



## ***Delia radicum (Diptera: Anthomyiidae): BIOLOGY, DAMAGE AND CONTROL STRATEGIES IN SPRING CABBAGE PRODUCTION IN THE STRUMICA REGION***

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### **Abstract**

The cabbage root fly (*Delia radicum* L.) is a significant pest of cabbage and other brassicaceous crops. It can produce three to four generations per year, with adult activity spanning from early spring through late autumn. The most severe damage typically occurs on young seedlings, although in cases of heavy infestation, even mature plants and developing heads may be affected. Control measures must be implemented preventively and initiated at the first signs of adult activity. Management is challenging because the larvae feed within plant tissues, making them difficult to reach with conventional treatments. Therefore, efforts should focus on preventing infestations through the use of integrated pest management approaches.

**Key words:** *insect pests, Brassica oleracea var. capitata, control strategies, integrated pest management.*

### **INTRODUCTION**

Cabbage (*Brassica oleracea* var. *capitata*), along with other members of the *Brassicaceae* family, constitutes a vital component of vegetable production in the Republic of North Macedonia (Martinovska Stojcheska et al., 2021). These crops are primarily cultivated in the southeastern and central regions of the country (Statistical Yearbook of the Republic of North Macedonia, 2025). In the Strumica region, spring cabbage is sown on an area of about 1000 ha, with a yield of more than 50 000 tons during the spring season. Last few years, the cabbage root fly (*Delia radicum* L.) has emerged as a significant pest of spring cabbage, threatening both the quality of production and the stability of the yield.

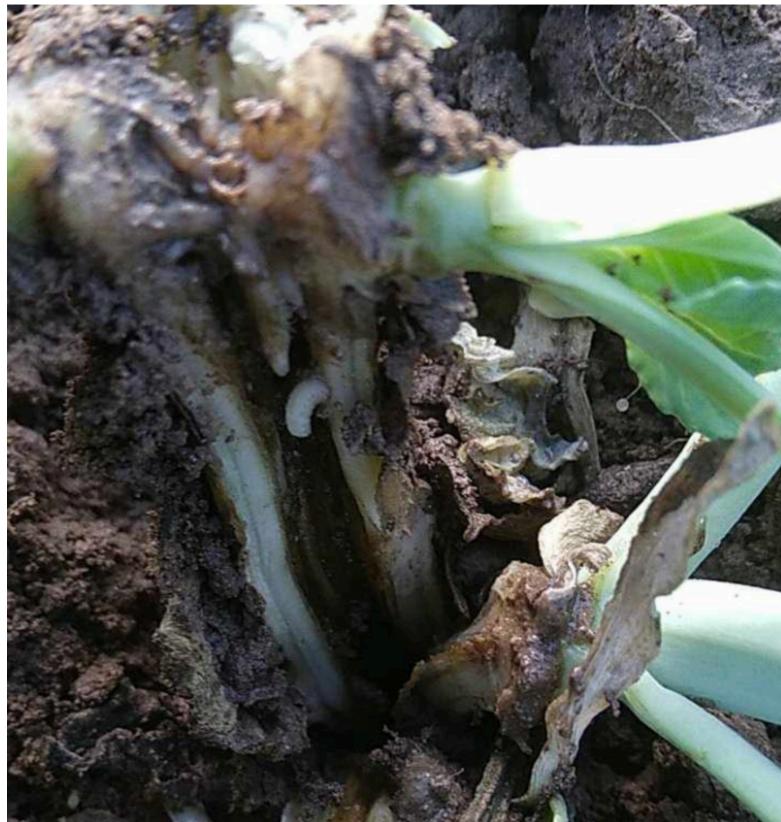
The cabbage root fly is a type of insect that attacks all types of cabbage, and is most harmful to young specimens as well as to kale, kohlrabi, cauliflower, and broccoli. It can also live on other types of brassicas, but does not cause much damage to them.

The larvae of the fly inhabit the root collar area and cause the most damage there, which is only noticed when plants show signs of wilting and

stunted growth (Kumar and Singh, 2015). They dig tunnels inside the roots of the plant, suck juices, and as a result, the plant slowly changes color and dies. The greatest damage is caused by the first generation, because the larvae attack young plants that have not yet grown strong enough.

### **Taxonomy and identification**

The cabbage root fly (*Delia radicum* L.) is part of the fly family Anthomyiidae, order Diptera. The adult fly is about 5 to 6.4 mm in length and resembles the housefly in general appearance. Males have three stripes on their backs that run the entire length of this part of the body. On the other hand, females lack them, and differ in having a lighter color (Edde, 2022). The eggs are elliptical, white, and only 1 millimeter long, with one transverse groove in the middle. The larvae are light yellow-white, have no developed legs, are narrowed at the front of the body, and their heads are atrophied (Figure 1). When they grow up, they can be between 7 and 8 mm long (Edde, 2022). The pupae are cylindrical, smoothly rounded, brown, and about 5.5 mm long (Edde, 2022).



**Figure 1.** Larvae of *Delia radicum* L. in the root of the spring cabbage.

### Biology

The cabbage root fly overwinters as a pupa, while adults emerge in late April and May (when the soil temperature reaches 12 °C) (Soroka & Dosdall, 2011a). The newly hatched insects feed mainly on weeds, after which they move on to the cabbage plants.

Once they have mated, the gravid females begin looking for a host plant to lay their eggs (Edde, 2022). Each female lays up to 80 eggs during the first 14 or 21 days of life. They place them on the root collar or in the soil in the immediate vicinity of the plant (Edde, 2022). The optimal temperature for egg laying is 18.3–21.1°C, and larvae hatch from eggs within 3–5 days at 27°C to 30°C (Edde, 2022). There are three larval instars, all legless. The first larval instar feeds on the finer hairs of the root system until they grow up a little, when they can start feeding inside the main root (Edde, 2022).

The larvae develop for about a month, after which they turn into pupae. They can be found at a depth of up to 15 cm in the soil, as well as on the plant's roots themselves. The

adult flies of the first generation emerge at the end of June (Finch & Collier, 1983). The second generation of cabbage root fly can therefore be expected at the end of July or at the beginning of August.

### Damage caused by *D. radicum* L.

The damage is caused by larvae feeding on the root system of the plant. Larvae feed on the cortical tissue of the main tap root and lateral roots, and when plants are heavily attacked, the cortex and phloem may be partly or wholly destroyed (Figure 2, Figure 3). The affected plants fail to grow normally, show signs of either wilting or stunted growth, and in the severest attacks may die. Secondary damage occurs when feeding channels are subsequently invaded by soil-borne fungi, including *Rhizoctonia*, *Pythium*, and *Fusarium* species. This may cause host plant mortality or decreased crop yields by up to 52% (Dosdall, 1998). A single plant can have a large number of larvae, which can lead to complete crop failure, even at a younger stage of development.



**Figure 2.** Damage to the main tap root of spring cabbage caused by larval feeding of *D. radicum* L..

The second and third generations of larvae attack the roots less, but feed exclusively on the upper parts of the cabbage. This is why holes appear on the leaves, which later cause them to rot and decay.



**Figure 3.** Leaf deformation of the attacked plant by cabbage root fly.

A field survey in the Strumica region revealed patchy plant development and signs of cabbage root fly infestation. Damage was concentrated in areas with poor drainage and no netting protection. Up to 25% yield loss was

estimated in non-rotated plots. It was noted that the greatest damage was caused by the first generation that appears, because the larvae attack young plants that have not yet grown strong enough (Figure 4).



**Figure 4.** Field symptoms of *D. radicum* infestation in spring cabbage field, Strumica region.

### Control strategies

The management of the cabbage root fly is challenging because the larvae feed within plant tissues, making them difficult to reach with conventional treatments. Therefore, efforts should focus on preventing infestations through integrated pest management approaches.

The basic way to control and protect the spring cabbage against the cabbage root fly is to practice crop rotation and spatial isolation, as well as covering cabbage during the summer with an agrotextile. If this does not show the desired results, it is necessary to apply more intensive irrigation and increased nutrition of the plant itself, so that the plants grow stronger, faster, and thus mitigate the consequences.

Soroka & Dosdall (2011b) recommend the removal and destruction of all crop debris immediately after harvest and the control of cruciferous weed species that could act as food and overwintering resources for the fly.

A major role in controlling the cabbage root fly has its natural enemies. The immature stages of the cabbage root fly are food for many arthropods. Laboratory studies conducted by Finch (1996) showed that large numbers of *D. radicum* eggs were eaten by beetles in 13 of the 25 genera of the Carabidae family. The wasps *Phygadeuon* spp. (Ichneumonidae), *Aphaereta* spp. (Braconidae), *Trichopria* sp.

(*Diapriidae*) attack the larval or pupal stage of *D. radicum* (Hemachandra, 2004; Riley, 2009). The fly *Coenosia tigrina* F. (Muscidae) is a pupal parasitoid of *D. radicum* (Read, 1958).

Entomopathogenic nematodes are also a biological control option for the larvae of the cabbage root fly (Kocan et al., 1998; Kapranas. et al., 2020).

*Entomophthora muscae* (Cohn) Fresenius and *Strongwellsea castrans* Batko & Weiser (Entomophthoraceae) are parasites of the adult cabbage root fly (Griffiths, 1986), while several isolates of *Metarhizium anisopliae* Sorokin (Clavicipitaceae) and *Beauveria bassiana* Vuillemin (Cordycipitaceae) are pathogenic to the second-stage larvae of the fly (Snelling, 2004).

Chemical agents can be applied through the irrigation system, because in this way the root collar and the area around it, where the eggs and larvae are located, will be best treated. It is also recommended, when possible, cabbage seedlings and other brassicas to be immersed in containers with water where a substance for controlling cabbage fly has been added, immediately before transplanting to a permanent position. The goal is to destroy the larvae as soon as they hatch.

We can recommend the use of pheromone traps to monitor the number of adult flies. If they are noticed, it is better experts to be

consulted so that the cabbage or other brassica vegetables can be protected in a timely and adequate manner. When larvae are noticed on

plants in the root zone, it is usually too late to use chemical protection, so it is recommended to remove and destroy the attacked plants.

### CONCLUDING REMARKS

The cabbage root fly (*D. radicum* L.) is a significant pest of cabbage. There are three to four generations per year, and it is present in the field from early spring to late autumn.

The most severe damage it causes to young plants. In years of severe infestation, even mature cabbage heads can be affected. Activities to control it, need to be carried out preventively and as soon as its presence is noticed. The management of this pest is difficult because the larvae live in plant tissue and are thus protected. Therefore, efforts should focus on preventing infestations through integrated pest management approaches.

Among non-chemical measures, practicing crop rotation and spatial isolation, as well as covering young cabbage plants with agrotextiles

or fine insect-proof nets during the adult flight period is an effective strategy for preventing oviposition. Adult fly activity should be monitored using pheromone traps.

In cases where pest presence is confirmed or initial plant damage is observed, intensified irrigation and enhanced nutrient management may help alleviate stress and partially mitigate yield losses, although these measures do not directly suppress the pest population.

For chemical control of adult flies and to prevent oviposition, the use of insecticides is recommended. Applications should be precisely timed based on pheromone trap captures to ensure maximum efficacy and reduce unnecessary pesticide use.

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***Delia radicum* (Diptera: Anthomyiidae): БИОЛОГИЈА, ШТЕТНОСТ И СТРАТЕГИИ ЗА КОНТРОЛА ПРИ ПРОИЗВОДСТВОТО НА ПРОЛЕТНА ЗЕЛКА ВО СТРУМИЧКИОТ РЕГИОН)**

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**Резиме**

Зелковата мува (*Delia radicum* L.) е значаен штетник на зелката и другите култури од фамилијата Brassicaceae. Годишно може да се јават три до четири генерации, при што имагата се активни од рана пролет до доцна есен. Најзначајни оштетувања предизвикани од зелковата мува се јавуваат кај младите растенија, иако во случаи на силен напад, можат да бидат засегнати и веќе формираните главици на зелката. Мерките за контрола мора да се спроведуваат превентивно и да се започнат при првите знаци на активност на имагата. Контролата на бројноста на популацијата на зелковата мува е предизвик бидејќи ларвите се хранат во растителните ткива. На тој начин тие се тешко достапни за конвенционални третмани. Затоа, заштитата на зелката треба да се фокусира на спречување на појавата на зелковата мува и контрола на популацијата преку системот на интегрирална заштита.

**Клучни зборови:** штетни инсекти, *Brassica oleracea* var. *capitata*, стратегии за контрола, интегрирална заштита на расленијата.