STUDIES ON FLOWERING, FRUITING AND RESIDUAL EFFECT OF SOME BREAKING DORMANCY AGENTS ON TWO PLUM CULTIVARS

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Abstract

This study was conducted during 2014 and 2015 seasons to compare the effect of spraying dormancy-breaking agents Dinitro-O-Cresol (DNOC) in the form of Universal oil at two concentrations (5% and at 6%);Duromix (which contains 50 % Hydrogen cyanamide) at 1% + Mineral oil at 1.5 %; Thiourea at 1.5% + Mineral oil at 1.5 %; Light mineral oil at 2% [CAPL2] and a control treatment, at mid-January, in two seasons, on flowering; fruiting and detecting the residual effect of breaking agents on Hollywood and Beauty plum cultivars. Measurements included chilling requirements; dates of different stages of flower bud opening; flower bud opening percentages; fruit set percentages; heat requirements; dates of fruit maturity; yield; fruits physical and chemical properties and the residual of breaking agents in fruits. Results indicated that calculating chilling hours using temperature at 10.0 ^{0}C or below was more suitable than temperature at or below 7.2 ^{0}C or 15.0 ^{0}C. Application of all dormancy breaking agents had advanced fruit set stage which ranged from 17 to 21 days for the two cultivars. Universal oil at 6% and Duromix at 1% + Mineral oil at 1.5 % treatments gave the highest fruit set percentages of the two cultivars. Meanwhile, Uinversal at 5% and Duromix at 1% + Mineral oil at 1.5 % treatments gave the highest percentages of fruit set of Beauty cultivar. Uinversal at 6% had the lowest accumulated growing degree days from time of flower bud break till fruit maturity in Hollywood cultivar. Uinversal at 6% had the highest yield weight per tree in Hollywood and Beauty cultivars. Uinversal at 5%; Uinversal at 6% and Duromix at 1% + Mineral oil at 1.5 % had the earliest fruit maturation of the two cultivars. Uinversal at 6% and Duromix at 1% + Mineral oil at 1.5 % treatments significantly increased fruit size; weight and diameter of the two cultivars. There were no agent residues found in fruits in the two cultivars 110 days from after application. It can be recommended that Dinitro-O-Cresol at 6 % and Duromix at 1% + Mineral oil at 1.5 % were the best dormancy-breaking agents application on Hollywood and Beauty cultivars .Moreover, it is safely compounds to use.

Dormancy-breaking agents, Dinitro-O-Cresol{Universal oil}, Duromix {Hydrogen cyanamide}, Thiourea , Light mineral oil [CAPL2] , residual effect.

INTRODUCTION

Plum tree remains in dormancy during December and January and Bud break takes place from the first week of February after completing the chilling requirements. Prevailing weather conditions during the whole crop growing season have direct bearing upon the phonological events of the crop which ultimately affected the crop yield. The duration of each growth phase is a result of crop response to external environmental factors [Dwyer and Stewart (1986)]. Using of rest-breaking chemicals led us to look for alternatives to long–used chemicals such as Dinitro-O-Cresol(DNOC) that in combination with oil is still used in Israel to break bud rest of deciduous fruit trees [Erez *et al.*, (1993)]. Treatment of El-dorado plum trees with dormex, thiourea, Krestalon (A compound fertilizer) , thiourea +Krestalon terminated winter dormancy, accelerated flowering and vegetative bud break and increased the percentage of bud break , fruit set and yield with the Dormex treatment being the most effective Shahin *et al.*, (1997). Meanwhile, krisanapook and Subhadrabandhu (1993) mentioned that high concentration of hydrogen cyanamide was toxic as noticed by dried dead shoots. North (1993) indicated that cyanamide, a powerful rest – breaking agent on a range of fruit kinds, may replace DNOC/oil in the short-term, but acute toxicity symptoms limit its medium–term acceptance. Attempts to reduce its concentration without compromising efficacy by the dual application of other agents has been investigated. Although mineral oils have long been known as rest-breaking agents, new and registered oil products applied alone and in conjunction with other potential substances have shown promise.

Therefore, this investigation was carried out to compare the effect of spraying dormancy- breaking agents universal oil (at two concentrations 5% and 6%); Duromix at 1 % + mineral oil at 1.5 %; Thiourea at 1.5% +Mineral oil at 1.5 % and Light mineral oil at 2% in addition to the control on chilling requirements ;opening date ;opening percentages of vegetative and flower bud ; fruit set percentages; heat requirements ; dates of fruit maturity ; yield and fruit physical and chemical properties of two plum cultivars Hollywood and beauty. Also, detecting the residual effect of dormancy-breaking agents in fruits.

MATERIALS AND METHODS

The present investigation was carried out during two successive seasons of 2014 and 2015 to study the effect of some breaking agents on flowering, fruiting and residual effect on "Hollywood" and "Beauty" plum cultivars (*Prunussalicina*.) in a private orchard at Khatatba region, Menofia Governorate. The trees were eight years old plum

cultivars budded on Mariana plum rootstock. Trees were planted at 5m apart, and grown in a clay soil under flood irrigation system.

Eighteen trees in each cultivar as far as possible uniform in size and vigor were chosen and treated with breaking agents at mid-January in two seasons.

Dormancy breaking agents used in this study were:-

1- Dinitro-O-Cresol (DNOC) in the form of Universal oilts 5%.
2- Dinitro-O-Cresol (DNOC) at 6%.
3- Thiourea at 1.5% + mineral oil at1.5 %.
4- Hydrogen Cyanamid (Duromix) at 1% + mineral oil at 1.5%.
5- Light mineral oil (in the form CAPL2) at 2%.
6- Control (Untreated trees).

A complete randomized block design with 3 replicates was used. The following determinations were measured:-

A - Chilling and heat requirements:-

Data degrees of temperature were obtained from the central laboratory for Agricultural climate [CLAC] all year around by means of a hygrothermogragh, (model H 311 weather Measure Corporation) in a weather shelter, placed 1.5 m above ground.

A. I. Determination of chilling requirement:-

In each season, temperatures were recorded every 1 hour all year around. Calculation of chilling hours started in late fall when temperature dropped to 15°C (Dec., 2014 and Dec., 2015). The termination of vegetative bud was determined when about 50% of total number of buds took the pyramidal shape. On the other hand, the chilling termination of flower bud was determined when about 50% of the total number of buds took the dome shape.

Chilling requirements of vegetative and flower buds were calculated as follows:

Total hours at or below 7.2°c, 10.0°c and 15.0°c were recorded according to Weinberger (1950), Gilreath and Buchaman (1981), Sherman and Lyrene (1989), respectively.

A. 2. Heat units:-

Heat units were calculated at the moment of chilling termination until maturity of fruit. Different stages of flower bud development (bud swell, complete flowering, petal fall and fruit set) until fruit maturity, in relation to accumulated heat units at each defined stage, were determined for each treatment and cultivar.

Heat units in terms of growing degree days (GDD) from the predicted time of dormancy completion until fruit maturity were calculated according to the following equation as described by Singhand Niwas (2015):

GDD=(Min. + Max.) / 2 - 10, where (10.0°c = base temperature)

B - Vegetative growth:-

B.1. Date and percentage of vegetative bud opening:

Date of vegetative bud opening was determined when a bud showed the first sign of opening (bud burst).Opening percentage of vegetative buds (as a percentage of total number of vegetative buds) was determined 30 days after bud burst stage.

B.2. Shoot length:

Shoot length was measured at the end of the growing season (December).

C- Flowering and fruiting:

C.1. Percentage of flower bud opening:

Percentage of flower bud opening was recorded and determined at the completion of flowering (Full bloom) on 25 shoots / tree of each treatment and cultivar and calculated as follows:-

$$\text{Percentage of flower bud opening} = \frac{\text{Number of opened flower buds}}{\text{Total number of flower buds}} \times 100$$

It should be pointed out that total number of flower buds was counted when buds took the dome shape.

C.2. Dates of the different four stages of flower bud opening:

Dates of the different four stages of flower bud development were recorded and correlated with heat units required to reach each stage. These stages are:

1-Bud sweel 2-full flowering

3-Petal fall4- Fruit set

C.3. Fruit set percentage:

Fruit set was determined by counting number of set fruits (after 30 days of full bloom). Percentage of fruit set was calculated as follows:-

$$\text{Fruit set \%} = \frac{\text{Number of set fruit}}{\text{Total number of flowers at full bloom}} \times 100$$

C.4.Yield:-

The total number of fruits per tree was counted Yield weight was estimated by multiplying number of fruit X average weight of fruitat harvest time of each treatment and cultivar,.

C.5. Fruit properties:

At harvest time of each treatment and cultivar, sample of 25 fruits per tree was taken for studying the following physical and chemical properties:

C.5.A. Physical properties:

Weight, size, length and diameter of fruit were measured. Fruit firmness was measured with Effegl, penetrometer 11.1 mm diameter prob, Effigl, Alfonsing, Italy and expressed as $Lb/inch^2$.

C.5.B. Chemical properties:-

Total soluble solids in juice (T.S.S.) were measured with a hand referactometer.

Juice acidity was determined according to A.O.A.C., (1970) and calculated as gram anhydrous citric acid/100 ml. Juice.

D. Determination of Universal; Thiourea; Hydrogen Cyanamide and Mineral Oil Residues :-

Extraction method:

- Universal ; Thiourea ; Hydrogen cyanamide:-

It is extracted from plant material (fruit) with methanol. The methanol is evaporated from extract, the remaining water phase is extracted with n-hexane, after concentrating the solvent and the residue is determined by chromatography using sulfur – specific flame photometric detector (Lopez-Femandez *et al.,* 2014).

- **Mineral oils :**

A procedure for the determination of mineral oils in edible oil has been fully developed. The procedure consists of using a sulphuric acid-impregnated silica gel (SAISG) glass column to eliminate the fat matter. A chemical combustion of the fatty acids takes place, while the mineral oils are not affecting by the sulphuric acid. The column is eluted with hexane using a vacuum pump and the final extract is concentrated and analyzed by gas chromatography (GC) with flame ionization detector (FID). (Wrona *et. al.* 2013).

Recovery experiment:

We do this experiment {table (1)} for evaluation the method that we use. Take control samples and spike it by known amount of tested compound and analysis it by the mentioned method. Then calculated the concentration that was found relative to that added.

Table 1. Recovery percentages of Universal; Thiourea ; Hydrogen Cyanamide and Mineral oil Residues.

Treatments	Recovery percentage
Universal 5%	70.0%
Universal 6%	70.0%
Thiourea 1.5% + mineral oil 1.5%	75.5%
Duromix 1.0%+ mineral oil 1.5%	72.0%
CAPL2	92.0%

Statistical analyses:-

Experimental data were subjected to one way analysis of variance (ANOVA) and differences between means were separated using the (L.S.D.) at 5% level of probability using M-state software (Snedecor and Cochran, 1982).

RESULTS AND DISCUSSION

3-1Chilling requirement of vegetative and flower buds:-

Available and estimated chill hours (C.H.) from dormancy until vegetative bud break took the pyramidal shape (table 2) and from dormancy till flower bud break took the dome shape (table 3) were accumulated 30.0 and 22.0 C.H. in 2014 and 2015 seasons respectively at or below 7.2 ^{0}c under different treatments of two cultivars.

At or below 10.0^{0}c, during the first season Hollywood plum trees treated with Universal at 5% and thiourea 1.5%+ mineral oil 1.5% had the lowest chilling hours to reach vegetative and flower buds break (284.0 C.H.) followed by those treated with Universal at 6% and (Duromix 1.0% + mineral oil 1.5%) which had 293.0 C.H. to break vegetative and flower buds dormancy, while, trees treated with CAPL2 and control had 29.0C.H. to break vegetative and flower buds dormancy. On the other hand, Beauty plum trees treated with Universal 5%; (Duromix 1.0% + mineral oil 1.5%) and CAPL2 had the lowest chilling hours had 284.0 C.H. to reach vegetative and flower bud break.

At or below 15.0 ^{0}C, during the first season Hollywood plum trees treated with Universal at 5 % and thiourea 1.5% +mineral oil 1.5% needed 1151.0 C.H. to break vegetative and flower buds, followed by (Universal at 6 %) and (Duromix 1.0% + mineral oil 1.5%) which needed 1155.0 C.H. to break vegetative and flower bud dormancy, while, untreated trees needed 1194.0 C.H. to break vegetative bud dormancy and 1185.0 C.H. to break flower dormancy. Meanwhile, Beauty plum trees treated with Universal at 5%;Duromix 1.0% + mineral oil 1.5% and CAPL2 had the lowest chilling hours 1151.0 C.H. to break vegetative and flower buds .On contrast, untreated trees needed 1194.0C.H.to break vegetative buds and 1184.0 C.H to break flower buds.

On the other hand, during the second season thiourea 1.5 % + mineral oil 1.5 %; Duromix 1.0 % + mineral oil 1.5% and CAPL2 treatments on Hollywood trees were the most effective ones to break vegetative and flower buds which needed 1161.0 C.H. Meanwhile, Beauty trees with Duromix 1.0% + mineral oil 1.5% and caple$_2$ had 1161.0 C.H. to break vegetative bud dormancy. On the other hand,

Universal at 5% and Duromix 1.0% + mineral oil 1.5% and CAPL2 treatments needed 1161.0 C.H. to break flower bud dormancy. On the contrary, untreated trees needed 1214 C.H. for Hollywood and 122.0 C.H. with Beauty cultivar to break vegetative bud break. While, Flower buds of the two cultivars need 1189.0 C.H.to break dormancy.

In this concern, Stadler *et al.,* (1991) applied a rest- breaking agent hydrogen cyanamide to established trees of plum cultivars Gaviota, Santa rosa and Songold growing in marginal regions. Concentrations of 0.5 or 1.0 % applied 4 or 6 weeks before expected full bloom generally gave earlier and more uniform bud break in all cultivars. Application of DNOC in late Dec. or early Jan. on apple caused earlier bud break (Saad 1993). Martin (2012) mentioned that estimated chill hours at 7.2 ^{o}Crequired250 C.H. of Beauty and 300 – 400 C.H. of Hollywood plum cultivars. Hydrogen cyanamide at 3% and Thiourea at 1.5% singly or in combination with mineral oil at 5% were sprayed on Caninoapricot, in early February. It was found that thiourea followed Hydrogen cyanamide in enhancing (Eissa 2007).

Table 2. Chilling hours at or below 7.2 ^{0}c, 10.0^{0}c or 15.0 ^{0}c on vegetative buds of two plum cultivars under different treatments in 2014 and 2015 seasons.

Treatments	Hollywood								Beauty							
	2014 season				2015 season				2014 season				2015 season			
	Dates of rest termination*	Chilling hours at or below			Dates of rest termination *	Chilling hours at or below			Dates of rest termination *	Chilling hours at or below			Dates of rest Termination *	Chilling hours at or below		
		7.2 °C	10.0 °C	15.0 °C		7.2 °C	10.0 °C	15.0 °C		7.2 °C	10.0 °C	15.0 °C		7.2 °C	10.0 °C	15.0 °C
Universal 5%	Feb. 10	30.0	284.0	1151.0	Feb.11	22	315	1163.0	Feb. 10	30.0	284.0	1151.0	Feb. 12	22.0	319.0	1167.0
Universal 6%	Feb.11	30.0	293.0	1155.0	Feb.14	22	328	1169.0	Feb. 11	30.0	293.0	1155.0	Feb. 11	22.0	315.0	1163.0
Thiourea 1.5% + mineral oil 1.5%	Feb. 10	30.0	284.0	1151.0	Feb.10	22	306	1161.0	Feb. 11	30.0	293.0	1155.0	Feb. 11	22.0	315.0	1163.0
Duromix 1.0%+ mineral oil 1.5%	Feb.11	30.0	293.0	1155.0	Feb.10	22	306	1161.0	Feb. 10	30.0	284.0	1151.0	Feb. 10	22.0	306.0	1161.0
CAPL2	Feb.12	30.0	299.0	1159.0	Feb.10	22	306	1161.0	Feb. 10	30.0	284.0	1151.0	Feb. 10	22.0	306.0	1161.0
Control	Mar. 5	30.0	299.0	1194.0	Mar.7	22	343	1214.0	Mar. 6	30.0	299.0	1197.0	Mar. 8	22.0	311.0	1220.0

*Date of rest termination was determined when 50 % vegetative buds took the pyramidal shape.

Table 3. Chilling hours at or below 7.2 0c, 10.00c or 15.0 0c on flower buds of two plum cultivars under different treatments in 2014 and 2015 seasons.

Treatments	Hollywood								Beauty							
	2014 season				2015 season				2014 season				2015 season			
	Dates of rest termination *	Chilling hours at or below			Dates of rest termination *	Chilling hours at or below			Dates of rest termination *	Chilling hours at or below			Dates of rest Termination *	Chilling hours at or below		
		7.2 °C	10.0 °C	15.0 °C		7.2 °C	10.0 °C	15.0 °C		7.2 °C	10.0 °C	15.0 °C		7.2 °C	10.0 °C	15.0 °C
Universal 5%	Feb.10	30.0	284.0	1151.0	Feb.11	22.0	315.0	1163.0	Feb.10	30.0	284.0	1151.0	Feb.10	22.0	319.0	1161.0
Universal 6%	Feb.11	30.0	293.0	1155.0	Feb.14	22,0	328.0	1169.0	Feb.11	30.0	293.0	1155.0	Feb.11	22.0	315.0	1163.0
Thiourea 1.5% + mineral oil 1.5%	Feb.10	30.0	284.0	1151.0	Feb.10	22.0	306.0	1161.0	Feb.11	30.0	293.0	1155.0	Feb.11	22.0	315.0	1163.0
Duromix 1.0%+ mineral oil 1.5%	Feb.11	30.0	293.0	1155.0	Feb.10	22.0	306.0	1161.0	Feb.10	30.0	284.0	1151.0	Feb.10	22.0	306.0	1161.0
CAPL2	Feb.12	30.0	299.0	1159.0	Feb.10	22.0	306.0	1161.0	Feb.10	30.0	284.0	1151.0	Feb.10	22.0	306.0	1161.0
Control	Feb.25	30.0	299.0	1185.0	Feb.25	22.0	331.0	1189.0	Feb.26	30.0	299.0	1191.0	Feb.25	22.0	331.0	1289.0

*Date of rest termination was determined when 50 % Flower buds took the dome shape.

B. Dates of vegetative bud opening:-

It is obvious from table (4) that all bud break agents applied under study started opening of vegetative bud [15-20] days approximately earlier than the control plants in this study. In this respect (Dennis, 1994) stated that dormancy actually ends when further chilling no longer effectively hastens bud break. However, once a critical number of chill units have been accumulated, heat units hasten bud break.

Table 4. Dates of vegetative bud opening of two plum cultivars under different treatments in 2014 and 2015 seasons.

Treatments	Hollywood		Beauty	
	2014	2015	2014	2015
Universal 5%	Feb. 21	Feb. 22	Feb.19	Feb.20
Universal 6%	Feb.20	Feb.20	Feb.21	Feb.20
Thiourea 1.5% + mineral oil 1.5%	Feb.18	Feb.21	Feb.18	Feb.16
Duromix 1.0%+ mineral oil 1.5%	Feb.20	Feb.20	Feb.17	Feb.19
CAPL2	Feb.21	Feb.20	Feb.21	Feb.21
Control	Mar.5	Mar.7	Mar. 6	Mar. 8

Dates were determined when a bud showed the first sign of opening bud burst.

C.) Opening percentages of vegetative and flower buds:

Results in table (5) show the effect of different breaking agents under study on vegetative and flower bud opening percentages in the two seasons. Hollywood trees treated with Universal at 5% ; Universal at 6% and Duromix 1.0% + mineral oil 1. 5% had the highest significant vegetative buds opening percentage in the two seasons. Meanwhile, Beauty trees treated with Universal at 5 %; Universal at 6%; thiourea 1.5% + mineral oil 1. 5 % and Duromix 1.0 % + mineral oil 1. 5% had the highest significant vegetative bud opening percentages in the first season. In the second season, trees treated with Universal at 5 %; Universal at 6% and Duromix 1.0 % + mineral oil 1. 5% had the highest vegetative bud opening percentages. Moreover, Hollywood trees treated with Universal at 5%; Universal at 6%; thiourea 1.5% + mineral oil 1. 5 % and (Duromix 1.0 % + mineral oil 1. 5%) had the significant flower bud opening in the two seasons. Meanwhile, Beauty trees treated with Universal at 5%; Universal at 6 %; (thiourea 1.5% + mineral oil 1. 5 %) and (Duromix 1.0 % + mineral oil 1. 5%) had the highest flower bud opining percentages in the first season. In the second season, Universal at 5%; Universal at 6%; thiourea 1.5% + mineral oil

1. 5 %; Duromix 1.0 % + mineral oil 1. 5%) and CAPL2 had the highest significant flower bud opening percentage in the second season.

In this respect, Aly *et al.*, (1998) stared that Appling Dormex at 2% to the tree of five plum cultivars, increased the percentages of floral and vegetative buds, shortened blooming period, increased the overlapping between cultivars except with Hollywood was which earlier than the other and increased fruit set percentage. Also, Essia (2007) reported that to spray 'Canino' apricot trees with Dormex at 3% + mineral oil at 5% to achieve highest percentage of flower buds.

Table 5. Opening percentage * of vegetative and flower buds of two plum cultivars under different treatments in 2014 and 2015 seasons.

Treatments	Hollywood				Beauty			
	Vegetative buds (%)		Flower buds (%)		Vegetative buds (%)		Flower buds (%)	
	2014	2015	2014	2015	2014	2015	2014	2015
Universal 5%	52.09A	59.5 A	40.6 A	46.4 A	50.21 A	62.3 A	42.5 A	49.3 A
Universal 6%	56.8 A	61.7 A	44.8 A	49.3 A	53.7 A	64.9 A	42.9 A	50.2 A
Thiourea 1.5% + mineral oil 1.5%	44.3 B	48.3 B	42.4 A	43.5 A	54.66 A	51.7 B	39.8 A	44.5 A
Duromix 1.0%+ mineral oil 1.5%	54.26 A	60.4 A	43.8 A	47.1 A	52.4 A	65.8 A	40.5 A	49.9 A
CAPL2	18.43 C	24.3 C	33.9 B	40.6 B	22.13 B	31.5 C	32.7 B	45.1 A
Control	15.81C	19.5 C	8.31 C	12.3 C	18.9 B	23.6 D	9.6 C	13.7 B

Means in each column followed by the same letters are not significantly different at 5% level.

*Opening percentage of vegetative buds (as a percentage of total number of vegetative buds) was determined 30 days after bud burst stage.

*Opening percentage of flower bud was determined at full bloom.

3.2) Vegetative growth:-

A. Shoot Length:-

Data in table (6) obtained that Universal at 5 % and CAPL2 treatments induce the highest shoot length of Hollywood cultivar in the two seasons. Universal at 5% and 6% gave the highest shoot length in the second season with Beauty cultivar.

Table 6. Shoot length of two plum cultivars as affected by different treatments in 2014 and 2015 seasons.

Treatments	Shoot length(cm)			
	Hollywood		Beauty	
	2014	2015	2014	2015
Universal 5%	42.23B	47.5A	36.67BC	49.33A
Universal 6%	31.67D	32.67CD	39.00B	47.67AB
Thiourea 1.5% + mineral oil 1.5%	31.33D	37.00C	30.33D	26.33D
Duromix 1.0%+ mineral oil 1.5%	30.33D	30.67D	33.33CD	31.67C
CAPL2	47.00A	43.33B	48.67A	43.33B
Control	37.67C	15.00E	36.67BC	13.00E

Means in each column followed by same latters are not significant at 5% level.

3.3. Flowering:-

A. Dates of flower bud opening:-

It is obvious from tables (7, 8) that the greatest enhancement of complete flower stage was noticed with Duromix at 1.0 % + mineral oil at 1.0 % treatment Hollywood cultivar and thiourea at 1.5 % + mineral oil at 1.5 % treatment with Beauty cultivar, in the two seasons. Moreover, in fruit set stage Universal at 5% ; Universal 6% ; Duromix at 1.0 % + mineral oil at 1.0 % and CAPL2 treatments resulted more earliness (20 days) with Hollywood cultivar than the control plants. All treatments except CAPL2 treatment were earlier (20 days) than control plants in the first season with Beauty cultivar. The same trend was observed in the second season; all treatments achieved 17-20 days earlier with Hollywood and ranged from 17-21 days earlier with Beauty cultivar compared to the control plants.

In this respect, Erez *et al*. (1993) stated that using Dinitro-0- Cresol in combination with oil was and still is used in Israel to break bud rest of deciduous fruit trees. Results in pome fruits (apple) showed that the combination of oil and 0.25% Cyanamide was very good for bud break. Also, Eissa (2007) studied the application of Dormex at 3% singly or in combination with light mineral oil at 5% on Canino Apricot. He found that it was most effective in advancing flower bud development stage.

Table 7. Dates of different stages of flower bud opening and fruit set of two plum cultivars under different treatments in 2014 season.

Treatments	Hollywood				Beauty			
	Bud swell	Complete flowering	petal full	Fruit set	Bud swell	Complete flowering	petal full	Fruit set
Universal 5%	Feb.10	Feb.26	Feb.29	Mar.5	Feb.10	Feb.27	Feb.29	Mar.5
Universal 6%	Feb.11	Feb.28	Mar.3	Mar.6	Feb.11	Feb.26	Feb.28	Mar.4
Thiourea 1.5% + mineral oil 1.5%	Feb.10	Feb.25	Feb.28	Mar.8	Feb.11	Feb.24	Feb.28	Mar.4
Duromix 1.0%+ mineral oil 1.5%	Feb.11	Feb.22	Feb.25	Mar.5	Feb.10	Feb.24	Mar.1	Mar.4
CAPL2	Feb.12	Feb.25	Feb.29	Mar.5	Feb.10	Feb.26	Feb.29	Mar.4
Control	Feb.25	Mar.11	Mar.13	Mar.25	Feb.26	Mar.10	Mar.12	Mar.25

Table 8. Dates of different stages of flower bud opening, petal full and fruit set of two plum cultivars under different treatments in 2015 season.

Treatments	Hollywood				Beauty			
	Bud swell	Complete flowering	petal full	Fruit set	Bud swell	Complete flowering	petal full	Fruit set
Universal 5%	Feb.11	Feb.28	Mar.1	Mar.5	Feb.12	Feb.27	Mar.2.	Mar.4
Universal 6%	Feb.14	Feb.28	Mar.1	Mar.5	Feb.11	Feb.26	Feb.29	Mar.4
Thiourea 1.5% + mineral oil 1.5%	Feb.10	Feb.25	Feb.28	Mar.8	Feb.11	Feb.23	Feb.28	Mar.4
Duromix 1.0%+ mineral oil 1.5%	Feb.10	Feb.23	Feb.27	Mar.6	Feb.10	Feb.25	Mar.1	Mar.4
CAPL2	Feb.10	Feb.24	Feb.28	Mar.7	Feb.10	Feb.25	Feb.28	Mar.8
Control	Feb.25	Mar.12	Mar.14	Mar.25	Feb.25	Mar.10	Mar.13	Mar.25

3.4 Fruiting:-

A. Fruit set Percentage:-

Results in table (9) indicated that Universal 6% and Duromixat 1.0%+ mineral oil at 1.5% treatments induced the highest significant fruit set percentages of Hollywood cultivar in the first season. But, in the second season Universal at 5%; Universal at 6% and Duromix at 1.0 % + mineral oil at 1.5% gave the highest significant fruit percentages.

Universal at 5%; Universal at 6% and (Duromix at 1.0 % + mineral oil at 1.5%)treatments gave the highest significant values in Beauty cultivar in the first season. But, in the second one Universal at 6% andDuromix at 1.0 % + mineral oil at 1.5% gave the highest fruit set Percentage.

From the above results, we notice that during the first season which had less recorded accumulation chilling units (at or below 10.00C and 15.00C) with Hollywood and Beauty plum trees had less fruit set in comparison with the second season.

In this respect, El-Fakharani *et al*. (1994) stated that dormancy breaking agentson seven plum cultivars had a significant effect on the percentage of fruit set except with Hollywood according to date of application. However, Aly *et al*. (1998) who reported that the highest percentage of fruit set with Hollywood cultivar occurred with 1% Dormex. Also, Eissa (2007) recommended spraying "Canino" apricot trees with Dormex at 3%+ mineral oil at 5% to achieve highest percentage of fruit set.

Table 9. Fruit set percentages of two plum cultivars as affected by different treatments in 2014 and 2015 seasons.

Treatments	Fruit set %			
	Hollywood		Beauty	
	2014	2015	2014	2015
Universal 5%	8.3 B	9.9 A	7.9 A	9.5 B
Universal 6%	9.6 A	10.8 A	8.4 A	11.6 A
Thiourea 1.5% + mineral oil 1.5%	6.7 C	7.3 B	6.2 B	7.5 C
Duromix 1.0%+ mineral oil 1.5%	9.9 A	10.7 A	8.2 A	10.2 A
CAPL2	6.8 C	7.4 B	6.4 B	7.7 C
Control	6.3 C	6.4 B	5.3 C	6.2 D

Means in each column followed by same latters are not significant at 5% level.

B. Heat requirements:-

Data obtained in tables (10, 11, 12, 13)for 2014 and 2015seasonsindicated that the accumulated growing degree days from time of flower bud break till fruit maturity for all treatments were lower than the control. Universal 6%treatment gave

the lowest values 885.9 and 884.2H.u in 2014 and 2015 seasons respectively with Hollywood Cultivar. On the other side,Duromixat 1.0%+ mineral oil at 1.5%, Universal at 5% and Universal at 6% treatments resulted in the lowest values (915.5, 904.3 and 904.3H.u.) in the first season. Universal at 5%, Universal at 6%, Thioureaat 1.5% + mineral oil at 1.5% and Duromixat 1.0%+ mineral oil at 1.5% treatmentsproduced the lowest values in the second season with Beauty cultivar.

Table 10. Heat units required for different stage of flower bud opening until fruit maturity of Hollywood cultivar as affected by different treatments in 2014 season.

Treatments	Date of D.S.	Complete flowering		Petal fall		Fruit set		Maturity	
		Days after D.S.	G.D.D	Days after D.S.	G.D.D	Days after D.S.	G.D.D	Days after D.S.	G.D.D
Universal 5%	Feb.2	24	110.5	27	126.8	32	173.3	107	898.5
Universal 6%	Feb.3	25	118.7	29	134.9	32	173.3	106	885.9
Thiourea 1.5%+ mineral oil 1.5%	Feb.1	24	110.5	27	126.8	36	199.5	111	915.8
Duromix1.0%+mineral oil 1.5%	Feb.1	21	98.8	24	110.5	33	175.9	108	904.3
CAPL2	Feb.2	23	104.3	27	126.8	32	173.3	110	908.5
Control	Feb.13	27	126.8	29	134.9	41	229.9	117	1079.9

D.S. =Dome shape of flower bud. G.G.D= Growing degree day.

Table 11. Heat units required for different stage of flower bud opening until fruit maturity of Beauty cultivar as affected by different treatments in 2014 season.

Treatments	Date of D.S.	Complete flowering		Petal fall		Fruit set		Maturity	
		Days after D.S.	G.D.D	Days after D.S.	G.D.D	Days after D.S.	G.D.D	Days after D.S.	G.D.D
Universal 5%	Feb.1	26	121.4	28	129.4	33	175.9	108	904.3
Universal 6%	Feb.1	25	118.7	27	126.8	32	173.3	108	904.3
Thiourea 1.5%+ mineral oil 1.5%	Feb.2	23	104.3	26	121.4	31	165.2	110	908.5
Duromix1.0%+mineral oil 1.5%	Feb.2	22	100.5	28	129.4	31	165.2	107	898.5
CAPL2	Feb.1	25	118.7	28	129.4	32	173.3	111	915.5
Control	Feb.15	24	110.5	26	121.4	39	216.5	115	1056.4

D.S. =Dome shape of flower bud. G.G.D= Growing degree day.

Table 12. Heat units required for different stage of flower bud opening until fruit maturity of Hollywood cultivar as affected by different treatments in 2015 season.

Treatments	Date of D.S.	Complete flowering		Petal fall		Fruit set		Maturity	
		Days after D.S.	G.D.D	Days after D.S.	G.D.D	Days after D.S.	G.D.D	Days after D.S.	G.D.D
Universal 5%	Feb.1	27	127.9	33	167.2	43	191.2	110	890.3
Universal 6%	Feb.3	26	122.8	27	127.9	31	145.3	108	884.2
Thiourea 1.5%+ mineral oil 1.5%	Feb.1	24	111.2	27	127.9	36	175.2	110	890.3
Duromix1.0%+mineral oil 1.5%	Feb.1	22	104.45	26	122.8	34	158.2	110	890.3
CAPL2	Feb.1	23	110.2	27	127.9	35	162.3	114	912.4
Control	Feb.6	35	174.8	37	184.7	48	214.3	127	1045.2

D.S. =Dome shape of flower bud. G.G.D= Growing degree day.

Table 13. Heat units required for different stage of flower bud opening until fruit maturity of Beauty cultivar as affected by different treatments in 2015 season.

Treatments	Date of D.S.	Complete flowering		Petal fall		Fruit set		Maturity	
		Days after D.S.	G.D.D	Days after D.S.	G.D.D	Days after D.S.	G.D.D	Days after D.S.	G.D.D
Universal 5%	Feb.2	25	116.4	29	139.7	31	145.3	109	885.2
Universal 6%	Feb.1	25	116.4	28	132.4	32	169.5	110	890.3
Thiourea 1.5%+ mineral oil 1.5%	Feb.1	22	104.5	27	127.9	32	169.5	110	890.3
Duromix1.0%+mineral oil 1.5%	Feb.1	24	111.2	29	139.7	32	169.5	110	890.3
CAPL2	Feb.1	24	111.2	27	127.9	36	175.2	114	912.4
Control	Feb.6	33	174.2	36	175.2	48	214.3	127	1045.2

D.S. =Dome shape of flower bud. G.G.D= Growing degree day.

C. Dates of fruit maturity; harvest period and yield per tree:-

Data in table (14) show the effect of different breaking agents under study on fruit number, yield weight per tree and dates of fruit maturity.

1) Date of fruit maturity:-

Different dormancy breaking treatments resulted in advancing date of fruit maturity. Application of Universal 5%, Universal 6% and Duromix 1.0%+ mineral oil 1.5% considered the best treatments in this aspect with the two cultivars and the two seasons. Moreover, all used breaking agents induce earlier maturity than the control by 17 to 21 days.

2) Fruit number per tree:-

Hollywood andBeauty tree treated with Universal 6% treatment had the best significant fruit number in the two seasons compared with other treatments.

On thecontrary, Stadler *et al*., (1991) mentioned that hydrogen cyanamide at 0.5 or 1.0 % did not significantly increase the number of fruits per tree of Gaviota plum cultivar.

3) Yield weight per tree:-

Hollywood and Beauty tree treated with Universal 6% treatment had the highest significant yield weight per tree of Hollywood and Beautycvs.in the two seasons, compared with other treatments.

In this respect, El-wakeel *et al.,* (1973) stated that spraying universal at 4% increased yield on six plum varieties. Also, Bepete and Jackson (1993) sprayed hydrogen cyanamide at 1.5% on some apple cultivars. They found that it gave satisfactory bud break and flowering and gave heavy crops. Likewise, thiourea at 1% applied in spring time onSunbrite peach and Weinberger nectarine varieties increased the yield (kiiden *et al.,* 1993), and kiwi fruit (Schuck and petri, 1995) concerning the positive effect of the application of various dormancy – breaking agents such as hydrogen cyanamide and thiourea whether singly or in combination with mineral oil enhancing yield, and improving fruit quality.

Table 14. Dates of fruit maturity, harvest period and yield per tree of two plum cultivars as affected by different treatments in 2014 and 2015 seasons.

Treatments	Hollywood						Beauty					
	2014 season			2015 season			2014 season			2015 season		
	Dates of fruit maturity	Tree Yield		Dates of fruit maturity	Tree Yield		Dates of fruit maturity	Tree Yield		Dates of fruit maturity	Tree Yield	
		No. of fruit	Weight (kg)		No. of fruit	Weight (kg)		No. of fruit	Weight (kg)		No. of fruit	Weight (kg)
Universal 5%	May 19	623.3B	11.80C	May 21	239.0C	5.28C	May 19	854.0B	16.59C	May 21	227.7C	6.14C
Universal 6%	May 19	955.0A	33.76A	May21	522.7A	20.73A	May 19	919.3A	38.50A	May 21	460.0A	18.00A
Thiourea 1.5% + mineral oil 1.5%	May 22	156.0D	4.76D	May21	121.3D	3.95D	May 22	152.7D	5.06D	May 21	204.3D	4.75D
Duromix 1.0%+ mineral oil 1.5%	May 19	415.3C	15.58B	May21	412.3B	14.34B	May 19	507.0C	27.65B	May 21	412.3B	16.42B
CAPL2	May 22	43.00E	1.50E	May25	73.33E	1.43E	May 22	59.33E	2.91E	May 25	78.00E	1.97E
Control	June 9	23.33F	0.66F	June 12	22.67F	0.56F	May 9	39.67F	0.73F	June 12	33.67F	0.62F

Means in each column followed by same latters are not significant at 5% level.

4.) Physical and Chemical properties of fruits:-

Results in tables (15 and 16) indicated Duromix 1.0%+ mineral oil 1.5% and Universal 6% treatments significantly increased the size, weight and diameter of fruits in the two cultivars in the two seasons compared to other treatments. However, Universal 5% and control treatments had the highest significant values in firmness with Hollywood cultivar in the two seasons. Meanwhile, control treatments achieved the highest firmness with Beauty cultivar. On the other hand, Duromix 1.0%+ mineral oil 1.5% treatments in the first season, and Duromix 1.0%+ mineral oil 1.5% and Universal 5% in the second one resulted in the longest fruit in Hollywood cultivar. Universal 6%**;** Duromix 1.0%+ mineral oil 1.5% and CAPL2 in the first season , and Universal 5% and Universal 6% in the second one induced the longest fruit length in Beauty cultivar. With regard to T.S.S CAPL2 and Duromix 1.0%+ mineral oil 1.5% treatments in the first season, and CAPL2 treatment only in the second onereduce the highest significant content of T.S.S with Hollywood cultivar. Meanwhile, Thiourea 1.5% + mineral oil 1.5% and Duromix 1.0%+ mineral oil 1.5% in the two seasons with Beauty cultivar. With regard to acidity, control treatment induced the highest content of acidity in Hollywood cultivar. On the other hand control; (Thiourea 1.5% + mineral oil 1.5%) and Duromix 1.0%+ mineral oil 1.5% treatments gave the highest acidity in Beauty cultivar.

In this respect, kiiden *et al*. (1993) mentioned that thiourea at 1% application affected the fruit quality positively and increased the fruit size. Also, Eissa (2007) stated that spraying 'Canino'apricot trees with Dormex at 3% + meniral oil at 5% achieved the highest fruit weight, volume and flesh thickness.

Table 15. Physical and chemical properties of fruits of two plum cultivars under different treatments in 2014 season.

Treatments	Hollywood							Beauty						
	Fruit					TSS (%)	Acidity (%)	Fruit					TSS (%)	Acidity (%)
	Size (cm)	Weight (gm)	Length (cm)	Diameter (cm)	Firmness (lb\inch$_2$)			Size (cm)	Weight (gm)	Length (cm)	Diameter (cm)	Firmness (lb\inch$_2$)		
Universal 5%	16.38D	18.52F	3.47D	3.33C	1.90A	8.17B	0.59E	21.77E	19.24F	3.43C	3.53Bc	0.90C	10.67C	1.58B
Universal 6%	34.48B	34.64B	3.80C	4.33A	1.07D	8.33B	1.38CD	45.86B	47.38A	4.47A	3.97A	1.20B	10.83C	0.75D
Thiourea 1.5% + mineral oil 1.5%	34.51B	31.49D	4.10AB	3.93B	1.97A	7.67C	1.30D	24.03D	34.73D	4.07B	3.53Bc	0.93C	12.33A	2.19A
Duromix 1.0%+ mineral oil 1.5%	37.83A	36.84A	4.23A	4.43A	1.37C	8.83A	1.51B	50.87A	45.83B	4.47A	3.73B	0.87C	11.33B	1.97A
CAPL2	31.30C	33.48C	3.97BC	4.10B	1.70B	8.67A	1.42BC	39.14C	39.77C	4.30AB	3.50C	0.87C	10.67C	1.18C
Control	15.23E	22.74E	3.00E	3.50	1.87A	7.67C	2.26A	16.84F	22.57E	3.03D	3.40C	1.87A	8.67D	2.14A

Mans in each column followed by same latters are not significant at 5% level.

Table 16. Physical and chemical properties of fruits of two plum cultivars under different treatments in 2015 season.

Treatments	Hollywood							Beauty						
	Fruit					TSS (%)	Acidity (%)	Fruit					TSS (%)	Acidity (%)
	Size (cm)	Weight (gm)	Length (cm)	Diameter (cm)	Firmness (lb\inch$_2$)			Size (cm)	Weight (gm)	Length (cm)	Diameter (cm)	Firmness (lb\inch$_2$)		
Universal 5%	23.28E	25.84C	3.47C	3.37C	2.27A	8.13B	0.68D	28.88C	28.20C	3.73AB	3.53B	0.50D	11.67B	1.52B
Universal 6%	37.53A	38.32A	3.93A	4.43A	1.37C	7.67CD	1.19C	31.26A	33.95A	3.77A	3.83A	1.20B	11.33C	0.81D
Thiourea 1.5% + mineral oil 1.5%	30.94B	26.40C	3.40C	3.90B	1.37C	7.50D	1.19C	23.71E	22.61E	3.50C	3.47B	0.87C	12.17A	2.12A
Duromix 1.0%+ mineral oil 1.5%	25.85C	33.74B	3.73B	4.47A	1.40C	7.83C	1.55B	30.56B	29.12B	3.53BC	3.87A	1.10B	10.67D	1.95A
CAPL2	24.25D	22.38D	3.40C	4.07B	1.40C	8.67A	1.52B	24.88D	25.46D	3.47C	3.33B	1.10B	10.67D	1.23C
Control	18.87F	22.27D	3.03D	3.40C	1.87B	7.83C	2.03A	18.90F	21.61F	3.07D	3.40B	1.83A	8.83E	2.17A

Means in each column followed by same latters are not significant at 5% level.

3.5.Determination of Universal ;Thiourea ; Hydrogen Cyanamide and Mineral Oil Residues :-

The data tabulated in table (17) showed that no residues found in two seasons in all treatments, except mineral oil, It was found 0.001 Mg/ g (ppm) in the first season while it didn't detect in the second season and these data is acceptable because the samples were taken to analysis after 110 days from application in each season in both cultivars. The control was taken to do Recovery to evaluate the method and chemicals. The data showed that Recovery percentages were 92%, 75.5%, 70 %and 72% for mineral oil, thiourea, universal and Hydrogen cyanamide, respectively.

In this respect, Erez *et al*. (1993) using rest-breaking treatments such as Dinitro-O-Cresol that in combination with oil and cyanamide for improving the level of bud break and for advancing bloom and vegetative development. In pome fruits (apple) the combination of oil and 0.25% cyanamide were found to result in a very good bud break with no phytotoxic effects on flower buds. Meanwhile, krisanapook and Subhadrabandhu (1993) mentioned that high concentration of hydrogen cyanamide were toxic noticed by dried dead shoots. Thus, North (1993) indicated that cyanamide, a powerful rest – breaking agent on a range of fruit kinds, may replace DNOC/oil in the short-term but acute toxicity symptoms limit its medium – term acceptance. Attempts to reduce it concentration without compromising efficacy by the dual application of other agents has been investigated. Although oils have long been known as rest-breaking agents, new and registered oil products applied alone and in conjunction with other potential substances have shown promise.

Table 17. Residual effect of some breaking agents of two cultivars under study after 110 days of application in 2014 and 2015 seasons.

Treatments	Hollywood		Beauty	
	2014	2015	2014	2015
Universal 5%	ND*	ND	ND	ND
Universal 6%	ND	ND	ND	ND
Thiourea 1.5% + mineral oil 1.5%	ND	ND	ND	ND
Duromix 1.0%+ mineral oil 1.5%	ND	ND	ND	ND
CAPL2	0.001	ND	ND	ND

*ND: non detectable

CONCLUSION

Finally we can conclude that Dinitro-O-Cresol at 6 % and Duromix at 1% + Mineral oil at 1.5% application on Hollywood and Beauty cultivars were the best dormancy- breaking agents.Also, all tested compounds can be used safely 110 days after application.

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دراسات على التزهير والإثمار والأثر المتبقي لبعض كاسرات السكون على صنفين برقـــــوق

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أجريت هذه الدراسة خلال موسمي ٢٠١٤ ، ٢٠١٥ لمقارنة نأثير الرش بالمواد الكاسره للسكون

- داي نيترو أورثو كريزول في صورة زيت اليونيفرسال بتركيزين ٥% ، ٦% .
- مادة الديوروميكس (يحتوي علي ٥٠ % سينامايد الهيدروجين بتركيز ١% + زيت معدني بتركيز ٥ر١%
- مادة الثيوريا بتركيز ٥ر١% + زيت معدني ٥ر١% .
- زيت معدني خفيف بتركيز ٢% في صورة (كابل ٢)
- والكنترول

وتم الرش بتلك المواد في منتصف يناير في الموسيمين وذلك لدراسة تأثيرها علي التزهير والإثمار وتحديد الآثر المتبقي من تلك المواد الكاسرة للسكون على الثمار في صنفي برقوق هوليود وبيوتى ٠

شملت القياسات إحتياجات البرودة – مواعيد تفتح البراعم – نسبة تفتح البراعم الزهرية – نسبة عقد الثمار – الإحتياجات الحرارية – مواعيد نضج الثمار – المحصول – الصفات الفيزيائية والكيميائية للثمار – الأثر المتبقي على الثمار .

أشارت النتائج إلى أن :-

- ساعات البرودة المتجمعة عند درجة حرارة ١٠ م°أو أقل كانت مناسبة أكثر من درجة الحرارة أقل من أو تساوي ٧,٢ م° ، ١٥ م°٠
- كما أن إضافة المواد الكاسرة للسكون بكرت من مرحلة عقد الثمار بحوالي ١٧ – ٢١ يوم في كلاً الصنفين ٠
- أن المعاملة بزيت اليونيفرسال بتركيز ٦% ومادة الديوروميكس بتركيز ١% + الزيت المعدني بتركيز ١,٥ % أعطى أعلى نسبة في عقد الثمار فى صنفى هوليود وبيوتى ٠
- وبالنسبة للإحتياجات الحرارية المتجمعة من وقت كسر سكون البراعم حتى نضج الثمار كانت أقل عند استعمال زيت اليونيفرسال عند تركيز ٦% لصنف هوليود .
- كان أعلى محصول للشجرة مع زيت اليونيفرسال عند تركيز ٦% وذلك لصنف هوليود وبيوتى .

- أدت المعاملة بزيت اليونيفرسال بكلا من التركيزين ٥% ،٦% الى تبكير فى نضج الثمار
- وبالنسبة لحجم ووزن وقطر الثمار كانت المعاملة بزيت اليونيفرسال عند تركيز ٦% ومعاملة الديوروميكس بتركيز ١,٠ % + الزيت المعدني بتركيز ١,٥ % أعطى أعلى حجم ووزن وقطر للثمار فى كلاً من الصنفين
- لا يوجد أثر سام متبقي لتلك المواد الكاسرة للسكونفي الثمار جميعها وذلك بعد فترة ١١٠ يوم من إضافة تلك المواد.

ويمكن التوصية :- بأن الرش بزيت اليونيفرسال عند تركيز ٦% ومادة الديوروميكس بتركيز ١% مع الزيت المعدني بتركيز ١,٥% كمواد كاسره للسكون أعطى أعلى نسبة في عقد الثمار مع صنفى هوليود وبيوتى – وكانت هذه المواد آمنة وغير سامة بعد ١١٠ يوم من الرش على الإشجار.