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Orijinal araştırma (Original article)

Prunasin contents of Turkish apricot cultivars and artificial infestation of rootstocks by *Capnodis tenebrionis* (Linnaeus, 1758) and *Capnodis carbonaria* (Klug, 1829) (Coleoptera: Buprestidae)

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Summary

These studies were conducted in Izmir (Bornova) under natural conditions with three years old rootstocks grown in pots. One-day old neonates were used for artificial infestations of different apricot rootstocks and 5 neonates of *Capnodis tenebrionis* (Linnaeus, 1758) were given per rootstock for artificial infestation. The same procedure was followed for infestation of *C. carbonaria* (Klug, 1829). Relationship has not been determined between prunasin compounds of roots and infestation, but it has been determined prunasin accumulation between varieties. The percentage of *C. tenebrionis* infested saplings and the number of larvae per sapling arranged from the highest to the lowest for cultivar as follows: Şekerpare > Soğancı > X1 Zerdali > Kabaaşı > Tokaloğlu > Adilcevaz 2 > X2 Zerdali > Şam > Adilcevaz 1 > Hacıhaliloğlu > Adilcevaz 4 > Hasanbey while the percentage of *C. carbonaria* infested saplings and the number of larvae per sapling arranged from the highest to the lowest for cultivars as follows: Adilcevaz 1 > Adilcevaz 2 > X2 Zerdali > X1 Zerdali > Hacıhaliloğlu > Soğancı > Hasanbey > Şam > Adilcevaz 4.

Key words: *Capnodis tenebrionis, Capnodis carbonaria,* prunasin, apricot, *Prunus armeniaca*

Anahtar sözcükler: *Capnodis tenebrionis, Capnodis carbonaria,* prunasin, kayısı, *Prunus armeniaca*

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Introduction

Apricot is among the important fruit species in Turkey and as a consequence of extremely high variation in terms of eco-geographical conditions and after a long period of seed propagation, much genetic diversity developed in this species (Ozbek, 1978; Ercisli, 2004).

Since plant health problems play major role on fruit quality, so far several international projects having in common some fundamental aims are being carried out. One of these aims is resistance to disease and pests (Audergon, 1995; Bassi et al., 1995; Egea et al., 1999; Karayiannis & Mainou, 1999; Martinez-Gomez & Dicenta, 1999; Dicenta et al., 2000; Martinez-Gomez et al., 2000; Beckman & Lang, 2003).

The peach flatheaded rootborer [*Capnodis tenebrionis* (Linnaeus, 1758)] (Coleoptera: Buprestidae) is an important pest of apricot trees especially in southern Europe, Mediterranean areas (Viggiani, 1991; Bily, 2002) and in Turkey including Aegean, Central Anatolia and Marmara regions (Lodos & Tezcan, 1995; Tezcan, 1995 a, b; Tozlu & Özbek, 2000; Kanat & Tozlu, 2001). Although this problem is of great importance from the point of apricot production, the research on this subject is rather low.

Adults of *C. tenebrionis* feed on the cortex of twigs and young branches and oviposition on the ground. One female lays more than 500 eggs during her life span. Generally, plant species belonging to Rosaceae such as apricot (*Prunus armeniaca* Linnaeus, 1753), peach (*P. persica* (Linnaeus) Batsch, 1801), plum (*P. domestica* Linnaeus, 1753), cherry (*P. avium* Linnaeus, 1755) and almond (*Amygdalus communis* Linnaeus, 1753) are damaged by these pests (Lodos & Tezcan, 1995; Tezcan, 1995 a, b; Tozlu & Özbek, 2000; Kanat & Tozlu, 2001). The most harmful effect is carried out by larvae and they destroy the plants (Lodos & Tezcan, 1995). The second important species is the almond flatheaded rootborer [*Capnodis carbonaria* (Klug, 1829)] in Turkey. This species make the same damage to the above mentioned plant species in Turkey (Lodos & Tezcan, 1995; Tezcan, 1995 a, b; Kanat & Tozlu, 2001).

The cyanogenic glycosides are the natural products of plants and belong to the products of secondary metabolism. As it is known, cyanogenic glycosides have a potential danger owing to the production of HCN. Confirming this, harmful effect appeared in cows which eaten the stems and leaves of bird cherry (Sargison et al., 1996).

These compounds which are widely distributed in the plant kingdom are present in more than 2500 plant species including in families such as *Fabaceae*, *Rosaceae*, *Linaceae*, *Asteraceae* and others. The prunasin is one of the cyanogenic compounds and has a relatively broad distribution in *Rosaceae* family (Vetter, 2000).

Studies on cyanogenic compounds reveal that some cyanogenic forage plants contained the highest level at the intensive growth stage and some plants had the high value at the stage of seed and fruit development. On this matter, it was observed to be high cyanogenic compound during seed development in apricot (Ohtsubo & Ikeda, 1994).

Amygdalin and prunasin are cyanogenic glycosides exist in *Prunus* species. It was stated that, there was a relationship between levels of cyanogenic compounds (amygdalin and prunasin) in sweet and bitter kernelled almond trees (Dicenta et al., 2002a). In this respect, cyanogenic compound levels of leaves, and roots of 5 sweet-, 5 slightly bitter-, and 5 bitter-kernelled almond trees was determined. Prunasin was found only in the vegetative part (roots and leaves) for all genotypes. But, amygdalin was detected in the kernels, mainly in bitter genotypes. In this research, bitter-kernelled genotypes had higher levels of prunasin in their roots than nonbitter ones, but the correlation between cyanogenic compounds in the different parts of plants was not high. While prunasin seems to be present in most almond roots, only bitter-kernelled genotypes are able to transform it into amygdalin in the kernel (Dicenta et al., 2002a).

Distinct cellular localizations of the enzymes involved in the degradation pathway, possibly involving a seed coat prunasin hydrolase, have also been suggested to be related to bitterness in almond (Sánchez-Pérez et al., 2008). Prunasin seems to be the form of cyanogenic glycoside transported in the plant while amygdalin is utilized for storage (Frehner et al., 1990). Usai & D'hallewin (1990), studying three sweet- and one bitter-kernelled almond cultivars, found both amygdalin and prunasin in the kernels.

It was reported that, bitter taste of almond kernels is related to the content of the cyanogenic diglucoside amygdalin. The immediate amygdalin precursor (prunasin) is not produced in the seed, but it is translocated from the mother plant to the developing seed (Socias, 1998; Sánchez-Pérez et al., 2010). Prunasin was accumulate in testa and amygdalin was accumulate in embryo. These results are consistent with the seed coat being an important site of synthesis of prunasin as a precursor of amygdalin accumulation in the kernel (Franks et al., 2008). Upon crushing mature, bitter almond kernels, amygdalin is degraded by the activity of three enzymes: the β-glucosidases amygdalin hydrolase, prunasin hydrolase, and mandelonitrile lyase (McCarty et al., 1952; Chandler, 1957; Woodroof, 1967).

Cyanogenic compounds were found to be related with defence mechanisms (Jones, 1988). This would suggest a reproductive advantage for bitter-kernelled over sweet-kernelled genotypes. In fact, most of wild almonds are bitter-kernelled (Grasselly, 1976). In presence of high levels of cyanogenic compounds, neonates of *Capnodis* spp. can not penetrate into the tissue or die after entering. In this respect, it was shown that bitter kernelled almond genotypes exhibited resistance to larvae of *C. tenebrionis*. This property is due to cyanogenic glucosides contained in different organs of stone fruits (Malagon & Garrido, 1990; Usai & D’Hallewin, 1990). It was stated that there was a relationship between the cyanogenic content of the roots and resistance to neonates of *Capnodis* spp. Resistance to *C. tenebrionis* (capnode) has been associated with the presence of prunasin in the roots of *Prunus* species (Malagon & Garrido, 1990; Usai & D’hallewin, 1990; Mulas, 1994).

A clear relationship for these compounds between kernels and roots would accelerate the breeding of resistant rootstocks with high concentrations of cyanogenic compounds, since the inheritance of the bitterness of the kernel is known (Heppner, 1923, 1926; Dicenta & Garcia, 1993).

In another research, it was found that, strong resistance to the borers has been displayed by Mahaleb, *P. mahaleb,* and by two crosses of *P. persica x P. amygdalus,* 677 and Hansen (Salazar et al., 1991; Mendel et al., 2003). Bitter almond showed moderate resistance unexpectedly when compared to the findings of Malagon & Garrido (1990), and Salazar et al. (1991) that bitter almond was a highly resistant rootstock for *C. tenebrionis.* Mendel et al. (2003) showed a different picture, that, the resistance was inversely proportional to the cyanide content with significant correlation between the indices of susceptibility of both tested *Capnodis* species. Highest level of this monoglucoside occurred in the apricot rootstock, and the lowest was recorded in Hansen and Mahaleb, taxa displaying the strongest resistance. Different crosses of these species with bitter almond and possibly with *P. mahaleb* have a potential for breeding resistant rootstock.

In another study, an investigation was performed on the sorghum crop varieties resistant to shoot by *Atherigona soccata* Rondani, 1871 (Diptera: Muscidae) and stem borer *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae) showed that the cyanogenic glucoside existed in greater quantities in susceptible cultivars (Rizvi, 1992). Among eight clover cultivars, feeding damage caused by larvae of *Hypera postica* (Gyllenhal, 1813) (Coleoptera: Curculionidae) was least for a cultivar with high cyanide content (Ellsbury et al., 1992). In another work, a significant positive correlation was found between prunasin content and emergence of the peachtree borer *Synanthedon exitiosa* Say, 1823 (Lepidoptera: Sesiidae) (feeding on *Prunus* spp.) (Brown et al., 1991).

Dicenta et al. (2006) stated in another research that, apricot (*P. armeniaca*) rootstocks have been described as more susceptible to capnode (*C. tenebrionis*) than other species of *Prunus*. In Spain, ‘Real Fino’ and ‘Canino’ seedlings are the two most important rootstocks for apricot. In this work the susceptibility of seedlings of these cultivars to capnode grubs was studied. Roots were analysed by HPLC to determine the prunasin contents. The results showed a high variability among the seedlings in both cultivars regarding damage in roots and prunasin contents. Furthermore, a high correlation between resistance to capnode grubs and prunasin content in roots was observed.

Sefer et al. (2006), were determined the situation of phenolic compounds in sweet and bitter apricot varieties. For this purpose, sweet apricot varieties such as Kabaaşı, Şam and Hasanbey and bitter varieties such as Adilcevaz 2, Adilcevaz 4 and X1 Zerdali were used. Phenolics and cyanogenic glycosides were analysed by using thin layer chromatography and high performance liquid chromatography, and it was found that bitter kernelled apricots contain higher levels of phenolic and cyanogenic compounds in the leaves, roots and seeds than sweet kernelled ones.

To evaluate the potential of *Prunus* rootstocks for resistance to *Capnodis* spp., Yehuda et al. (2001) were compared 10 such rootstocks with neonates of *C. tenebrionis* and *C. carbonaria.* Eight weeks later the percentages of infested saplings and the numbers of larvae per sapling were determined. The lowest indexes of susceptibility to *C. tenebrionis* and *C. carbonaria* were displayed by Hansen 536 (*P. amygdalus* x *P. persica*) and Mahaleb (*P. mahaleb*), respectively. However, there was no direct relationship between resistance to *Capnodis* and level of cyanogenic compounds in the root cortex. Despite the high resistance against the borers shown by Mahaleb and Hansen, both cultivars had the lowest cyanide potentials.

Similarly, in order to determine the relationship between resistance to the *Capnodis* spp. and the content of the cyanogenic compounds in the roots 15 descendants of a cross between Garrigues and Tuono almond cultivars which are 5 sweet, 5 slight bitter, and 5 bitter kernelled were used. Root samples were taken during spring. The bitter kernelled genotypes contained high cyanide concentrations but, the levels were lower than the rest. Only, some genotypes such as S3088 (slight bitter), S3066 and S3070 (sweet), appeared in their roots similar or even higher cyanide levels than some bitter individuals. The slight bitter and sweet kernelled almonds exhibited similar behavior and their cyanide content was intermediate level in the roots (Dicenta et al., 2003).

The objective of this research is to evaluate the plant-pest relationships regarding to resistance mechanisms by investigating the larval population. The other purpose of the study is to determine the quantitative distribution of prunasin that is one of the cyanogenic compounds, in the roots of bitter and sweet kernelled apricot seedlings used as rootstocks. Thus, it could be useful to design strategies of breeding apricots with high cyanogenic contents in their roots, probably conferring resistance to *C. tenebrionis* and *C. carbonaria.*

Material and Methods

In the current study, the root samples of sweet (Şekerpare, Tokaloğlu, Kabaaşı, Soğancı, Şam, Hacıhaliloğlu, Hasanbey) and bitter (X1 Zerdali, X2 Zerdali, Adilcevaz 1, Adilcevaz 2, Adilcevaz 4) kernelled apricot varieties were tested to *C. tenebrionis.* In these tests, 3 years old plants grown in pots were used. Totally 11-20 seedlings were tested in each variety.

The tested varieties were Soğancı, Şam, Hacıhaliloğlu, Hasanbey, X1 Zerdali, X2 Zerdali, Adilcevaz 1, Adilcevaz 2 and Adilcevaz 4 for *C. carbonaria.* The total number of rootstocks tested for *C. tenebrionis* was 240 belonging to 12 varieties of apricot and it was 180 belonging to nine varieties of apricot for *C. carbonaria.*

If pots were broken or were damaged by different factors, these replications were excluded from evaluation and the rest of the replications were evaluated at final stage.

Root infestation

Adults of *C. tenebrionis* were collected from infested apricot, cherry and plum groves in July 2001. They were kept in ventilated cages and fed with fresh branches of apricot, mahaleb (*P. mahaleb*), cherry and plum. Oviposition in the cages occurred in boxes that were filled with sandy soil and replaced daily. Egg incubation temperature was at 27 ± 1ºC. After incubation, one-day old neonates were used for artificial infestations of apricot rootstocks. Five neonates were given per rootstock for artificial infestation from the end of July to the mid of August, 2001. After artificial infestation of plants, surface of soil of each pot covered with organdy muslin in order to protect them from infestation of nontarget organisms during the further research period. The roots of seedlings were dissected in the second half of April to the first half of May, 2002. As it is presented on the Table 1; infected and uninfected plants were noted and the number of larvae found under bark of roots were counted. The same procedure was followed for infestation of *C. carbonaria*.

It was thought that different number of larvae may be survive at different rootstocks and the rate of surviving larvae (%) **S** of rootstocks was determined for each *Capnodis* species.

For this reason, following equation which used in this kind of studies by previous researchers was taken (Mulas, 1994).

$$\mathbf{S = l / L + p / P + [(p1 / p) \times 1] + [(p2 / p) \times 2]}$$

It was calculated using this equation where **l**: the number of surviving larvae; **L**: out the total of larvae inoculated; **p**: the total number of infested plants; **P**: out of the total number of plants; **p1**: the number of plants infested with one; **p2**: two larvae out of the total number of infested plants were analyzed (Mulas, 1994).

Cyanogenic compounds

Roots samples of infested plants were dried at 65ºC for 48 hours for chemical analysis after dissection. Samples were extracted in methanol, and stored in refrigerator until they were analyzed. Cyanogenic glycosides were analyzed by using high performance liquid chromatography. JASCO High Performance Liquid Chromatography LC-900 Intelligent Pomp and ET 125/4 Nucleosil 120-S C18 column was used.

Prunasin was used as standard. The evaluations were carried out at 210 nm wavelength. Flowing speed was 0.5 ml. mobile phase was Acetonitrile: water (1: 4). Sample injection was 5 µl. Obtained values were compared to prunasin standard, and prunasin content was determined.

The data were analyzed statistically by one-way ANOVA using SAS computer programme (SAS, 1996).

Results and Discussion

As it has been seen in Table 1, average infestation rate of saplings was higher (25.35 %) in sweet cultivars than bitter cultivars (21.47 %) for *C. tenebrionis,* in general. In sweet kernelled varieties, a great majority of the seedlings do not have larvae. On the other hand, one larva was found in some seedlings of the varieties. Soğancı and Şekerpare ranked the first row, but Tokaloğlu, Hasanbey and Şam ranked the last rows in terms of one larvae. Two larvae per seedling were detected only in Tokaloğlu and Şekerpare. In bitter kernelled varieties, similarly to sweet kernelled ones, parallel results were obtained for no larvae. For one larva, the highest value occurred in X1 Zerdali. In addition, two larvae were determined in this variety but, only one seedling had two larvae. The percentage of *C. tenebrionis* infested saplings and the number of larvae per sapling arranged from the highest to the lowest for cultivar as follows: Şekerpare > Soğancı > X1 Zerdali > Kabaaşı > Tokaloğlu > Adilcevaz 2 > X2 Zerdali > Şam > Adilcevaz 1 > Hacıhaliloğlu > Adilcevaz 4 > Hasanbey.

For no larvae, average prunasin content in sweet and bitter kernelled apricot varieties was determined 1.41 mg/ml (Figure 1). For one larva, this value was 1.19 in sweet kernelled varieties, and 0.99 in bitter kernelled varieties. As it was evaluated for two larvae, this content was 0.72 for sweet kernelled varieties and 2.31 for the others. General mean values of sweet and bitter kernelled apricots were 1.18 and 1.25, respectively. At this situation it was observed that bitter kernelled apricots contained relatively much more prunasin than the sweet ones in terms of general evaluation. Besides, confirming this datum, it was found to be low infestation rate in bitter kernelled apricot varieties. Taking into account this situation, according to general evaluation it could be said that there was a relationship between infestation rate and prunasin content in bitter kernelled varieties and resistance to *C. tenebrionis*. On the other hand, according to evaluation in each variety, it is not possible to give a correlation between sweet and bitter kernelled cultivars in accordance with the results of infestations. Taking into account the bitterness situation it will be doubtful that there is a positive relationship between resistance and kernel bitterness. Similarly, the result of prunasin content of bitter and sweet kernelled apricot seedlings confirmed the same results.

Table 1. Infestation rate and the rate of surviving larvae of apricot varieties infested by *Capnodis tenebrionis* (Linnaeus, 1758)

Cultivars	Kernell Sweetness	Number of replication	Number of larvae		Infestation rate of saplings (%)	Rate of surviving larvae (%)
			One larva	Two larvae		
Şekerpare	Sweet	20	9	1	50.00	1.1600a
Soğancı	Sweet	19	8	0	42.10	0.9263ab
Kabaaşı	Sweet	18	5	0	27.78	0.6109ab
Tokaloğlu	Sweet	20	2	2	20.00	0.5600ab
Şam	Sweet	19	3	0	15.79	0.3474b
Hacıhaliloğlu	Sweet	17	2	0	11.76	0.2588b
Hasanbey	Sweet	20	2	0	10.00	0.2200b
X1 Zerdali	Bitter	19	6	1	36.84	0.8735ab
Adilcevaz 2	Bitter	16	4	0	25.00	0.5500ab
X2 Zerdali	Bitter	19	4	0	21.05	0.4631ab
Adilcevaz 1	Bitter	15	2	0	13.33	0.2933b
Adilcevaz 4	Bitter	18	2	0	11.11	0.2444b

Means followed by a same letter do not significantly different from each other at P=0.05. The data were analyzed statistically one-way ANOVA using SAS (SAS, 1996).

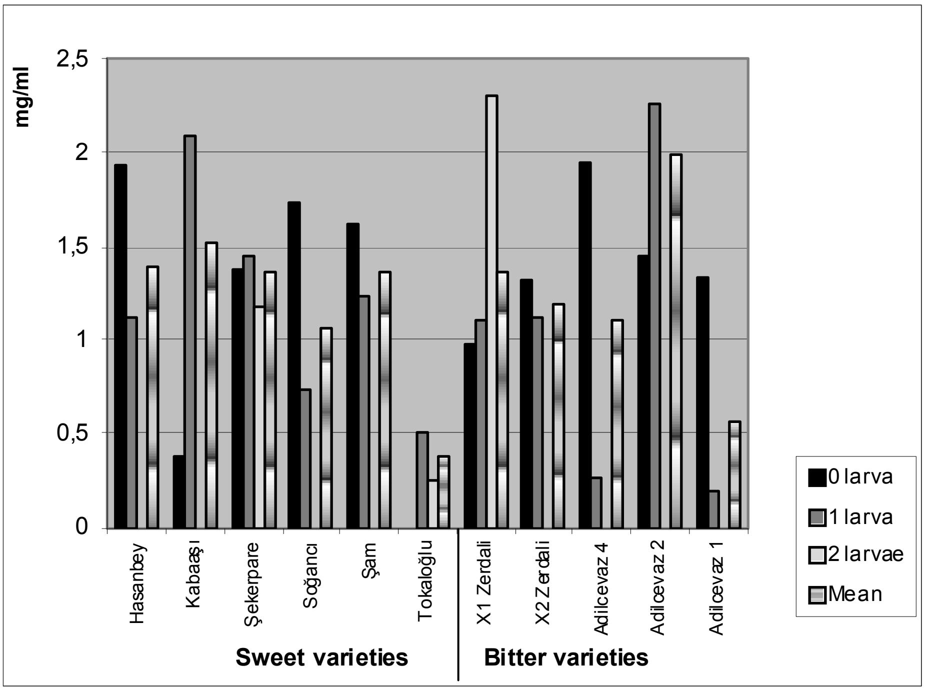

Figure 1. Prunasin contents of apricot varieties infested by *Capnodis tenebrionis* (Linnaeus, 1758).

As it has been seen in Table 2 and Figure 2, average infestation rate was higher in bitter cultivars (22.88 %) than sweet cultivars (16.55 %) for *C. carbonaria*. In sweet kernelled varieties, a great majority of the seedlings do not have larva. On the other hand, one larva was found in some seedlings of the varieties. Hacıhaliloğlu, Soğancı, Hasanbey and Şam had 3, 3, 2 and 1 seedling respectively in terms of one larva. Two larvae per seedling were detected only in Şam. In bitter kernelled varieties, similarly to sweet kernelled ones, parallel results were obtained for no larva. For one larva, Adilcevaz 1 and Adilcevaz 2

Table 2. Infestation rate and the rate of surviving larvae of apricot varieties infested by *Capnodis carbonaria* (Klug, 1829)

Cultivars	Kernell Sweetness	Number of replication	Number of larvae		Infestation rate of saplings (%)	Rate of surviving larvae (%)
			One larva	Two larvae		
Hacıhaliloğlu	Sweet	16	3	0	18.75	0.4125a
Soğancı	Sweet	16	3	0	18.75	0.4125a
Hasanbey	Sweet	11	2	0	18.18	0.3999a
Şam	Sweet	19	1	1	10.53	0.2947a
Adilcevaz 1	Bitter	17	6	0	35.29	0.7765a
Adilcevaz 2	Bitter	16	5	0	31.25	0.6875a
X2 Zerdali	Bitter	17	3	1	23.53	0.5882a
X1 Zerdali	Bitter	16	2	1	18.75	0.4875a
Adilcevaz 4	Bitter	18	1	0	5.56	0.1222a

Means followed by a same letter do not significantly different from each other at P=0.05. The data were analyzed statistically one-way ANOVA using SAS (SAS, 1996).

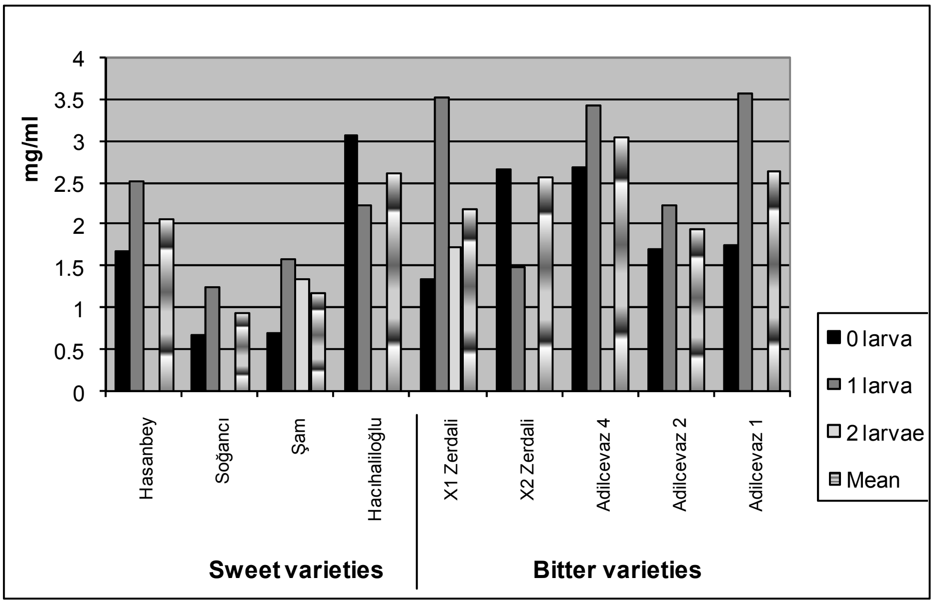

Figure 2. Prunasin contents of apricot varieties infested by *Capnodis carbonaria* (Klug, 1829).

had the highest value. One larva per seedling was detected only in one seedling of Adilcevaz 4 variety. Besides, two larvae were not found in Adilcevaz 1, 2 and 4 varieties. Controversary, two larvae occurred in one seedling of X1 and X2 Zerdali varieties. The percentage of *C. carbonaria* infested saplings and the number of larvae per sapling arranged from the highest to the lowest for cultivars as follows: Adilcevaz 1 > Adilcevaz 2 > X2 Zerdali > X1 Zerdali > Hacıhaliloğlu > Soğancı > Hasanbey > Şam > Adilcevaz 4.

For no larva, mean prunasin content in sweet kernelled apricot varieties was 1.53 mg/ml and in bitter kernelled apricot varieties was 2.03 mg/ml. For one larva, this value was 1.88 mg/ml in sweet kernelled varieties, 2.84 in bitter kernelled varieties. As it was evaluated for two larvae, this content was 1.33 for sweet kernelled varieties and 2.68 for the bitter ones. General mean values of sweet and bitter kernelled apricots were 1.58 and 2.52, respectively. According to general evaluation, bitter kernelled apricots were contained much more prunasin than the sweet ones. Thus, bitter kernelled apricot varieties had high value for both prunasin content and infestation rate. On the other hand, according to evaluation in each variety, it is injudicious to give a correlation between sweet and bitter kernelled cultivars in accordance with the results of infestations. Taking into account the bitterness and infestation rate, it will be indefinable that there are the positive relationship between resistance and sweet and bitter kernelled apricot varieties. On the contrary, bitter kernelled apricot varieties had high prunasin content, exhibited higher infestation rate than the sweet ones. At this moment, it is not possible to give a correlation between resistance to *C. carbonaria* and bitterness. The percentage of *C. carbonaria* infested saplings per cultivar arranged from the highest to the lowest number of larvae per sapling was as follows: Adilcevaz 1 > Adilcevaz 2 > X2 Zerdali > X1 Zerdali > Hacıhaliloğlu > Soğancı > Hasanbey > Şam > Adilcevaz 4. In another investigation, individual analysis does not show a close relationship between the amygdalin content in the kernel (bitter trees) and the prunasin content in the vegetative part, since some bitter genotypes had less prunasin than some sweet ones (Dicenta et al., 2002a). Prunasin is present in the vegetative part of most almond genotypes, although only some genotypes are able to store it in the kernels. These individuals, the bitter ones, would be those that traditionally have been considered homozygous recessive (ss), so the bitter flavor would be related to the possibility of transforming the prunasin into amygdalin in the kernel (Dicenta et al., 2002a).

The fact that bitter kernelled apricots have high levels of cyanogenic compounds in their roots, is of great importance from the point of resistance to pests. On this matter, certain results were not obtained in this research. Confirming this data, it was found out that cyanogenic content of bitter almonds were higher than the non bitter genotypes in the seeds (Usai & D'Hallewin, 1990; Dicenta et al., 1999), whereas this phenomenon did not significantly occur in the roots and leaves. Dicenta et al. (2002a) stated that, individual analysis does not show a close relationship between the amygdalin content in the kernel (bitter trees) and the prunasin content in the vegetative part, since some bitter genotypes had less prunasin than some sweet ones. Their results offer promise for breeders as they could select individuals with higher prunasin concentrations in roots, independent of the sweetness or bitterness of kernel. This could be particularly useful for sweet almonds with high prunasin contents in their roots, which could then be vegetatively propagated and grown on their own roots (Dicenta et al., 2002a,b). In another work, Dicenta et al. (2009) studied prunasin content and the resistance to capnode grubs of almond descendants of different genotypes with respect to bitterness. Three months after having inoculated the plants with neonate grubs, incidence of damage in roots and presence of grubs were determined. Afterwards, prunasin content in the roots was determined by HPLC. The results showed that the damage level was similar in the three families. The prunasin contents seemed to be independent of kernel bitterness and behaved as a quantitative trait. The lack of relationship was found between prunasin contents and damage in roots might be due to an anomalous low incidence of capnode grubs in the roots. Similarly, in another research that resistance to *C. tenebrionis* and *C. carbonaria* of 10 *Prunus* rootstocks were investigated, it was found that there was an inverse relationship between resistance to *Capnodis* and level of cyanogenic compounds in the root cortex. Adults of both *Capnodis* spp. were not prevented by high levels of cyanogenic compounds in the scion twig cortex. Similar to our results, their findings suggest that cyanide potential is not a reliable indicator of the degree of resistance in *Prunus* spp. rootstocks to *Capnodis* spp., and the level of prunasin may be linked to other chemicals or mechanisms that provide the plant with the means to deter colonization of the root by *Capnodis* (Mendel et al., 2003).

However, the relationship between these compounds in seeds and roots has not been determined. If there was close relationship, it would be simple to obtain almond trees with high concentrations of cyanogenic compounds in the roots, since the control of the bitter flavor of the seed is well-known (Dicenta & García, 1993). In another study of the same researchers, there was no correlation between root damage of different almond cultivars and the content of prunasin (Canovas et al., 2002). It is of vital importance to state varieties which are resistant to pests. For this purpose, in the future further work must be carried out much deeper to obtain resistance of apricot rootstocks to pests.

Özet

Türkiye kayısı çeşitlerinin prunasin içerikleri ve çöğürlerin *Capnodis tenebrionis* (Linnaeus, 1758) ve *Capnodis carbonaria* (Klug, 1829) (Coleoptera: Buprestidae) ile yapay bulaştırılması

Bu çalışma saksıda yetiştirilen üç yaşında çöğürlerle İzmir (Bornova)'de doğa koşullarında gerçekleştirilmiştir. Çalışmada, farklı kayısı çeşitlerinin çöğürleri *Capnodis tenebrionis* (Linnaeus, 1758)'in bir günlük, birinci dönem beşer larvasıyla yapay olarak

bulaştırılmıştır. Aynı işlem *C. carbonaria* (Klug, 1829)'nın bulaştırılmasında da izlenmiştir. Enfeksiyonlarla prunasin içerikleri arasında bir ilişki bulunamamış, ancak çeşitler arasında prunasin birikimi açısından farklılık saptanmıştır. Duyarlılığın sıralamasının en yüksekten en düşüğe doğru *C. tenebrionis* için Şekerpare > Soğancı > X1 Zerdali > Kabaaşı > Tokaloğlu > Adilcevaz 2 > X2 Zerdali > Şam > Adilcevaz 1 > Hacıhaliloğlu > Adilcevaz 4 > Hasanbey şeklinde; *C.carbonaria* için ise en yüksekten en düşüğe doğru olmak üzere Adilcevaz 1 > Adilcevaz 2 > X2 Zerdali > X1 Zerdali > Hacıhaliloğlu > Soğancı > Hasanbey > Şam > Adilcevaz 4 şeklinde olduğu ortaya konmuştur.

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