pattern, maturity and quality of fruits. None of the treatments were found to be effective in hastening harvest maturity (by slashing the period of slow-growth) although, size of the fruits increased with some treatments. Quality parameters like TSS, ascorbic acid, and sugar content increased in all treatments, while titratable acidity and flesh firmness decreased. Physical and biochemical analysis of fruits revealed that the fruits attained optimum maturity at 190 days after full bloom.

Key words: Kiwifruit, growth regulators, yield, growth phases

INTRODUCTION

Kiwifruit, native to Central China, is a rich source of Vitamin C and minerals like K, Ca, and P. At present, it is cultivated on a commercial scale in New Zealand, Italy, USA, China, Germany and Spain. In India, it is successfully grown commercially in the mid-hill region of Himachal Pradesh since 1963 and has become one of the most important fruit crops.

The kiwifruit, however, is a long-gestation crop, with fruit-growth extending to over 30 weeks, covering an entire growing-season of the temperate climate. The fruit takes a long time to mature because of a period of slow-growth spanning 3-4 weeks, which separates the two phases of rapid growth. Various growth regulators like NAA, 2,4,5-T, Ethrel and 2,4-D have been successfully used in the past for slashing down the period of slow fruit-growth. It has been reported that the growing period of fig fruit was reduced to 60 days from the normal 120 days by application of 2,4,5-T (25ppm). Celical *et al* (1997) reported that Ethrel application at 250-500 ppm (at the end of slow-growth period II) stimulated growth and shortened the time to maturity, without any adverse effect on fruit quality. Despite the virtues that hold it in high esteem and its tremendous potential for cultivation, very little information is available with regard to fruit-growth and maturity in kiwifruit. The present study was, therefore, conducted to define various phases of fruit-growth in and kiwifruit study the effect of some PGR's on the pattern of fruit-growth and maturity.

MATERIAL AND METHODS

The experimental area was located at an altitude of 1200 MSL. Seven year old vines of cv. Abbott, planted at a distance of 2.5m x 2.5m, were selected for the experiment. Eight hormonal concentrations, viz., 2,4,5-T (20 and 40 ppm), NAA (25 and 40 ppm), Ethrel (100 and 300 ppm), 100ppm ethrel + 10ppm NAA, and 300ppm ethrel + 10ppm NAA were applied at 60 days after full bloom. The experiment was laid out in RBD with three replications per treatment.

Fruit growth was recorded in terms of fruit-length and fruit diameter at weekly intervals, from 15 days after fruit set until harvest. Values obtained for fruit length and diameter were then plotted on a graph to determine different phases of fruit growth. To determine the effect of treatments on hastening fruit maturity, five samples were taken at weekly intervals, commencing approximately two weeks before anticipated date of harvest. These fruits were then subjected to various physical and biochemical analyses such as firmness, juice content, TSS, titratable acidity, sugars,

etc. for estimation of optimum time taken to fruit-maturity.

RESULTS AND DISCUSSION

Pattern of fruit growth

Fruit growth (in terms of increase in length and diameter) was recorded at weekly intervals and is presented in figure 1. The growth curve shows that fruit-growth followed double sigmoid pattern showing 9-10 weeks of rapid growth (Phase I), followed by 3-4 weeks of slow-growth (Phase II) and, another period of rapid growth (Phase III) for 11-12 weeks as fruits approached maturity. Growth rate declined 3-4 weeks before the fruits turned fully mature.

Growth pattern of the fruits can thus be divided into three phases:

Phase I - 0-70 days from full bloom (DFFB)

Phase II - 71-98 days from full bloom

Phase III - 99-183 days from full bloom

Plant growth regulator treatments applied with the aim of reducing the total period of slow-growth (Phase I) failed to enhance growth-rate during this phase. Fruits in all treatments followed a similar pattern of growth. Although application of growth regulators increased the final fruit-size, these had no effect on hastening maturity. Similar results were obtained by Harris *et al* (1953) in peach when they applied 11ppm 2,4,5-T. Application of 2,4,5-T, however, did not influence fruit growth in peaches in a study conducted by Hidgon (1950).

Fruit length

It is evident from data presented in Table 1 that all the treatments increased fruit-length over the Control. Net increase in fruit-length was maximum (38.89mm) in treatment T8 (300ppm Ethrel + 10ppmNAA), which was significantly higher than in all other treatments. Untreated fruits (Control) were showed lowest net increase in fruit-length. Increased fruit-size 10.5% on application of 2,4,5-T was also observed by Crane and Brooks (1952) in apricot.

Table 1. Effect of various growth regulator treatments on fruit length (mm)

Treatment	Date[δ]	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
May	09	18.76	17.89	19.60	17.83	20.88	18.57	18.35	19.06	18.07
	16	22.61	22.10	22.94	22.33	22.95	22.90	22.51	23.26	21.95
	23	26.16	26.02	25.98	26.02	26.97	26.68	26.30	26.46	25.20
	30	29.17	29.16	28.86	29.18	30.78	30.38	29.72	29.47	28.12
June	06	31.98	31.81	31.43	31.89	33.18	33.48	32.68	32.46	30.45
	13	34.43	33.98	33.54	33.91	35.28	35.95	35.04	35.14	32.36
	20	36.44	35.77	35.33	35.60	37.09	37.76	37.03	37.65	33.99
	27	38.32	35.92	36.49	36.80	38.59	38.86	38.46	40.09	35.40
July	03	39.52	36.93	37.47	37.90	39.55	39.50	39.48	42.49	36.63
	10	40.16	37.39	38.03	38.42	40.06	39.94	39.95	43.59	37.09
	17	40.50	37.60	38.36	38.67	40.45	40.17	40.24	44.40	37.35
	24	40.83	37.75	38.53	38.78	40.69	40.28	40.40	44.62	37.50
	31	41.05	37.86	38.62	38.86	40.91	40.53	40.50	44.76	37.61
Aug	07	41.23	38.28	39.05	39.29	41.09	40.89	40.88	44.87	38.15
	15	41.59	38.85	39.63	39.86	41.77	41.34	41.46	45.56	38.83
	22	42.07	39.63	40.41	40.56	42.52	42.23	42.23	46.36	39.59
	29	42.73	40.54	41.34	41.37	43.33	43.14	43.15	47.25	40.55
Sep	05	43.44	41.47	42.30	42.31	44.24	44.08	44.13	48.17	41.54
	12	44.24	42.46	43.35	43.28	45.17	45.23	45.19	49.18	42.61
	19	45.15	43.52	44.48	44.31	46.16	46.52	46.32	50.02	43.72
	26	46.14	44.63	45.65	45.44	47.17	47.87	47.54	51.23	44.78
Oct	03	47.15	45.83	46.91	46.62	48.35	49.16	48.80	52.29	45.74
	10	48.24	47.08	48.08	47.86	49.55	50.35	50.12	53.49	46.55
	17	49.32	48.37	49.17	47.86	50.76	51.36	51.33	54.70	47.23
	24	50.21	49.56	50.15	50.04	51.90	52.36	52.29	55.92	47.55
	31	50.53	50.40	50.29	50.97	52.67	53.27	52.98	56.82	48.08
Nov	07	50.75	50.93	51.43	51.48	53.08	53.78	53.41	57.53	48.29
	14	50.87	51.25	51.62	51.72	53.30	54.09	53.60	57.95	48.43
Net increase		32.11	33.36	32.02	33.89	32.42	35.52	35.25	38.89	30.36

[δ]Year 1999

T_1=20 ppm 2,4,5-T T_4= 50 ppm NAA T_7=100 ppm Ethrel +10 ppm NAA

T_2=40 ppm 2,4,5-T T_5= 100 ppm Ethrel T_8=300 ppm Ethrel +10 ppm NAA

T_3=25 ppm NAA T_6= 300 ppm Ethrel T_9=300 ppm Ethrel +10 ppm NAA

Taha and Abbas (1987) also observed an increase in fruit-size with application of NAA on 'Hungarian Best', 'Rose' and 'Cheletano' apricots. This increase in fruit-size by application of growth regulators may have been due to accelerated starch hydrolysis and mobilization of food material from other plant-parts to the fruit.

Harvest maturity

Fruits subjected to various hormonal treatments were analyzed for physico-chemical attributes on different harvest dates, ranging from 176 to 204 days from full bloom. Among the various parameters evaluated as indices for maturity in kiwifruit by several workers, TSS and flesh-firmness have been suggested to be the most reliable (Rana, 1997). TSS content in the range of 6-8% was recorded between D2 at 183 DFFB to D3 harvesting date at 190 DFFB. Rana (1997) also reported optimum harvesting time for cv. Abbott to be when TSS ranged from 8.6 to 8.8. This was observed on the third harvest date (at 190 DFFB) in our study. Optimum flesh-firmness (9.08-8.16 kg/cm^2) was also recorded on the third (D3) harvest date at 190 DFFB, which suggests that this is the optimum harvest time. In the present study, all treatments enhanced TSS content over the Control on all harvest dates, but, optimum TSS content was attained only during the second and third harvest dates in all treatments. This indicates that the various hormonal treatments had no effect on hastening of fruit maturity.

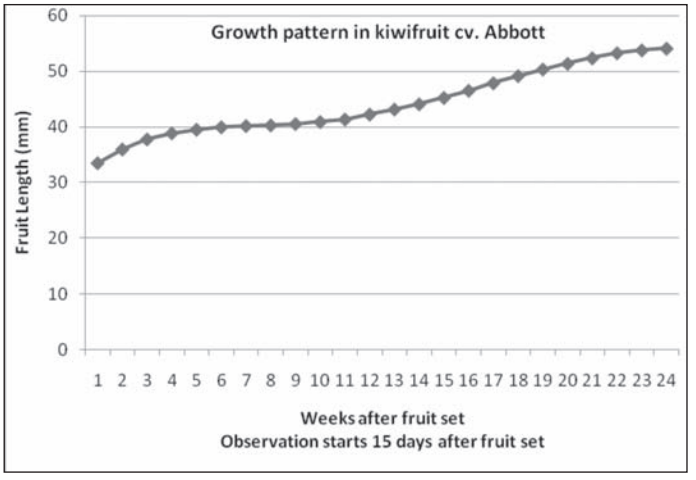

Fig 1. Fruit growth pattern in kiwifruit cv. Abbott

Table 2. Effect of various growth regulator treatments on fruit retention (%) and fruit yield (kg/vine)

Treatment	Mean fruit retention(%)	Yield (kg/vine)
T_1 (20 ppm 2,4,5-T)	75.00	3.57
T_2 (40 ppm 2,4,5-T)	68.75	3.18
T_3 (25 ppm NAA)	83.33	4.17
T_4 (50 ppm NAA)	77.08	3.73
T_5 (100 ppm Ethrel)	79.17	3.83
T_6 (300 ppm Ethrel)	75.00	3.28
T_7 (100 ppm Ethrel+ 10 ppm NAA)	9.17	3.65
T_8 (300 ppm Ethrel +10 ppm NAA)	75.00	4.27
T_9 (Control)	91.58	4.27
CD (p = 0.05)	5.05	0.52

Effects

Treatment	0.10
Date	0.08
Treatment X Date	0.16

Table 3. Effect of growth regulator treatment and harvest date on kiwifruit flesh firmness (kg/cm^2)

Date/Treatment	D1 (176 DFFB$^{\delta}$)	D2 (183 DFFB$^{\delta}$)	D3 (190 DFFB$^{\delta}$)	D4 (197 DFFB$^{\delta}$)	D5 (204 DFFB$^{\delta}$)	Mean
T1 (20 ppm 2,4,5-T)	10.97	10.32	9.48	8.82	7.97	9.51
T2 (40 ppm 2,4,5-T)	9.96	9.81	9.14	8.67	7.78	9.07
T3 (25 ppm NAA)	10.93	0.44	9.80	8.99	8.19	9.67
T4 (50 ppm NAA)	10.00	9.83	9.24	8.38	7.62	9.02
T5 (100 ppm Ethrel)	10.10	9.84	9.27	8.65	7.91	9.15
T6 (300 ppm Ethrel)	9.12	8.95	8.22	7.78	7.00	8.21
T7 (100 ppm Ethrel + 10 ppm NAA)	10.96	10.33	9.71	8.93	8.42	9.67
T8 (300 ppm Ethrel + 10ppm NAA)	9.34	9.31	8.92	8.57	7.50	8.78
T9 (Control)	10.73	10.45	79.62	78.82	8.04	9.53
Mean	10.26	9.92	9.27	8.63	7.83	

$^{\delta}$DFFB = Days from full bloom

Effects	*CD (P = 0.05)*
Treatment	0.16
Date	0.14
Treatment X Date	0.10

Table 4. Effect of growth regulator treatment and harvest date on kiwifruit TSS (%)

Date/Treatment	D1 (176 DFFB ð)	D2 (183 DFFB ð)	D3 (190 DFFB ð)	D4 (197 DFFB ð)	D5 (204 DFFB ð)	Mean
T1 (20 ppm 2,4,5-T)	5.13	6.16	7.78	8.54	9.31	7.39
T2 (40 ppm 2,4,5-T)	4.92	6.97	8.01	8.92	9.43	7.65
T3 (25 ppm NAA)	5.37	6.34	8.24	9.06	9.67	7.74
T4 (50 ppm NAA)	5.09	6.50	8.33	9.22	9.79	7.79
T5 (100 ppm Ethrel)	5.73	6.97	8.52	9.71	10.31	8.25
T6 (300 ppm Ethrel)	5.79	7.02	8.83	9.92	10.44	8.40
T7 (100 ppm Ethrel + 10 ppm NAA)	5.16	6.92	8.07	8.97	9.78	7.78
T8 (300 ppm Ethrel + 10ppm NAA)	5.19	6.59	7.99	8.93	9.92	7.72
T9 (Control)	4.20	5.89	8.17	8.17	9.3	7.15
Mean	5.18	6.60	8.22	9.05	9.77	

ð DFFB = Days from full bloom

Effects	CD (P=0.05)
Treatment	0.16
Date	0.14
Treatment X Date	0.10

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