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SEASONAL DYNAMICS OF MOST DETRIMENTAL PEST INSECTS SPECIES ON CABBAGE PLANTS IN MONTENEGRO
SEZONSKA DINAMIKA NAJŠTETNIJIH INSEKATSKIH VRSTA NA KUPUSNJAČAMA U CRNOJ GORI

Abstract

In the course of 2000 and 2001, from locations with representative properties in the geographical and agricultural regions in Montenegro: Zeta-Bjelopavlići (Grbe, Vranjske Njive, Sadine, Grbavci, Balabani and Trešnjica); the coastal region (Prčanj); and the region of high mountains and deep valleys (Kolašin - Smailagića Polje), insects were collected from crops of cabbage, collards, cauliflower, Brussels sprouts, broccoli and kohlrabi using Malaise Traps, Barber soil traps, Yellow dishes, Light Traps, and manually from the plants. In this paper, the most significant pests were highlighted, which are the species from the genus Pieris spp, followed by Brevicoryne brassicae L., Aleyrodes proletella L., species from the genus Phyllotreta spp and species belonging to the family Curculionidae. We can separate the Eurydema ventrale Kol. species as less dangerous. All of them, one by one, can completely destroy cabbage plants in Montenegro, in cases where we cannot, or do not want to, protect plants by using chemical treatments. In this paper, we also presented the seasonal dynamics of those insects.

Key words: trap, insects, entomophauna, cabbage plants, seasonal dynamics of the species

Izvod

Tokom 2000. i 2001. godine in the sites sa reprezentativnim karakteristikama geografsko-agrarnih cjelina Zete-Bjelopavlića, Primorja i Visokoplaninsko-dolinskog regiona izvršeno je sakupljanje insekata u usjevima kupusnjača. Korišćene su ustaljene metode tj. klopke koje sakupljaju veliki broj vrsta: malaise, Barber, žute i svjetlosna klopka, kao i metod sakupljanja insekata sa biljaka. U radu su akcentovane najznačajnije štetne vrste, odnosno jedinke kupusove vaši, buvača, kupusove leptiraste vaši, crvene kupusove stjenice, pipa i kupusara. Prema rezultatima eksperimenta po svojoj destruktivnosti na prvom mjestu su kupusari (pripadnici roda *Pieris*), zatim ravnopravno slijede: kupusova vaš (*Brevicoryne brassicae* L.), kupusova leptirasta vaš (*Aleyrodes proletella* L.), buvači (*Phyllotreta* spp.) i pipe (vrste familije Curculionidae). Kao manje štetnu izdvojili bi crvenu kupusnu stjenicu (*Eurydema ventrale* Kol.). Ove vrste,

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pojedinačno, mogu da izazovu potpuno propadanje kompletnog usjeva, ukoliko se na vrijeme ne primijeni hemijska zaštita kultura. U radu je data njihova sezonska dinamika.

Ključne riječi: klopka, insekti, entomofauna, kupusnjače, sezonska dinamika vrste

INTRODUCTION

According to UN Food and Agriculture (FAO) data (1995), cabbage is cultivated worldwide in an area of 1,751,000 hectares with an average yield of 24.05 t/ha. In Serbia and Montenegro there was about 200,000 ha devoted to growing vegetables, of which about 25,000 - 27,000 ha produced cabbage and kale, with a yield of 10 - 11.5 t/ha (**Statistical Yearbook of the Federal Republic of Yugoslavia**, 1997). In Montenegro, for the period from 1998 to 2002, these crops were cultivated, on average, in an area of 1952.6 ha, with a yield of 13.13 t/ha (**Statistical Yearbook Montenegro**, 2003). It should be emphasised that there is a trend of increasing the area for cabbage plants, with average yields showing a slight, but still relatively low, growth. The volume of cabbage and kale production, compared to the average of 2637.5 t for the period of 1947-1956, reached the level of 10,535.1 t for the period of 1987-1996 (**Statistical Documentary Basis**, 1998), which can serve as an indicator that production of cabbage plants is receiving increasing attention. Trials with regard to analysing the possibility of growing winter cabbage plants (**Popović et al**., 1990; **Mirecki**, 1999) show that, as of late, even more attention is being given to vegetable production. The most significant plants in production are white or heading cabbage, and collard *Brassica oleracea* var. *acephala* L., which is a specific plant in agricultural production in Montenegro, including both of its varieties – continental and coastal (**Pajović**, 2004). **Pavlek** (1978) underlined that these collard forms are, in essence, endemic plants. Recently, in addition to these two crops, cauliflower *Brassica oleracea* var. *botrytis* subvar. *Cauliflora* is increasingly grown, and there are also attempts to increase the production of Brussels sprouts *Brassica oleracea* var. *gemmifera* and broccoli *Brassica oleracea* var. *botrytis* subvar. *cymosa*. From all that has been stated above, it can be concluded that there are attempts to introduce and increase production of new species and varieties of cabbage plants in Montenegro, in addition to those that are grown traditionally.

The main objective of this paper is to determine the most significant species of pest insects present in cultivated cabbage plants in Montenegro. It would be also interesting to mention the opinion presented by **Aleksić** (1972) that the most pervasive plant protection problems with cabbage plants are of entomological nature, as opposed to, e.g., tomato and capsicum, where problems of a phyto-pathological nature prevail. It should also be stated that, from the viewpoint of scientific research, nobody has addressed the pests of cultivated cabbage plants in the territory of Montenegro for the period from World War II until today.

Among the pests of the order Heteroptera, the references show that bugs of the genus *Eurydema* are of significant importance. **Stanković** (1963) denied the stance that prevailed until then, that *Eurydema ornata* L. from this genus is the most frequent cause of damage, establishing that the species *Eurydema ventrale* Kol. is the one that causes the most damage to vegetable crops from the Brassicaceae family, underlining the closeness of the two species (**Stanković**, 1964). **Dimić** (1994) also pointed to the species *Eurydema ornata* L. (*ventrale* Kol.) (cabbage stink bug), claiming that it can be seen in both wild and cultivated plants of the Brassicaceae family. The same author claimed that *Eurydema oleracea* L. (rape bug), a related species, was similar in terms of its significance. **Vukasović et al.** (1962) underlined *Eurydema ventrale* Kol. (cabbage stink bug) as the most significant one, presenting data showing that *Eurydema ornata* and *Eurydema oleracea* in our country infest rape and are almost never found in vegetable crops. **Ilić** (1950) was of the opinion, shared by **Čamprag et al.** (1996), that the species *Eurydema ventrale* Kol. is more significant in our country, while *Eurydema oleracea* L. is, to a lesser extent, found in cultivated crucifiers.

The next significant group of insects, representatives of which can cause significant damage in crucifiers, is the Homoptera order. **Sivčev** (1993) established that in the area of Zemun, five species of aphids from the Aphididae family can be found in cabbage crops: *Brevicoryne brassicae* L. – cabbage aphid – according to this source, accounts for 99% of the total population of aphids found. In addition, the same source identified *Myzus persicae* Sulz. (green peach aphid), *Macrosiphon euphorbiae* Thomas., *Aulacorthum solani* Kalt. and *Metapolophium dirhodum* Walk at less than 1%. The author emphasised the polyphagous character of these four species. In cabbage plants, **Dimić** (1994) underlined in particular *Brevicoryne brassicae* L. and *Rhopalosiphon* (*Brevicoryne*) *pseudobrassicae* Dav., which he states are very closely related to cabbage aphid. The cosmopolitanism of *Brevicorine brassicae* L., the most significant cabbage plant pest, is also underlined by **Ilić** (1950) and **Tanasijevič and Simova-Tošić** (1987). A number of pests from the Aleyrodidae family can be found in cabbage plants. In our country, **Dimić** (1994) names *Trialeurodes vaporariorum* Westw. and *Aleyrodes brassicae* Walk. as potentially harmful species; while **Tanasijević and Simova-Tošić** (1987) also name *Aleyrodes proletella* L. (cabbage whitefly).

In the order Coleoptera, numerous cabbage plant pests belong to species of the families Curculionidae and Chrysomelidae, subfamily Halticinae. Species of the family Curculionidae are particularly frequent in the harmful entomophauna of cabbage plants, among which the most numerous genus is C*eutorrhynchus*, as stated by **Ilić** (1950); **Danon** (1953); **Vukasović et al.** (1962); **Tanasijević and Simova-Tošić** (1987); and **Dimić** (1994). Species of the family Chrysomelidae subfamily Halticinae have great significance in the production of cabbage plants. There is a whole group of species and genera that are potentially harmful for cabbage plants, the most prominent being the genus *Phyllotreta* and the genus

Psylliodes, species of which are largely oligophagous, as stated by **Radosavljević** (1924); **Ilić** (1950); **Aleksić** (1972); **Tanasijević and Simova-Tošić** (1987); **Vukasović et al.** (1962); **Dimić** (1994) and **Nonveiller** (1960).

In the production of crucifiers, extraordinary significance is rightly attached to the order of Lepidoptera. All authors agree on the significance of species belonging to the family Pieridae. **Vukasović et al.** (1962) identified *Pieris brassicae* L. (large cabbage whitefly), *Pieris rapae* L. (small cabbage whitefly) and *Pieris napi* L., indicating that the former two species are often found together, sometimes inflicting significant damage, while the latter species, according to the authors, is a found less frequently. Similar findings have been presented by **Ilić** (1950), **Dimić** (1994), **Tanasijević and Simova-Tošić** (1987), **Čubrilović** (1958) and **Aleksićs** (1972). We would like to emphasise in particular the findings of **Radosavljević** (1924), who noted a higher occurrence of *Pieris brassicae* in the area of Podgorica in 1922.

MATERIALS AND METHOD

The fieldwork was carried out during the vegetation period, from 2000 to 2011. In the course of 2000, insects were collected from crops of cabbage *Brassica oleracea* var. *capitata* from sites in Grbe and Vranjske Njive; collard *Brassica oleracea* var. *acephala* from sites in Sadine and Prčanj; Brussels sprouts *Brassica oleracea* var. *gemmifera* from sites in Prčanj and Grbavci; and broccoli *Brassica oleracea* var. *botrytis* subvar. *cymosa* or var. *italica* from the site in Grbavci. In the course of 2001, insects were also collected from crops of *Brassica oleracea* var. *capitata* from sites in Trešnjica, Smailagića Polje and Balabani; collard from the sites in Sadine, Grbe, Prčanj, Vranjske Njive and Smailagića Polje (please note that collard is not a widespread vegetable in the northern region of Montenegro); Brussels sprouts from the Balabani site; broccoli from the site in Smailagića Polje; and also from the cauliflower *Brassica oleracea* var. *botrytis* from sites in Balabani and Smailagića Polje; and kohlrabi *Brassica oleracea* var. *gongyloides* from the site in Balabani.

Montenegro can be divided into several regions, i.e., geographical-agricultural entities. The most frequently-used divisions are: the Coastal Region; the Zetsko-Bjelopavlićka Plain; the Krst plateau of Western Montenegro, or the holokarst region; the Region of High Mountains; and the Region of Valleys in the High Mountains Region. The sites where the research was conducted were: in 2000: Grbe (Danilovgrad), Vranjske Njive (Podgorica), Sadine (Podgorica), Grbavci (Zeta) and Prčanj (Kotor); in 2001: Grbe, Vranjske Njive, Sadine, Balabani (Zeta), Trešnjica (Zeta), Prčanj and Smailagića Polje (Kolašin). Since the six sites are grouped in the Zetsko-Bjelopavlićka Plain, in describing the features of these sites we will take them aggregately, as a single region, while for the sites in Prčanj and Kolašin we will present individual characteristics.

Kolašin, that is, the Smailagića Polje site near Kolašin, is situated in the central part of the Republic at 42°49"18´ north latitude and 19°31"32´ east longitude, at about 950 meters above sea level in the High Mountains Region.

The whole region of northern Montenegro is one of the most typical Dinarides areas, with distinctively high mountains and deeply intersected river valleys. The Smailagića Polje site is situated two to three kilometres northeast of the town, towards Bjelasica Mountain. Brown eutric soil on gravel dominates at this site. The area around Kolašin has a mean annual air temperature of 8 ^{o}C, with warm summers and very cold winters. In this whole area, days with frost and ice are frequent; snow-cover height is about 70 - 100 cm, and the number of snowy days is 76, on average. The sum of precipitation for Kolašin is about 2000 mm per annum (**Statistical Yearbook of Montenegro,** 2002 and 2003).

The village of Prčanj and the Prčanj site are situated in the Bay of Boka Kotorska, at 42°25"33´ north latitude, 18°46"38´ east longitude, while the actual site is about 5 meters above sea level. Prčanj is situated at the bottom of Vrmac Mountain (766 m), which divides the Bay of Kotor from the Bay of Tivat, five kilometres west of the town of Kotor. In Prčanj, there is brown antropogenous soil on a carbonate layer. The whole bay, and hence the site, has a typical Mediterranean climate with mild winters and warm summers, less hot than those in the Zetsko-Bjelopavlićka Plain. Mean daily air temperature in 2001 in Kotor was 16 ^{o}C. The sum of precipitation for that year was 1363.6 mm. It should be mentioned that snow, as well as strong and stormy winds, are very rare (**Statistical Yearbook of Montenegro**, 2002 and 2003).

The Zetsko-Bjelopavlićka Plain is situated in a pronounced morphological and geo-tectonic line in the area of Montenegro and the Dinarides in general (the line borders with Herzegovina, the Duge gorge, Nikšićko Polje, Bjelopavlići, Zeta, and the Lake of Skadar). The orientation is northwest – southeast, from the Glava Zete (42°40' north latitude, 16°40' east longitude), across the valley of the Zeta River and the lower Morača to the Lake of Skadar (42°14' north latitude, 17°06' east longitude). The elevation of the plain decreases slowly from 55 meters above sea level at the Bjelopavlićka Plain, through 45 meters above sea level at the northern edge of the Zeta Plain around Podgorica, to 6.5 meters above sea level at the shore of the Lake of Skadar. The length of the plain is 60 - 70 kilometres from the Glava Zete to the Lake of Skadar, covering an area of about 40,000 ha. Generally, the relief is flat, sloping slightly towards the watercourses of the Zeta and the Morača towards the Lake. The powerful layers of loam, loess-like flat terrain, and warm Mediterranean climate promoted the establishment of deeper soils which, depending on the influence of other pedological processes, evolved into different types of brown soils (the Grbe and Vranjske Njive sites). On the Sadine, Grbavci and Trešnjica sites, shallow brown soils prevail, and to a smaller extent rendzina. In the Lower Zeta, towards the flood zone of the Lake of Skadar, fine grained and powerful alluvium is deposited, where alluvial (the Balabani site) and marsh soils were formed. The climate of the Zetsko-Bjelopavlićka Plain is an Adriatic variant of Mediterranean climate, modified by the influence of surrounding mountains, according to **Pavićević** (1983). Mean annual temperature is about 15.5 ^{o}C. Extreme temperatures below -10 ^{o}C are extremely rare; winters are mild and rainy, more humid and colder than on the

coast and due to advection of cold air from the north, the number of frosty days is three times higher. Snow, too, is more frequent than at the seaside, although it is rare in this region, too. Average annual precipitation is above 2100 mm; the sum of precipitation is high, but with extremely unfavourable distribution. There are long rainy periods with perhumid climate and a brief summer period with extremely arid climate.

According to **Southwood** (1977) it is practically impossible to count all vertebrates in a habitat; therefore, the method that is most cost-effective and, from the technical viewpoint, the most appropriate, is to determine the population by sampling. The author underlines the need to provide the highest accuracy of such methods so that the given estimate is closest to the actual situation in nature. We decided to use the customary method in this trial, i.e., traps that collect a large number of species non-selectively.

Malaise traps were used at the Sadine, Prčanj and Smailagića Polje sites over the course of 2001. These traps were checked once a week at the Sadine site and bi-weekly at the other two sites. In both years, at all the sites, pitfall traps, so-called Barber pots, were used, which is a standard method for collecting walking insects. All Barber pots were checked once a week, with the exception of the Prčanj and Smailagića Polje sites, which were checked bi-weekly. Barber pots were 9 cm in circumference and 14 cm in height; they were dug into the soil so the opening would be at the level of the terrain. A modification was used, i.e., protection against entry of rain or irrigation water from the sprinkler system was installed, with the total height of 21 cm (of which the height of the support was 8 cm) and 10 cm in circumference. On all of these sites, during the whole period of collecting, yellow pots were used; the most frequently used method of coloured pitfall water traps. Yellow colour, in the case of cabbage plants, has a direct link with the yellow colour of cabbage flowers; the traps were placed throughout this period, in order to follow the increase in yields. All the pots were checked once a week, with the exception of the Prčanj and Smailagića Polje sites, which were checked bi-weekly. Plastic yellow pots 5 cm in depth and 17 cm in diameter were used. Only on the Sadine site, from November 2000 until the end of the collecting period, that is, until the end of October 2001, light traps were used all the time. Among a large number of different variations of these traps, we used the trap described by **Lazarević** (1960), with the improvement introduced by **Sivčev** (1981). The light trap was used in the inhabited suburban community of Podgorica-Tološi, in an area without public lighting. The trap was turned on once a week and worked throughout the night. In addition to the stated methods for insect catching, weekly, or bi-weekly, as appropriate. The insects from the traps were separated in laboratories and kept in 70% alcohol until determination. The insects were then determined, with keys given by **Crowson** (1967) and **Booth et al.** (1990) for determination of insects of the order Coleoptera; **Holloway et al**. (1987) for determination of Lepidoptera; **Oldroyd** (1954) for determination of Diptera; **Ricards** (1956) for determination of Hymenoptera; **Borror et al**. (1989) and **Schmidt** (1970) for determination orders and families of all other orders.

RESULTS AND DISCUSSION

Among the total of 49,929 insects collected, the presence of extremely harmful insect species was established. Among the species characterised as harmful, there were six pests that can entirely destroy the yield of cabbage plants. It should be noted that we separated these species, either because of their permanent occurrence in most of the sites, or because of the damage caused in certain sites. We are of the opinion that each of the species stated can individually cause complete destruction of the crop. Contrary to the usual method of presenting the insect species by the place they take in the insect systematics, we decided to present these species, genera or families according their destructiveness. According to the situation in the field, it can be concluded that the most detrimental specie or species are individuals of the genus *Pieris*, followed by *Brevicoryne brassicae*, *Aleyrodes proletella*, species of the family Curculionidae, species of the genus *Phyllotreta* and, finally, *Eurydema ventrale*. In the charts, all individuals that were caught from the sites will be presented, in all developmental stages, regardless of the collection method used in catching them.

Without any exaggeration, on the basis of the quantity and particularly expressed destructiveness, we can pronounce that the caterpillars of cabbage butterflies are collectively the most harmful insects in fields that produce cabbage plants (Chart 01). According to our findings, the most harmful of all the insects in cabbage plants crops in Montenegro, by far, are representatives of the order Lepidoptera, sub-order Rhopalocera, super-family Papilionoidea, or family Pieridae, as appropriate, which are members of the genus *Pieris*. Members of the said family are tropical and moderate-climate butterflies, small to medium in size, usually white or yellow in colour. The caterpillars are exclusively phytophagous, so the caterpillar *Pieris rapae* L. is by far the most harmful among the representatives of daytime butterflies in general. It should be emphasised that specimens of *Pieris brassice* L. were caught, while not a single specimen of the rape butterfly was not caught. The *Pieris brassice* L. butterflies were caught, without any exceptions, from all the sites during both years of collecting, with all the insect-catching methods applied, except, naturally, the light trap. Insects of the genus *Pieris* pose a continuous threat to cabbage plant crops, as they attack plants in all developmental stages and they can always cause full defoliation.

The chart below clearly shows that the abundance of these insects in both years increases slightly during the vegetation period, reaching its maximum at the end of August and in September, following which there is a drastic decline in the number of individuals.

These data are in line with the biology of species; that is, it is in line with the data that these insects have two and sometimes even three generations overlapping in one year. The decline in numbers correlates with the unusually rainy September during both years of experiment, which is probably what caused such a sharp decline in population numbers. Humidity has an unfavourable effect on caterpillars, which, under such conditions, are easily affected by diseases

caused by micro-organisms, which is why we are of the opinion that the population numbers fall more slowly when the end of summer and beginning of autumn are drier.

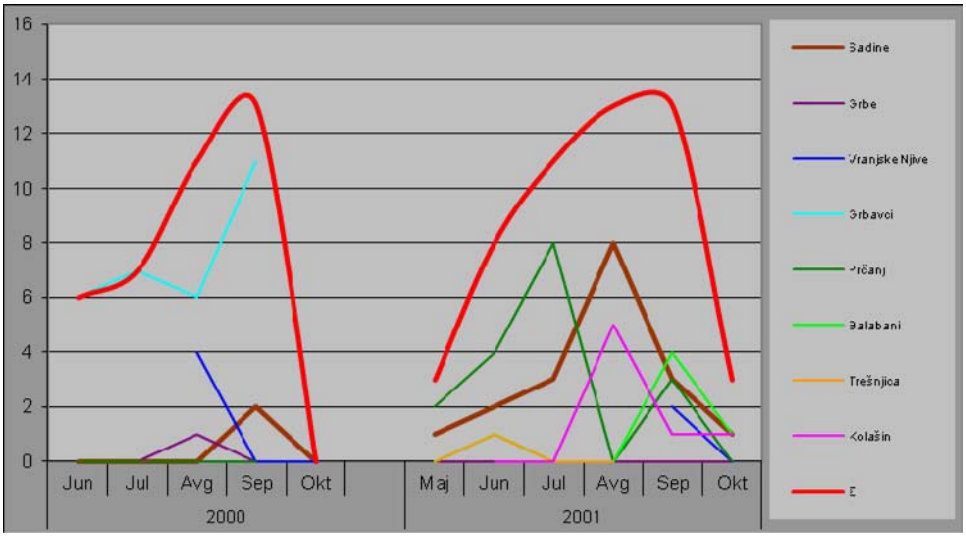

Chart 1: Seasonal dynamics of species from the genus *Pieris*.
Grafikon 1: Sezonska dinamika vrsta roda Pieris.

By rank of their harmfulness to cabbage plants, the second place is taken by representatives of the order Homoptera, sub-order Sternorrhyncha, super-family Aphidoidea; that is, the Aphididae family. The findings of **Sivčev** (1993) should be reiterated, as he established that five species of aphids belonging to this family can be found in cabbage crops in the area of Zemun. According to the source, *Brevicoryne brassicae* L. is the dominant and, in economical terms, the most significant species, accounting for 99% of the total number of individuals collected. Our findings are in line with the findings of Sivčev. We would like to mention that all the stages of this aphid cause damage by sucking the plant juices, which results in stopping the growth, and twisting and yellowing of leaves, while a more intensive infestation results in death of the whole plant. However, the cabbage aphid is more significant in younger plants, although it causes significant damage to adult plants, which is shown in the example of the Trešnjica site, where, in mid-August, the whole plantation of the white, i.e., heading cabbage was destroyed. Cabbage aphids were caught at all the sites where insects were collected. It is interesting to note that aphid individuals also were caught at the Sadine site in November and December 2000, and also in January and February 2001, on the basis of which it can be concluded that the species, in milder winters, is always present in the crops of cabbage plants, remaining in the field over the winter, at least in the region of Zeta and Bjelopavlići. The aphids were caught by all collecting methods that we applied,

although the largest number of individuals was caught by yellow traps.In this case, too, the chart presents all the individuals of all stages in sum (Chart 02).

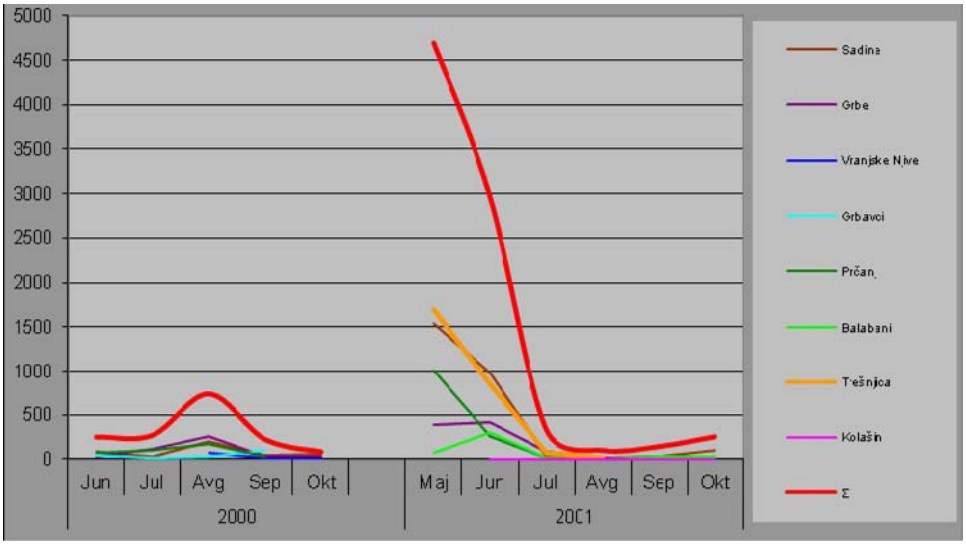

Chart. 2: Seasonal dynamics of species *Brevicoryne brassicae.*
Grafikon 2: Sezonska dinamika vrste Brevicoryne brassicae.

The chart shows that the dynamics of the species was not the same in both years of the research. In the course of 2000, the curve grew slightly during June and July and fell slightly in September and October, with the maximum peak in August. This is similar to curves reflecting the individual sites. In the course of 2001, the numerousness of individuals fell drastically from the maximum number in May until early August, and then grew slightly until the end of the collecting period, in October. The curve reflecting the year 2000 shows normal insect population development and also shows that their numerousness was not high compared to 2001. However, the curve for 2001 looks unusual, to say the least. The most important cause of this is the fact that collecting of insects from the Trešnjica site took place in this year only, and we already stated that the numerousness of aphids from that site was so high that it caused full destruction of the crop. In addition to Trešnjica, the number of insects from the Prčanj and Sadine sites was extremely high, too. In our opinion, the drastic decline in the population numbers can be attributed to extremely high temperatures over the summer months, and above all, stopping of insect collecting from the Trešnjica site. Furthermore, the slight increase in population numbers later on was, most probably, due to more favourable weather conditions. In any case, in years with ideal developmental conditions this species can have up to 16 overlapping generations per year, with a development cycle length of 16 days.

There is one more representative of the sub-order Sternorrhyncha, order Homoptera, super-family Aleyrodoidea and family Aleyrodidae that, according

to our findings, belongs to the group of the six most harmful pests in cabbage plants in Montenegro. These small insects, covered by a waxy powder that they excrete as self-protection from environmental effects, are quite polyphagous and harmful, particularly in cases of overpopulation. The species of this family, covering mainly the sub-tropical and tropical species are well-known pests of ornamental plants, in vegetable and fruit growing. The most important species for cabbage plants is *Aleyrodes proletella* L. (cabbage whitefly). The principle that applies to this species is that, if the elementary conditions are met – high humidity and temperature – development of a single generation lasts for about 30 days, so the species can have 10 generations per year. It is important to underline, together with this information, that the imago eclosion is very much prolonged, thus assisting in overlapping of generations of the species. As already stated, the adult specimens of this species, or family, as appropriate, were caught from all the sites, except Kolašin, during both years of collecting. The insects were caught in yellow traps and by manual collection from plants, and at the Grbavci site only; they were also caught by Barber traps. The mass occurrence of these insects in Grbavci can be explained by micro-climatic conditions that are ideal for the development of whiteflies: increased humidity during the entire vegetation period and, naturally, high temperatures over the summer months. It should be noted in particular that the cabbage whitefly is the species that can be significant at all stages of cabbage development.

Only adults were presented in the chart for the *Aleyrodes proletella* species (Chart 03). The chart shows the dynamics of the population, which, just like in the previous case, is not the same in both years of research, although the discrepancy is lower than in the dynamics of the species *Brevicoryne brassicae*. In the course of 2000, the curve shows a high growth from the beginning of collecting until mid-July, when the maximum was recorded. The population levels then fall until the end of August, and then record a decline, milder than before, until the end of the collecting. It should be noted immediately that the curve of the sum of individuals caught and the curve of the individuals caught from the Grbavci site almost overlap. We emphasise this information in particular, since, on the basis of the number caught and field data from the Grbavci site in 2000, we included this insect species among the six most destructive ones in the research area. In the course of 2001, the population grew from May to mid-July, reaching the first maximum, and then fell by mid-August. Then, as of mid-August, the number grew until mid-September, when the maximum was approximately the same as in July, and then fell until the end of collecting in October. The chart shows that the first maximum overlaps with the maximum of the curve that relates to the insects caught from the Grbe site, while the other is related to the Balabani site. This information only supports the fact that the species reaches its maximum only when micro-climatic conditions at the site are favourable.

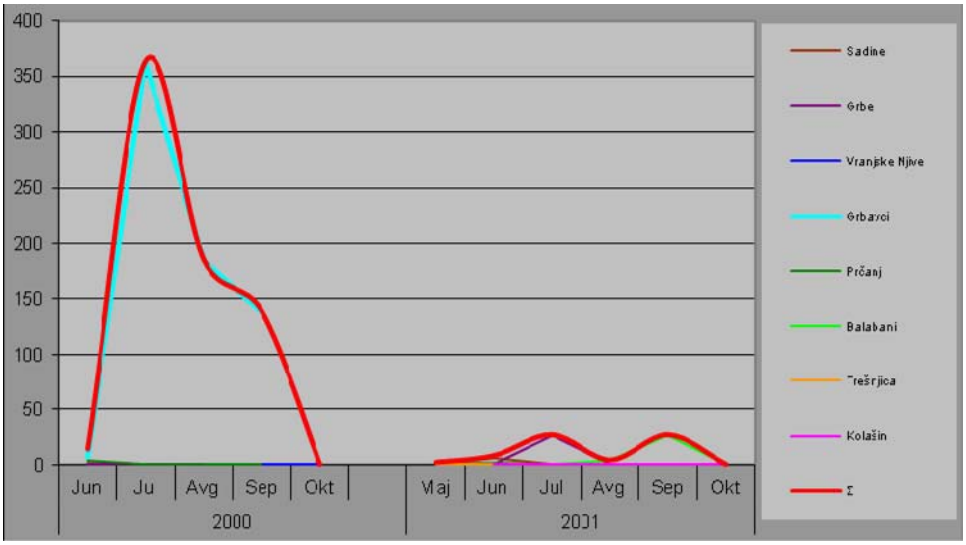

Chart. 3: Seasonal dynamics of species *Aleyrodes proletella*.
Grafikon 3: Sezonska dinamika vrste Aleyrodes proletella.

In the order Coleoptera, we identify, as the first among the most significant species, those of the super-family Curculionoidea, that is, family Curculionidae. These insects are easily distinguished by rostrum, which is a trunk-like snout, due to which they received one of their common names: 'trunk beetle'. Most of the weevils were collected by Barber pots, followed by yellow pots; very few individuals were caught by other collecting methods. A large number of weevil species that were not determined in detail were collected from the sites, so we aggregated all the species of this family into the six most significant cabbage plants pests. It should be noted here again that we caught insects causing significant damage that were only in the larvae stage, and we were not able to grow them to the adult stage, so we were unable to determine the species. Most probably this was the species *Ceuthorrhynchus quadridens* Panz. – cabbage stem weevil – as stated by **Kereši and Sekulić** (2001). In any case, the species of the family Curculionidae are more significant for young plants, but these can be harmful even later, as was the case at the Grbe and Grbavci sites. At the Grbavci site, the weevils caused total destruction of broccoli crops.

In the case of the family Curculionidae, all the species found and all developmental stages were presented together (Chart 04). The chart shows that the dynamics of members of this family were not the same in both years. In the course of 2000, the curve had a slightly downward trend in June and early July, while in July the population grew, reaching its maximum in mid-August. The curve then shows a decline in the numbers until the end of September, when, until the end of collecting, almost no weevils were caught.

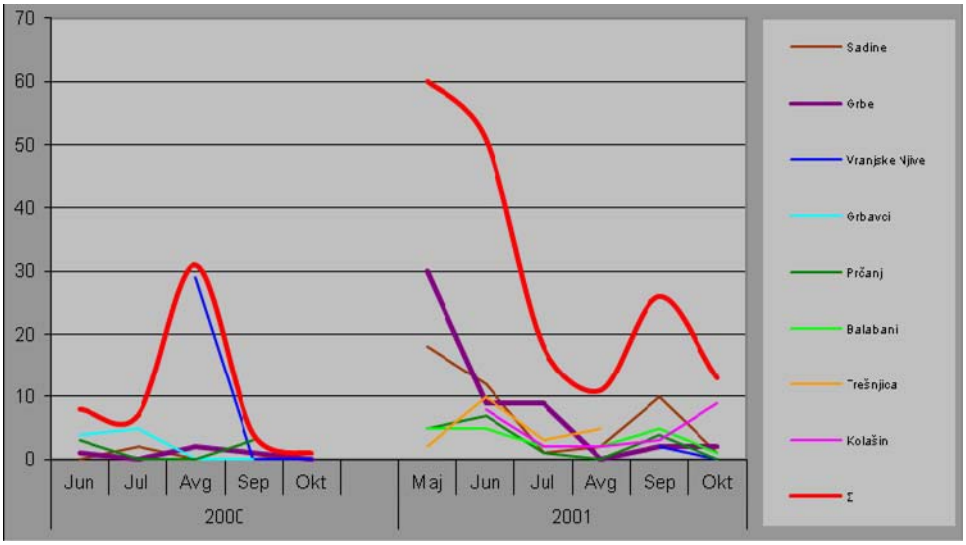

Chart. 4: Seasonal dynamics of species from the family *Curculionidae.*
Grafikon 4: Sezonska dinamika vrsta familije Curculionidae.

It should be noted that the maximum in August was, obviously, connected with the beginning of collecting from the Vranjske Njive site, where a large number of weevils were collected in early August.

The curve for 2001 was, at first, similar to that for the species *Brevicoryne brassicae*; that is, the number of individuals decreases in the period of June-August from the maximum in May, and then grows to a secondary maximum in September, which is lower than the first one. It should be noted that on almost all the sites, the number of weevils was high in May and was declining by mid-June and July; on those grounds, the cumulative value is high. Also, on a larger number of sites, an increase in population numbers takes place again, resulting in a secondary maximum. We are of the opinion that the fact that all stages of weevils were presented aggregately most influenced the occurrence of two maximums.

In the order Coleoptera, genus *Phyllotreta* is among the six most harmful species. These insects are members of the super-family Chrysomeloidea, family Chrysomelidae, sub-family Halticinae: flea beetles. The main point when it comes to flea beetles is that individuals of this genus were always caught at all the sites and in almost all the traps. They cause damage primarily by feeding on the leaves, leaving small apertures on them, so in major infestations the leaf looks like a sieve, and for that reason the plants die; the damage is mainly inflicted by imago. Flea beetles can have significant importance for young plants, which have a small leaf surface, and during the seedling stage, they can destroy the seedlings in entirety.

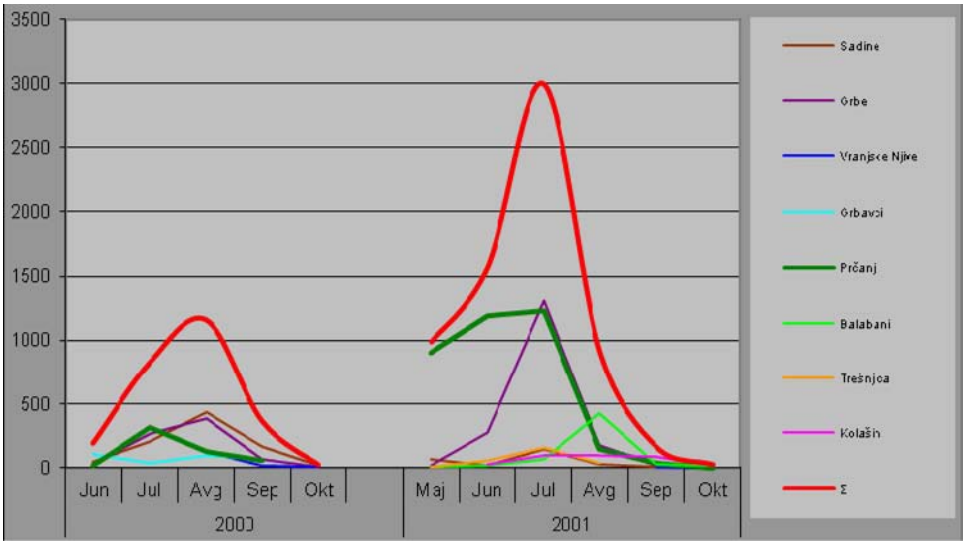

Chart. 5: Seasonal dynamics of species from the genus *Phyllotreta*
Grafikon 5: Sezonska dinamika jedinki roda Phyllotreta.

In the case of individuals of the order *Phyllotreta*, only the adults of all the species caught were presented, aggregately (Chart 05). The seasonal dynamics of these insects is almost the same in both years of research, with a smaller population in 2000. In any case, the chart shows that the population numbers grow evenly from the beginning of the vegetation until the beginning of August in 2000, and the end of July in 2001. This is when the maximum number is reached, followed by a decline until the end of collecting in October, which is fully in line with their life cycle. Namely, the majority of flea beetles have only one generation per year, where adults overwinter and produce a new generation following an additional feeding, while adults of the new generation feed at the end of the vegetation period when they begin a slow withdrawal for overwintering.

According to a provisional gradation that we presented, the last and the least harmful of these six pest groups is *Eurydema ventrale* Kol. It belongs to the order Heteroptera, super-family Pentatomoidea, family Pentatomidae. The findings of **Stanković** (1963) that the species *Eurydema ventrale* Kol., being the dominant species, inflicts most of the damage to the cabbage crops of the Brassicaceae family, should be mentioned here once more. In line with that, during our experiment the dominant species of the genus and the family and the whole order was this one. We find interesting the findings about the species *Eurydema oleracea* (rape bug), that reference sources consider a species not so often found, with a northern distribution area, which rarely infests the cultivated cabbage plants species.

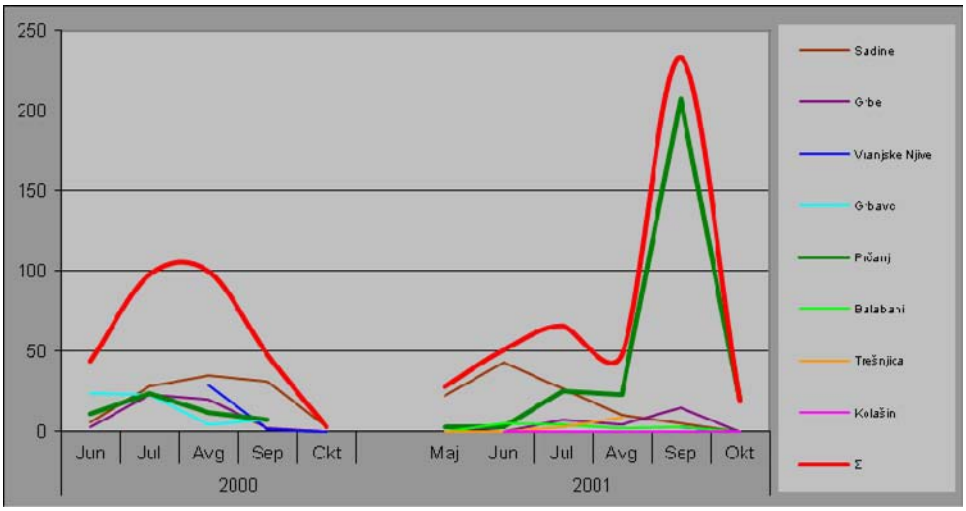

Chart. 6: Seasonal dynamics of the species *Eurydema ventrale* and *Eurydema oleracea.*
Grafikon 6: Sezonska dinamika vrsta Eurydema ventrale i Eurydema oleracea.

Our findings are contrary to the assertions made above, as the rape bug was found on cabbage plants, as vegetable crops, exclusively at the Prčanj site, the southernmost of all the sites included in the research. We would like to underline that the common cabbage bug was caught from all the sites – with the exception of the Kolašin site – throughout the period, by all methods of collection. The collecting of individuals with Barber pots was, nevertheless, less intensive, but the numbers correlated to the maximum occurrence of adults on plants. The individuals of these two species doubtlessly belong to the group of six insect species that can be a factor in limiting the production of cabbage plants in Montenegro, and an important one in all the stages of cabbage plant development.

It can be said that the seasonal dynamics of these species are regular. Chart 06 presents all the developmental stages of both collected species, together. The chart shows that in 2000, the curve shows an upward trend from the beginning of the collecting until the end of July, when the maximum was recorded, followed by a slow reduction until October. In 2001, the dynamics were slightly different; namely, two maximums can be noted – the first in July and the second, connected with the number of insects from the Prčanj site, during September. It should be underlined that the generations of these species overlap and that throughout the year individuals of all developmental stages can be found due to a prolonged period of egg-laying. Also, both species produce two generations per year; imagos of the first occur in the first half of June and of the second, in August, which corresponds to our findings, with smaller deviations resulting from the presentation of imago and larvae stages aggregately.

CONCLUSION

During the two-year research, a total of 49,929 insects were caught. The individuals were determined to the different levels of orders, families and species. Analysing the role of the insects caught in the entomophauna, as well as on the basis of their relation with the cabbage plants (insects-plants) and their interrelations (insects-insects), we have provisionally categorized all of the collected insects into groups of harmful insects, useful insects, and indifferent entomophauna.

On the basis of the data collected, six taxons stand out from the group of harmful insects (species, genera and families), each of which can entirely destroy the cabbage plant crops in the research area.

Of the total number of individuals of insects caught, 23.42% were individuals of cabbage aphid, 19% were flea beetles, 1.54% was cabbage whiteflies, 1.48% was cabbage stink bugs, 0.48% were weevils and 0.16% were cabbage butterflies.

According to our results, regardless of the presented number of specimens within the entomophauna of cabbage plants, the first ranked are belong to the genus *Pieris* (cabbage butterflies), followed equally by: *Brevicoryne brassicae* (cabbage aphid), *Aleyrodes proletella* (cabbage whitefly), *Phyllotreta* spp (flea beetles) and species of the Curculionidae family (weevils). We would like to point to *Eurydema ventrale* (the cabbage stink bug) as a less harmful insect.

The species mentioned above are particularly dangerous in specific stages of cabbage plant development. In the seedling stage, which means young plants in the nursery or immediately after replanting, flea beetles are particularly harmful. Younger plants are particularly susceptible to infestations of weevils and cabbage aphids, while older ones are particularly vulnerable to cabbage bug and cabbage whiteflies. Cabbage butterflies, if they occur in sufficient numbers, can literally destroy the entire crop at any stage. These extremely dangerous pests significantly reduce a yield, which certainly implies the need to place them under systematic, continuous monitoring and population control measures.

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SEASONAL DYNAMICS OF MOST DETRIMENTAL PEST INSECTS SPECIES ON CABBAGE PLANTS IN MONTENEGRO

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Summary

In the course of 2000 and 2001, from locations with representative properties of geochartical and agricultural regions in Montenegro: Zeta-Bjelopavlići (Grbe, Vranjske Njive, Sadine, Grbavci, Balabani and Trešnjica), Coastal (Prčanj) and the region of high mountains and deep valleys (Kolašin - Smailagića Polje), insects were collected from crops of cabbage, collard, cauliflower, Brussels sprouts, broccoli and kohlrabi using the Malaise Trap, Barber soil traps, Yellow dishes, Light Traps and manual gathering. The most dangerous pests are highlighted in this paper. According to the results, , species from the genus *Pieris* spp. are in first place, followed by *Brevicoryne brassicae* L., *Aleyrodes proletella* L., species from the genus *Phyllotreta* spp. and species belonging to the family Curculionidae. Less harmful is the *Eurydema ventrale* Kol. species. All of them, individually, can completely destroy cabbage plants in Montenegro, when we cannot, or do not want to, protect plants by applying chemical treatments. In this paper we also presented the seasonal dynamics of these insects.

During the whole period of collecting, in all locations, we collected 49,929 insects. The determination was done on all individuals at different levels - order, family, genus or species level. Analysing the role of collected insects in entomophauna, in the sense of their relation with cabbage plants (insects-plants) or in the sense of their interrelations (insect-insect), we subdivided all of them into groups: pests, useful insects, and indifferent insects.

We highlighted six taxons (species, genus or families) from the group of pest insects; all of them, individually, can totally destroy the crops. From the total 49.929 insects, 23.42% were individuals of *Brevicoryne brassicae*, 19% were *Phyllotreta* spp., 1.54% were *Aleyrodes proletella*, 1.48% were *Eurydema ventral*, 0.48% were individuals from the Curculionidae family, and 0.16% were *Pieris* spp. According to our results the greatest destruction was inflicted by *Pieris* spp. (cabbage butterflies), followed by *Brevicoryne brassicae* (cabbage aphid), (*Aleyrodes proletella* (cabbage whitefly), *Phyllotreta* spp. (flea beetle) and family Curculionidae (weevils). Less destructive is the *Eurydema ventrale* (cabbage stink bug). Species, or taxons, are especially dangerous in certain periods: nursery plants are sensitive to species from the genus *Phyllotreta*; young plants are vulnerable to attacks by species from the family Curculionidae and *Brevicoryne brassicae*. Older plants are sensitive to *Eurydema ventrale* and *Aleyrodes proletella*. Cabbage butterflies can totally destroy all crops at any time. All of these pests can reduce the yield, so we need to carry out continuous monitoring and control their population.