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PHYTOSANITARY SITUATION IN SUGAR BEET CROPS IN BELARUS

Halina HAJYIEVA, Sergey SOROKA

Republican Scientific Unitary Company "Institute of Plant Protection"
p. Priluki, Minsk region, Belarus
E-mail: belizr@tut.by

Abstract

The changes of phytosanitary situation taking place recently in sugar beet crops are shown. The most frequent weed species in sugar beet crops are couch grass (*Agropyron repens* (L.) Pal. Beauv.), fat hen (*Chenopodium album* L.), field violet (*Viola arvensis* Murr.), Japanese barnyard millet (*Echinochloa crus-galli* (L.) Pal. Beauv.), redroot amaranth (*Amaranthus retroflexus* L.), knotgrass (*Polygonum aviculare* L.), black bindweed (*Polygonum convolvulus* L.), white campion (*Melandrium album* (Mill.) Garcke), marsh betony (*Stachus palustris* L.), rugged knotweed (*Polygonum lapathifolium* L.) and non-odorous matricary (Matricaria perforate Merat). On the national level, sugar bee crops contained on average 23.6 weeds per m^2 belonging to 18 botanical families.

Among pests, click beetles (f. *Elateridae*), clouded shield beetle (*Cassida nebulosa* L.) and striped tortoise beetle (*Cassida nobilis* L.), beet fly (*Pegomya hyoscyami* Panz), beet or bean aphid (*Aphid fabae* Scop.), beet fleas (*Chaetocnema* gen.) and beet carrion beetle (*Aclypea opaca* L.); among the diseases – black root of sugar beet the occurrence of which is observed annually, cercosporosis (*Cercospora beticola* Sacc.), powdery mildew (*Erysiphe communis* Grev. *f. betae* Jacz.), powdery scab (*Actinomyces scabies* (Thaxter) Gussow, *A. cretaceous* (Kruger) Gussow, *A. albus* (Gasp.) Wol., *A. violacera* (Gasp.) Wol.) and foot-rot of sugar beet (boron deficiency).

Key words: sugar beet, weed infestation, pests and diseases, weed plants, harmfulness, structure of dominance.

Introduction

The current agroclimatic conditions in the Republic (temperature rise and favourable conditions for pest wintering), reduction of soil tillage volumes, non-observance of rotations, elimination of stubble breaking, fertiliser application without considering of soil nutrient supply, application of protective measures against phytophages at mass development of separate insects led to essential changes in the phytosanitary situation of crops.

In Belarus, annual sugar beet yield losses due to weeds make up 23–24% and more. Depending on the research year, sugar beet crops before harvesting had 15–45 weeds per m^2, which is 2–15 times higher than the threshold of harmfulness. The knowledge of weed species composition, the dynamics of its formation and a degree of sugar beet weed infestation in a specific field enables a better choice of protective measures and raise their efficiency essentially. Moreover, one should take into account

that the concrete relations between weed and cultural plants influence not only the specific and quantitative weed composition, time of appearance but also the duration of their combined growing with the crop. The researchers of the Institute of Plant Protection determined that a combined growing of sugar beet with weeds is permissible for not more than 15 days from the moment of seedling emergence and herbicide application at that time is the most expedient. With the increase of crop weed infestation from 30 to 80 days a sharp competition between weed and cultural plants is observed, for this, sugar beet root yield is decreased by 53.5–99.1% /Dvoryankina, 1987/.

It is known, that a great damage to sugar beet production farms is done not only by weeds but also by diseases and pests. The most common and harmful are sugar beet phytophages: wireworms (f. *Elateridae*), clouded shield beetle (*Cassida nebulosa* L.) and striped tortoise beetle (*Cassida nobilis* L.), beet fly (*Pegomya hyoscyami* Panz), beet or bean aphid (*Aphid fabae* Scop.), beet fleas (*Chaetocnema* gen.) and beet carrion beetle (*Aclypea opaca* L.). The potential yield losses to diseases reach 20%, in separate farms and regions they can be more significant being a reason of total yield kill during vegetation or at storage /Dospekhov, 1985/. As a result, despite the system of protective measures, the level of resistance of the majority of registered sugar beet varieties and hybrids to black root does not meet the modern production demands and does not secure full plant maintenance. Up to 15–20% of them die before seedling emergence, 10–15% at "cotyledon" plant stage – second pair of true leaves damage. Moreover, these plants lose resistance to root rots and other diseases. For preventive disease treatment a complex of agrotechnical and chemical techniques is developed, but due to wide specific agent composition the disease control is complicated.

Materials and Methods

The determination of weed species composition and weed number in sugar beet crops in different zones of the Republic was done during 1996–2007 with the help of itinerary inspections using general methods /Instruction, 1986/.

The incidence and harmfulness of dominant sugar beet phytophage species was determined by conventional entomological methods /Recommendations, 1981/. Population number and plant damage during vegetation period was done using the following methods: plant inspection, entomological net cutting, frames (0.25 x 0.25 cm) putting, selection of plant samples, stationary areas records. The structure of arthropodas dominance was determined using Engelmann /Engelmann, 1978/ scale. Sugar beet disease infestation records were accomplished following the methods described in the book "Methods of sugar beet researches" /Methods, 1986/.

The obtained results were statistically processed using the methods of analysis of variance and regression-correlation analysis /Dospekhov, 1985/.

Results and Discussion

The phytosanitary monitoring of sugar beet crops in 2007 showed that the most frequent weed species were couch grass (*Agropyron repens* (L.) Pal. Beauv.) – 4.1 stems per m^2, fat hen (*Chenopodium* album L.) – 3.9 plants per m^2, field violet (*Viola arvensis* Murr.) – 2.8 plants per m^2, Japanese barnyard millet (*Echinochloa crus-galli* (L.) Pal. Beauv.) – 2.4 plants per m^2, redroot amaranth (*Amaranthus retroflexus* L.) – 2.0 plants

per m^2, knotgrass (*Polygonum aviculare* L.) – 1.5 plants per m^2, black bindweed (*Polygonum convolvulus* L.) – 1.0 plant per m^2, white campion (*Melandrium album* (Mill.) Garcke) – 1.0 plant per m^2, marsh betony (*Stachus palustris* L.) – 1.0 plant per m^2, rugged knotweed (*Polygonum lapathifolium* L.) – 0.8 plant per m^2 and non-odorous matricary (*Matricaria perforate* Merat) – 0.6 plant per m^2.

The annual group of weeds is presented by 24 species, 22 of which are dicotyledonous. The perennial ones are presented by 8 rhizome and sobole – 12.5%. The number of species growing in sugar beet crops has essentially increased during the last seven years (Table 1).

Table 1. Weed species occurring in sugar beet crops (itinerary inspection, 1996–2007)

	Number of weed species per m^2			
	1996–2000	2001–2005	2006	2007
Total number of weeds:	19	25	39	32
Annual	14	19	28	24
Including dicotyledonous	12	17	25	22
Grass	2	2	3	2
Perennial	5	6	11	8
Including dicotyledonous	4	4	9	6
Grass	1	1	1	1
Spore		1	1	1
LSD_{05}	6.0			

Sugar beet weed cenosis is composed of 18 botanical families. The most common and frequent are species from the families Aster *(Asteraceae),* Buckwheat *(Palygonaceae),* Cabbage *(Brassicacea),* Pink *(Caryophyllaceae),* Deadnettle *(Lamiaceae),* Poa *(Poaceae*), Plantain *(Plantagynaceae),* Geranium *(Geraniaceae*). 9 weed species belong to Aster family, 3 species to Cabbage, Pink, Deadnettle, Poa, 2 species to Plantain and Geranium, 1 species to the remaining families.

On the national level, sugar bee crops contained on average 23.6 weeds per m^2 (Table 2). The annual spp. number made 17.5 per m^2 (74.2%), perennial – 6.1 per m^2 (25.8%). The highest weed infestation was identified in Brest district – 32.5 weeds per m^2, in Grodno – 21.1 weeds per m^2, in Minsk – 19.8 weeds per m^2.

There were fields practically free of weeds and fields with weed number of 72.0 and even 109.0 per m^2. In separate fields the number of *Amaranthus retroflexus*, *Echinohloa crus-galli*, *Chenopodium album* and *Polygonum aviculare* was 16.0–19.0 per m^2, *Brassica napus* and *Polygonum convolvulus* – 11.0–12.0 per m^2 .

While analyzing the data on sugar beet weed infestation one can make a conclusion that during the last 6 years it has essentially decreased. However, due to high level of *Echinochloa crus-galli, Viola arvensis*, *Chenopodium album*, *Polygonum* spp. (*Polygonaceae* Juss.) weed infestation is preserved as a result of agrotechnical measures' failure and insufficient volume of glyphosate-containing herbicides application at the rates of more than 5 l ha^{-1} in autumn for sugar beet sowing soil preparation, *Agropyron repens*, *Sonchus arvensis* L., *Cirsium arvense* (L.) Scop. and *Mentha arvensis* L., number has not decreased, *Equisetum arvense* L., *Galium aparine* L., and *Polygonum*

persicaria L. number has increased. Until the year 2001, *Viola arvensis* was not found in sugar beet. Since 2003 *Taraxacum officinale* Web. and *Veronica arvensis* L., have been identified, and since 2004 and 2005 – *Galium aparine* L. and *Mentha arvensis*.

Table 2. Number of weeds in sugar beet (itinerary inspection, 1996–2007)

	Number of weeds per m^2			
	1996–2000	2001–2005	2006	2007
Total number of weeds:	366	32.8	31.6	23.6
Annual	281	26.8	23.2	17.5
Including dicotyledonous	246	22.3	14.7	15.0
Grass	35	4.5	8.5	2.5
Perennial	85	6.0	8.4	6.1
Including dicotyledonous	28	1.5	1.2	1.8
Grass	57	4.0	7.0	4.1
Spore		0.5	0.2	0.2
LSD_{05}	109.1			
Threshold of harmfulness 3–10 weeds per m^2				

The species diversity of sugar beet entomocoenosises includes 171 arthropodas species belonging to 111 genera from 44 families, among them entomophages make up 49%, phytophages – 42%, saprophages – 9%.

72 insect species can feed on sugar beet plants but their harmfulness, as observations have shown, is essentially different. In the structure of dominance one can refer to dominant and subdominant species 21 phytophages (Table 3).

In Figure the structure of species dominance by their harmfulness is presented and it shows that 6 pest species do constant damage and can cause up to 10% yield loss or 29% from the total dominant number. *Agriotes sputator* L., *Agriotes lineolatus* L., *Selatosomus aeneus* L., *Aphis fabae* Scop., *Cassida nebulosa* L., *Cassida nobilis* L. belong to this phytophage group.

Beet leaf beetles are common in Europe and are encountered in Northern America. In the world fauna there are up to 3000 species of beet leaf beetle subfamilies belonging to 140 genera. In the Ukraine 35 beet leaf beetles are known; among them 32 species belong to *Cassida* genus. In Belarus, two beet leaf beetles are found, but the most widespread and harmful is a beet one (*Cassida nebulosa* L.). Annually, in the Southern regions of the Republic focus phytophage number is higher than the economic threshold of harmfulness (ETH), such fields are treated with insecticides. In 2003 in two farms of Stolbtsy and Kopyl regions of Minsk district practically 100% plant damage by the phytophage was determined with a degree of damage 50–75%. *Chenopodium album*, *Atriplex, Galeopsis* spp., *Amaranthus retroflexus* and beet that is why the highest phytophage harmfulness is observed on weed-infested plots. In field trials along with beet and goosefoot leaf scales in sugar beet weed-infested fields there were green beet leaf beetle (*Cassida viridis* L.), the beetles and larvae of which fed on wild deadnettle, mint leaves, sow thistles. Earlier this species was not found in sugar beet crops and based on literary data does not create any danger for sugar beet crops in the Ukraine and

Northern Caucasus. Apart beet leaf beetle the main sugar beet pests in Belarus are beet leaf-miner fly, beet aphid, beet flea beetles and carrion beetle. However, their number and harmfulness is changing with years. Beet flea beetle harmfulness significantly depends on environmental conditions. In humid cold years, as was the case in 2001, 2004, 2006, the quickly growing seedlings suffered not so much from pests. The beet flea beetles are the most active in hot, dry spring. According to sugar beet crops inspection in 2002, 2003, 2007 sugar beet damage by beet leaf beetles varied from 7 to 48% (maximum to 100%) with a degree of damage, mainly up to 10% (maximum – 50%).

Table 3. Dominant sugar beet phytophage species

Insect species	Degree of damage
Aphis fabae Scop.	4
Empoasca flavescens F.	1
Psammatettix striatus L.	1
Adelphocoris lineolatus Gz.	1
Lygus pratensis L.	1
Polimerus vulneratus Pz.	1
Aelia acuminata L.	1
Orthotylus flavosparsus C.Sahlb.	1
Piesma quadrata Fieb.	1
Agriotes sputator L.	4
Agriotes lineolatus L.	4
Selatosomus aeneus L.	4
Chaetocnema concinna Marsh.	2
Cassida nebulosa L.	4
Cassida nobilis L.	4
Aclypea opaca L.	3
Agrotis segetum Schif.	3
Autographa gamma L.	3
Mamestra brassicae L.	3
Pegomya hyoscyami Panz.	3
Phytomyza atricornis Mg.	1

Note: 1 – weak damage, yield losses up to 1%; 2 – periodical average damage, yield losses up to 3%; 3 – average damage, periodical yield losses up to 57%; 4 – constant average damage, periodically strong, yield losses up to 10% and higher; 5 – constant strong damage in different zones of Belarus, the yield losses up to 15% and more.

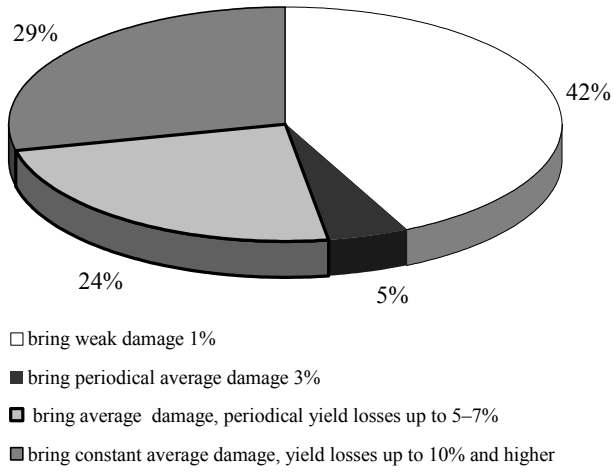

Figure. Structure of phytophage dominance by their harmfulness in sugar beet crops

Beet carrion beetle (*Aclypea opaca* L.) is found in all rotation fields but especially higher number is observed in sugar beet and crops, following sugar beet (barley, clover, winter wheat following clover). Recently beet carrion beetle number and harmfulness has significantly decreased (during the last ten years the phytophage number was lower than the economic threshold of harmfulness (ETH) but annually in the Republic there are found fields with higher than the economic threshold of harmfulness level.

The increased sugar beet colonization by beet leaf-miner flies (*Pegomya hyoscyami* Panz.) – up to 14 eggs per plant (threshold – 4–12 eggs per plant depending on sugar beet development stage) and plant damage (up to 100%) was observed in 2003, 2004 and 2007 what was promoted by favourable meteorological conditions (moderately warm and humid weather) during the larvae hatching period. There were fields with a degree of leaf damage more than 50%, they were treated with insecticides. Plant damage by beet leaf 2nd generation miner fly varied from 2 to 80% with a degree of damage 10–25%. High plant colonization by aphid (*Aphis fabae* Scop) (especially in the Southern regions of the Republic) was observed in 2000, 2005 and 2006 – up to 80% of plants with 1–2 point density (threshold – 5–15% plants depending on colonization period) at 16–30% of crops colonization. In 2002 in many farms the pest colonization reached 100% and in spite of useful entomophage activity there was a need for insecticide treatments against this pest. Under production conditions, it was determined that beet or bean aphid prefers table beet as a fodder plant. So, table beet colonization has made 76%, fodder – 68% and sugar beet – 49%.

In separate years in the southern districts of the Republic a high number of beet weevil (*Tanymecus palliates* Fab.) was observed and in separate fields plant damage made up 100%. In Belarus, up to now there has been no special research on this pest, though it is noxious for sugar beet. In this connection, there is a necessity in studying the area of spread, biology features, ecology, phytophage phenology and harmfulness,

determination of abiotic, biotic and anthropogenic factors influencing the phytophage spread and harmfulness.

Starting from 1999 high number click beetle focuses – wirewarms (*Elateridae* f.) appeared: sugar beet leaf damage made 20%, plant kill – from 8 to 98% (in focuses)

The main difference of sugar beet pest species composition in Belarus from the other neighbouring countries lies in the fact that a dangerous pest of the Ukrainian beet planting-beetroot weevil (*Bothynoderes punctiventris* Germ.) is absent in our Republic, such pests as southern (*Chaetocnema breviuscula* Fald.) and western (*Ch. tibialis* Heig.) brassy flea beetles, *Psylliodes cupreata* Duft., beet moth (*Iporimosehema (Lima) ocellatella* Boud.) and others. It is noteworthy, that sugar beet colonization, pest population number and plant damage differ depending on the agroclimatic zone of the Republic and by research years. The higher phytophage number and harmfulness is observed in the southern agroclimatic zone.

Black root of sugar beet affects sugar beet from seed germination to the second pair of true leaves formation. The disease reasons are unfavourable conditions for sugar beet seedling development: poor soil structure, soil pH, surface cap formation, soil crust formation, soil surplus or lack of moisture, lack of nutrients, inadequate agronomical practices and unqualified pre-sowing seed dressing. Black root decrease sugar beet yield by 39% and more. Black root spread in the farms of the Republic in 2001–2007 was 10–100%, the disease development from 6 to 67%.

One of the harmful sugar beet diseases is leaf spot disease of sugar beet (*Cercospora beticola* Sacc.), however, its expression depends on the weather conditions in the second half of beet vegetation. For example, in 2001 and 2003 vegetation seasons characterized by high temperatures and high relative air humidity, the epiphytoty disease development (from 71% at 47–100% spread) was noticed. In the years with cold rainy weather (2002 and 2004) in the second half of vegetation at disease spread from 0 to 100% the development made up 0–45%. Hot dry weather is also unfavourable for leaf spot disease of sugar beet development. In 2005, at the end of August the disease spread did not increase 10–15% and only at the end of vegetation reached 50–60% characterized by weak development. In 2007, the first symptoms of leaf spot of sugar beet were spotted in the 2nd ten-day period of July. During this period, the contamination was of single spot character and did not increase 1–5%. In the 3rd ten-day period of August there were rains and leaf spot disease of sugar beet increased: before harvest leaf spot disease spread varied from 10 to 100% with the development up to 53%. In the experimental field of the RUC "Institute of plant protection" the disease development made up 61%.

The weather conditions during the 2007 vegetation season (hot and dry weather in the second half of sugar beet vegetation) were favourable for powdery mildew (*Erysiphe communis* Grev. *f. betae* Jacz.) development: the disease occurred on 42% of sugar beet crops with a spread from 0 to 100% and the development from 0 to 23%.

Very often sugar beet plants having suffered from leaf spot of sugar beet are infected by root diseases and scab. In 2001, in some farms of Grodno district root crops were strongly infected by rots the agents of which were presented by a complex of pathogens: fungi of *Fusarium, Trichotecium, Penicillium, Alternaria* genus. In one of the farms root crop rot spread made up 85% at 75% of the disease development. The yield

from this field was excluded from deliveries for industrial processing at sugar concern. In the other farm the disease spread made up 83% at 50% of development. Heart rot and dry rot of root crops are expressed at insufficient supply of sugar beet with mobile boron combinations, stipulating the violation of physiological plant functions. The first symptoms are expressed in wilting of the youngest rosette leaves (a heart), they turn out black, dying away and get rot. That is why the name of the disease is "heart rot". Usually heart rot occurs at the end of July or in August. In hot and dry weather, nutrient uptake by plants is weakened, which results in much stronger disease development: the disease symptoms are expressed in fruit neck passing to dry rot. The disease spread in 2001–2004 did not increase 11–14%, at the same time in 2005–2007 when during the period of the intensive leaf growth the weather was hot and dry and blocked boron uptake by plants, the spread of boron deficiency in many farms of the Republic reached 60–100% with 2–76%.

Conclusions

1. In Belarus, the essential changes in phytosanitary situation of crops have taken place as a result of temperature rise, the formed structure of sowing areas, violations of agricultural crop growing technologies,.

2. In sugar beet crops the most frequent weeds are *Agropyron repens*, *Chenopodium album*, *Viola arvensis*, *Echinochloa crus-galli*, *Amaranthus retroflexus*, *Polygonum aviculare*, *Polygonum convolvulus*, *Melandrium album*, *Polygonum scabrum* and *Matricaria inodora*. Despite the system of protective measures, weed plant number before harvest increases 2–11 times the threshold one and the number of species has essentially increased during the last seven years.

3. 72 insect species can feed on sugar beet plants, however, their occurrence and harmfulness are essentially different. The most widespread and harmful under the conditions of the Republic are wireworms, beet fleas, beet carrion beetle, beet mining fly, beat or bean aphid, beet leaf beetle. In separate years, high number of beet weevil is observed.

4. Among the diseases – black root of sugar beet is of economic importance, the occurrence of which is observed annually, cercosporosis, in separate years – boron deficiency and powdery mildew.

5. Further monitoring of phytosanitary situation in sugar beet crops in different agroclimatic zones of the Republic will give an opportunity to control qualitative and quantitative changes in noxious insects, diseases and weed plant fauna, develop a forecast of noxious organisms appearance and plan the tactics of crop protection.

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