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MANAGEMENT OF THE PESTS IN THE CONVENTIONAL AND BIOLOGICAL SYSTEMS FOR PEA GROWING

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Abstract

Pea (*Pisum sativum* L.) is a valuable grain legume crop, the seeds of which are used for human food and fodder. The seeds are consumed in a mature or green state. The priorities of the peas as a crop are the following: it is a legume, which enriches the soil with nitrogen; peas are the best possible precursor - clears the areas early; non-particular to soil and growing conditions; high protein content crop. However, the growing process of this crop could be worse by various pests that lead to product quality decay or they could even destroy the pea production. Economically important pests in field cultivation of peas are: pea aphid (*Acyrthosiphon pisum* Harris), pea weevil (*Bruchus pisi* L.) and pea moths (*Laspeyresia nigricana* Step. and *Laspeyresia dorsana* L.). Field experiments on pea variety Paldin were conducted at the Maritsa Vegetable Crops Research Institute, Plovdiv to determine the effectiveness of different plant protection products against a natural background of pest infestation. The biological activity of the insecticides Deca EC 50 ml/da (a. i. deltamethrin), Oasis 5 EC 25 ml/da (a. i. esfenvalerate), Piretro Natura EC 75 ml/da (a. i. pyrethrins), Neem Azal T/S 0.3% (a. i. azadirachtin), Naturalis 100 ml/da (a. i. *Beauveria bassiana*), Dipel 2 X 100 g/da (a. i. *Bacillus thuringiensis* var. *kurstaki* strain ABTS) and Rapax 100 ml/da (a. i. *Bacillus thuringiensis* subsp. *kurstaki*, strain EG 2348) against the main pests of peas in conventional and biological production systems was established.
Key words: pea, pests, insecticides, conventional and biological production

INTRODUCTION

Pea (*Pisum sativum* L.) is an important grain legume crop. Many abiotic and biotic factors limit the productivity of pea. Among the biotic constraints, insect pests are main factors limiting the pea yield. Over 15 insect pests are known to feed on pea, however only a few of these insect herbivores are known to cause a considerable amount of losses in pea production. They attack all parts of the plant at different stages, from sowing to harvest (French, 2004; Sharma et al., 2010; Yadav and Patel, 2015).

The pea aphid, *Acyrthosiphon pisum* Harris (Homoptera: Aphididae) is a serious pest in pea (*Pisum sativum* L.) crops causing large yield losses. *A. pisum* generally feeds on the lower surface of leaflets, and on buds and pods of pea plants, from which it ingests phloem nutrients (Carrillo et al., 2013). Severe damage can occur to peas due to direct feeding and virus spread. Direct feeding on pea results in sap being removed from terminal leaves and the stem. Heavy infestations on pea can cause stunting, deformation, wilting and even death. Aphids can also feed on pods, causing them to curl, shrink and only partially fill. Direct feeding therefore leads to yield loss and reductions in crop quality (Megersa, 2016). Plants infested up to time of flowering recovered from the damage and their yield is normal. With a longer attack from plant growth to flower opening or longer reduces dry matter production, reduces the number of pods per plant and the number of seeds per pod, increases the percentage of empty

pods, reduces the weight of 1000 seeds and yield, reduces the weight of nitrogen-fixing root nodules, but does not affect the protein content of seeds (Maiteki and Lamb, 1985).

The pea weevil (*Bruchus pisi* L.) (Coleoptera: Bruchidae), is a primary limiting factor for worldwide production of pea. Female lay the eggs on the surface of immature pea pods and hatch to produce larvae (neonate to first-instar) that burrow through the pod wall from the underside of eggs. After boring through the pod wall, first-instar larvae bore into a seed to reach cotyledon tissue, their ultimate food source. Larval development occurs within a single seed in a pod (Clement et al., 2009).

The pea moth, *Laspeyresia nigricana* Steph., is one of the principal pests of garden and field peas. Its larvae feed within the pods causing considerable damage to the developing seeds and giving to their contents a very unsightly appearance (Wright and Geering, 2009).

Although, the insect pests are controlled by diversified measures but chemical control of insect pests is yet considered as more effective than rest of the methods. However, chemical insecticides are applied only if the insect population crosses the economic threshold level and control measures are taken when population exceeds economic threshold level (Sahito et al., 2013).

Natural pesticides are pesticides made by organisms usually for their own defense, or are derived from a natural source such as plant, animal, bacteria, fungi and certain mineral, use to control pest naturally. The common natural pesticides uses are neem (*Azadiracta indica*), microbial pesticide *Bacillus thuringiensis* and pyrethrins. Natural pesticides usually target specific sites in the insect such as nervous system, resulting in knock-down, lack of coordination, paralysis and death (Oguh et al., 2019).The primary active ingredient of most neem-based pesticides is azadiractin, a liminoid compound, which has multiple biological activities on more than 400 insect species from several orders. Azadirachtin-based compounds have insecticidal, feeding deterrent, repellent, antioviposition, and physiological properties (Shannag et al., 2014).

Pyrethrum, also known as pyrethrins, is extracted from the seed of *Chrysanthemum cinerariaefolium*. Pyrethrum is effective against a wide range of pests such as whitefly, mealybugs and thrips, but will not control mites. Pyrethrins have a rapid "knockdown" effect preceding insect death and insects usually die in a few minutes or hours following exposure to a fatal dose (Fernández-Grandon et al., 2020).

Bacillus thuringiensis is an aerobic Gram- positive endospore-forming bacterium which is a part of the family *Bacillaceae* and it is widely used in agriculture as a biological pesticide. Commercial formulations of *B. thuringiensis* have been used for the last few decades in the control of lepidopteran insects and, in more recent times, beetles and flies. Many of these products are based on spore-crystal preparations derived from a small number of wild-type strains (Hernández-Fernández, 2016). After ingestion by a herbivorous insect, the crystal dissolves in the alkaline environment of the insect midgut, releasing one or more insecticidal crystalline proteins, also known as a delta-endotoxin. They can be activated by midgut proteases. Once activated, the crystalline proteins interact with larval midgut epithelial cells and destroy membrane integrity, ultimately leading to insect death (Xiao and Wu, 2019).

Pest management through biological control is confident using different predators, parasites and pathogens. Entomopathogenic fungi are considered unique compared to other micropathogens. Entomopathogenic fungi can be used for pest control and do not affect on other non-target organisms (Abdou et al., 2017). *Beauveria bassiana* (Balsamo) Vuillemin is a generalist entomopathogen and has been found infecting many arthropod species, including

members of the Coleoptera, Hemiptera, and Diptera (Baverstock et al., 2006). One of the advantages of entomopathogenic fungi is that the host insect need not ingest them. Entomopathogenic fungi, such as *Beauveria bassiana*, infect the host insect by penetrating the insect cuticle. Germ tubes grow through the layers of the cuticle using the enzymatic action and finally enter the haemocoel (Anderson et al., 1995; Fan et al., 2007).

The aim of the study was to determine the effectiveness of various plant protection products against major pests in pea grown in open field conditions.

MATERIALS AND METHODS

The studies were conducted in 2019-2020 at "Maritsa" VCRI - Plovdiv in the field under a natural background of pest infestation, in condition of conventional and biological production of pea variety Paldin.

Aphids (Homoptera: Aphididae)

In aphid-infested pea plants are sprayed with the appropriate concentration/dose of insecticide. The number of live individuals before spraying and at intervals after 1, 3, 5, 7, 10 and 14 days on pre-marked pea plants was counted. Test pest: pea aphid (*Acyrthosiphon pisum* Harris). Test products for plant protection: conventional production - Deca EC 50 ml/da (a. i. deltamethrin) and biological production - Piretro Natura EC in a dose of 75 ml/da (a. i. pyrethrins), Naturalis 100 ml/da (a. i. *Beauveria bassiana*). Total area of the experimental plot 200 m^2 conventional and 200 m^2 biological pea production. The effectiveness (E%) was calculated by the formula (Henderson and Tilton, 1955):

$$E\% = \left(1 - \frac{TaxCb}{TbxCa}\right).100$$

Ta - number of live aphids in the variant after treatment; *Tb* - number of live aphids in the variant before treatment; *Ca* - number of live aphids in the control after treatment; *Cb* - number of live aphids in the control before treatment.

Pea weevil (*Bruchus pisi* L.)

Field experiments were performed on pea variety Paldin. The insecticides were sprayed twice at intervals of 7 days. Test products for plant protection: conventional production - Oasis 5 EC 25 ml/da (a. i. esfenvalerate) and biological production - Piretro Natura EC in a dose of 75 ml/da (a. i. pyrethrins), Neem Azal T/S 0.3% (a. i. azadirachtin). The first treatment was carried out during flowering and the formation of the first pods at the establishment of 10 numbers/100 plants. Total area of the experimental plot 200 m^2 conventional and 200 m^2 biological pea production. After harvesting the peas from the field, average samples of 500 seeds were taken. They are placed in glass jars insulated with cheesecloth at room temperature for 50 days. The percentage of damaged seeds was then recorded and the effectiveness (%) was calculated (Abbott, 1925).

$$E = \left(\frac{Ik - Iv}{Ik}\right).100 \ (\%), \text{ where}$$

E - effectiveness,%; *Ik* - percentage of infested seeds in the control (%); *Iv* - percentage of infested seeds in the variant (%).

Pea moths (*Laspeyresia nigricana* Step. and *L. dorsana* L.)

Field experiments were performed on pea variety Paldin, under natural infestation by pea moths. It was sprayed twice with insecticides at intervals of 7 days. Test plant protection products: conventional production - Deca EC 50 ml/da (a. i. deltamethrin) and biological production - Rapax 100 ml/da (a. i. *Bacillus thuringiensis*, subsp. *kurstaki*, strain EG 2348), Dipel 2 X 100 g/da (a. i. *Bacillus thuringiensis* var. *kurstaki* strain ABTS), Neem Azal T/S 0.3% (a. i. azadirachtin). The first treatment was carried out during flowering and the formation of the first pods. Total area of the experimental plot 200 m^2 conventional and 200 m^2 biological pea production. After harvesting

the peas from the field, average samples of 500 seeds per variant were taken. The percentage of damaged seeds was reported and the effectiveness (%) was calculated (Abbott, 1925).

The experiments with biological plant protection products were conducted in a certified biological field.

Data were processed using Duncan's multiple range test at P<0.05 levels (Duncan, 1955).

RESULTS AND DISCUSSION

The use of chemical plant protection products is one of the widely used and effective methods for pest control. Unfortunately, there are risks of environmental pollution and the appearance of resistance in populations. Therefore, attempts are being made to determine the effectiveness not only of chemical insecticides but also of biological products as an alternative possibility for pest control.

In conventional pea production, the insecticide Deca EC showed the highest effectiveness of 83.11% 5th day after treatment against pea aphid (Picture 1). This insecticide shows a relatively good initial effect. An effectiveness of 63.68% was reported on the first day after treatment. Bioproduct Piretro Natura EC 75 ml/da has a relatively good biological activity (E = 78.46% at 5th day after treatment) close to that of Deca EC 50 ml/da, which is probably due to the good contact action of pyrethrins similar to pyrethroids. The biological product Naturalis 100 ml/da demonstrates a slower effect, typical for the microbial products. It has a longer duration of action, as at the end of the period effectiveness of 57.94% for this treatment was reported, while the biological activity for the other products is below 55.00%. A maximum value of effectiveness 75.28% was reported in 7 days after treatment. This product can also be successfully included into biological pea production systems (Table 1).

Table 1. Effectiveness of plant protection products against pea aphid (*Acyrthosiphon pisum* Harris)

Variants	Days after treatment	E, (%)
Deca EC 50 ml/da	1	63.68 bc
Piretro Natura EC 75 ml/da		51.67 bc
Naturalis 100 ml/da		47.76 b
Deca EC 50 ml/da	3	80.07 ab
Piretro Natura EC 75 ml/da		71.58 ab
Naturalis 100 ml/da		63.16 ab
Deca EC 50 ml/da	5	**83.11** a
Piretro Natura EC 75 ml/da		**78.46** a
Naturalis 100 ml/da		74.36 a
Deca EC 50 ml/da	7	73.75 ac
Piretro Natura EC 75 ml/da		67.64 ac
Naturalis 100 ml/da		**75.28** a
Deca EC 50 ml/da	10	61.16 bc
Piretro Natura EC 75 ml/da		54.04 bc
Naturalis 100 ml/da		62.77 ab
Deca EC 50 ml/da	14	55.00 c
Piretro Natura EC 75 ml/da		43.93 c
Naturalis 100 ml/da		57.94 ab

a, b, c..–Duncan's multiple range test (p<0.05).

The product Oasis 5 EC 25 ml/da demonstrated very good effectiveness - 92.06% in the field experiments, conducted for determining the effectiveness of the tested products against pea weevil (Picture 3 and 4). Oasis 5 EC is an insecticide from the group of pyrethroids, with stomachic and contact action, with fast initial effect and good post-effect. The treatments carried out with this product can ensure well-preserved production of seeds in the field. The phytopesticide Neem Azal T/S 0.3% shows relatively good biological activity (E = 66.96%) against this pest. The product might be applied into the biological production systems as an alternative for control of *B. pisi*. Neem Azal T/S is a systemic insecticide, characterized by a strong inhibitory effect in the juvenile stages of insects. This insecticide disrupts the normal cycle of conversion in insects by blocking the release of the hormone ecdysone in larvae, thus stopping the moulting and passing to another age. It reduces vital activity in adults

and impairs the maturation of eggs in females after entering their body. Therefore, they do not lay eggs. The biological product Piretro Natura EC 75 ml/da has an inadequate effectiveness of 60.71% against this pest (Table 2). This is probably due to the short contact action.

Table 2. Effectiveness of plant protection products against pea weevil (*Bruchus pisi* L.) in cultivation of pea variety Paldin in two production systems

Variant	Infested seeds, %	E, %
Conventional production		
Oasis 5 EC 25 ml/da	3.00	92.06
Control	37.80	-
Biological production		
Piretro Natura EC 75 ml/da	14.80	66.96
Neem Azal T/C 0.3%	17.60	60.71
Control	44.80	-

The control of pea moths (Picture 2) is difficult due to the screened lifestyle of the caterpillars. Treatments should be carried out at the appropriate time before their nibbled at the pods and seeds. From the tested products, the contact insecticide Deca EC 50 ml/da shows very good effectiveness (E = 81.48%) and can be used in conventional plant protection systems to control these pests. From the biological products Dipel 2 X 100 g/da shows the best effectiveness - 72.73%. This insecticide can be used to control *Laspeyresia* spp. in biological production systems. Our results confirm those of Wrzodak and Rybczyński (2010) for the good biological activity of the product Dipel 2 X against moths. The product Rapax 100 ml/da showed a satisfactory effectiveness of 68.18%, and the phytopisticide Neem Azal T/S 0.3% had inadequate biological activity (E = 63.64%) (Table 3).

Table 3. Effectiveness of plant protection products against pea moths (*Laspeyresia nigricana* Step. and *L. dorsana* L.) in cultivation of pea variety Paldin in two production systems

Variant	Infested seeds, %	E, %
Conventional production		
Deca EC 50 ml/da	1.00	81.48
Control	5.40	-
Biological production		
Rapax 100 ml/da	1.40	68.18
Dipel 2 X 100 g/da	1.20	72.73
Neem Azal T/C 0.3%	1.60	63.64
Control	4.40	-

Picture 1. Pea aphid (*Acyrthosiphon pisum* Harris)

Picture 2. Pea moths (*Laspeyresia* spp.)

Picture 3. Pea weevil (*Bruchus pisi* L.)

Picture 4. Damage of pea weevil

Picture 5. Growing of pea crop

CONCLUSIONS

The product Deca EC 50 ml/da and the bioproducts Piretro Natura EC 75 ml/da and Naturalis 100 ml/da have good aficidal activity and can be included for effective control on pea aphid (*Acyrthosiphon pisum* Harris) in the respective conventional and biological system for pea growing.

The product Oasis 5 EC 25 ml/da and the phytopesticide Neem Azal T/S 0.3% have good biological activity against pea weevil (*Bruchus pisi* L.) and can be used in conventional and biological systems for pea growing, respectively.

The insecticide Deca EC 50 ml/da and the bioproduct Dipel 2 X 100 g/da are effective against pea moths (*Laspeyresia nigricana* Step. and *L. dorsana* L.) and can be included in conventional and biological systems for pea growing.

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