Bull. Fac. Agric., Cairo Univ.,53
(2002): 639- 652.

EFFECT OF SOME TREATMENTS ON SPUR FORMATION ON NEWLY INTRODUCED JAPANESE APPLE CULTIVARS IN COMPARISON WITH ANNA APPLE

(Received :20.1.2002)

By
W. A. Abd El-Wahab, T.A. Fayed and I. E. El-Shenawy

Pomology Department, Faculty of Agriculture, Cairo University

ABSTRACT

Fuji, Orin and Tsugaru apple cultivars were introduced from Japan and planted in the experimental orchard of the Pomology Department, Faculty of Agriculture, Cairo University, Giza. They grew vegetatively for 4 years without forming fruit spurs. Summer pruning (tipping, bending and girdling) and paclobutrazol (pp_{333}) alone or in different combinations were tested on 2-year-old shoots for stimulating the formation of fruit spurs on these cultivars in comparison with Anna apple. The combined treatments, specially tipping + bending + girdling + pp_{333} were significantly effective for producing fruit spurs than single ones. Anna apple formed the highest significant number of spurs per shoot, followed by Fuji then Orin, while Tsugaru cultivar had the lowest tendency in this respect.

Distribution of fruit spurs along the shoot differed according to the treatment and the cultivars. Either tipping or pp_{333} stimulated spur formation at the terminal part; girdling enhanced it at the basal part, but bending stimulated it at the medium part of shoot. Considering the triple or tetra combined treatments, fruit spurs were mainly formed at the medium part in Orin, terminal part in Fuji and at both parts in Tsugaru shoots.

Chemical analysis revealed that higher contents of total carbohydrates, C/N ratio, abscisic acid and indoleacetic acid, besides low total nitrogen, protein and gibberellins may be in favour of fruit spurs formation.

Key words: *apples, endogenous hormones, pruning treatments, spur formation.*

1. INTRODUCTION

Three apple cultivars namely Fuji, Orin and Tsugaru (Appendix) were introduced in January 1996 from Japan through Japan International Cooperation Agency (JICA) and planted in the experimental orchard of the Pomology Department, Faculty of Agriculture, Cairo university, Giza. They are the main apple cultivars grown in Japan, Fuji (>50%), Orin and Tsugaru (both about 10%) as cited by Neri and Sugiyama (2000). They are budded on Maruba-Kaido (*Malus prunifolia*), a semivigorous to vigorous, the main rootstock in Japan.

Fuji fruits can be stored in controlled atmosphere year-round (good storage capacity),meanwhile Tsugaru fruits are of short life (Jongpil *et al.*, 1999). However, under our experimental conditions either of the three cultivars failed to form fruit spurs and hence bore no fruits through 4 years after planting.

Dadu and Donika (1998) recorded that early summer pruning of young apple trees is traditionally performed to stimulate the production of fruiting spurs on older wood. Baolin *et al.*, (1999) found that drawing the branches of 4-year-old Fuji apple trees to an angle of 70-80° in early April and girdling them at the base with a width of 1/10 of base diameter greatly increase the number of fruit spurs and fruit set, while untreated vigorous branches bore no fruit. Ferree and Schmid (1999) added that bending vigorous laterals resulted in more flowering spurs than heading for the apple cultivars, Gala and Red Cort.

Murav'ev (2000) concluded that early summer pruning of apples significantly weakens growth and can be recommended as an extreme measure for cultivars having vigorous renewal growth, *e.g.* Orlovsky Sinap. Kondratenko *et al.*, (1998)showed that girdling led to deposition of excess assimilates in the form of starch, initiation of photosynthesis, premature aging of the leaves and stimulated the initiation of generative organs.

Treatment of paclobutrazol at 1000 ppm on 5-year-old Fuji apple was most effective for increasing the number of flowers than control. However, the combination of heading and paclobutrazol had greater effect on the production of fruiting spurs than each alone (Ferree and Schmid, (1999). Nickell (1982) ascribed the effect of pp_{333} to its retardational acts by reducing gibberellin production, therefore, it can control the vegetative growth.

The present investigation was carried out to study the effect of some summer pruning treatments and/or paclobutrazol for fruiting spur formation on three newly introduced Japanese apple cultivars.

2. MATERIALS AND METHODS

This investigation was carried out during the two successive seasons (1999-2000 and 2000-2001) at the experimental orchard, Faculty of Agriculture, Cairo University, Giza on 4-year-old trees of three Japanese apple cvs.,*i.e.* Fuji, Orin and Tsugaru in addition to Anna cv. each grown on Malus rootstock. The trees were planted at 3x4 meters in clay loamy soil, trained as open vase shape system and were mostly similar in growth. Three summer pruning treatments (tipping of 0.5-1 cm, bending at 70-80° and girdling by 1.0 cm ring) and spraying with paclobutrazol (pp_{333}) at 1000 ppm on 15^{th} July, in addition to combinations between them besides untreated control trees.

Three trees, representing three replicates, were used for each treatment. For each season, nine 2-year-old shoots were labelled per tree on 15^{th} July.

Percentage of spur formation on the selected shoots as well as their distribution on shoot parts (terminal, medium and basal) were determined at the end of the growing season (15^{th} December).

Methanolic extracts (Diaz and Martin, 1972) of fresh samples of spurs or buds plus nodal tissues all along the shoots of the tetra combined treatment (tipping + bending + girdling + pp_{333}) and control respectively were prepared on the 15^{th} of December for the determination of endogenous hormones (abscisic acid, gibberellins and indoleacetic acid) using Gas Liquid Chromotography (GLC) as adopted by Davis *et al.*, (1968).

In addition, total carbohydrates (Smith *et al.*, 1956), total nitrogen (Pregal, 1945), C/N ratio and total protein were estimated in dried samples.

Data were tabulated and statistically analyzed according to the complete block design (Snedecor and Cochran, 1972). Means were compared using New LSD value at 5% level (Waller and Duncan, 1969). The percentages were transformed into angles before subjecting to statistical analysis.

3. RESULTS AND DISCUSSION

3.1. Spur formation

3.1.1. Percentage of spurs per shoot

Data presented in Tables 1 and 2 and Figs. 1 and 2 reveal that control trees of the three newly introduced Japanese apple cultivars fai.ed completely to form spurs. Meanwhile Anna cv. formed 25.8 & 29.07% spurs per shoot at the two seasons, respectively. On the other hand, all treatments significantly increased the percentage of spur formation in the four apple cultivars under study. The combined treatments were much more effective in this concern than either of the single treatments. The most promising treatment for all cultivars under study was the combined treatment (tipping + bending + girdling + pp_{333}). It was followed by triple combined treatments (bending + girdling + pp_{333}), (tipping + bending + girdling) then (tipping + bending + pp_{333}) in descending order.

Table (1): Effect of some treatments on spur formation % per shoot of newly introduced Japanese apple cultivars in comparison with Anna apple (Season 1999-2000).

Treat. \ Cultivars	Orin	Fuji	Tsugaru	Anna	Mean
Tipping	1.68	8.55	8.05	30.78	12.26
Bending	4.23	11.22	8.7	28.08	13.6
Girdling	8.05	11.60	7.44	26.3	13.35
Pp_{333}	3.21	7.90	9.51	36.84	14.23
Tipping + Bending	22.4	32.04	16.65	54.18	34.87
Tipping + Girdling	22.8	34.5	18.72	51.21	31.80
Tipping + pp_{333}	29.1	32.07	15.78	47.34	31.07
Bending + Girdling	27.81	33.9	17.04	47.19	31.48
Bending + pp_{333}	25.83	35.1	14.25	55.8	33.49
Girdling + pp_{333}	28.32	40.15	19.35	50.04	34.46
Tipping + Bending + Girdling	56.1	43.08	24.48	65.4	47.26
Tipping + pp_{333} + Bending	48.0	48.3	25.68	64.23	46.55
Bending + pp_{333} + Girdling	55.2	50.3	31.77	69.3	51.64
Bending + pp_{333} + Girdling + Tipping	65.7	64.53	34.11	70.44	58.7
Control	0.0	0.0	0.0	25.8	6.46
Mean	8.85	10.07	5.66	16.09	

New L.S.D at 0.05 for:

Treat. : 1.455 Cvs : 0.93 Treat x cvs : 0.84

Fig.(1) : Control Fuji apple trees without forming fruit spurs.

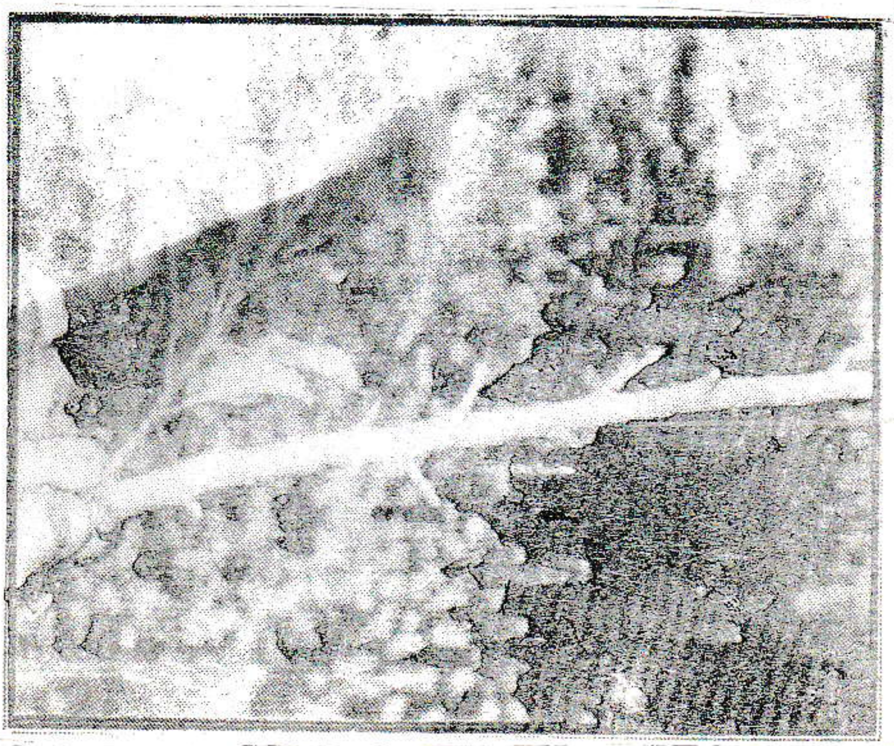

Fig. (2) : The stimulating effect of the tetra combined treatments (tipping + bending + girdling + pp 333) on forming fruit spurs on 2-year-old shoots of Fuji apple cultivar.

Table (2): Effect of some treatments on spur formation % per shoot of newly introduced Japanese apple cultivars in comparison with Anna apple (Season 2000-2001).

Treat. \ Cultivars	Orin	Fuji	Tsugaru	Anna	Mean
Tipping	1.95	11.1	12.6	33.18	14.7
Bending	5.7	14.76	13.59	33.0	14.26
Girdling	8.49	14.50	13.38	28.8	16.29
Pp_{333}	4.47	9.54	16.5	20.16	12.66
Tipping + Bending	28.5	35.73	24.33	57.75	36.57
Tipping + Girdling	27.18	37.47	24.33	54.27	35.81
Tipping + pp_{333}	28.8	36.0	20.04	49.5	33.59
Bending + Girdling	31.38	44.49	23.85	49.83	37.39
Bending + pp_{333}	31.5	43.59	18.12	58.56	33.4
Girdling + pp_{333}	28.98	47.2	27.39	49.71	38.32
Tipping + Bending + Girdling	56.37	55.98	28.14	63.48	50.99
Tipping + pp_{333} + Bending	52.98	64.59	31.38	65.85	53.7
Bending + pp_{333} + Girdling	57.66	62.49	41.88	80.49	60.63
Bending + pp_{333} + Girdling + Tipping	65.1	68.85	45.0	77.13	64.02
Control	0.0	0.0	0.0	29.07	7.27
Mean	28.60	40.58	22.7	50.05	

New L.S.D at 0.05 for
Treat : 1.983
Cvs : 0.872
Treat x cvs : 0.611

The double combined treatments gave less stimulatory effect on spur formation, although they were significantly higher than the single treatments. This trend was true for all the cultivars under investigation in both seasons. Anna apple showed the highest significant number of spurs per shoot, followed by Fuji then Orin, while Tsugaru formed the lowest number in both seasons of the present trial.

These findings are in parallel with those found by Dadu and Donika (1998), Baolin *et al.*, (1999), Ferree and Schmid (1999) and Murav'ev (2000) on different apple cultivars. The effect of tipping and bending may be due to the controlling of apical dominance phenomenon, *i.e.,* the inhibition of lateral bud growth by auxin emanating from the apical bud (Devlin, 1972). Nickell (1982) ascribed the effect of pp_{333} to its retardational acts by gibberellin production and hence govern vegetative growth. Moreover, Kondratenko *et al*., (1998) showed that girdling leads to deposition of excess assimilates in the form of starch and stimulates the initiation of generative organs.

3.1.2. Distribution of spurs at shoot parts

Spur formation percentages at the three shoot parts (terminal, median and basal) of the four apple cultivars under study as affected by the treatments are presented in Tables 3 and 4. Generally the mean values indicate the highest significant percentage of spur formation on the median part of the shoot in Orin and Anna apple cultivars, but it was at the terminal part in Fuji and at both terminal and median parts of the shoot in Tsugaru cultivar. Similarly, SungDo and Heejae (1999) found that Fuji apple produced higher percentage of terminal flower buds than Jonagold cultivar. This trend was ascertained in the tetra combined treatment (tipping + bending + girdling + pp_{333}) in all cultivars under study as well as in the triple combined treatments in the Japanese cultivars.

It is worth to mention that single treatments had different promising effects on the distribution of fruiting spurs along the shoot of Japanese apple cultivars under investigation. Either of tipping or pp_{333} stimulated spur formation at the terminal part, meanwhile girdling promoted it at the basal part, but bending enhanced spur production at the median part. On the other side, all the single treatments stimulated spur formation only at the middle part of Anna shoots. This difference may be due to the fact that Anna apple bears flowers on shoots and spurs, while Japanese apple cultivars bear its flowers only on spurs.

3.2. Chemical contents of buds and spurs

Buds plus nodal tissues of control and spurs of tetra combined treatment (tipping + bending + girdling + pp_{333}) were analyzed for determination of total carbohydrates, nitrogen, C/N ratio and protein (Table, 5) as well as endogenous gibberellins, abscisic acid and indoleacetic acid (Table, 6).

Total carbohydrates and C/N ratio were significantly increased in spurs; meanwhile total nitrogen and total protein tended to decrease

Table (3): Effect of some treatments on spur formation at shoot parts of newly introduced Japanese apple cultivars in comparison with Anna apple (season 1999-2000).

Cultivars	Orin				Fuji				Tsugaru				Anna			
Treat.	Terminal	Median	Basal	Mean	Terminal	median	Basal	Mean	Terminal	median	Basal	Mean	Terminal	median	Basal	Mean
Tipping	1.86	0.0	0.0	0.62	8.05	0.51	0.0	2.85	8.05	0.0	0.0	2.68	5.39	14.55	10.63	10.26
Bending	0.28	3.95	0.0	1.41	0.0	9.29	1.93	3.74	0.91	7.35	0.45	2.9	2.33	15.64	10.11	9.36
Girdling	0.0	0.13	7.92	2.68	0.0	0.35	11.26	3.87	0.0	1.33	6.12	2.48	2.16	13.85	10.32	8.77
Pp_{333}	3.16	0.05	0.0	1.07	7.88	0.05	0.0	2.64	6.52	3.0	0.0	3.17	12.03	15.81	10.32	12.28
Tipping + Bending	12.15	10.3	0.0	7.48	11.54	18.66	1.85	10.68	5.87	9.46	1.33	5.55	22.5	21.42	11.45	18.06
Tipping + Girdling	2.16	0.85	19.75	7.59	11.57	6.31	16.63	11.5	7.1	2.28	9.35	6.24	26.62	13.69	10.91	17.07
Tipping + pp_{333}	18.93	3.82	1.36	9.7	22.43	8.9	0.75	10.69	10.49	5.32	0.0	5.26	17.92	19.4	10.03	15.78
Bending + Girdling	0.0	7.13	20.68	9.27	5.2	11.4	22.16	11.3	0.05	7.48	9.52	5.68	15.74	18.52	12.93	15.73
Bending + pp_{333}	7.31	18.52	0.0	8.61	11.17	18.42	5.63	11.7	5.86	8.92	2.49	5.75	19.52	20.11	16.17	18.6
Girdling + pp_{333}	6.93	1.43	20.51	9.44	8.58	9.71	21.86	13.38	1.24	7.26	10.85	6.45	20.91	13.77	15.35	16.68
Tipping + Bending + Girdling	18.62	27.47	10.03	18.7	14.83	12.33	15.91	14.36	8.32	7.63	8.52	8.16	22.71	25.16	17.52	21.8
Tipping + pp_{333} + Bending	20.45	24.74	2.86	16.0	22.08	16.48	9.75	16.1	13.91	6.41	5.36	8.56	22.22	19.35	22.51	21.41
Bending + pp_{333} + Girdling	16.39	20.14	18.75	18.4	18.84	15.82	15.66	16.77	9.82	12.56	9.38	10.59	25.87	30.41	19.68	23.1
Bending + pp_{333} + Girdling + Tipping	21.32	24.48	20.05	21.9	25.07	16.38	23.08	21.51	15.45	9.12	10.61	11.37	16.04	32.27	22.14	23.48
Control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001	0.0	0.0	0.0	0.0	2.21	13.59	10.08	8.6
Mean	8.6	9.86	8.13		10.62	9.64	9.77		6.24	5.87	4.93		15.08	19.17	14.03	

New L.S.D at 0.05 for:

Orin	Fuji	Tsugaru	Anna
Treat. (T) : 0.281	Treat. (T) : 0.888	Treat. (T) : 1.159	Treat. (T) : 1.257
Part. (P) : 0.198	Part. (P) : 0.628	Part. (P) : 0.819	Par. (P) : 0.889
(T) x (P) : 0.162	(T) x (P) : 0.513	(T) x (P) : 0.669	(T) x (P) : 0.726

Table (4) : Effect of some treatments on spur formation at shoot parts of newly introduced Japanese apple cultivars in comparison with Anna apple (season 2000-2001).

Cultivars	Orin				Fuji				Tsugaru				Anna			
Treat.	Terminal	Median	Basal	Mean	Terminal	median	Basal	Mean	Terminal	median	Basal	Mean	Terminal	median	Basal	Mean
Tipping	1.97	0.0	0.0	0.65	9.9	1.2	0.0	3.7	12.6	0.0	0.0	4.2	8.2	15.1	9.9	11.06
Bending	0.4	5.3	0.0	1.9	0.0	11.81	2.97	4.92	2.15	10.33	1.12	4.53	3.6	18.1	11.3	11.0
Girdling	0.0	0.2	8.3	2.83	0.0	0.69	13.82	4.83	0.0	2.6	10.8	4.46	3.1	15.9	9.8	9.6
Pp_{333}	4.3	0.18	0.0	1.49	9.52	0.3	0.0	3.18	10.8	5.71	0.0	5.5	11.01	17.9	13.7	14.2
Tipping + Bending	15.9	12.6	0.0	9.5	12.6	20.2	2.95	11.91	7.8	13.65	2.88	8.11	24.15	23.15	10.01	19.25
Tipping + Girdling	2.8	1.6	22.8	9.06	11.13	8.16	18.19	12.49	8.9	3.7	12.6	8.11	28.51	14.71	11.05	18.09
Tipping + pp_{333}	22.6	4.6	1.8	9.6	25.8	7.9	2.3	12.0	12.51	7.53	0.0	6.68	19.22	20.31	9.99	16.5
Bending + Girdling	0.0	8.6	22.8	10.46	7.11	10.6	26.8	14.83	1.1	9.15	13.6	7.95	16.71	20.1	13.02	16.61
Bending + pp_{333}	9.6	21.9	0.0	10.5	10.3	24.6	8.71	14.53	5.66	9.45	3.01	6.04	18.05	23.01	17.51	19.52
Girdling + pp_{333}	8.8	1.3	18.9	9.66	10.25	10.23	26.71	15.73	3.12	9.16	15.13	9.13	22.03	12.71	14.99	16.57
Tipping + Bending + Girdling	17.15	30.3	8.9	18.79	20.9	16.7	18.4	18.66	10.2	8.05	9.9	9.38	21.62	24.5	18.91	21.16
Tipping + pp_{333} + Bending	23.6	25.7	3.7	17.66	30.6	20.1	16.9	21.53	17.8	8.7	4.9	10.46	20.33	20.71	24.81	21.95
Bending + pp_{333} + Girdling	15.17	21.6	20.9	19.22	23.8	19.6	19.1	20.83	13.6	18.1	10.2	13.96	28.9	31.6	20.01	26.83
Bending + pp_{333} + Girdling + Tipping	20.2	25.9	19.01	21.7	27.11	15.99	25.75	22.95	20.9	11.9	12.8	15.0	19.6	33.85	23.7	25.71
Control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.67	14.82	11.6	9.69
Mean	9.49	10.65	9.8		13.25	11.21	11.97		8.47	7.86	6.46		16.51	20.43	14.68	

New L.S.D at 0.05 for:

Orin	Fuji	Tsugaru	Anna
Treat. (T) : 0.395	Treat. (T) : 0.897	Treat. (T) : 0.995	Treat. (T) : 1.172
Par. (P) : 0.283	Par. (P) : 0.663	Par. (P) : 0.771	Par. (P) : 0.896
(T) x (P) : 0.318	(T) x (P) : 0.766	(T) x (P) : 0.872	(T) x (P) : 1.005

Table (5): Effect of combined treatment (tipping, bending, girdling and pp_{333}) on carbohydrate nitrogen, C/N ratio and protein contents (mg/ 100 g .fresh weight) of fruiting spurs in comparison with those in buds of control trees (season 2000-2001).

Treat. Cvs	T. Carbohydrate			Nitrogen			C/N ratio			Protein		
	Tipping + bending + girdling + pp_{333}	Control	Mean	Tipping + bending + girdling + pp_{333}	Control	Mean	Tipping + bending + girdling + pp_{333}	Control	Mean	Tipping + bending + girdling + pp_{333}	Control	Mean
Orin	27.18	11.88	19.53	0.33	0.66	0.49	82.36	18.0	50.18	2.16	4.92	3.5
Fuji	29.06	14.66	21.86	0.27	0.42	0.34	100	34.9	67.45	3.91	6.84	5.37
Tsugaru	31.01	12.88	21.9	0.31	0.51	0.41	100	25.25	62.63	2.85	7.65	5.25
Anna	30.17	14.25	22.2	0.31	0.93	0.62	97.3	15.32	56.31	4.38	8.65	6.51
Mean	29.35	13.4		0.31	0.63		94.92	23.37		3.33	7.02	

New L.S.D at 0.05 for:

T. Carbohydrate	Nitrogen	C/N ratio	Protein
Treat. : 0.85	Treat. : 0.216	Treat. : 0.961	Treat. : 0.672
Cv. : 0.241	Cv. : 0.153	Cv. : 0.350	Cv. : 0.121
T x cv. : 0.362	T x cv.: 0.187	T x cv. : 0.651	T x cv.: 0.311

Table (6): Effect of combined treatment (tipping, bending, girdling and pp_{333}) on endogenous hormones of fruiting spurs in comparison with those in buds of control trees (season 2000-2001).

Treat. Cvs	GA_3			ABA			IAA		
	Tipping + bending + girdling + pp_{333}	Control	Mean	Tipping + bending + girdling + pp_{333}	Control	Mean	Tipping + bending + girdling + pp_{333}	Control	Mean
Orin	27.88	30.83	29.39	18.02	1.31	9.66	9.08	4.33	6.71
Fuji	26.57	28.07	27.32	25.7	5.74	15.72	29.27	22.54	15.91
Tsugaru	25.1	25.62	25.42	23.98	7.46	15.72	36.48	27.93	32.2
Anna	17.9	22.75	18.83	12.23	8.44	10.34	22.09	19.98	21.04
Mean	23.64	26.82		19.98	5.74		24.23	18.69	

New L.S.D at 0.05 % for:

GA_3	ABA	IAA
Treat. : NS	Treat. : 0.925	Treat. : 0.921
Cv. : 0.812	Cv. : 0.018	Cv. : 0.663
T x cv.: NS	T x cv.: 0.563	T x cv.: 0.775

in spurs of the treated trees of all apple cultivars under study as compared with buds of control trees. In this respect, Hao *et al*. (1991) found that paclobutrazol application to delicious apple increased leaf content of chlorophylls, starch, carbohydrates and soluble sugars and most amino acids, but had little effect on total protein. Moreover, Huang *et al*., (1995) on four-year-old apple cv. Aki Fuji trees demonstrated that paclobutrzol treatment increased photosynthetic rates and dry matter accumulation in roots than those of untreated trees.

Determination of endogenous hormones (Table, 6) revealed a significant increase in spur content of abscisic and indoleacetic acids and a decrease in gibberellins in the treated trees as compared with those in buds of the untreated ones (control). Similarly, Niu *et al*., (1994) showed that leaf ABA content of apple trees was increased due to paclobutrazol treatment and this was concomitant with the increase of flower initiation. The significant reduction in gibberellins in the fruiting spurs due to the tetra combined treatment under study than vegetative buds of control trees would confirm the findings of Marino and Greene (1981) on early McIntoch apple that gibberellins inhibit flowering on both spurs and one year old wood.

In conclusion, it appeared that high total carbohydrates, C/N ratio, abscisic acid and indoleacetic acid besides low total nitrogen, protein and gibberellins may favour the production of fruit spurs on the Japanese apple cultivars. Therefore , the treatments that could drive the chemical content in this direction may stimulate formation of fruiting spurs.

4. REFERENCES

Baolin G., Junxia Y., Junxiang Z., Zhen. G. and Shuzhi H. (1999). Study on the effects of widening the growing angles of vigorous branches for fruit bud formation of young apple trees. Department of Horticulture, Hebei Agricultural Univ., Boading, Hebei, China (Hort. Abst., 70:872).

Dadu K. YA. and Donika I.N. (1998). A novel system of apple tree pruning in intensive orchards. Sadovodstvo I vinogradarstvo No. 5/6 14 (Ru) (Hort. Abst., 69: 5631).

Davis L. A., Heinz D.E. and Addicott F.T. (1968). Gas-liquid chromatography of trimethylsilyl derivatives of abscisic acid and other plant hormones. Plant Physiol., 43: 1389-94.

Devlin R.M. (1972). Plant physiology. Affiliated East West press. Pvt. Ltd. New Delhi pp. 446.

Diaz D.H. and Martin G.C. (1972). Peach seed dormancy in relation to endogenous inhibitors and applied growth substances. J. Amer. Soc. Hort. Sci. 97: 651-54.

Ferree D.C. and Schmid J.C. (1999). Influence of temporary bending and heading on branch development and flowering of vigours young apple trees. Fruit varieties Journal 53: 231-235. (Hort. Abst. 70: 3621).

Hao S.G., Yang H., and Sun Z.M. (1991). Physiological changes induced by paclobutrazol in "Delicious" apple. Fruit Science Reports 18: 163-172. China (Hort. Abst., 46: 1645).

Huang W.D., Shen T., Han Z. H. and Liu S. (1995). Influence of paclobutrazol on photosynthesis rate and dry matter partitioning in the apple tree. J. of Plant Nutrition 18: 901-910., China (Hort. Abst., 65: 10439).

Jongpil C., Yongsoo H., Jaechang L. and Hulser D. (1999). Cell wall component changes during maturation and storage in Tsugaru and Fuji apple fruits. J. Korean Soc. Hort. Sci., 40: 705-710 (Hort. Abst., 70: 4536).

Kondratenko P. V., Tartachnik I. I. and Silaeva A.M. (1998). Effect of girdling on the dynamics of assimilates in the leaves of apple sadovodstvo I vinogradarstvo No. 3,9-10 (Hort. Abst. 68: 9242).

Marino F. and Greene D.W. (1981). Involvement of gibberellins in the biennial bearing of "Early McIntoch" apples. J. Amer. Soc. Hort. Sci., 106: 593-596.

Murav'ev A. A. (2000). Early summer pruning of apples in young orchards. Sadovodstvo I vinogradarstvo No. 2,2 (Hort. Abst., 70: 6412).

Neri D. and Sugiyama N. (2000). Apple growing in Japan tradition and innovation. Rivista di frutticoltura di Ortofloricoltura, 62: 44-55. (Hort. Abst., 71: 1131).

Nickell L.G. (1982). Plant Growth Regulators Agricultural uses. Springer Verlag. Berlin., pp. 173.

Niu Z.M., Li G. and Gao X.M. (1994). Effects of paclobutrazol on endogenous ABA content of leaves and flower bud formation of apple trees. J. of Fruit Sci., 11: 97-99. China (Hort. Abst., 65: 9463).

Pregal F. (1945). Quantitative Organic Micro Analysis. 4^{th} ed. J. A. Churhilled Lted., London., P.126-9.

Smith F., Gilles M.A. Hamilton J.K. andGedees P.A. (1956). Colorimetric metods for determination of sugar and related substances. Anal. Chemic., 28:350-365.

Snedecor G.W. and Cochran W.G. (1972). Statistical methods. 6^{th} ed. The Iowa State Univ., Press, Ames, Iowa USA pp. 593.

SungDo O. and Heejae L. (1999). Differences in regrowth and terminal flower bud formation of "Fuji" and "Jonagold" apple trees in response to summer heading back pruning of current season's shoots. Korean J. of Hort. Sci. & Tec., 17: 333-336.

Waller R. A. and Duncan D. B. (1969). A bays role for the symmetric multiple comparison problem. Amer. Stat. Assoc. J., 1485-1503.

تأثير بعض المعاملات على تكوين الدوابر لبعض أصناف التفاح الياباني المستورد حديثاً مقارنة بالتفاح الانا

وفاء عبد الحليم عبد الوهاب ، طارق عبد العليم فايد ، إبراهيم الشناوى غنيم

قسم الفاكهة -كلية الزراعة - جامعة القاهرة

ملخص

تم إستيراد أصناف التفاح الفوجى ، أورين ، تسيجارو من اليابان وتمت زراعتها بمزرعة التجارب الخاصة بقسم الفاكهة بكلية الزراعة - جامعة القاهرة واستمر النمو الخضرى لمدة ٤ سنوات بدون تكوين دوابر ثمرية.

أجريت معاملات التقليم الصيفى وهى التطويش، الثنى ، التحليق ، الرش بمادة الباكلوباترازول سواء منفردة أو معاملات مركبة على أفرع عمر سنتين وذلك بغرض تحفيز تكوين الدوابر الثمرية على تلك الأصناف مقارنة بالتفاح الآنا.

وقد أظهرت النتائج أن المعاملة المركبة الرباعية (التطويش + التحليق + الثنى + الرش بالباكلوباترازول) أعطت أعلى نتيجة معنوية فى تكوين الدوابر الثمرية مقارنة بالمعاملات المنفردة.

١- أعطى صنف الآنا أعلى نتيجة معنوية بالنسبة لعدد الدوابر على الفرع يليها الصنف الفوجى والأورين بينما كان الصنف تسيجارو أقلها.

٢- أختلف توزيع الدوابر على طول الفرع بالنسبة للأصناف والمعاملات. ازدادت نسبة الدوابر فى الجزء الطرفى من الفرع مع المعاملة بالتطويش أو الرش ، وفى الجزء القاعدى مع المعاملة بالتحليق ولكن زادت فى الجزء الوسطى مع المعاملة بالثنى. وزاد تكوين الدوابر فى الجزء الوسطىمن الفرع للصنف أورين مع المعاملات المركبة الثلاثية والرباعية والجزء الطرفى بالنسبة للصنف الفوجى والجزء الطرفى والوسطى للصنف تسيجارو.

٣- اتضح من التحليل الكيماوى زيادة كل من الكربوهيدرات الكلية ونسبة الكربون للنيتروجين وحمض الأبسيسك وأندول حمض الخليك بالإضافة إلى انخفاض كمية النيتروجين والبروتين وكذلك الجبرالين مع تكوين الدوابر الثمرية.

المجلة العلمية لكلية الزراعة - جامعة القاهرة -المجلد (٥٣) العدد الرابع (أكتوبر ٢٠٠٢): ٦٣٩-٦٥٢ .