Rape Stem Weevil (*Ceutorhynchus napi* Gyll. 1837) and Cabbage Stem Weevil (*Ceutorhynchus pallidactylus* Marsh. 1802) (Coleoptera: Curculionidae) – Important Oilseed Rape Pests

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Summary

Stem mining weevils, rape stem weevil (*Ceutorhynchus napi* Gyll. 1837) and cabbage stem weevil (*Ceutorhynchus pallidactylus* Marsh. 1802) have become more important oliseed rape pests. Rape stem weevil is present in middle and west European countries and cabbage stem weevil is present in almost all European countries. The most important morphological difference between adults is colour of their legs. Biological and ecological characteristics of these two pests are similar, stem mining weevils are observed as pest complex. Differences in biology cause different approach in pest control. Both species have single generation annually. Larvae feed inside the petioles and stems of oilseed rape. Phyrethroids are used for adult control of stem mining weevils.

Key words

oilseed rape, rape stem weevil, cabbage stem weevil

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Introduction

Stem mining weevils, rape stem weevil (*Ceutorhynchus napi* Gyllenhal, 1837) and cabbage stem weevil (*Ceutorhynchus pallidactylus* Marsham, 1802) have become more important oilseed rape pests. Oilseed rape in Croatia is grown on about 15000 ha and production increases gradually with an average yield about 3.01 t/ha. Oilseed rape is the most important crop for oil production and the most important raw material for biodiesel, which production in the world constantly increases. In its production there are numerous problems associated with crop protection against diseases, pests (Maceljski and Jelovčan, 2007; Jelovčan et al., 2007; Gotlin Čuljak et al., 2008; Jelovčan et al., 2008) and weeds, also with the development of resistance to the pesticides. There was no investigation about stem mining weevils in oilseed rape in Croatia. They haven`t been directly controlled and it is thought that they can be controlled together with the pollen beetle (*Meligethes aeneus* Fabricius 1775). Investigations that were conducted within the project "Integrated control of pests in oilseed rape for biodiesel production" show that attack intensity of mentioned pests is 100% in some years and locations as well as suspect that stem mining weevils are controlled together with pollen beetles. The intention of this paper is to show morphological, biological and ecological characteristics of these pests based on literature review. According to preliminary investigations (Gotlin Čuljak et al., 2010) yield of oilseed rape can be reduced by stem mining weevils up to 800 kg/ha. Furthermore, objective of the authors is to discuss the necessity of the control and the possible optinos for monitoring and decision thresholds.

Systematics

Order: Coleoptera

Suborder: Polyphaga

Superfamily: Curculionoidea

Family: Curculionidae Latreille, P.M., 1802

Subfamily: Ceutorhynchinae Gistel, J., 1848

Genus: *Ceutorhynchus* Germar, E.F., 1824

Species: *Ceutorhynchus napi* Gyllenhal, 1837 – rape stem weevil

Species: *Ceutorhynchus pallidactylus* Marsham, 1802; syn. *Ceutorhynchus quadridens* Panzer, 1795 – cabbage stem weevil

Species distribution

Rape stem weevil is present in Austria, Belgium, Bulgaria, Czech Republic, Danish mainland, France, Germany, Hungary, Italy, Netherlands, Poland, Slovakia, Spain and Switzerland (Alonso-Zarazaga, 2004). It is also present in Croatia (Maceljski, 1974; 1979; 2002). Cabbage stem weevil is present in Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Danish mainland, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Latvia, Liechtenstein, Lithuania, Luxemburg, Macedonia, Malta, Moldova, Monaco, Montenegro, Northern Ireland, Norway, Poland, Portugal, Romania, Russia (European part), San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey (European part) and Ukraine (Alonso-Zarazaga, 2004).

Morphology

C. napi (Figure 1) is the largest species of *Ceutorhynchus* genus that can make damages on oilseed rape. Body of adults is greyish, 3.2 – 4 mm long with three rows of whitish hairs between the longitudinal furrows on the elytra (Alford et al., 2003). Legs of the rape stem weevil are black (Maceljski, 2002). Eggs are greyish-white, oval, smooth, 0.7 – 0.8 mm long and 0.4 – 0.46 mm wide (Scherf, 1964). Larvae are yellowish-white, up to 8 mm long, solid structure, true legs are absent, head capsule is brown and chitinized with one pair of stemmata. On the head capsule (cranium) there are six furrows (Figure 2) and front part of labrum is rounded with 23 furrows (Dosse, 1953) (Figure 3). Structure of rape stem weevil (Figure 4) in lateral papillary knots can be seen on detail of skin. Pupa is white, 3.2-3.7 mm long and 1.7-2.2 mm wide (Figure 5).

Figure 1. Adult form of rape stem weevil (*C. napi*) (Jelovčan)

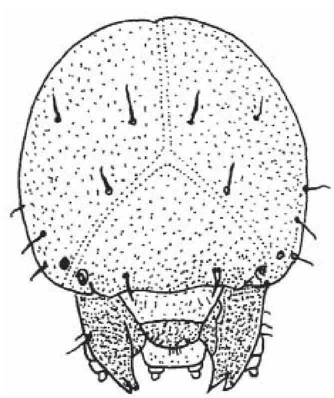

Figure 2. Skull (cranium) of rape stem weevil larva (original according to Scherf, 1964)

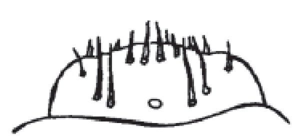

Figure 3. Upper lip (labrum) of rape stem weevil larva (original according to Scherf, 1964)

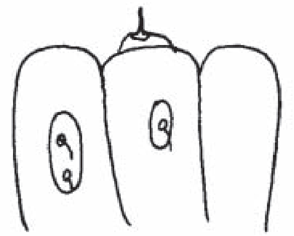

Figure 4. Detail of skin structure of rape stem weevil larva (lateral view) (original according to Dosse, 1953)

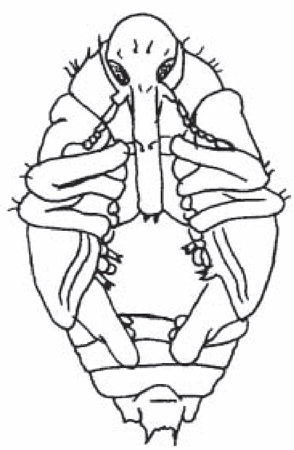

Figure 5. Rape stem weevil pupa (original according to Scherf, 1964)

Body of *C. pallidactylus* (Figure 6) is 3.4 mm long. Males are smaller than females, but females have convex abdomen. Basic color of adults is black, but the body of insect is covered by greyish peels, so it looks greyish. Rostrum is relatively long, thin and curved. Between the longitudinal furows on elytra there are three rows of whitish setae (Alford et al., 2003). Tarsus and tibia are red-yellowish and brown-reddish (Sekulić and Kereši, 1998).

Eggs are white, oval, 0.48-0.58 mm long and 0.29-0.39 mm wide. Larvae go through three stages in their life-cycle. First larval stage is 0.9 mm long, second stage is 6 mm long and third stage is 8 mm long. Body of larvae is white, elongated and head is yellowish. Cranium (Figure 7) of the first larval stage is 0.24 mm wide, of the second stage is 0.4 mm wide and of the third stage is 0.5 mm wide. On the labrum (Figure 8) there are 23 furrows. The skin has smooth structure from lateral side (Figure 9) (Dosse, 1953).

Figure 6. Adult form of cabbage stem weevil (*C. pallidactylus*) (Jelovčan)

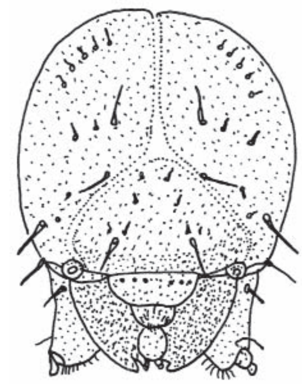

Figure 7. Skull (cranium) of cabbage stem weevil larvae (original according to Scherf, 1964)

Figure 8. Upper lip (labrum) of cabbage stem weevil larvae (original according to Scherf, 1964)

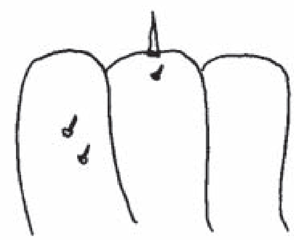

Figure 9. Detail of skin structure of cabbage stem weevil larvae (lateral view) (original according to Dosse, 1953)

The most important morphological differences between adults of rape stem weevil and cabbage stem weevil are shown in Table 1.

Determination of eggs (Figure 10) and larvae (Figure 11) of rape stem weevil and cabbage stem weevil is difficult to conduct according to morphological characteristics. Reliable identification of larvae can be done by establishing the composition of the various modes of skin maceration and tissue staining (Dosse, 1953).

Biology and ecology

Biological and ecological characteristics of stem mining weevils are very similar. They are often monitored as a complex of pests, although biological characteristics are different and

Table 1. Morphological differences between adult forms of rape stem weevil and cabbage stem weevil

	Ceutorhynchus napi Gyll.	*Ceutorhynchus pallidactylus* Marsh.
Body lenght	3.2 – 4 mm	3.4 mm
Body colour	Grey	Black with greyish peels
Leg colour	Black	Reddish-yellow to red
Formations on elytrae	Three rows of whitish hairs between the longitudinal furrows on the elytra	Three rows of whitish setae between the longitudinal furows on the elytra

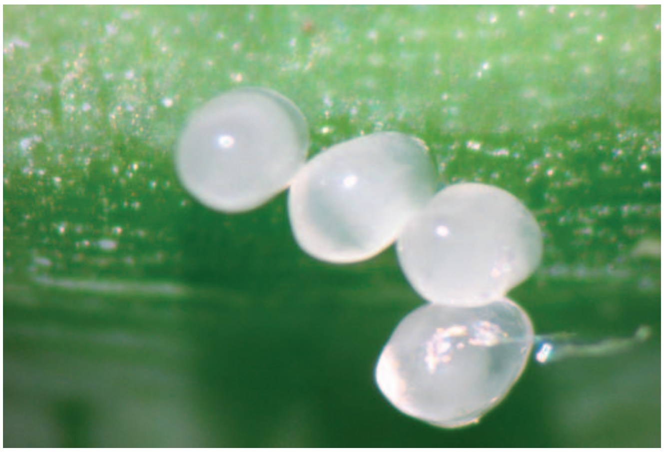

Figure 10. Eggs of stem mining weevils (Juran)

Figure 11. Larva of stem mining weevils (Juran)

demand different approach of control. Adults of *C. napi* overwinter in ground around plants where they have finished their developement and where they pupate (Maceljski, 1974). Adults occur very early, in February and March and begin to fly when temperature exceeds 9°C. The flight is the most intensive at a temperature of 12-15°C (Maceljski, 1974) when they spread to other oilseed rape fields. Mass flight of *C. napi* occurs when temperature maximum exceeds 12.2°C (Šedivy and Kocourek, 1994). Oilseed rape can be affected from the beginning of stem elongation (BBCH 30). Adults of rape stem weevil colonize host plants (oilseed rape and other plants of family Brassicaceae) and feed aditionaly with leaves and stems where they make needle like cavities (Čamprag, 1962). Damages that make overwintering generation are not significant. In period from nine to 11 days after first flight activity 50% of the females can be found carring eggs (Büchs, 1998). After aditional feeding and copulation, females lay eggs into the hole in stem that they previously made by rostrum. Eggs are layed singly in developed and elongated stems near terminal bud (Alford et al., 2003). Females can lay 12 – 60 eggs into the stem (Maceljski, 1974). Embryonic development lasts 7 – 42 days what depends on temperature (Čamprag, 1962; Scherf, 1964; Maceljski, 2002). After hatching, larvae live inside the stems and move upwards or downwards and their development lasts 30 – 40 days (Maceljski, 2002). Larvae development depends on climate and lasts 3 – 6 weeks (Čamprag, 1962). After completion of the development, most frequently in May and June, larvae perforate holes in stem and drop to the ground and pupate in the soil (Maceljski, 1974). Adult stage is reached about a month later. Adults remain within their earthen chambers and do not emerge until the following spring.

Adults of *C. pallidactylus* overwinter shallow into the soil or under leaves and other plant remains, near the fields where plants from family Brassicaceae were cultivated (Sekulić and Kereši, 1998). They appear when soil temperature is 9°C (Čamprag, 1962) or when it exceeds 10°C (Maceljski, 1974). When soil temperature, 5 cm below surface, exceeds 6°C adults appeare (Büchs, 1998). Flight activity starts and first adults appear when temperature is 12°C (Sekulić and Kereši, 1998). Peak of the flight activity is reached on the temperature 14.5°C (Šedivy and Kocourek, 1994). Males and females have different time of apperance after overwintering. Males appear earlier and females 10 - 15 days later than males. Percentage of females increases gradually over a period after overwintering. During appearance of new generation in June and July, percentage of males and females in population is equal (Büchs, 1998). Egg-carrying females appear in average 15 days after the first peak of flight and after 28 days 50% of the females carry eggs (Büchs, 1998). Adults feed on weeds and on cultivated cabbage. If they are disturbed during feeding, they fall to the ground and look like they are dead (Sekulić and Kereši, 1998). Females lay eggs in small groups of four and rearly two eggs (Sekulić and Kereši, 1998). According to Hiiesaar et al. (2003) females lay 2 – 8 eggs into stem and leaf epidermis. During life cycle one female lays about 40 - 100 eggs. Oviposition lasts 21 – 116 days what depends on climate (Čamprag, 1962; Sekulić and Kereši, 1998). Eggs are laid in small groups, preferably in the underside of petioles and in the young shoots. Females prefer laying eggs into the leaves where females of *C. napi* have already laid eggs (Dechert and Ulber, 2004) and avoid laying eggs in plants which are increasingly under attack of *Psillyodes chrysocephala* Linnaeus 1758 which larvae make galeries inside oilseed rape stems (Ferguson et al., 2006). Both species of stem mining weevils prefer oilseed rape plants with higher stem diameter (Dechert and Ulber, 2004; Ferguson et al., 2003). Embryonic development lasts 4 – 21 days (Čamprag, 1962; Sekulić and Kereši, 1998; Marczali et al, 2007) what depends on temperature. Sum of effective temperatures required for egg and larvae development is 160°C on an average and starts from 10°C (Šedivy and Kocourek, 1994). Larvae live in upper part of the stem and in lower leaves petioles of the ground leaves. They start to feed inside the petioles in groups and after that move to the stems and lateral shoots (Alford et al., 2003; Maceljski, 1974). Length of the first stage of larval development is 3 – 5 days, second stage is 4 – 6 days and third is 13 – 21 days. Total duration of larval development is 3 – 5 weeks what depends on environmental conditions (Scherf, 1964; Sekulić and Kereši, 1998; Alford et al., 2003; Marczali et al., 2007). Pupation lasts 15 – 30 days (Čamprag, 1962) and according to Marczali et al. (2007) pupation and apperance of the new adults lasts 24±2 days. Adults of cabbage stem weevil emerge from pupae in the summer, during June, and prior to enternig hibernation can cause damages to vegetable brassicas (Alford et al., 2003; Büchs, 1998). Whole development (embryonic development, larvar stage, pupation and apperance of the new adults) lasts 68±7 days (Marczali et al., 2007).

Both species of stem mining weevils have single generation annually.

Dechert and Ulber (2004) in their investigations showed that females of *C. pallidactylus* tend to lay eggs in plants that have been already infested by eggs and larvae of *C. napi*, rather than in uninfested plants. Larvae of cabbage stem weevil shift their feeding niche towards the stem base when feeding in individual plants attacked by both species.

Adults of stem mining weevils consume their own eggs that were released too early or improperly during oviposition. The consumption of own eggs is an adaptative response to internal or external distortions. It may compensate partially loss of deficient nutrients that are constituent part of their eggs (Kozlowski, 2010).

Parasitoids of rape stem weevil larvae are two species of the family Ichneumonidae, *Tersilochus fulvipes* Gravenhorst 1829 (Kadza, 1956; Aubert and Jourdheuil, 1958; Jourdheuil, 1960; Horstmann, 1971; Šedivỳ, 1983; Ulber, 2000, cit. Ulber, 2003) and *Tersilochus moderatus* Linnaeus (Dosse, 1951, cit Ulber, 2003). *Stenomalina gracilis* Walker 1834 (Pteromalidae) is parasitoid that is reared in Poland from the rape stem weevil larvae (Klukowski and Klem, 2000 cit. Ulber, 2003). Parasitoids of rape stem weevil adult forms are not known.

Parasitoids of cabbage stem weevil larvae are species of the family Ichneumonidae, *Tersilochus obscurator* Aubert 1959 (Aubert and Jourdheuil, 1958; Juordheuil, 1960; Lehmann, 1965; Horstmann, 1971; Šedivỳ, 1983; Klingenberg and Ulber, 1994; Nissen, 1997; Nitzsche, 1998; Ulber, 2000; Kraus and Kromp, 2002, cit. Ulber, 2003), *Tersilochus tripartitus* Brischke 1880 (syn. *T. melanogaster* Thomson) (Günthardt, 1949; Jourdheuil, 1960, cit. Ulber, 2003), *Tersilochus exilis* Holmgren 1860 (Herrström, 1964, cit. Ulber, 2003) and *Stibeutes curvispina* Thomson 1884 (Nissen, 1997, cit. Ulber, 2003). *Trichomalus lucidus* Walker 1835 (Pteromalidae) was reared from cabbage stem weevil larvae by Nissen (Ulber, 2003). Parasitoid of cabbage stem weevil adults is *Microctonus melanopus* Ruthe (Speyer, 1925) (Braconidae) that is reared from other *Ceuthorhynchus* species and from adult forms of cabbage stem flea beetle (*P. chrysocephala*) (Speyer, 1925; Günthardt, 1949; Jourdheuil, 1960, cit. Ulber, 2003).

Plant density has significant impact on degree of stem mining weevils parasitation. Number of adult forms of rape stem weevil and *T. fulvipes* is significantly greater at low than at high plant density. Oilseed rape plant density has not any impact on relation beetwen adults of cabbage stem weevil and *T. obscurator*. Number of larvae of cabbage stem weevil is significantly greater in plots with low plant density than in plots with high plant density. Population density of cabbage stem weevil larvae is similar at low and at high plant density per square meter, which indicate how the plant resources that are needed for oviposition and larvae development were sufficiently available, even at low plant density of oilseed rape. The number of larvae of rape stem weevil per plant does not depend on number of plants per unit area (Fischer and Ulber, 2006), also parasitation level of cabbage stem weevil does not depend of plant density per square meter (Neumann and Ulber, 2006).

Nielsen and Philpsen (2004, cit. Jaworska i Wiech, 1988; Kingler, 1988; Shanks and Agodelo-Silva, 1990; Mannion and Jason, 1992) in their investigation show that stem mining weevils are sensitive on application of entomopathogenic nematodes (*Steinernema feltiae* Filipjev 1934, *Heterorhabditis megidis* Poinar, Jackson et Klein 1987 and *Heterorhabditis bacteriophora* Poinar 1975), where 75% adults of stem mining weevils were infected by mentioned species.

Harmfulness of stem mining weevils on oilseed rape

The egg deposition of *C. napi* females results in twisiting and spliting of tissue, followed by distortion and disruption of the growth. Infested tissue is often invaded by secondary organisms, especially the fungal pathogen *Leptosphaeria maculans* (Desm.) Ces. & De Not. (anamorph *Phoma lingam* (Tode) Desm.) (Alford et al., 2003). Larvae cause disruptions in the growth of plants that often leads to thickening, especially in young plants. Adults feed on leaves and stems of attacked plants doing needle cavities. Such losses are not significant, except for a mass appearance when vegetable brassicas are replanted. Damages caused by larvae can be sometimes huge even if one larva is present in attacked plant (Čamprag, 1962). Plants are deformed, stagnate in growth and decay rapidly. For 24 hours after oviposition plants respond by histological changes. Above the attacked part, plants have slower development, stems are deformed, become spiral and tissue bursts (Figure 12). Plant produces lateral shoots and gets bushy appearance. Consequently, seed maturation is expanded and harvest is complicated. In single stem about ten larvae can be found and stem is completely hollow. The attack of this pest is stronger if humidity is increased during the spring. Sowing of earlier varieties of oilseed rape may avoid an attack, because at the time of oviposition plants are overgrown. The greater damages occur if at the end of March an intensive growth of the plants is not started (Maceljski, 1974). *C. pallidactylus* larvae feed on oilseed rape plants and cause formation of large cracks in the stem and in the lateral shoots (Figure 13).

Figure 12. Oilseed rape stem deformation and bursting caused by *C. napi* (Juran)

Figure 13. Crack in the lateral shoot caused by *C. pallidactylus* (Juran)

Larval infestation causes distortion of tissue and loss of vigour, such damage being especially severe on spring oilseed rape (Alford et al., 2003). On winter oilseed rape, larvae are most often found in the main and lateral shoots and direct damage caused is rarly of any significance. According to Maceljski (1974) larval attack does not cause deformation or cracking of tissue but yellowing and falling off the leaves. Feeding of cabbage stem weevil larvae and adults on oilseed rape plants increases the possibility of infection with *L. maculans* that can cause stem canker (Broschewitz and Daebeler, 1987, cit. Alford et al., 2003).

Oilseed rape hybrids that are sown in spring are more resistant to attack of stem mining weevils and losses are not high (Šedivỳ and Vašák, 2002). According to Kasa and Kondra (1986, cit. Šedivỳ and Vašák, 2002) plants of spring oilseed rape quickly pass through a stage of stem elongation (BBCH 30-39) and therefore are not suitable for oviposition of *C. palidactylus*.

In 1966 for the first time in Croatia there were reported damages caused by rape stem weevil and at one location deformations of 0.5% of plants were reported (Maceljski, 1979). Damages caused by cabbage stem weevil were also identified in 1966, 1969 and 1971 when could be found up to 70% of plants with up to 15 larvae per plant infested by *C. pallidactylus*. Very strong attacks with total loss of yield were established in some locations in 1972 (Maceljski et al., 1980).

In 1982 and 1983 there were particularly vulnerable areas around Županja and Vinkovci where over 90% of oilseed rape plants were infected (Danon et al., 1985).

In continental Europe (Germany, Poland) cabbage stem weevil is harmful in winter and spring oilseed rape. In United Kingdom there is less problem in winter oilseed rape while in France and Switzerland *C. pallidactylus* is not considered as economically important pest (Alford et al., 2003). Rape stem weevil is more important pest in west European countries than in central European countries (Marczali et al., 2007).

Thresholds and pest control

Apperance and flight activity of adults of stem minig weevils in oilseed rape are controled using yellow water traps (34x26x7 cm) that should be instaled into the field at the beginning of stem elongation (BBCH 30). They are filled with water and instaled on metal holders with the possibility of moving up to be whole vegetation period at the level of the crop.

According to data from the native literature, control of rape stem weevil is required in case: in yellow water trap over 10-20 adults in successive days are caught; more than one adult were found at five plants or signs of oviposition on more than 20% of plants were evidented (Maceljski 1983a, 1983b, 2002). Thresholds for cabbage stem weevil were not determined but are considerably larger than the thresholds for rape stem weevil. After the thresholds are achieved the control should be implemented within eight days after the first catch in yellow water trap, which is bigger than 10 – 20 adults (Maceljski, 1983a, 1983b, 2002) or if more than one egg were found per two plants (Maceljski, 1983a). According to Maceljski (2002) rape and cabbage stem weevil are sufficiently suppressed by applying insecticides against pollen beetle, especially in the earlier application, but also because of the increased adversity of stem mining weevils direct control would be necessary. Intensity of the stem mining weevils attack is determined by the number of adults caught in yellow water traps preferably every day before noon or at dusk (Maceljski, 1983a). If the inspection is not done every day, determined number of adults is converted in one day.

According to EPPO standards (2003), control of rape stem weevil is necessary when within three days in yellow water trap 10 adults are caught. In Germany, the practice of producers is to combine rape and cabbage stem weevil together in a threshold decision (10 adults per yellow water trap in three days), but due to differences in their biology that is not correct (Büchs, 1998). In areas where rape stem weevil is dominant insecticide appli-

Table 2. Pest control thresholds for rape stem weevil (*C. napi*) in several European countries (according to Alford et al., 2003)

Austria (BFL, 2000)	10 adult forms/yellow water trap within three days[1]
Dannmark	Pest is not present
Finland	Pest is not present
France (Pilorgé et al., 1997)	Threshold is not established
Germany (Garbe et al., 1996)	10 adult forms/yellow water trap within three days[1]
Poland (Anon., 2000)	20 adult forms/yellow water trap within three days or 2 - 4 adult forms/25 plants
Sweden	Pest is not present
Switzerland (Büchi, 1988)	Threshold is not established
United Kingdom	Pest is not present

[1] *C. napi* i *C. palidactylus* (Table 3) are not monitored separately

Table 3. Pest control thresholds for cabbage stem weevil (*C. pallidactylus*) in several European countries (according to Alford et al., 2003)

Austria (BFL, 2000)	10 adult forms/yellow water trap within three days[1]
Dannmark	Threshold is not established
Finland	Threshold is not established
France (Pilorgé et al., 1997)	Threshold is not established
Germany (Garbe et al., 1996)	10 adult forms/yellow water trap within three days[1]
Poland (Anon., 2000)	20 adult forms/yellow water trap within three days or 2 - 4 adult forms/25 plants
Sweden	Threshold is not established
Switzerland (Büchi, 1988)	Threshold is not established
United Kingdom	Threshold is not established

[1] *C. napi* (Table 2) and *C. palidactylus* are monitored separately

cation is necessary immediately when thresholds are exceeded. In areas where cabbage stem weevils dominate insecticide application is necessary two or three weeks after the highest catch in yellow water traps, even if the thresholds are exceeded several times. According to Büchs (1998) population density of cabbage stem weevil is concur with the peak of the flight activity of pollen beetle. Therefore, no additional use of insecticides against pollen beetle is necessary, because this pest and later migrating cabbage stem weevil are successfully controled by subsequent application of pyrethroids.

Stem mining weevils part of their life cycle spend as larvae hidden in plant and adults are retained often in the flowers and seed pods, so control is difficult to implement (Kovačević, 1968). Pyrethroids are used for adults control of stem mining weevils from "green bud" to "yellow bud" stage (BBCH 50 – 59) (Walters et al., 2003). Pyrethroids application against stem mining weevils has effect on other pests that appear later (*Brevicoryne brassicae* Linnaeus 1758, *Dasineura brassicae* Winnertz 1853 and *Ceutorhynchus assimilis* Paykull 1800) because of repellent effect of pyrethroids. Number of treatments against oilseed rape pests (including stem mining weevils) and the cost of insecticide treatments had been changed in Poland during the history (Walczak i Mrówczyński, 2006). In the eighties of the 20th century the use of organophosphorus insectides dominated. After eighties the use of the number of active pyrethroid substances gradually increased. According to Heimbach et al. (2006) there is the possibility of resistance development of stem mining weevils to pyrethroids. At the end of the nineties of the 20th century there were a greater number of biological products for control oilseed rape pests.

Zaller et al. (2008a, 2008b) in their investigations show that damages from stem mining weevils and yield decreas would be smaller if oilseed rape would be grown on soils with below average quality in combination with a smaller number of plants per plot and slower development of the crop.

In Table 2 pest control thresholds for rape stem weevil and in Table 3 pest control thresholds for cabbage stem weevil in several European countries are presented.

Rape and cabbage stem weevils are usually considered as complex of pests but according to differences in biology that is not correct. Monitoring of appearance of stem mining weevils is necessary in order to determine which species occurs in greater numbers. In areas where rape stem weevil is dominant treatments should be done immediately after the threshold is reached, because females and males appear in the same time. In areas where cabbage stem weevil is dominant treatment should be done after two to three weeks because females emerge later than males.

Conclusions

Stem mining weevils become important and regular pests of oilseed rape in Croatia. Yellow water traps sholud be instaled into the field in February to detect appearance of adult forms. Control of the traps should be carried out every three days. After the identification of caught adults it is necessary to determine which weevil occurs in a greater population. If rape stem weevil is dominant it is necessary to apply insecticides as soon as the pest control threshold is reached. In areas where cabbage stem weevil is present in a larger population and pest control threshold is reached, the insecticides can be applied in 2-3 weeks, because males and females do not emerge at the same time. If identification is not possible, due to a severe differences in morphology between rape and cabbage stem weevil, the control can be implemented in two ways: 1) producers would make a minimum mistake if the oilseed rape crop is treated after 10 adults of any stem mining weevil are caught in the yellow water trap within three days or 2) the fertility of females can be cheked in a way that random, from the yellow water trap, 10 adult forms are taken and the abdomen of the pest is pressed. If eggs come out from 20% of caught adults, it is neccessary to apply appropriate insecticide.

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