THIDIAZURON (N-PHENIL-N[1]-(1,2,3-THIDIAZOL-5-YL) UREA) AS A PROMOTER OF BUDBREAK ON PEACH (*Prunus persica* L. Batsch) AND JAPANESE PLUM (*Prunus salicina* Lindl.)

G. Calderón-Zavala; J. Rodríguez-Alcázar

Especialidad de Postgrado en Fruticultura-IREGEP-Colegio de Postgraduados, 56230 Montecillo, México. E-mail: cazagu@colpos-colpos.mx.

SUMMARY

The biological efficiency of thidiazuron (TDZ) as early fall budbreak promoter on 'Diamante' peach trees (*Prunus persica* L. Batsch) and 'Corazón Rojo' japanese plum trees (*Prunus* sp.) was evaluated in subtropical climatic conditions. Spraying TDZ at 250 and 500 mg·liter^{-1} promoted about 90 % floral budbreak 35 days after application on peach; the higher concentration (500 mg·liter^{-1}) gave better results ($P\leq$ 0.05) than the comercial treatment (hydrogen cyanamide at 5 ml·liter^{-1} + mineral oil 2 %). In plum the results were similar. TDZ at 250 mg·liter^{1} on previously defoliated peach and plum trees, promoted over 85% flower budbreak in mid-october, which means aproximately 40 days of advance in relation to the control, but defoliated.

KEY WORDS: Citokinin, growth regulator, forced production, out-off season production.

THIDIAZURON (N-PHENYL-N[1]-(1,2,3-THIDIAZOL-5-YL) UREA) COMO PROMOTOR DE LA BROTACIÓN EN DURAZNO (*Prunus persica* L. Batsch) Y CIRUELO (*Prunus salicina* Lindl.)

RESUMEN

Se llevó a cabo un trabajo para evaluar la eficacia biológica del thidiazurón (TDZ) como promotor de la brotación a principios de otoño en durazno 'Diamante' y ciruelo japonés 'Corazón Rojo' en condiciones de clima subtropical. Con la aspersión de 250 y 500 mg·litro^{-1} de TDZ se obtuvo alrededor del 90 % de yemas florales brotadas 35 días después de la aplicación de tratamientos en durazno: la concentración mayor superó significativamente al testigo comercial (cianamida de hidrógeno 5 ml·litro^{-1} + citrolina 2 %). En ciruelo los resultados fueron similares, la aplicación de TDZ 250 mg·litro^{-1} en árboles previamente defoliados en ambas especies promovió una floración de más del 85 % hacia mediados de octubre, lo cual significa un adelanto de ésta de alrededor de 40 días respecto al testigo sin aplicación, pero defoliado.

PALABRAS CLAVE: Citocinina, regulador de crecimiento, producción forzada.

INTRODUCTION

Tipically temperate zone fruit tree, like peaches and plums, have been grown in Mexico in moderate to medium chill accumulation zones. Zacatecas state leads production in peach, and the peach area is located in places with chilling accumulation between 550 to 750 chill units. However, with the new low chilling cultivars obtained by breeding programs, peach and plum comercial production in subtropical areas is possible in a off-season production scheeme promoting blosoms in fall or in early winter. This offers a crop alternative in subtropical areas because the aim is the fruit production for fresh market in winter and early spring. In the subtropics the chilling acumulation is low (less than 300 chill units) and the strategies to overcome inadequate chilling includes mainly: the use of low-chilling cultivars, defoliation and pruning techniques and chemical sprays of bud breaking promoters on trees when the have begun to be in dormancy during late fall on winter.

In the subtropics, temperate fruit culture has depended on chemical sprays to stimulate budbreak and in some cases compensate for incomplete chilling to induce a new cycle of growth and fruiting. Hydrogen cyanamide has been successfully used worlwide as an effective and economical budbreak promoter, nevertheless it has dis-

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adventages like risk of phytotoxicity and human toxicity, besides to be a corrosive and dangerous sustance. Therefore, is necessary an efficient, economical and innocuous alternative budbreak promoter.

Citokinins are growth regulators that have shown a high efficiency as budbreak promoters (Broome and Zimerman, 1976). Thidiazuron (N-phenyl-N'-(1,2,3,-thidiazol 5-yl) urea) is a chemical product with citokininic activity and it has reported like an efficient in summer-dormant apple buds budbreak promoter (Liu *et al*., 1993). Others reports (Wang *et al*., 1986; Faust *et al*., 1991) showed that thidiazuron has the capacity to release lateral buds from dormancy, and was more effective than cytokinins in breaking dormancy in apple buds. In some cultivars, Thidiazuron application, previous to endodormancy, may substitute the chilling needs in apple buds (Steffens and Stutte, 1989). However, the effect of the chemical is related to concentration, cultivar and time application dependent. The purpose of the current study was to evaluate the biological efficiency of TDZ as a paradormancy budbreak promoter in early fall in off-season production of peach and japanese plum in subtropical conditions.

MATERIALS AND METHODS

The research was carried out at Los Reyes, Michoacán, México region, located 19°35' NL and 102°28' WL starting from late summer 1995 to 1996. Is a subtropical place with 19.4°C average annual temperature and 972.4 mm annual rainfall (García, 1981).

Two experiments were carried out in 'Diamante' peach and 'Corazón Rojo' japanese plum grafted on peach. The 5 year-old peach trees were spaced at 5 x 4 m and 3 year-old vigorous tree plums, at 5 x 2 m. Both peach and plum were trained to an open center and their chilling requirement is of 250 and 150 chill units, respectively (Rodríguez and Sherman, 1994).

Table 1 shows the treatments tested. In peach, only treatments numbers four, five, six, eight and nine were applied a week before defoliating trees, whereas all of them were tested on plum trees. Treatments without the defoliating agent, $ZnSO_4$ (1.5 %) and urea (5 %), were applied on previously defoliated trees, 5 days before treatment. In both experiments the treatments were arranged in a completely random design with 5 replicates. Revent® (a.i. Thidiazuron 20 %) and Dormex® (a.i. hydrogen cianamide 49 %) were sources of TDZ and hydrogen cianamide.

Dinamics of flower bud and vegetative budbreak were monitored during October 1995 (less than one month after the begining of the experiments) and the budbreak was expressed in percentage of flower and vegetative budbreak; consequently, date to full bloom (80 % flower budbreak), advancement of blooming (days) in relation to control untreated (AFB), days to full bloom after treatments application (DFBAT) were determined too. Also, fruit set was calculated per mixed branch sampled. On total flower number basis. Finally, phytotoxicity sympthoms observations were recorded. Flower and vegatative budbreak were calculated in four mixed branches sampled per tree on total flower or vegetative buds number basis.

An analysis of variance for each variable was done for each experiment. The multiple comparison of flower and means was made using the Tukey´s test ($P \leq 0.05$). Data expressed in percentage were transformed by function arcosen $\sqrt{\%}$ but discussion is based on actual percentage data.

TABLE 1. Chemical treatments applied on 'Diamante' peach and 'Corazón Rojo' plum on September 15th 1995 at Los Reyes, Michoacán, México.

Number	Treatment
1	TDZ 125 mg·liter^{-1} + STS + Defoliating agent[z]
2	TDS 250 mg·liter^{-1} + STS + Defoliating agent
3	TDZ 500 mg·liter^{-1} + STS + Defoliating agent
4	TDZ 125 mg·liter^{-1} + STS
5	TDZ 250 mg·liter^{-1} + STS
6	TDZ 500 mg·liter^{-1} + STS
7	Hydrogen cyanamide 5 ml·liter^{-1} + STS 2 % + Defoliating agent
8	Hydrogen cyanamide 5 ml·liter $^{-1}$ + STS 2 %
9	Defoliating control
10	Undefoliated control

[z]Defoliating agent is the mixture zinc sulfate at 1.5 % (W/V) and urea 3 % (W/V).
STS = Saf T Side® 2 %, a mineral oil.
TDZ = Thidiazuron

RESULTS AND DISCUSSION

'Diamante' Peach

The TDZ treatments promoted an early budbreak as compared to control; 35 days after treatment application (20th October) the percentage of flower budbreak was over 90 % (Table 2). Thidiazuron at the highest concentration per liter (500 mg·liter^{-1}) had a significant greater percentage of budbreak as compared to comercial control (hydrogen cianamide 5 mg·liter^{-1} + 2 % STS) and untreated trees, while the TDZ lowest concentration (125 mg·liter^{-1}) had a similar effect than hydrogen cianamide treatment and both reached the full bloom at same date (18th October) and consecuently, there were not differences in advancement of full bloom and day at full bloom after application (Table 2).

TABLE 2. Effect of thidiazuron (TDZ) and hydrogen cianamide (HC) in flower budbreak promoter applied September 15th 1995 at Los Reyes, Michoacan. México on 'Diamante' peach trees.

Treatment[z]	Percentage of flower budbreak (October 20)	DFBAT	Date of full bloom	AFB (days)
TDZ 125 mg·liter^{-1}	87.0 b[y]	33 b	Oct 18	36.4 c
TDZ 250 mg·liter^{-1}	89.0 b	31 b	Oct 16	38.4 b
TDZ 500 mg·liter^{-1}	98.0 a	26 c	Oct 11	42.8 a
HC 5 mg·liter^{-1}	86.0 b	33 b	Oct 18	36.4 c
Control defoliated (untreated)	13.4 c	69 a	Nov 23	0 d
L.S.D.	5.5	4		1.6

[z]TDZ and Hydrogen cianamide treatments were added with SAFT SIDE parafinic oil 2 %.
[y]Means with the same letter in column are not significantly different (Tukey, $P \leq 0.05$).
DFBAT = Days at full bloom after treatments application.
AFB = Advancement full bloom in relation to control untreated.

In general, the highest percentage and the best homogeneity of flower budbreak was obtained with TDZ 500 mg·liter^{-1} spray which was significantly better than comercial control (hidrogen cianamide 5 mg·liter^{-1} improving advancement of full bloom in about 7 days (43 vs. 36 days as showed in Table 2). However, TDZ at the highest concentration resulted in phytotoxicity sympthoms, a general chlorosis in early stages of vegetative growth and necrosis of apex of first leaves. However, is also important to indicate that these sympthomps disappeared after few days and that the new leaves after 4th or 5th node recovered their healthy and normal development and fruit set was not affected (Table 3).

Table 3 shows that the vegetative budbreak recorded at October 20th (35 days after treatment application = DATA) was increased significantly with 500 mg·liter^{-1} TDZ and hydrogen cianamide treatment. In fact, it has been observed that hydrogen cianamide promotes an advancement of vegetative budbreak respect to floral budbreak.

TABLE 3. Effect of thidiazuron (TDZ) and hydrogen cyanamide on vegetative budbreak and fruit set on 'Diamante' peach in Los Reyes, Michoacán, Mexico.

Treatment[z]	Vegetative budbreak (%) (October 20th)	Fruit set (%)
1. TDZ 125 mg·liter^{-1}	81.0 c[y]	62.4 a
2. TDZ 250 mg·liter^{-1}	87.6 b	65.8 a
3. TDZ 500 mg·liter^{-1}	98.4 a	66.0 a
4. Hydrogen cianamide 5 mg·liter^{-1}	99.0 a	64.0 a
5. Control defoliated (untreated)	6.4 d	63.4 a
L.S.D.	5.5	9.8

[z] TDZ and hidrgen cianamide treatments were added with SAF T SIDE parafinic oil 2 % applied September 15th 1995.
[y] Means with the same letter in column are not significantly differents (Tukey, $P \leq 0.05$).

Results obtained in this work are in agreement with reports, that indicate the TDZ efficiency as a budbreak promoter during dormancy in fruit crops like apple, even though, TDZ has been used mainly in organogenesis *in vitro* with this exceptions (Steffens y Stuffe, 1989; Want *et al*., 1991a, 1991b, 1991c; Wang and Faust, 1990, 1992; Liu *et al*., 1993). However, in these reports TDZ promoted budbreak at the end of dormancy which means that trees were exposed to chill accumulation in winter and their chill requeriment was covered at least partially. Whereas, in the present work the aim was to promote flowering prior to the begining of dormancy, and bloom was obtained on October (Table 2), showing that TDZ is an efficient chemical to induce an out off season bloom.

Thidiazuron stimulated budbreak in the oldest branches of the tree. This effect of TDZ is particularly important on aging peach trees and helps to rejuvenate the canopy and productivity. Best effects were observed with TDZ 250 and 500 mg·liter^{-1}; however, only treated buds responded to the treatment, meaning that the effect is localized, as reported by Wang *et al*. (1991a).

Our results indicate that spraying TDZ at 250 mg·liter^{-1} is the best dosage for a budbreak promotion in off-season peach production, corresponding at Revent® 1.25 mg·liter^{-1} mixtured with winter oil at 2 %.

So, TDZ is a promoter of budbreak of high efficacy in an scheme off-season peach production and with the adventage of its low toxicity, DL_{50} rat >400 mg TDZ per kg (Hoechst Shering, AgrEvo) and the low concentration required, compared with Dormex, the commercial treatment widely used, which is corrosive and toxic.

Other observations suggest that TDZ can be used to make budbreak more uniform even in cases when budbreak has started with no phytotoxic effect on flowers or vegetation present. It is also important to indicate that best results are obtained only if treated plants are defoliated or the defoliant mixed with the TDZ at the moment of application.

'Corazón Rojo' plum

The effect of TDZ on plum was only evaluated on basis to budbreak percentage. Table 4 shows that 22 days after treatments application flower and vegetative budbreak was over 72%. TDZ 250 mg·liter^{-1} treatment was the best treatment in trees previously defoliated or with the defoliant at the time of application. Budbreak was increased significantly with TDZ 250 mg·liter^{-1} reaching 87 % of open buds in trees previously defoliated. TDZ at the lowest concentration effect was similar to hydrogen cianamide treatment; however, a direct relationship was established becoming better the results (high budbreak percentage) with the increase in TDZ concentration.

Table 4 shows the high efficacy of TDZ at 500 mg·liter^{-1} treatment, which promoted a total budbreak reaching 100% of flower and vegetative buds (35 days after application, October 20th) whereas hydrogen cianamide application only promoted about 87 % budbreak. However, that concentration caused phytotoxicity symptoms indicated as stopped vegetative growth with a rosetting appearence, smaller leaves and light chlorosis, with the stipules showing and abnormal development (large-sized). Also even after two months from treatment application was still observed the failure in developing new growth.

TABLE 4. Effect of thidiazuron (TDZ) and hydrogen cianamide on off-season budbreak in paradormancy of 'Corazón Rojo' plum at Los Reyes, Michoacán, México. Treatments were applied September 15th 1995.

Treatment[z]	Oct. 7 (22 days after application)	Oct. 20 (35 days after application)
1. TDZ 125 mg·liter^{-1} + D[y]	72.0 c[x]	80.0 d
2. TDZ 250 mg·liter^{-1} + D	79.0 bc	88.6 bc
3. TDZ 500 mg·liter^{-1} + D	94.6 a	100.0 a
4. TDZ 125 mg·liter^{-1} PD[w]	75.0 bc	82.0 cd
5. TDZ 250 mg·liter^{-1} PD	87.0 ab	92.0 ab
6. TDZ 500 mg·liter^{-1} PD	98.0 a	100.0 a
7. Hydrogen cianamide 5 mg·liter^{-1} + D	75.0 bc	85.0 bcd
8. Hydrogen cianamide	79.0 bc	87.0 bcd
9. Control defoliated	6.0 d	17.0 e
10. Control without defoliation	3.6 d	7.2 f
L.S.D.	12.9	8.4

[z]All treatments with TDZ and Dormex were mixed with Saf T Side oil 2%.
[y] Defoliant agent: $ZnSO_4$ at 1.5 % + Urea 3 %.
[x] Means with the same letter in column are not significantly differents (Tukey, $P \leq 0.05$).
[w]PD = previously defoliated.

Thidiazuron sprays did not affect the tender twigs while hydrogen cianamide treatment burn them. In addition, TDZ promote an excellent effect on lateral budbreak increasing the small lateral twigs which is expected to have an influence on later crops.

Therefore, the best treatment was TDZ 250 mg·liter^{-1} improving budbreak without risk of phytotoxicity damage or stopping new growth and its effect was better on trees previously defoliated. Floral and vegetative budbreak occurred simultaneously and this may also be atributed to the exceptional low chill requerimient of 'Corazón Rojo' plum (Rodríguez and Sherman, 1994).

CONCLUSIONS

Thidiazuron is an efficient paradormancy budbreak chemical promoter in peach and japanese plum under subtropical conditions. The best concentration is 250 mg·liter^{-1} plus mineral oil 2 %.

The effects of Thidiazuron sprays were better than the commercial treatment (hydrogen cianamide 5 mg·liter^{-1} + mineral oil 2 %).

The best effects of Thidiazuron sprays are obtained on previously defoliated trees.

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