Response of Flordasun Peach to Pruning Severity and Chemical Thinning: Gibberellic Acid and Ethrel I-Yield and Fruit Quality

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ABSTRACT

Pruning severity levels and chemical thinning rates with gibberellic acid (GA_3) at pre-bloom stage and ethrel at post-bloom stage of Flordasun peach trees in 2000 and 2001 induced yield significant reduction but improved both physical and chemical fruit properties. In general, the heavy pruning level and the higher concentration of both chemical thinners (GA3 & ethrel) caused a significant increment in the average fruit's weight and size, the fruit pulp and seed weights. The ethrel application reduced the fruit firmness, meanwhile inversely increased the total soluble pectin. On the other hand, the pruning and (GA_3) treatments increased the fruit firmness due to inducing total soluble pectin reduction. The best results in terms of total soluble solids, vitamin C, total phenols and total sugars were obtained by the three ethrel application rates. The fruit juice acidity was increased by (GA_3), decreased by ethrel and was not affected by the pruning treatments. As for the fruit pigments, the obtained results showed that the total chlorophyll was significantly decreased by the pruning and ethrel applications and increased by (GA_3) treatment. It is obvious that the ethrel application markedly encouraged coloration of "Flordasun" peach due to the significant increment in the fruit carotene and anthocyanin contents.

INTRODUCTION

North Sinai's mild winter climate and early spring season offer unique opportunities for early season peach production. So, peaches are considered to be the leading deciduous fruit crops grown in the peninsula. But unfortunately, commercial peach production has been plagued by various problems in recent years. Shortage rainfall and peach tree short- lives have adversely affected peach productivity in the district the last decade. So, peach growers have been caught in difficult situation because of low prices and the lack of consistent cropping for large-scale marketing. Moreover, most cultivated peach varieties have a tendency to overcrop and set far more fruit than can be grown to large size with good quality. Growers must ensure that producing a quality product remains their ultimate goal. Furthermore, it is essential to achieve adequate fruit size in order to satisfy consumers. Such improvement could generally be achieved by one method-regulation of crop load. While proper cultural practices such as correct plant nutrition and adequate irrigation are essential, these do not affect final fruit size to the same degree as crop load adjustment. Suitable pruning and thinning management can be used to control the number of fruit per tree in order to increase fruit size and quality as well as to insure adequate vegetative growth in the trees. Variation in pruning severity had greater effects than variation in pruning date (Genard *et al.*, 1998). Fruit firmness and titratable acidity were highest in the most severe pruning treatment (Monet, 1998). Crop loading is also inversely proportional to fruit color and soluble solids content. Researches have shown that crop load adjustment is the most reliable way to increase fruit soluble solids content, more so even delaying harvest a few days (Crisosto *et al.*, 1997; Day and DeJong, 1990). Large final fruit size in peach is correlated with high soluble solids, sugars, dry weight and firmness (Dann and Jerie, 1988). Work is constantly being to arrive at a program for chemical thinning which can reduce both the time and high costs associated with hand thinning (Marini, 1985; Marini, 1996; Marini *et al.*, 1991 and Slover, 2000). Therefore, the present trial was designed to evaluate the effect of pruning severity and chemical thinning that promise to reduce crop load and improve fruit quality of "Flordasun" peach after being applied at pre- and post-bloom stages.

MATERIALS AND METHODS

The present investigation was carried out during 2000 and 2001 successive growing seasons on 9-year- old 'Flordasun' peach (*Prunus persica* L. Batsch) trees on bitter almond (*P. amygdalus* L.) rootstock, grown in sandy soil under rainfed conditions at 'Rafah', North Sinai Governorate. The trees were as uniform as possible, planted at 5x5m spacing and received the appropriate cultural practices adopted in the district. The experimental trees received the different pruning and spraying treatments as follows: Unpruned (control), light, medium and heavy pruning i.e. (pruning 25% "14 buds", 50% "10 buds" and 75% "6 buds" of the original shoot length at mid January. Sprayed with water (control), 50, 100, 150 ppm of gibberellic acid (GA_3) at the pre-bloom stage (mid January) or 25, 50 and 100 ppm ethrel (2- chloroethyl phosphonic acid) at the post-bloom stage (12 February). Each plot included one tree and each treatment was replicated four times in a randomized block design. Five limbs per each experimental tree were selected to determine the fruit drop percentage.

At harvest, fruits number and weight were recorded for each experimental tree on May 1st of both seasons. From a random sample of twenty mature fruits of each treatment the fruit characteristics including seed, pulp and average fruit weight were recorded. Fruit firmness was measured at two opposite sides on the equator of each fruit (skin removed) using fruit pressure tester at 5/16 plunger. The percentage of total soluble solids (T.S.S.) was determined in the fruit juice using a hand refractometer.

Total acidity was estimated as malic acid and vitamin C was determined using 2,6-dichlorophenol indophenol dye according to the A.O.A.C (1980). Peel pigments, i.e., total chlorophyll and carotene (mg/100g fresh weight) were colourimetrically determined according the procedure outlined by Moran and Porath (1980). Anthocyanin (mg/100g fresh weight) was determined according Rabino *et al.*, (1977). Total sugars percentage was determined according to the procedures outlined by Malik and Singh (1980). Total soluble pectin percentage was determined according to McComb and McCready (1952) and total phenol percentage was determined according to the A.O.A.C (1980).

Appropriate analysis of variance was performed on results of both seasons. Comparisons among means of different treatments were performed using the least significant difference test at ($p < 0.05$) level as described by Steel and Torrie (1982).

RESULTS AND DISCUSSION

Fruit yield and Quality evaluation

1.Yield

Concerning the effect of pruning severity, spraying gibberellic acid (GA_3) at pre-bloom or ethrel (CEPA) at post-bloom stages on yield, the data are presented in Table (1). The results showed that all levels or rates markedly reduced yield expressed either as number of fruits or kilograms per tree compared with the untreated trees (control) in both seasons. It is obvious that the crop load either, as number of fruits/tree or kg/tree was inversely proportional to the pruning severity level. Comparing with the untreated trees (control), the data showed that the medium pruning level significantly reduced the yield as number of fruits/tree in the second season. Meanwhile, the heavy pruning level decreased significantly the yield either as number of fruits/tree or kg/tree in both seasons. In the meantime, significant differences were found between the heavy pruning level on one hand and both the light and medium pruning levels on the other hand in 2000 and 2001 seasons. These results are in accordance with those of Dominguez *et al.*, (1998) working on clingstone peaches cultivated under rainfed in the Mexican tropic and Grossman and DeJong (1998).

Spraying trees in both experimental seasons with GA_3 at 50, 100, 150ppm and ethrel at 50 and 100ppm treatments decreased significantly the yield as compared with the unsprayed trees (control), except for ethrel at 50ppm for yield as kg/tree in the second season.

The heavy pruning level and the 150ppm GA_3 or 100ppm ethrel concentration were obviously most efficient in reducing the fruit yield expressed either as number of fruits per tree (265&257), (252&280), (322& 365) or fruits as kg per tree (23.24&22.44 kg), (21.51&24.616kg), (27.98&32.51kg) in 2000 and 2001 seasons, respectively.

The obtained results agreed with those previously reported by Abdel-Hamid (1999), Sourour (1993), Southwick *et al.*, (1996) and Taylor and Taylor (1998) working on 'Flordaprince', 'EarlyGrand' 'Loadel' and 'Redhaven & Cresthaven' peach cvs., respectively.

Table (1): Effect of pruning severity and gibberellic acid or ethrel as chemical thinners on yield, fruit drop percentage and some physical parameters of Flordasun peach in 2000 and 2001 seasons.

Treats.	No. of fruits/ tree		Yield/ Tree (kg)		Fruit drop (%)		Fruit size ml^3		Average fruit weight (g)		Pulp weight (g)		Seed weight (g)	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Control	450	500	35.39	37.62	14.68	22.40	76.98	75.36	78.65	75.23	68.25	64.85	10.40	10.38
Light pruning	428	448	34.28	37.41	18.78	27.38	79.00	78.29	80.10	83.51	68.58	72.35	11.52	11.16
Medium pruning	399	400	33.73	34.02	19.69	34.35	81.95	83.00	84.53	85.05	72.65	72.65	11.88	12.40
Heavy pruning	265	257	23.24	22.44	21.88	38.56	83.45	85.45	87.71	87.30	75.16	74.35	12.55	12.95
GA_3 50ppm	302	306	25.04	25.41	33.92	40.65	79.15	81.65	82.93	83.03	71.58	71.25	11.35	11.78
GA_3 100ppm	271	288	22.88	24.83	40.70	44.64	82.65	84.87	84.44	86.20	72.07	73.45	12.37	12.75
GA_3 150ppm	252	280	21.51	24.61	44.86	48.88	84.75	86.00	85.36	87.90	72.39	74.65	12.97	13.25
Ethrel 25 ppm	410	443	33.04	34.66	18.20	23.45	83.65	84.67	80.59	78.24	70.29	67.23	10.30	11.01
Ethrel 50 ppm	345	400	29.28	33.80	24.51	26.62	87.60	89.25	84.87	84.49	73.87	72.65	11.00	11.84
Ethrel 100ppm	322	365	27.98	32.51	29.54	29.00	89.97	94.35	86.90	89.08	74.87	76.58	12.03	12.50
$L.S.D_{0.05}$	52.50	62.10	4.01	4.69	4.08	4.17	6.12	6.38	5.91	5.68	4.10	5.82	1.61	1.96

Chemical thinning of blossoms, rather than developing fruits maximizes the ability to adjust the fruit-to- leaf ratio, a method particularly desirable in early ripening peach cultivars with a short fruit developmental period and fruit sizing problems (Byers and Lyons, 1985) and Southwick *et al*., (1995). Flower and fruitlet abscission during development are known to be due to the activation of pre-differential abscission zones (AZs) located between twig and pedicel, and /or pericarp. Major advances on biochemical and molecular aspects are related to β-1,4-endogluconase (EG) and polygalacturonase (PG), two cell hydrolases involved in the cell wall disassembly responsible for fruit shedding. In peach, an (EG) gene highly expressed in leaf and fruitlet by (AZs) has been isolated. AZ activation is preceded by an induction of ethylene biosynthesis. Ethylene, besides a dramatic stimulator of (PG) and (EG), up or down regulates several other abscission related genes (Bonghi *et al*., 2000).

2. Fruit drop (%):

Data presented in Table (1) obviously clarified that in both experimental seasons, all the pruning treatment levels and both chemical thinners rate caused a significant increment in the fruit drop percentages compared with the untreated trees (control), except the 25ppm ethrel concentration in both seasons. In the meantime, differences were statistically significant among all treatments in both 2000 and 2001 seasons, except the three pruning levels in the first season and between the 25 and 50 ppm ethrel in the second season. The uppermost fruit reduction values resulted from the 150 ppm GA_3 application (44.86 & 48.88 % fruit drop) in the first and second seasons, respectively. These results are in agreement with those of Khalil *et al.*, 1990 using 'Alsol 800' and ethephon on nectarines, Southwick *et al.*, 1995 using gibberellic acid on 'Loadel' peach cv. and Fallahi (1997) using Dormex on 'Early Spur Rome ' apple and 'Redhaven' peach cultivars.

3- Physical fruit properties:

Fruit size, fruit, pulp and seed weight:

Data of both seasons concerning the effect of the different pruning levels and chemical thinner rates on the main fruit characteristics, i.e., fruit size, fruit, pulp and seed weights are illustrated in Table (1). It is clear that such fruit characteristic parameters were positively proportional to the pruning severity levels and rates of both chemical thinners (GA_3 and ethrel) in both seasons. In other words, comparing with the untreated trees (control), a gradual increment was found in fruit size, fruit, pulp or seed weights in 2000 and 2001 seasons. The uppermost values of fruit size, fruit and pulp weights resulted always from the 100ppm ethrel treatment (89.97& 94.35ml^3), (86.90&89.08g) and (74.87&76.58g) in the first and second seasons, respectively. Also, the different pruning levels and chemical thinner rates increased significantly the average fruit weight in both seasons comparing to the control, except both the light and medium pruning levels, the 50, 100ppm GA_3 and 25, 50ppm ethrel in the first season and the 25ppm ethrel in the second season. All pruning and thinning treatments except, the light pruning level and the 50ppm GA_3 in both seasons significantly affected the fruit size.

Analogical pattern of response could be noticed for both pulp and seed (kernel) weights as affected by the different pruning levels and both chemical thinner rates. Comparing with the untreated trees (control), all treatments increased significantly the pulp weight, except the light pruning level, 50 and 100ppm GA_3 treatments in the first season and the 25ppm ethrel application in both seasons. Similarly, the seed weight was significantly affected by the different treatments, except the light pruning level, 50ppm GA_3, 25 and 50ppm ethrel treatments in both seasons. In the meantime, insignificant difference was found between the control and the medium pruning level in the first season only. These results are in line with those of Chanana *et al.*, 1998; Muhammad *et al.*, 1996 and ZhiGuo *et al.*, 2001.

4.1 Total soluble solids (TSS):

The different pruning levels and both chemical thinner rates increased the fruit total soluble solids content (TSS) in the fruits yielded from treated trees compared with the untreated ones (control) in both seasons (Tables 2 and 3). Differences were statistically significant between the control and the 100, 150ppm GA_3 and all ethrel concentrations in both seasons. The obtained herein results are in agreement with those of Fallahi (1992) and Myers (1993) working on peach trees. Pruning and thinning practices change the leaf area and photosynthetic capacity of a tree and also appear to affect the metabolic equilibrium between the root system and the ariel part of the tree by reducing the number of growing shoots that function both as sources and sinks for nutrients and hormones (Grochowska *et al.*, 1984).

4.2 Acidity:

Data of the present investigation revealed that, in both seasons, the fruit juice acidity as affected by the pruning severity levels did not show a consistent trend. Meanwhile, a gradual increment was observed in the fruit juice acidity percentages by increasing GA_3 concentration in both seasons. Significant differences were found between the 150ppm GA_3 treatment and the control in both experimental seasons. Such increment could be attributed to releasing of some organic and amino acids during carbohydrates and protein synthesis (Dann and Jerie, 1988). On the other hand, it is obvious in both experimental seasons that the three ethrel concentrations caused a significant reduction in the fruit juice acidity as compared with the remained treatments including the control (Tables 2 and 3). These results are in agreement with those of Abdel-Hamid (1999), Johnson and Handley (1989) and Koul and Muthoo (1999) working on peach trees.

Table (2): Effect of pruning severity and gibberellic acid or ethrel as chemical thinners on some fruit quality parameters of Flordasun peach in 2000 season.

Treatments	TSS (%)	Acidity (%)	V.C (mg/100 ml)	Total sugars (%)	Total phenols (mg/g)	Total soluble pectin (%)	Firmness (pounds/ inch^2)	Total chlorophyll (mg/100g)	Total carotene (mg/100g)	Anthocyanin (mg/100g)
Control	10.48	0.86	17.47	6.30	98	1.76	10.26	6.92	2.65	12.65
Light pruning	10.76	0.85	17.49	6.48	97	1.74	10.38	6.75	2.72	12.80
Medium pruning	10.86	0.86	17.50	6.78	94	1.70	10.46	6.36	2.80	13.25
Heavy pruning	10.78	0.85	17.54	7.80	92	1.64	10.54	6.30	2.88	13.40
GA_3 50ppm	10.58	0.87	18.25	6.52	96	1.58	10.80	7.22	2.75	13.95
GA_3 100ppm	11.54	0.92	18.45	7.65	95	1.44	11.18	7.29	2.82	13.97
GA_3 150ppm	11.62	0.98	18.60	7.75	91	1.37	11.23	7.37	2.90	14.23
Ethrel 25 ppm	11.78	0.74	18.50	7.58	89	1.89	9.70	6.44	3.27	15.28
Ethrel 50 ppm	11.84	0.72	18.56	8.32	88	1.90	9.64	6.32	3.40	16.15
Ethrel100ppm	11.95	0.70	18.78	8.56	85	1.92	9.62	6.24	3.65	16.25
L.S.D $_{0.05}$	1.04	0.11	1.13	0.57	7.00	0.13	0.55	0.48	0.34	1.68

4.3 Vitamin C:

Data of both experimental seasons clearly showed a marked increment in vitamin C in the fruit juice with increasing either pruning levels or chemical thinner (GA_3 & ethrel) rates comparing with the control (Tables 2 and 3). Differences were statistically significant between both the 150ppm GA_3 and 100ppm ethrel concentrations and the control in 2000 and 2001 seasons. These results are in harmony with those of Ebel *et al.*, (1999) working on "Empress" peach and Zilkah *et al.*, (1988) working on peaches and nectarines.

4.4 Total sugars:

Results presented in Tables (2&3) reflected an increment in the fruit total sugars content as affected by all the pruning treatment levels and both chemical thinners rates comparing with fruits of untreated trees (control). The uppermost values came always from fruits yielded from trees sprayed with 50 and 100ppm ethrel (8.32 &8.41%) and (8.56 & 8.72%) in the first and second seasons, respectively. In the meantime, significant differences were found between the control and each of the heavy pruning level, the 100ppm GA_3 concentration and the three ethrel rates in both experimental seasons. These findings are in agreement with those of Muthoo *et al.*, (1997) working on 'Flordasun' peach and Zilkah *et al.*, (1988) on peaches and nectarines.

Table (3): Effect of pruning severity and gibberellic acid or ethrel as chemical thinners on some fruit quality parameters of Flordasun peach in 2001 season.

Treatments	TSS (%)	Acidity (%)	V.C (mg/100 ml)	Total sugars (%)	Total phenols (mg/g)	Total soluble pectin (%)	Firmness (pounds/ inch^2)	Total chlorophyll (mg/100g)	Total carotene (mg/100g)	Anthocyanin (mg/100g)
Control	11.00	0.95	17.80	7.00	95	1.75	10.56	7.34	2.73	13.40
Light pruning	11.15	0.94	18.00	7.45	94	1.73	10.70	7.22	2.76	14.15
Medium pruning	11.25	0.93	18.65	7.60	93	1.68	10.85	6.82	2.98	14.65
Heavy pruning	11.35	0.95	19.15	7.73	90	1.62	11.00	6.30	3.01	15.15
GA_3 50ppm	11.00	1.00	18.65	7.58	93	1.51	11.05	7.38	2.78	14.60
GA_3 100ppm	12.20	1.06	18.90	7.95	92	1.48	11.52	7.42	2.86	14.85
GA_3 150ppm	12.98	1.12	19.68	8.12	90	1.46	11.84	7.60	3.00	15.20
Ethrel 25 ppm	12.45	0.86	18.70	8.20	87	1.90	10.03	6.65	3.15	15.94
Ethrel 50 ppm	12.65	0.87	18.82	8.41	86	1.92	9.88	6.51	3.24	16.74
Ethrel100ppm	12.85	0.84	19.70	8.72	85	1.92	9.74	6.15	3.34	17.28
L.S.D $_{0.05}$	1.06	0.12	1.40	0.62	8.00	0.15	0.48	0.46	0.36	1.90

4.5 Total phenols:

Investigating the effect of the different pruning levels and chemical thinner (GA_3 & ethrel) rates on the total phenols content of fruits, data in Tables (2&3) showed that all treatments caused a gradual decrease as compared with the control. In the meantime, significant differences were only found between the three -ethrel rates and the control in both seasons. These results confirmed those of Paulson et *al.*, (1980) working on peaches.

4.6 Total soluble pectin and Fruit firmness:

Data in Tables (2&3) clearly showed that the different pruning levels and chemical thinner (GA_3 & ethrel) rates differently affected the total soluble pectin and the fruit firmness. It is obvious that the three pruning levels increased to some extend the fruit firmness and decreased the fruit total soluble pectin as compared with the control, but differences did not reach the limit of significance in both seasons. The obtained results are in harmony with those of Hassan

(1990), Saeid and Khalil (1993) working on Meet-Ghamr and Southwick *et al.*, (1998) on "Loadel" cvs. peach.

Regarding the effect of the chemical thinner rates, the obtained results revealed that (GA_3 & ethrel) treatments inversely affected both the fruit total soluble pectin and the fruit firmness. In other words, the three GA_3 application rates caused a significant increment in fruit firmness, except the 50ppm concentration in the first season and decreased significantly the total fruit soluble pectin content as compared with the control. Meanwhile, the three ethrel application rates decreased significantly the fruit firmness and caused significant increment in the total fruit soluble pectin content (Tables2&3). The obtained herein results are in agreement with those of Abdel Hamid (1999) and Marini (1985) working on peaches.

4.7 Fruit pigments:

4.7.1 Total chlorophyll:

Concerning the total fruit chlorophyll content, analogous pattern of response was observed with both the pruning levels and etherel rates. The concerned treatments decreased the total fruit chlorophyll content as compared with the control in both 2000 and 2001 seasons. Data presented in Tables (2&3) showed that the total fruit chlorophyll content was significantly lower with all pruning levels and etherel rates compared with the control, except the light pruning level in the two experimental seasons. These results are in line with those of Sims *et al.*, (1974) investigating the effect of 2-chloroethyl phosphonic acid on peach quality and maturation.

As for the GA_3 treatments, it is quite evident that all GA_3 concentrations increased the total fruit chlorophyll content than the control, but differences did not reach the limit of significance in both seasons, Tables (2&3). Murphey and Dilley (1988) mentioned that the change in apple fruit color might be due to the destruction of chlorophyll, revelation of pigments previously masked and synthesis of new pigments.

4.7.2 Total carotene and anthocyanin:

Data presented in Tables (2&3) revealed that the pruning severity levels and the GA_3 chemical thinner rates slightly increased the total fruit carotene and anthocyanin content than the control. Differences were not big enough to be statistically significant in both experimental seasons. These findings are in harmony with those of Abdel-Hamid (1999) and Dann and Jerie (1988) on peaches.

Anthocyanins are representatives of a large group of flavonoid plant pigments responsible for most of the red, blue and intermediate colors of flowers and fruits. All peach naturally occurring anthocyanins are glycosides, the corresponding algycone being called anthocyanidins (Costa *et al.*, 1995).

In this respect, it is obvious that ethrel application encouraged coloration of 'Flordasun' peach fruit. The three ethrel levels caused a significant increment in the fruit carotene and anthocyanin contents as compared with the control in both seasons. These results are in harmony of those of Grossman and DeJong (1998) and Vitagliano *et al.*, (1998) working on peach trees.

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الملخص العربي

استجابة أشجار الخوخ صنف فلورداصن لشدة التقليم والخف الكيماوى باستخدام حمض الجبريليك و الإيثريل

١- المحصول وجودة الثمار

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أوضحت نتائج الدراسة خلال موسمى ٢٠٠٠، ٢٠٠١ أن مستويات التقليم المتبعة لأشجار خوخ فلورداصن و استخدام مواد الخف الكيماوى سواء حمض الجبريليك قبل الإزهار أو الإيثريل بعد الإزهار أدت إلى نقص معنوى فى المحصول وحسنت من الصفات الطبيعية والكيميائية للثمار. بصفة عامة فإن المستوى الشديد من التقليم والتركيزات العالية لكل من مواد الخف المستخدمة(١٥٠ جزء فى المليون& ١٠٠ جزء فى المليون إيثريل) أحدثت زيادة معنوية فى كل من وزن وحجم الثمار ووزن كل من اللب والبذور. كما أوضحت النتائج أن المعاملة بالإيثريل قللت من صلابة الثمار نتيجة لزيادة محتواها من البكتين الكلى الذائب. و على العكس من ذلك فقد أدت معاملات التقليم والرش بحمض الجبريليك إلى زيادة صلابة الثمار نتيجة لإنخفاض محتواها من البكتين الكلى الذائب. وقد حققت المعاملة بالتركيزات الثلاثة المستخدمة للإ يثريل أفضل النتائج من ناحية المواد الصلبة الذائبة الكلية ، فيتامين ج ، المواد الفينولية والسكريات الكلية. وقد زادت حموضة عصير الثمار بالمعاملة بحمض الجبريليك ونقصت بالمعاملة بالإيثريل ولم تتأثر معنويا بمعاملات التقليم. كذلك أدت المعاملة بالإيثريل وبمعاملات التقليم إلى نقص معنوى فى محتوى الثمار من الكلوروفيل الكلى بينما أدت المعاملة بحمض الجبريليك إلى زيادة محتواها منه. كان من الواضح تأثير المعاملة بالإيثريل على تحسين التلوين فى ثمار الخوخ فلورداصن نتيجة للزيادة فى محتواها من صبغات الكاروتين و الأنثوسيانين.