

CHANGES OF SOME BIOECOLOGICAL AND PHENOLOGICAL PECULIARITIES OF THE COLORADO POTATO BEETLE (*Leptinotarsa decemlineata* SAY) IN THE AGROCLIMATIC ZONES IN BELARUS

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Abstract. In the present paper, there are rendered the results on studying *Leptinotarsa decemlineata* SAY occurrence and development in different agroclimatic zones in Belarus. Abiotic and trophic factors effect on the pest phenology, biology, ecology changes in time and space are determined. It is determined that the bioecological peculiarities of the Colorado potato beetle populations in different regions of the republic have a significant zone differentiation. Association between potato crops development and phytophage stages, which are different according to the precocity varieties, in different ecological conditions is also studied.

Keywords: Belarus, Colorado potato beetle, biology, ecology, phenology, variety.

Rezumat. Schimbările unor particularități bioecologice și fenologice ale gândacului de Colorado (*Leptinotarsa decemlineata* SAY) din zonele agroclimatice ale Belarusiei. Lucrarea redă rezultatele studiului asupra apariției și dezvoltării *Leptinotarsa decemlineata* SAY în diferite zone agroclimatice din Belarus. Sunt determinate influența factorilor abiotici și trofici asupra fenologiei dăunătorului, biologia, schimbările ecologice în timp și spațiu. Se stabilește că particularitățile bioecologice ale populațiilor gândacului de Colorado în diferite regiuni ale republicii înregistrează diferențieri zonale semnificative. Este de asemenea studiată legătura dintre dezvoltarea culturilor de cartof și stadiile de dezvoltare ale dăunătorului, care diferă în funcție de precocitatea varietății cartofului, în condiții ecologice diferite.

Cuvinte cheie: Belarusia, gândacul de Colorado, biologie, ecologie, fenologie, varietate.

INTRODUCTION

Colorado potato beetle is widely spread and met in different states all over the world. At present, Colorado potato beetle area includes 4 geographically isolated regions: American, European-Siberian, Central Asian, Far East located on two continents (except the islands) (BULLETIN OEPP, 2012; PAVLJUSHIN et al., 2009). For the last 20 years a significant progression of the Colorado potato beetle to the north and east in its second, Eurasian area, is marked; as a result, in the north it occurred in many regions of Arkhangelsk region, Kareliya and Komi republics. In the east, it has reached Yenisei and Khakassia, in the south – Krasnoyarski region, it is found on Buryatiya and Primorski territory (PAVLJUSHIN et al., 2009; FASULATI, 2004), and has settled in foreign Asia in Iran and appeared in China.

Ecological plasticity and polymorphism promote the pest adaptation to soil-climatic conditions. Thus, the pest quickly adapts to the environmental abiotic factors changes, preserving a high viability, which is shown in its bioecological peculiarities changes (USHATINSKAYA, 1981; POTATO BEETLE, 2013).

On the territory of Belarus (Brest and Grodno regions), the Colorado potato beetle appeared in 1956. Until 1958, the focuses were of isolated character: small and quickly liquidated. Nevertheless, a mass arrival on the territory of the western regions was registered in 1959 from Poland. In a year the pest was found in Gomel and Minsk regions of the republic. In spite of the applied every year quarantine measures, the pest area has expanded and its field colonization has increased (DROZDOV et al., 1960).

In the sixties - seventies of the last century, the Belarusian scientists carried out the extensive researches on biology, ecology, phenology. But on some questions the inconsistent data are obtained. Thus, in literature different opinions in relation to the pest generations number are met. According to the data of L. S. Drozdov, A. F. Markovets, M. M. Pilko one generation is developed. F. N. Irodova and V. I. Kurilova have revealed that in the southern regions, the pest develops in 3 generations, in the northern ones – in one (IRODOVA & KURILOV, 1976). The results obtained by L. I. Arapova testify that in the republic, characterized on the whole by temperate climate, in the northern zone, the Colorado potato beetle develops mainly in one generation, in the southern zone the second full generation is possible (ARAPOVA, 1976).

Colorado potato beetle phenological terms calculation, done about 40 years ago, has shown, that in the European part of Russia not more than 3 generations of the Colorado beetle can develop (ARAPOVA, 1972). However, in the last years the pests generations number increased.

At present, in spite of regularly carried out protective measures in the republic, a high density of natural populations has formed, the Colorado potato beetle harmfulness increasing in potato agrocoenosis, under some circumstances. On the one hand, it is caused by the variable ecological plasticity, genetic polymorphism, the pest ability to an intensive adaptation in different conditions. On the other hand, the change of the agroclimatic zones borders (Fig. 1a, SHKLYAR, 1973; Fig. 1b, MELNIK, 2004) provided favourable conditions for the Colorado potato beetle development.

Based on the aforementioned ideas, the research aim was studying the changes and occurrence specification, some eco-biological peculiarities, phenology, number dynamics, association in potato crops development and the phytophage stages by precocity varieties for anthropogenic factors use substantiation while regulating Colorado beetle number taking into account zonal distribution.

MATERIAL AND METHODS

The pest occurrence and records were carried out by itinerary inspections of potato crops according to the general entomology methods, by recorded plants (areas) methods consisting in 5-20 adjoining to each other plants (VOLOVIK et al., 1995).

The researches were carried out in the northern, central, the southern and new agroclimatic zones of Belarus (Fig. 1b, MELNIK, 2004).

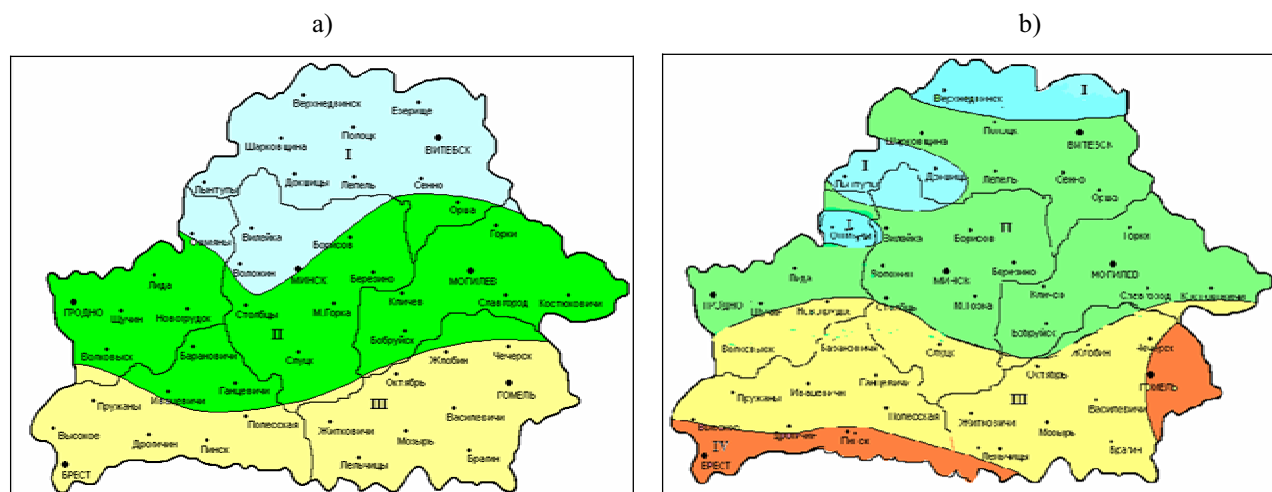


Figure 1. Change of agroclimatic regions borders in Belarus.

Legend:

a) borders of agroclimatic regions acc. to A.K. Shklyar (1973).

b) borders of agroclimatic regions acc. to V.I. Melnik in 1989-1999 Agroclimatic regions: I – The Northern zone, II – Central zone, III – the Southern zone, IV – New zone (active air temperatures sum is higher 10°C in zone: I – less than 2200, II – 2200 – 2400, III – 2400 – 2600, IV – more than 2600).

The population dynamics study, the pest bio-ecological peculiarities specification were carried out in 2000-2002, 2006-2009 on the base of the Republican Unitary Enterprise “Institute of Plant Protection” and in potato-cultivating agricultural enterprises in different agroclimatic zones of the republic by field trial carrying out.

The researches were done on different ripeness groups of Belarusian selection varieties: early – Lazurit, Delfin; medium-early – Arkhideya, Yavar, Sante; medium-ripe – Skarb, Krinitsa; medium-late – Lasunak, zhuravinka; late – Orbita, Atlant, Temp.

Weather conditions during potato vegetation were significantly differed: 2000, 2007 – warm and moderate-humid, 2002 – dry and hot, 2001, 2006, 2008, 2009 – humid and warm, what enabled us to study the dynamics of the Colorado potato beetle population.

The obtained data are treated by mathematical statistics method using the programs Microsoft Excel, Oda.

RESULTS AND DISCUSSIONS

Phytosanitary situation monitoring has shown that the Colorado potato beetle colonizes 98-100% of the potato crops every year. It is revealed that in comparison with the results obtained about 20 years ago, the character of the phytophage distribution in the republic has changed. At present, the area, colonized by the pest, has increased. Thus, if earlier a gradation of the potato colonized area in the northern part was from 2 to 30%, in 2007-2008 the pest colonized 100%. In the central zone an increase of the colonized area from 10-50% to 92-100% is marked, in the southern and new zones – from 60 to 94-100%.

In different climatic conditions during the years of researches a positive dynamics of the plants colonization increase and the pest number is marked in the southern and new zones in comparison with the northern and central ones. Thus, the plants colonization by the Colorado potato beetle in 2007-2008 during a period of larvae mass hatching in a new zone has reached 63.8-98.0%, which is 2.9 and 1.3 times higher in comparison with the northern (33.3-49.6%) part. A similar tendency in number is marked: in a new zone – 19.6-56.2 indiv./plant, 2 and 7 times higher than the parameters of the northern zone (8.1-9.8 indiv./plant) (Table 1).

It is determined that the potato and pest seasonal development phenology register zonal differences. In the southern regions, potato phenophases are registered 10-20 days earlier in comparison with the central and the northern regions, accordingly the phytophagous colonization takes place 1-2, in some years 3 weeks earlier in comparison with the central and 2-3 weeks and more, with the northern agroclimatic zone. This situation is caused by more favourable conditions for the pest development in the southern and new zones, providing the phytophage intensive development and the generations number increase.

Table 1. Dynamics of the potato plants colonization and the Colorado potato beetle number in different agroclimatic zones (according to the results of itinerary inspections).

| Agroclimatic zone | Plants colonization, % | Number, indiv./plant | | | |
|-------------------|---------------------------|----------------------|-----------|------|--------|
| | | In all | Including | | |
| | | | imago | eggs | larvae |
| 2007 | | | | | |
| The Northern zone | 33.3 | 8.1 | 0.1 | 6.5 | 1.5 |
| Central zone | 81.4 | 45.3 | 0.3 | 32.1 | 12.9 |
| The Southern zone | 78.0 | 60.8 | 0.5 | 50.5 | 9.8 |
| New zone | 98.0 | 56.2 | 0.5 | 41.0 | 14.7 |
| 2008 | | | | | |
| The Northern zone | 49.6 | 9.8 | 0.2 | 4.0 | 5.6 |
| Central zone | 42.4 | 10.1 | 0.1 | 6.0 | 4.0 |
| The Southern zone | 68.0 | 23.2 | 0.2 | 17.2 | 5.8 |
| New zone | 63.8 | 19.6 | 0.2 | 10.3 | 9.1 |
| 2009 | | | | | |
| Central zone | 88.8 | 16.4 | 2.6 | 0.7 | 13.1 |
| The Southern zone | 86.4 | 26.9 | 0.1 | 1.7 | 25.1 |
| New zone | 74.8 | 27.6 | 0.9 | 17.3 | 9.4 |

In connection with the pest zonal distribution a differentiation of protective measures carrying out tactics is possible; for this, a specification of the pest biological and phenological peculiarities in different ecological conditions is necessary. Thus, we have analysed certain bio-ecological Colorado potato beetle peculiarities in the agroclimatic zones of the republic.

It is determined that the pest number control parameter is soil temperature both during winter and spring-summer periods. It is revealed that at soil temperature decrease in winter period to $-9-12^{\circ}\text{C}$ at the depth of 1–3 cm, the insect depressive development is marked during potato vegetation. The phytophage vital activity takes place at soil temperature $+13^{\circ}\text{C}$, while according to L. I. Arapova's data (1976) – at $+14^{\circ}\text{C}$. Zonal differences are marked in terms of the pest going out of wintering places, what later on influences the population dynamics. In the southern and new zones such temperature is observed at the beginning of May, in the central and the northern – in the 3rd decade of May – the 2nd decade of June. Mass living of wintering places by the beetles takes place in the 2nd half of May (the southern and new zones) – June (the northern and central) when the average air temperature is $+14-15^{\circ}\text{C}$ (earlier – at $+16^{\circ}\text{C}$). Air temperature fall delays the imago leaving for 7–10 days.

In the years of researches the oviposition started during mass wintered beetles' leaving. The intensive egg laying is observed at an air temperature $+16-21^{\circ}\text{C}$. In the central zone it is marked in the 2nd - 3rd decades of June, at low air temperature – in the 1st decade of July, at the increased one – in the 1st decade of June. In the southern zone – mainly in the 2nd - 3rd decades of June, at the increased temperature – in the 3rd decade of May.

The larvae hatching is noticed at air temperature increase for more than $+15.5^{\circ}\text{C}$, which often takes place in the central zone in the 1st - 3rd decades of June, in the southern zone it starts 5–15 days earlier and takes place in the 3rd decade of May 2nd decade of June. At an air temperature within $+16-22^{\circ}\text{C}$ the larvae mass hatching and development fluctuate from 17 to 32 days. A mass pupation is noticed at an air temperature $+16-24^{\circ}\text{C}$ and lasts 10–14 days. In the central zone young beetles appeared in the 2nd decade of July, at an air temperature decrease – at the beginning of August, in the southern zone – in the 1st and 3rd decades of July, accordingly.

The Colorado potato beetle is a polycyclic species, which has a different number of generations in a year, forming under abiotic and biotic factors influence. As a result of carrying out the phenological researches it is revealed, that in the southern and new zones the phytophage developed in two generations with its incomplete and complete development cycle (Fig. 2). During the years with the increased air temperatures in the southern agroclimatic zone (for $0.8-7.1^{\circ}\text{C}$) the 3rd generation development is observed (Fig. 3), while ARAPOVA (1976) revealed that in the south only two generations developed. In the northern and central zones during all years of researches the 1st complete and the 2nd incomplete generations were noticed.

Potato crops and the pest development association study has allowed us to determine the periods of its maximum harmfulness. It is determined that they differed depending on the meteorological conditions, varietal peculiarities and agroclimatic zone of potato cultivation. Thus, during the years with air temperature close to the average perennial parameters during the pest going out of wintering places in the central agroclimatic zone, this period is observed on early and mid-early varieties at budding-blossoming stage, on mid-ripe, mid-late and late varieties – budding beginning-blossoming; in the southern agroclimatic zone accordingly – blossoming and budding-blossoming, accordingly.

In the years with the air temperature higher than the average perennial parameters during the pest going out of wintering places in the central (for $4.0-7.6^{\circ}\text{C}$) and in the southern (for $0.8-7.1^{\circ}\text{C}$) zones the phytophage harmfulness period coincided: on early and mid-early varieties with the complete seedlings-budding stage, mid-ripe, mid-late and late – budding beginning-budding. The pest number dynamics research taking into account the population age structure has shown that at that time the 2nd age larvae represented more than 40–50% from total number.

Analysing the data revealing the regularities of potato colonization by the pest depending on potato variety, it is determined, that early and mid-early varieties are colonized 5-7 days earlier in comparison with mid-ripe, mid-late and late ones. The larvae maximum number on early and mid-early varieties fluctuated within 23.0–65.1 indiv./plant, what

significantly increased the parameters on mid-ripe, mid-late and late – 12.0–45.3 indiv./plant. At a comparative estimation of the pest number dynamics in different agroclimatic zones on mid-ripe, mid-late and late potato varieties it is revealed that in the research years during the larvae mass hatching their density in the southern zone in comparison with the central one was 1.4-3.5 times higher.

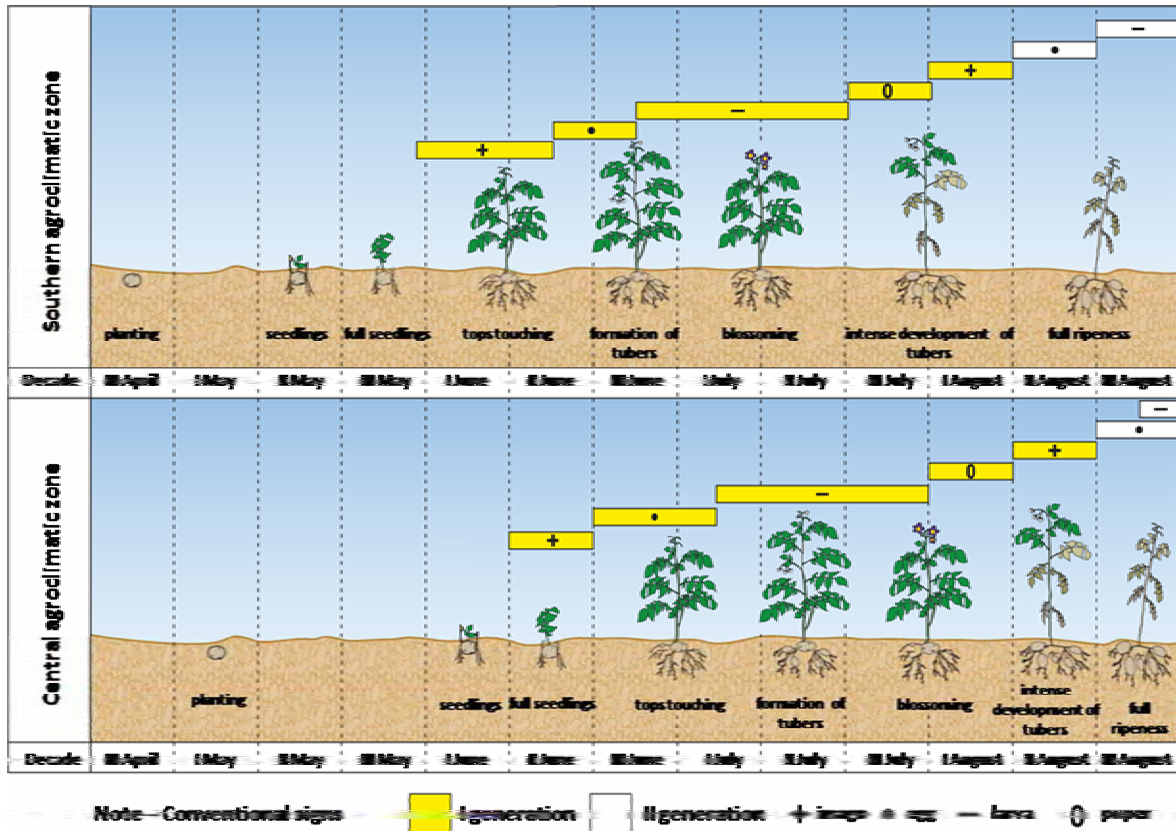


Figure 2. Phenological calendar of the Colorado potato beetle development on middle-ripening, middle-late and late potato varieties, 2009.

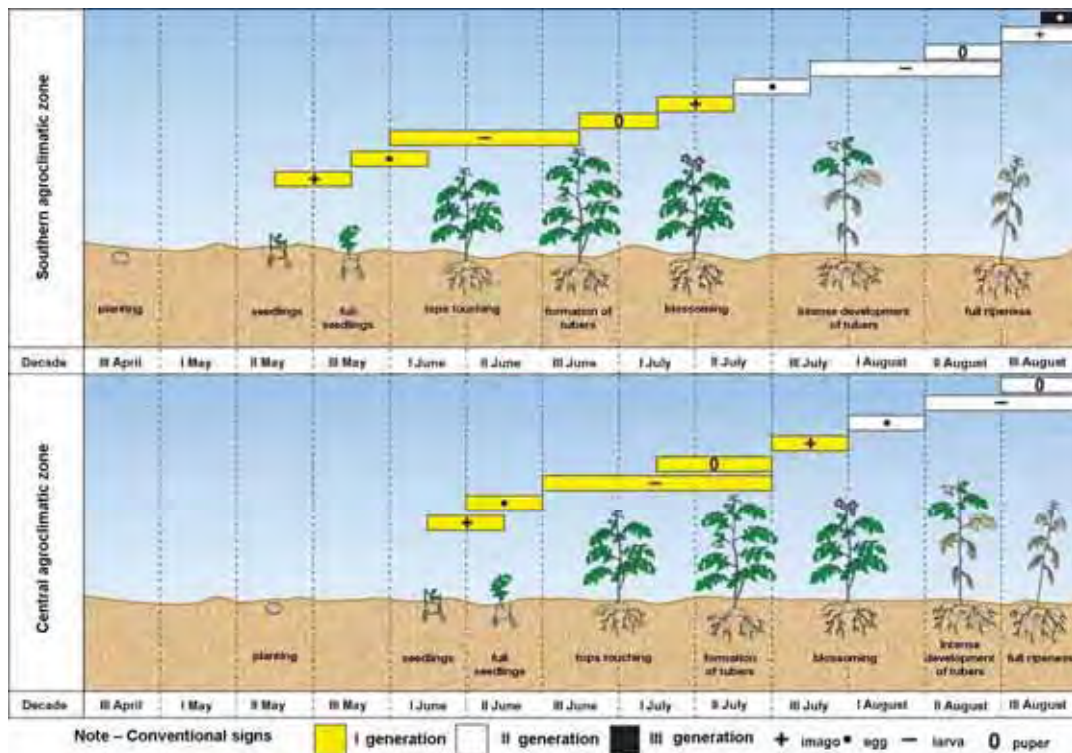


Figure 3. Phenological calendar of the Colorado potato beetle development on middle-ripening, middle-late and late potato varieties, 2007.

CONCLUSIONS

The results of the potato agrocoenosis itinerary inspections on the Colorado potato beetle incidence in Belarus have shown changes in the pest zonal distribution both on colonization and number. It is revealed that, every year, the Colorado potato beetle colonizes 98–100% of potato crops. The crops colonization and the pest number significantly differ while cultivating potato in different agroclimatic zones. During the larvae mass hatching the crops colonization by the Colorado potato beetle in a new agroclimatic zone was 1.3–2.9 times higher, the number –2–7 times in comparison with the northern one.

Significant differences in biological peculiarities, the phytophage and potato phenology in different agroclimatic zones are revealed. In the southern and new zones the crops colonization by the phytophage takes place 1–2, in some years – 3 weeks earlier in comparison with the central zone and 2–3 weeks and more – in comparison with the northern agroclimatic zone. In the central agroclimatic zone the 1st complete and 2nd incomplete generations develop. In the southern zone during the years with early colonization of potato crops and the Colorado potato beetle intensive development, the 2nd complete and the 3rd generation beginning are noticed.

The pest larvae maximum harmfulness depending on meteorological conditions, potato varietal peculiarities cultivated in different agroclimatic zones is dated to the period of full sprouting-blossoming.

Thus, the diversity of the republican natural conditions creates the phytophage zonal occurrence, what causes a differentiated approach for carrying out protective measures. The Colorado potato beetle number regulation can be carried out using insecticides by different mechanism action and method of application (before-planting tubers treatment and potato vegetative plants spraying) taking into account the pest phenological terms and biological peculiarities in different agroclimatic zones of the republic.

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