INDUCTION OF LATERAL SHOOTS IN UNPRUNED LEADERS OF YOUNG SWEET CHERRY TREES

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A B S T R A C T

Lack of training of strong dominant leader in young sweet cherry trees of "knip-boom" type may lead to malformation of tree canopy. The experiment was conducted using "knip boom" trees of sweet cherry cultivars 'Regina' and 'Schneiders' ('Schneiders Spate Knorpelkirche') on Mazzard rootstock. Unbranched tree leaders of approximately 90-120 cm long were treated as follows: 1. The lower one third to one half of the leader was covered with acrylic paint containing 5 g l^{-1} of BA + GA_{4+7} at the time between bud swell and bud burst; 2. The upper one third of the leader was removed (tipping) and its reminder was treated with BA + GA_{4+7} as in treatment 1; 3. Every third or forth bud on tree leader was removed with an apical bud left intact (disbudding). Intact, not treated trees served as a control. The trees of both cultivars responded similarly to applied treatments. Paint application of BA + GA_{4+7} and also leader tipping followed by BA + GA_{4+7} were most effective in inducing lateral shoots on tree leaders. In these cases shoot induction zone was limited to the chemical application zone. Disbudding had little effect on branching of unpruned sweet cherry tree leaders. Two years after the treatments no residual effects of employed procedures were noted.

Key words: benzyladenine, gibberellins, Promalin, shoot induction zone, shoot density ratio

INTRODUCTION

Most of the sweet cherry cultivars exhibit strong apical dominance, particularly in young trees (Miller, 1983; Jacyna and Puchała, 2004; Elfving and Visser, 2007). Recommended for using in sweet cherry dense plantings two-year-old nursery trees known as "knip-boom" (Sitarek, 2004), are characterized by well-developed first scaffold of strong shoots and a dominant leader with no laterals. Lack of side shoots on tree leader usually creates some problems since application of severe pruning to leader may unbalance tree function whereas no pruning may lead to canopy malformation. Pruning (tipping) can interrupt the apical dominance mechanism and encourage buds that otherwise might remain quiescent (Elfving and Visser, 2007). However, in the case of pruning, the strongest growth takes place just below the point of tipping and is limited to a few buds below. The shoots formed this way are strong and grow at very narrow crotch angles that makes them of little use in tree training.

Therefore, a number of alternative methods to increase branching such as disbudding, deblading, twisting, scoring, sanding or notching were examined (Ono et al., 2001; Neri et al., 2002; Sitarek, 2004; Zucconi, 2004; Elfving and Visser, 2007). Yet branching responses brought by these procedures are often inconsistent (Elfving and Visser, 2007).

Chemical branching stimulation usually involve application of either cytokinins (benzyladenine, BA) with or without gibberellins (Veinbrants and Miller, 1981; Jacyna and Puchała, 2004) or auxin transport inhibitors (Jacyna, 1987). Recently, the bioregulator cyclanilide, which is thought to interfere with auxin transport (Pedersen et al., 2006) was shown to stimulate the formation of laterals on current-season's shoots in nursery- and orchard-grown sweet cherry trees (Elfving and Visser, 2006). Low responsiveness of sweet cherry trees to BA sprays is likely associated with inadequate penetration of BA into shoot tissues as found by Edgerton (1979). Thus, BA application to sweet cherry trees is performed using a latex paint that assures longer availability of the growth regulator for a plant (Veinbrants and Miller, 1981; Miller, 1983). The other possibility of increasing the effectiveness of BA is the removal of physical barrier which impedes its penetration into active tree tissues (Elfving and Visser, 2007). It seems, however, that by combining cultural and chemical methods a more pronounced branching effect in young sweet cherry trees might be accomplished (Jacyna and Dodds, 1990; Ono et al., 2001; Neri et al., 2004, Elfving and Visser, 2007). Elfving and Visser (2007) reported that, when BA was applied to sanded or scraped bark of previous season cherry shoots, the number of newly induced shoots greatly increased. Neri et al. (2004) achieved satisfactory branching in several cultivars of sweet cherry by combined simultaneous application of deblading and BA spraying. Mika et al. and Grochowska et al. (cited by Mika,1986) reported that pruning increased cytokinin-, auxin-, and gibberellin-like activity by about 90, 60 and 190%, respectively. The objective of this research was to examine different methods of inducing lateral shoots on unpruned leaders of sweet cherry trees of cultivars 'Regina' and 'Schneiders' and on the residual effects of applied treatments.

MATERIAL AND METHODS

The experiment was conducted in a commercial orchards in Lublin district using sweet cherry trees of 'Regina' and 'Schneiders Spate Knorpelkirche' ('Schneiders') cvs on Mazzard rootstock (*Prunus avium* L.) in the first year after planting. The trees spaced at 3.5 x 1.5 m were of "knip-boom" type with the trunk of ca 60-70 cm long, a set of several strong shoots, and unbranched leader approximately 90-120 cm long. No pruning or other training practices before setting up the experiment were applied. The trees were subjected to the following treatments:

1. The lower one third to one half of the leader was entirely covered with brown acrylic paint containing 5 g l^{-1} of BA + GA_{4+7}. Work mixture was prepared by mixing 722 ml of acrylic paint with 278 ml of Promalin (Abbott Laboratories, Chicago, USA) that is a proprietary mixture containing 1.8% w/w of each BA and (GA_4 + GA_7). The paint was applied once with a brush at the time between bud swell and bud burst (Veinbrants and Miller, 1981);
2. The upper one third of the leader was removed at the dormant stage (tipping), and the remainder of the leader was treated as in treatment 1;
3. Every third or forth bud on tree leader was removed with an apical bud left intact (disbudding).
4. Untreated trees served as a control.

Data recording included measurements of growth characteristics of tree leader: location and length of shoot induction zone, shoot length distribution, shoot extension growth, number of shoots and shoot density ratio (SDR, number of shoots per 100 cm of leader's length or per cm of induction zone). Two years after treatments residual effects were recorded. A completely randomized designs with six (cv. 'Schneiders') and seven (cv. 'Regina') single tree replications were used. The trees of each cultivar set a separate experiment. The data were processed by Fisher's analysis of variance and the means were separated by Duncan's multiple range test at p = 0.05.

RESULTS AND DISCUSSION

The trees of both cultivars responded similarly to comparable treatments except for the length of leader extension in 'Schneiders' trees (Tab. 1 and 2). Application of BA + GA_{4+7} contributed to a significantly greater shoot induction on tree leader than any other treatment. This increment in the number of shoots was reflected in total shoot extension. There were some significant differences between the treatments in shoot length and the range of these differences was similar in trees of both cultivars (Tab. 1 and 2). Application of BA + GA_{4+7} to tipped leaders did not contribute to the increase of branching effect as compared with BA+GA_{4+7}-treated trees. Jacyna and Dodds (1990) reported that the addition of BA + GA_{4+7} to tipped

Table 1. Treatment effects on the growth of tree leader in 'Regina' sweet cherry trees

Treatment	Total number of shoots	Total shoot extension [cm]	Mean shoot length [cm]	SDR*	Leader extension [cm]
BA+GA_{4+7}	15.0 b**	354 b	23 a	14.7 c	68 a
BA+GA_{4+7}+LT***	7.8 a	222 a	29 b	11.7 b	128 d
Disbudding	5.7 a	172 a	30 b	6.1 a	109 c
Control	7.7 a	170 a	22 a	7.2 a	90 b

*shoot density ratio (number of shoots/100 cm leader length)
**values followed by the same letter are not significantly different at p = 0.05; comparison is valid within the same column.
***leader tipping

Table 2. Treatment effects on the growth of tree leader in 'Schneiders' sweet cherry trees

Treatment	Total number of shoots	Total shoot extension [cm]	Mean shoot length [cm]	SDR*	Leader extension [cm]
BA+GA_{4+7}	14.2 b**	352 b	25 a	11.9 b	101a
BA+GA_{4+7}+LT***	8.0 a	245 a	31 b	10.8 b	116a
Disbudding	6.7 a	211 a	32 b	6.6 a	107a
Control	8.0 a	204 a	26 ab	6.8 a	107a

*shoot density ratio (number of shoots/100 cm leader length)
**values followed by the same letter are not significantly different at p = 0.05; comparison is valid within the same column.
*** leader tipping

branches of 'Dawson' cherry trees brought about a significant increase in the number of laterals compared to trees treated with BA + GA_{4+7} only. The contradiction between the results of both trials may result from either different tree organs pruned, their position within canopy, and severity of pruning (Mika, 1986) since in the mentioned work of Jacyna and Dodds (1990) tree leader and side branches were more heavily pruned than the leaders in the experiment reported in this paper. The increase in the number of shoots induced by BA + GA_{4+7} obtained in this trial confirms earlier works by Miller (1983), Elfving (1985) and Jacyna et al. (1989) but contradicts that reported by Elfving and Visser (2007) who obtained good results of BA + GA_{4+7} treatments only when the bark of sweet cherry shoots was purposely injured by either notching, nicking, scoring or scraping.

Disbudding used in this experiment appeared to be of little use in increasing the number of lateral shoots on unpruned tree leader since it produced inconsistent results (Tab. 1 and 2). Similar data were presented by Elfving and Visser (2007). Selective disbudding when applied to barren wood facilitates tree training, and along with leader tipping and application of cloth pegs is used in Vogel's canopy (Zucconi, 2000; Sitarek, 2004).

Shoot density ratio (SDR) shows the number of induced shoots per 100 cm of leader length. It may be a good indicator of shoot induction potential of a given branching method. Despite obvious differences which occurred at the onset of this trial in leader length between untipped and tipped BA + GA_{4+7} treatments (data not shown), in both treatments the leaders showed significantly greater SDR than in the other treatments (Tab. 1 and 2). It is not clear whether BA + GA_{4+7} *per se* or tipping supplemented by phytohormone application were responsible for this high SDR in treatment 2 (Tab. 1 and 2). It is known, however, that tipping may cause an increase in the activity of hormones responsible for shoot growth, thus increasing their number and length (Mika,1986).

One of the important features in bioregulator paint application is movement of shoot induction zone upwards from the application zone. Detailed study by Jacyna and Puchała (2004) demonstrated small movement of induction zone when BA + GA_{4+7} or BA + GA_3 were applied to sweet cherry shoots. In hormone-treated leaders of both cultivars no movement of shoot induction zone was noted, but in 'Schneiders' trees this zone was somewhat reduced relative to application zone (Tab. 3). Excessive dispersion of low number of induced shoots in disbudded and control trees made impossible to distinguish a distinct shoot induction zone therein (Tab. 3). Study on shoot growth characteristics within particular length classes did not show many differences between the treatments except those in shoot density in the induction zone (Tab. 4). However, in 'Regina' cultivar the greatest differences among the treatments took place in the length class 10-20 cm, and particularly in 20-30 cm (Tab. 4).

The measurements performed in the orchard two years after treatments did not show any carry-over effects except those listed in Table 5, which presumably might have been incidental. It has been reported that BA+GA_{4+7} spray application to apple nursery trees might caused some deterioration in flower bud formation (Wertheim and Estabrooks, 1994). This reduction in flowering contrasts

Table 3. Treatment effects on the formation of shoot induction zone in leader of 'Regina' and 'Schneiders' sweet cherry trees

Treatment	Distance of shoot induction zone from [cm]:				Length of shoot induction zone [cm][*]	
	Bottom of leader		Top of leader			
	Regina	Schneiders	Regina	Schneiders	Regina	Schneiders
BA+GA_{4+7}	5 a[**]	7 a	56 b	62 b	42 ab	50 ab
BA+GA_{4+7}+LT[***]	10 b	12 a	27 a	23 a	30 a	39 a
Disbudding	16 c	13 a	23 a	30 a	53 b	60 b
Control	2 a	8 a	31 a	28 a	75 b	82 c

[*]in approximate limits
[**]values followed by the same letter are not significantly different at p = 0.05; comparison is valid within the same column
[***]leader tipping

Table 4. Differences between the means of examined growth characteristics within length classes in shoot length distribution in leaders of 'Regina' and 'Schneiders' sweet cherry trees

Length class [cm]	Mean shoot length		Number of shoots		Total shoot extension		SDR (I)[*]	
	Regina	Schneiders	Regina	Schneiders	Regina	Schneiders	Regina	Schneiders
≤ 10	ns	ns	ns[**]	ns	ns	ns	*	ns
> 10 – ≤ 20	ns	ns	*[**]	ns	*	*	*	*
> 20 – ≤ 30	ns	ns	**	ns	**	ns	***	*
> 30	ns	ns	ns	ns	ns	ns	**	*

[*]shoot density ratio per 1cm of shoot induction zone
[**]differences in each column marked with *, **, *** are significant at p = 0.05, 0.01, 0.001, respectively, otherwise not significant (ns)

Table 5. Differences between the means of growth characteristics in leader of ‘Regina’ and ‘Schneiders’ sweet cherry trees measured two years after application of the treatments in the orchard (residual effects)

Effect on:	Significance between treatment means	
	Regina	Schneiders
Leader extension	*[*]	ns
Total shoot number	ns	ns
Shoot extension growth	ns	*
Mean shoot length	ns	ns
SDR[**]	ns	ns

[*]differences in each column marked with * are significant at p = 0.05, otherwise not significant (ns)
[**]shoot density ratio

with the results obtained with BA + GA_{4+7} paint treatment in sweet cherries, where some increase in flower return was noted (Miller, 1983). Lack of residual effects of applied treatments may indicate that their satisfactory effectiveness in shoot stimulation occurs in the year of application.

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INDUKOWANIE BOCZNYCH ROZGAŁĘZIEŃ NA PRZEWODNIKACH NIECIĘTYCH DRZEWEK CZEREŚNI

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STRESZCZENIE

Brak cięcia formującego na silnych przewodnikach dwuletnich drzewek czereśni z jednoroczną koronką sprzyja deformacji korony. Nierozgałęzione i niecięte przewodniki czereśni odmian 'Regina' i 'Schneidera Późna' formowano za pomocą: 1. Traktowania dolnej 1/3-1/2 części przewodnika emulsją akrylową zawierającą 5 g BA + GA_{4+7} l^{-1}, przyrządzoną przez zmieszanie 278 ml Promalinu z 722 ml akrylowej farby emulsyjnej; 2. Usunięcia 1/3 części przewodnika (około 30-40 cm) i traktowania pozostałej części przewodnika emulsją, tak jak w kombinacji 1; 3. Usunięcia co 3-4 pąka z pozostawieniem pąka szczytowego. Kontrolę stanowiły drzewa nie poddane zabiegom będących przedmiotem badań. Reakcja drzew obu odmian na zastosowane zabiegi formujące była podobna. Najskuteczniejszym zabiegiem zwiększającym liczbę pędów było stosowanie emulsji zawierającej BA + GA_{4+7} (kombinacja 1). Zastosowanie BA + GA_{4+7} (kombinacja 1) oraz BA + GA_{4+7} połączonego z cięciem (kombinacja 2) zwiększało gęstość i równomierność rozmieszczenia pędów na przewodnikach. Pomiary wykonane dwa lata po zastosowaniu wymienionych zabiegów wykazały brak następczego działania na badane cechy, co może wskazywać, że stosowanie BA + GA_{4+7} osobno lub połączonego z cięciem przewodnika ma charakter doraźny, uwidoczniający się w roku stosowania.

Słowa kluczowe: benzyloadenina, gęstość indukcji pędów, gibereliny, Promalin, strefa indukcji pędów