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Effect of Thidiazuron and Oil Treatments on Dormant Break of Kanino Apricot in Warm Climates

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Abstract: Dormancy breaking agents are usually used to compensate insufficient chill accumulation that may cause severe production problems in fruit orchards. In this study we evaluated the biological efficiency of the Cytokinin like Thidiazuron (TDZ) + winter oil as fall bud break promoter on Kanino apricot trees (*Prunus armeniaca,* L) grown in a region with insufficient chill hours. The treatment was tested at different stages. Blooming date & percentage, flower bud abscission % and fruit set % were evaluated during two consecutive years. Dormant buds on branches of 2 years old were sprayed at 15 Nov., 15 Dec. and 15 Jan. with TDZ at 150, 200 and 250 mg/liter^{-1} + winter oil at either 3 or 4 %.
Results showed that spraying the higher dosage of both TDZ at 250 ppm + winter oil at 4% at 15 January (late date) responds better results ($P \leq 0.05$) followed in descending order by TDZ at 200 ppm + 4% oil than other treatments at other application dates and the control. It can be recommended that higher dosage responds better in this respect of early bud break % and blooming date with heavy flowering & fruiting and negative relationship between fruit set and flower bud abscission in Kanino apricot cv. cultivated in subtropical area.

Key words: Apricot, buds break, Thidiazuron, blooming, fruit set, dormancy.

Introduction

The main obstacle for temperate fruit production in sub-tropical areas is the lack of effective accumulated chilling. Where, warm winters result in prolonged dormancy leading to poor blooming, strong apical dominance, unsynchronized growth patterns and consequently low yields[1]. During winter, if buds received insufficient chilling requirement (CR) that needed to complete release dormancy, trees will leading to uneven floral bud burst, delayed foliation and poor fruit set[2].

Apricot as temperate fruits is grown in climates with well-differentiated seasons. The date of breaking dormancy was established after 10 days in growth chamber when 30 % of flower buds were in Baggiolinis stage B-C and there was a 30% weight increase in flower bud compared with relatively constant previous weight[3]. Though, in apricot varieties as with other deciduous species erratic and climatologically events prior to or during flowering are considered main determinates of fruiting success[4, 5].

One of the possible alternatives to avoid such problems is using low chilling requirement (CR) varieties to obtain satisfactory budding and blooming that usually reflected in the synchronization between developmental stage and climate[6]. Meanwhile, deep knowledge of chilling requirements and dormancy breaking date of cultivar are needed for optimum application date of breaking chemical agents where two-thirds of the chilling requirements have been satisfied[7]. Interest in artificial control of bud break is closely connected with commercial attempts to grow these species in warm locations. Response of deciduous trees to chemicals that

break dormancy may vary according to chilling accumulation, application time, concentration and environmental factors[8, 9]. The following chemicals are commercially used in various places: mineral oils (mostly of the superior), dinitro compounds *i.e.,* dinitro-cresol (DNOC) or dinitro-s-butyl phenol (DNSBP); KNO_3, Thiourea, Cyan amide and a mixture of N-(phenyl/methyl-1H-purin-6-amine (BA) + $GA_{4,\ 7}$[10]. DNOC winter commercial oil was used with success as rest breaking agents (RBAs) for apples and pears to ensure a great uniformity in bud break and to alleviate problems associated with delayed foliation. In addition, Dormex at 0.5 - 1% in combination with winter oil at 3 to 4% is commercially recommended on apples[11, 12, 13].

Now a day, the chemical Cytokinin-like (Thidiazuron, TDZ) was chosen taking into account treatment date at the point of which 2/3 to 3/4 of the chilling requirement had accumulated that is when 480-540 Cu had been accumulated in the field[10]. Promising results have been obtained on pears, cherries and plum with TDZ at 3% in mineral oil base (lift) ^{R} and registered for use on apples sprayed 5 to 6 weeks before expected full bloom at 304 chill units depending on chilling received and chilling requirement of cultivar[14, 15]. Also, [2]concluded that the TDZ was the most powerful dormancy breaking agent for "Bing" sweet cherry they have tested.

These observations, coupled with our understanding of rest breaking in apricot trees, prompted the current work firstly to study the effect of spraying different concentrations of the chemical Cytokinin-like Thidiazuron (TDZ) + winter oil and secondly the optimum time of application that required for development of dormant buds, blooming and fruit set in Kanino apricot cv. under warm climate conditions.

Material and Methods

The present study was conducted in a private farm at El-Khatatba, Monofia Governorate, Egypt through two seasons, 2011-2012 and 2012-2013 on ten year's old Kanino apricot trees (*Prunus armeniaca*, L) grown in a clay loamy soil under flood irrigation system. Results of soil analysis[16] are shown in Table (1).

Table 1 Soil Analysis

Properties	Values
Clay %	28
Silt %	29.0
Sand %	43.0
Texture	Clay loamy soil
E.C. m mhos/cm^3 P	0.52
pH (1 : 2.5 extract)	8.4
Organic matter %	1.46
Total N %	0.29
Available P %	4.6
Available K %	4.00

The CR of Kanino apricot in this area had been previously calculated following the protocol[17]. Four uniform trees were used as experimental replicates per each treatment. From each tree forty uniform shoots were chosen randomly and thirty six shoots were tagged to count total number of dormant buds in 3 different periods (15 Nov., 15 Dec. and15 Jan.). Selected shoots were sprayed in the same time by the dormant breaking agent Thidiazuron (TDZ) at three different concentrations 150, 200 and 250 ppm + winter oil at two concentrations (3 and 4 %). Where, the other 4 shoots were used as control (unsprayed). Count of reproductive number broken buds was recorded at weekly intervals from initial terminal bud break date to 1-2 weeks after estimated full bloom date (depending on rate of bud break) and recorded as total bud % for each shoot. Full bloom date was estimated fairly easily and reliably, based on long term orchards and adjusting according to accumulative unites and temperatures prior to spray date of the rest breaking agent (RBA) up to 4 - 7 weeks before expected full bloom[15].

The Following Measurements were Estimated[17]:

Blooming date:

Was established as F50, when 50 % of flowers were open.

Blooming percentage:

The number of flowers developed was recorded and expressed as total no. % of flower buds on those branches by dividing total no. of flower buds in those branches on the total number of buds x 100**.**

Flower bud abscission percentage:

Was determined by comparing the initial number of flower buds/branch and the final number of open flowers x 100.

Fruit set percentage:

Was calculated as: The number of fruits per total number of flower buds x 100.

Statistical Analysis

The experiments were arranged in a completely randomized block design with four replicates[18]. Data were subjected to analysis of variance using Computer Statistical Package (CO-STATE) User Manual Version 3.03, Barkley Co., USA, and means compared by the (L.S.D) test at P = 0.05 level of significance**.**

Results and Discussion

Effect of TDZ plus winter oil on bud break (%)

Table 2 Effect of the Dormant Breaking Agent Thidiazuron (TDZ) + Winter Oil on Bud Break%, Blooming Dates and Percentages of Kanino Apricot Trees during Two Seasons

Spraying date / Treatments		Bud break %			Blooming date (F_{50})			Blooming %		
		15 Nov.	15 Dec.	15 Jan.	15 Nov.	15 Dec.	15 Jan.	15 Nov.	15 Dec.	15 Jan.
2011/2012										
Control		39.6 ab	42.1 d	49.4 f	1/3	1/3	1/3	49.6 d	52.7 e	59.1 f
Winter Oil 3%	TDZ 150 ppm	39.6 ab	46.4 c	58.3 e	29/2	29/2	1/3	48.8 e	51.9 ef	65.6 e
	TDZ 200 ppm	39.7 ab	48.2 bc	66.8 d	28/2	25/2	23/2	49.8 d	57.3 c	76.3 c
	TDZ 250 ppm	39.6 ab	51.1ab	76.4 b	28/2	24/2	19/2	50.1 c	61.5 b	81.9 b
Winter Oil 4%	TDZ 150 ppm	39.8 a	50.6 b	72.0 c	29/2	28/2	27/2	50.2 c	55.0 d	70.2 d
	TDZ 200 ppm	39.7 ab	52.3 a	79.7 a	27/2	22/2	16/2	51.6 b	62.9 ab	86.4 a
	TDZ 250 ppm	39.9 a	54.8 a	82.1 a	27/2	21/2	16/2	53.2 a	63.4 a	89.3 a
										2012/2013
Control		35.1 cd	38.2f	47.3f	28/2	28/2	28/2	50.2 e	55.1e	61.2 g
Winter Oil 3%	TDZ 150 ppm	35.0 d	39.5e	55.6 e	28/2	27/2	27/2	50.6 e	57.2d	66.6 f
	TDZ 200 ppm	35.3 ab	43.8c	67.9 c	26/2	22/2	20/2	51.7 d	60.5c	76.3 d
	TDZ 250 ppm	35.2 bc	45.8b	72.8 b	25/2	20/2	17/2	52.4 c	63.7b	80.9 c
Winter Oil 4%	TDZ 150 ppm	35.1 cd	41.7d	62.5 d	27/2	25/2	23/2	51.8 d	58.3d	70.4 e
	TDZ 200 ppm	35.2 bc	47.4a	76.1a	24/2	18/2	15/2	53.9 b	65.8a	84.2 b
	TDZ 250 ppm	35.4 a	49.8 a	78.4 a	23/2	18/2	14/2	54.8 a	67.1a	87.5 a

Means in column followed by the same letter are not significantly different according to L.S.D. Test (P = 0.05).

It is obvious from (Table 2) that, different treatments reflected higher bud break ratios than the control except those of early application treatments (15 Nov.). Generally, the high concentrations of both TDZ at 250 ppm + winter oil at 4% in at late date (15 January) were more effective on bud break (82.1&78.4%) than different treatments at other application dates, also than the control (49.4 & 47.3%) in both studied seasons respectively. [10]mentioned to both dose and time for activate chemical effect; he concluded that the higher dosage with later treatments gave stronger effect. He added that no single rest breaking chemical can compensate for the total absence of chilling for fully resting bud. Early applications in Nov. by different TDZ concentrations + winter oil, showed a negative results on bud break with non significant differences between it and the control. These results are going in line with those obtained[17] who mentioned that the low accumulated chilling requirements of this period may cause this effect. Also, [13]on peach reported that breaking dormancy depends on the accumulation of winter chilling requirements. A positive effect on dormancy overcoming when applied growth regulators, Gibberellins and cytokines[19]. High temperatures during the chilling period reflected a negative effect on breaking dormancy and the more chilling that was accumulated in, the higher was the precocity achieved by the application of TDZ and winter oil[20].

As the breaking agents TDZ + winter oil were sprayed in 15 Dec., slight increase in bud break was obtained comparing by the negative effect of different treatments during 15 Nov. date, as well as the increment achieved in 15 Jan., that is true in both seasons. These results may be due to the different distribution of chill accumulation which are go in line with[3] who mentioned that, the chilling accumulation during first fortnight of November in general rather low, and the most efficient months in relation to chilling accumulation were in Dec. and Jan.

Generally speaking, it can be concluded that timing of treatments has a bearing on response to physiological development of dormant bud and in other words late application means that the treated buds will be in more advanced stage of development. The ability of TDZ to stimulate breaking of dormancy begins at the end of Endo dormancy[21]. On the other hand, deserves of the Cytokinin TDZ which in combination with mineral oil has showed an important action over dormancy release in different crops[15]. The earlier rest breaking agent application resulted in earlier and more rapid bud break response.

Regarding the combined action of both concentrations TDZ and winter oil at 3 or 4% on bud break values, it can be noticed that winter oil at 4% was more effective as combined with TDZ at 150, 200 and 250 ppm than those combined with winter oil at 3% at the same spraying date. Data also show that the higher the TDZ concentrations with later date treatments increased bud break % as applied with winter oil at 4% than 3%. These hold true in both seasons. These results may be due to enhancing respiration by TDZ + oil which driving it toward the accumulation of anaerobic end products such as ethanol and acetaldehyde[22] where low oxygen level causes bud break[7]. Besides, reduction of oxygen permeability through the oil enclosed structure, provided respiration is high enough in the dormant tissues[10]. Recently, concluded that TDZ was the most powerful dormancy breaking agent they have tested[23].

Effect of TDZ with winter oil on blooming date

Regarding to the blooming date, Table 2 show in general those different treated branches recorded significantly earlier dates than those of unsprayed branches (control). As for application date, it can be observed that late application date (15 Jan.) was more effective than the earlier date (15 Nov.). Concerning treatment concentrations, data show that the higher dose the earlier blooming date effect. Branches sprayed during Jan. with 4% winter oil combined with TDZ at either 200 or 250 ppm was earlier than control by (13 -14) days. Moreover, its late application date "15 Jan." recorded earlier blooming date than those early sprayed date "Nov." by (9-11) days. This hold true for the first and second season, respectively.

Effect of TDZ with winter oil on blooming percentage

Obtained results in Table 2 show a high positive correlation between TDZ + winter oil concentrations and blooming percentages. Different treatments at different application dates reflected higher blooming% values than control except those applied at early date (15 Nov.) during both seasons. It may be response to the low chill accumulation in this period. On the other hand, the highest blooming values (86.4 & 89.3%) and (84.2 & 87.5%) were significantly obtained for the 1st and 2nd season, respectively as branches sprayed during the end of high accumulation chill (15 Jan.) with high concentrations of (TDZ at 200 or 250 ppm + 4% winter oil). Where, [20]mentioned that TDZ+ oil treatment revealed higher blooming % over the three tested years than

control. It can be suggested that TDZ and winter oil were trigger for blooming at high chilling units. In this respect, [21]confirmed that the capacity of TDZ to increase blooming percentage of apple and blackberry *Cvs.* consecutively.

Effect of TDZ with winter oil on flower bud abscission%

It can be observed in Table (3) that flower bud abscission was significantly higher with different treatments at early application date which was lower in chill accumulation than branches sprayed in late period (15 Jan.). It can be say that application times have a bearing on response in relation to physiological development. The high reduction achieved in flower abortion was clearly observed by using 4% winter oil + TDZ at either 200 or 250 ppm during Jan. date which recorded (57.2 & 54.4 %) and (59.3 & 56.2 %) for the 1st and 2nd season, respectively.

These finding were in line with those[20] who reported that pistil abortion percentage was strongly increased by using TDZ and winter oil, when there was low chilling accumulation and there is no single rest breaking. The chemicals can compensate the absence of chilling requirements for fully resting[23]. He also found that mail formation of pistil at part of flower in apricots trees treated with TDZ in mild winter areas of Israel.

Effect of TDZ with winter oil on fruit set %

Table 3 Effect of the Dormant Breaking Agent Thidiazuron (TDZ) + Winter Oil on Flower bud Abscission % and Fruit Set % of Kanino Apricot Trees during Two Seasons

Final fruit set %			Flower bud Abscission %			Spraying date	
15 Jan.	15 Dec.	15 Nov.	15 Jan.	15 Dec.	15 Nov.	Treatments	
2011 /2012							
13.9 f	10.8 ef	9.6 f	88.7 a	87.6 a	85.4 a	Control	
15.0 e	11.2 e	10.5 ef	78.5 b	84.1 b	85.1 a	TDZ 150 ppm	Winter
16.5d	14.7 d	12.9 d	65.1 d	74.4 d	83.4 c	TDZ 200 ppm	Oil
19.2 c	17.6 c	15.7 c	61.7 d	70.6 e	82.7 d	TDZ 250 ppm	3%
14.6 F	11.9 e	11.8 de	71.8 c	79.3 c	84.2 b	TDZ 150 ppm	Winter
22.7 b	19.8 b	17.4 b	57.2 e	67.1 f	82.1 e	TDZ 200 ppm	Oil
24.6 a	21.5 a	19.0 a	54.4 f	65.4 f	81.6 f	TDZ 250 ppm	4%
2012/2013							
12.7 f	10.3 e	8.9 e	89.7 a	87.9 a	84.5 a	Control	
11.8 f	11.5 e	10.6 d	81.9 b	83.4 b	84.0 ab	TDZ 150 ppm	Winter
17.5 d	14.9 c	14.2 c	68.4 d	75.2 d	82.9 c	TDZ 200 ppm	Oil
20.4 c	16.2c	16.0 b	63.8 e	71.3 e	82.2 d	TDZ 250 ppm	3%
14.2 e	12.4 d	11.5 d	74.1 c	79.6 c	83.7 b	TDZ 150 ppm	Winter
22.1 b	18.5 b	17.6 a	59.3 f	68.8 f	81.7 e	TDZ 200 ppm	Oil
23.8 a	20.1 a	18.7 a	56.2 f	67.3 f	80.9 f	TDZ 250 ppm	4%

Means in column followed by the same letter are not significantly different according to L.S.D. Test (P = 0.05).

Table (3) show that both dose and application time dependent affected fruit set values that based on bud break, blooming and flower bud abscission as sprayed with TDZ + winter oil. The higher dosage and later treatment reflect stronger effect. Fruit set % was significantly higher in branches sprayed in the late date (15 Jan.) with 4% oil+ TDZ at 250 ppm (24.6 & 23.8%) followed in descending order by 4% oil+ TDZ at 200 ppm (22.7 & 22.1%) and 3% oil+ TDZ at 250 ppm (19.2 & 20.4%) for the 1st and 2nd season, respectively compared with control (13.9 & 12.7%). The higher bud break and blooming % in (Table 2) achieved in branches treated with 3% oil+ TDZ at 250 ppm at (15 Dec.) date did not translate into a high fruit set value in the first season

(Table 3). It may be due to the high flower bud abscission. In both seasons, no significant differences were found on fruit set % among different treatments and the control in the early date of application.

From the present study it can be concluded that spraying the higher dosage of both TDZ at 250 ppm + winter oil at 4% at late date (15 January) responds a clear positive effect on percentages of fruit set, bud break and blooming with negative relationship between fruit set and flower bud abscission responds better in respect of early bud break % and blooming date (F_{50}) with heavy flowering and fruiting in Kanino apricot cultivated in subtropical area. It might be due to formation of optimum superoxide free radicals in cell which causes quick maturity of spurs leading to breaking of dormancy and early flowering and fruiting under subtropical climate[9]. Results achieved from this research are conformed to those established by[20] who mentioned that, the high blooming percentage achieved in TDZ + oil treatment did not translate into a high fruit set value because of the high pistil abortion rate. He observed that TDZ + oil treatments brought forward the blooming by 7-14 days. Also, in agree with those[3] who mentioned to the use of chemical breaking agents which bring forward the date of dormancy breaking.

Conclusion

From the previously results obtained that the using the dormant breaking agent like Thidiazuron and oil winter treatments depends on the concentration and added date. Branches sprayed in 15 Jan. (late date) with higher dosage of those materials gave stronger effect. It can be concluded that spraying the higher dosage of both TDZ at 250 ppm plus winter oil at 4% at 15 January recorded the better results to be a good recommendation for early bud break % and blooming date with heavy flowering & fruiting and negative relationship between fruit set and flower bud abscission in Kanino apricot cv. cultivated in subtropical area.

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