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Influence of anthropogenic and climatic factors on the dynamics of penetration and spread of the quarantine pest *Tuta absoluta* Meyr. in Ukraine

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ABSTRACT

Tuta absoluta Meyr. is an invasive alien species that entered the territory of Ukraine as a result of anthropogenic factors in 2010 with a shipment of infected tomatoes from Turkey. Visual inspection and pheromone traps were used to detect and register the South American tomato moth, which were installed according to the generally accepted methodology. The analysis of the current state of distribution of the South American tomato moth in Ukraine and the world was carried out according to the data of the Department of Phytosanitary Safety in the fields of seed and nursery production of the State Service of Ukraine for Food Safety and Consumer Rights Protection. To achieve the goals, the ways and reasons for penetration were determined *T. absoluta* to Ukraine. Setting the quarantine status of harmful organisms in Ukraine in 2023 using lists A-1 and A-2 of the "List of regulated harmful organisms". The quarantine status of the American tomato moth has been established in Ukraine in 2023. As the results of study we determined the dynamics of the distribution and number of the pest from 2015 to 2023; and the area of pest infestation in Ukraine and in each infected region; the number of infected regions, districts, cities, settlements, homesteads, farms of all forms of ownership from 2015 to 2023.

Keywords: *Tuta absoluta* Meyr., plant quarantine, quarantine pest, methods of protection, distribution.

INTRODUCTION

Using intensive integrated crop production systems, is one of the key elements of which is the protection of plants from harmful (including quarantine) organisms. Plant quarantine plays a very important role in the general system of growing plant products and protecting them from harmful organisms in Ukraine and the world [Vergeles, *et al.,* 2021]. Phytosanitary measures are the sovereign right of each state to prevent the importation, introduction from abroad and the spread of harmful organisms such as pests, diseases and weeds. Phytosanitary quarantine measures are an important component of the national phytosanitary system of Ukraine and are designed to minimize the risk of introducing quarantine organisms that are absent or limited in distribution in Ukraine and can cause significant economic damage to the country's agricultural sector. Phytosanitary measures include inspection of plant products, certification of seeds and plant material, application of necessary quarantine treatments and issuance of phytosanitary certificates to ensure the safety of plant products imported into Ukraine [Electronic resource. Access mode: https://zakon.rada.gov.ua/laws/ show/3348-12#Text].

The modern phytosanitary system of Ukraine is aimed at minimizing the risks associated with the penetration and spread of harmful plant organisms, and is based on international standards. Phytosanitary measures are crucial to prevent the entry and spread of harmful organisms that can harm agricultural crops in Ukraine. The importance of strict control measures, such as monitoring plant quarantine organisms and creating a

quarantine system to ensure that imported plant material is free from pests and diseases is a priority [Sykalo and Chernega, 2021].

The importance of phytosanitary measures in Ukraine is reflected in the significant economic impact of plant quarantine on the Ukrainian agricultural sector. Phytosanitary measures can prevent the catastrophe of entry of quarantine organisms from the A1 list into Ukraine and protect Ukrainian crops. Phytosanitary measures include inspection of plant products and products of their processing at border quarantine points, quarantine inspection during vegetation and product storage, as well as the creation of reliable and effective monitoring and supervision systems [Zamoroka, 2023].

The Department of Control in the Field of Seed Production and Phytosanitary Safety of the State Service of Ukraine for Food Safety and Consumer Protection is responsible for compliance with phytosanitary legislation in Ukraine. The Department aims to prevent the emergence of new diseases, pests and weeds and to control existing pests, and is also a supervisory body responsible for compliance with phytosanitary legislation of Ukraine. The service inspects imported plants and plant products at checkpoints, including airports, seaports, railway stations, bus stations and other border crossing points. The presence of quarantine organisms in materials and goods is checked, and if they are detected, the products are disinfected or destroyed at the expense of the owner of the cargo (according to the decision of the state phytosanitary inspector), or returned to the country of origin [Burdulaniuk, *et al.,* 2021; Electronic resource. Accessmode: http:// surl.li/gjtln].

The issue of phytosanitary control has gained special importance in recent decades. Over the past few years, trade relations between the European Union (EU), other countries, and Ukraine have strengthened significantly. In 2014, at a joint meeting of the Council of the EU, the President of Ukraine, the EU leadership and the presidents of the EU member states, the Agreement on European Integration was signed. The agreement provides for the free movement of labor, goods, services and capital between Ukraine and the EU and regulates the entry of the Ukrainian economy into the EU common market. The agreement is dangerous from a phytosanitary point of view, as it increases the probability of the penetration of quarantine and other dangerous organisms into Ukraine. In addition, the risk of introducing and spreading dangerous quarantine organisms to the territory of the southern and eastern regions of Ukraine from the Russian Federation in connection with a full-scale military invasion has increased. Quarantine organisms can spread on the wheels and tracks of machinery, with the food supplies of the occupying forces. It is possible to determine the scope and danger of the penetration and spread of quarantine organisms only after the end of hostilities and a systematic and comprehensive survey of these territories and lands [Burdulaniuk, *et al.,* 2023].

Anthropogenic factors, understood as the set of processes of human activity that affect living organisms, their habitat, the functioning of the biosphere and ecosystems, are of decisive importance in the penetration and spread of quarantine and other dangerous organisms to the territory free from them [Dreval, 2017]. The main anthropogenic factors include:

- International trade and transport. Through containers and packaging materials, vehicles, sea transportation, insects or seeds enter new territories;
- Globalization and tourism: international tourism, population migration. People may inadvertently transmit quarantine organisms, for example, through contaminated shoes, clothing, or souvenirs made from plant materials;
- Changes in agriculture and landscape design. Favorable conditions for the spread of quarantine organisms include: the use of intensive farming methods, the development of agricultural lands, the expansion of agricultural territories;
- Climatic changes. Due to changes in temperature, humidity, and shifting of climatic zones, some territories become more favorable for the existence and reproduction of quarantine organisms. Organisms that previously did not survive in certain regions due to climatic limitations adapt to new conditions, which contributes to their spread;
- Infrastructure projects: construction of roads, railways, ports, land reclamation, changes in the water regime and landscape;
- Secondary spread due to anthropogenic changes in ecosystems, reduction of biodiversity. These factors weaken the protective mechanisms of the spread of pests;
- Urbanization. In populated areas, the number of ways to transfer pests through vegetation in parks and gardens is increasing [Komar, *et al.,* 2011].

Reducing the influence of anthropogenic factors on the penetration and spread of quarantine plant organisms, consists in carrying out effective quarantine measures, in particular monitoring, strengthening control on transport routes, regulation of trade [Razumova, 2013].

T. absolute is an invasive alien species that entered the territory of Ukraine in large numbers largely due to anthropogenic factors such as vehicles, sea transport, through containers and packaging materials, seed material. Invasive alien species are species [or/and taxa of a lower rank of living beings that have been accidentally or intentionally introduced, or introduced to territories new to them, where they are not normally found. They threaten or adversely affect biological diversity. Invasive species pose a serious threat to native plants and animals in Europe and are one of the top five causes of biodiversity loss. These species can have a significant negative impact on the economy (their economic impact in the EU is estimated at approximately 12 billion euros per year), as well as on human health [Borzykh, *et al.,* 2023; Brundu and Acciaro, 2023]. To date, there are no unified estimates of economic losses caused by invasive alien species in the world, including the American tomato moth, which is obviously caused by the lack of a unified methodology for such assessments [Zamoroka, 2023]. In particular, according to researchers' estimates [Turbelin, *et al.,* 2023], global economic losses from 1980 to 2019 amounted to 1,208 billion dollars, and according to others [Haubrock, *et al.,* 2021], only for Europe – 116.61 billion euros for the period 1960–2020 years.

The main goals of the study were to determine the importance of phytosanitary measures to prevent the entry into Ukraine of quarantine organisms (including the American tomato moth) from list A-1 and the spread of harmful organisms from list A-2 of the "List of regulated harmful organisms"; establish the role of anthropogenic factors in the penetration and spread of invasive alien species *T. absoluta to* the territory of Ukraine; and to determine the threat of the pest's negative impact on biological diversity and related ecosystem services.

MATERIAL AND METHODS

The distribution of the South American tomato moth from 2015 to 2023 was analyzed. Observations on the features of nutrition and development (from egg to adult) of the South American tomato moth were carried out on tomato crops in the Uman district of the Cherkasy region on an area of 14.01 ha. To detect the South American tomato moth, visual inspection and pheromone traps are used. Traps are set two weeks before planting tomatoes and checked for the presence of adults at all stages of growing, harvesting, packing and marketing of tomatoes. *T. absoluta*, traps must be set in accordance with generally accepted trapping rules so that it was possible to control the required adjustment zone. Pheromone traps are placed diagonally at a distance of 50–100 m from each other and at a height of up to 50 cm; 5 traps are used for an area of 5–10 ha. The pheromone dispensers in the traps are changed every month, the insert should be replaced every two weeks. Traps are checked daily until the first butterfly appears, and then once every seven weeks. All traps are checked simultaneously [Klechkovsky, *et al.,* 2015].

The first butterfly trapped is considered to be the beginning of the flight, and the beginning of mass flight is a rapid increase in the number of butterflies trapped. Records are made every 3–5 days to determine the dynamics of the butterflies' flight. The intensity of butterfly flights to pheromone traps, the duration of egg laying and embryonic development predict the duration of caterpillar regeneration and potential damage. In tomato crops, the survey is carried out at 50 points diagonally across the field, 10 plant samples are taken, and they are carefully examined for signs of damage. Surveys are conducted every 10 days from May to August-October, depending on the maturity group of the variety. The result of visual monitoring is phytosanitary information about the state of the pest population. Determine the dynamics of rebirth and feeding of caterpillars and density. The percentage of damaged plants and the degree of damage are used to characterize the harmfulness of caterpillars [Stankevich, 2017].

For successful visual monitoring, it is necessary to know the peculiarities of the morphology of the South American tomato moth and the characteristic diagnostic signs of damage to various organs of tomatoes. Identification of insects by their morphology can be difficult due to their small size, since they do not have a well-defined hidden lifestyle, the first thing to look for is damage. As *T. absoluta* is a quarantine object, when a pest is detected, or any symptoms of damage, it is necessary to notify the specialists of the Department of Phytosanitary Safety Control in the Field of Seed

Production and Nursery of the State Service for Food Safety and Consumer Protection of Ukraine, who, based on the results of the survey, make a decision to introduce a quarantine state in a certain territory [Movchan, 2002.; Movchan, *et al.,* 2016].

The analysis of the current state of distribution of the South American tomato moth in Ukraine and the world was carried out according to the data of the Department of Control in the Fields of Seed Production and Nursery, Quarantine and Plant Protection of the State Service for Food Safety and Consumer Rights Protection of Ukraine [Electronic resource. Access mode: http://surl.li/gjtln].

RESULTS AND DISCUSSION

According to Order No. 397 of 07.16.2019 "On Amendments to the List of Regulated Harmful Organisms" [Electronic resource. Access mode: https://zakon.rada.gov.ua/laws/show/z0879-19#Text], the list of quarantine organisms (A-2), which are limited in distribution in Ukraine, includes five species of insects, one nematode, five pathogens and six types of weeds [Electronic resource. Accessmode: https://zakon.rada.gov.ua/laws/show/z0879-19#Text]. As of 2023, the following quarantine pests are registered in Ukraine: *Hyphantria cunea* Drury., *Diabrotica virgifera* Le Conte., *Phthorimaea operculella* Zell., *Ceratitis capitata* Wied., *Frankliniella occidentalis* Perg. They are also called internal quarantine pests. With of list A-1 (Quarantine organisms absent in Ukraine) in recent years have discovered: *Bemisia tabaci, Tuta absoluta* Meyr. *Agrilus planipennis* Fairmair. These are dangerous quarantine pests that have been identified by many international and regional plant protection agencies, which have also been found in Ukraine, and for which a complex of protection measures is being carried out with the aim of their localization and elimination. Probably, if this does not happen, these pests will be transferred to the A-2 list, so research in this direction is relevant [Electronic resource. Access mode: https://zakon.rada.gov.ua/laws/show/z1300-06#Text].

The South American tomato moth was imported to Ukraine in 2010 with cargoes of infected tomatoes from Turkey and Syria. Then an outbreak of the pest was detected in the Crimean Autonomous Republic and Odesa Region. Infected tomato crops were found both in open ground and in greenhouses. In 2012, after surveying 79.0 ha of land in the Kherson region, this pest was also detected, and the following year it was detected in the Mykolaiv region. In 2018, quarantine restrictions were introduced for the first time in Zaporizhzhya Oblast (Gulaypil, Melitopol, and Kamian-Dnipro districts) on a total area of 52.7 ha due to the detection of the South American tomato moth. In addition, according to the results of the investigation, new foci of the pest were discovered in the Skadovsky district and new epidemics of the pest were discovered for the first time in the Bilozersk and Holopristan districts of the Kherson region. Quarantine was introduced on an area of 83.95 ha. According to the results of the observations of the specialists of the State Production and Consumer Service and the results of the monitoring of Solanaceous plantations, it can be stated that at the moment this pest can be classified as a quarantine pest with a limited distribution in Ukraine [Stankevich, 2017]. All criteria of the South American tomato moth correspond to the status of "current pest" according to the International Standard of Phytosanitary Measures - IFRS No 8 "Determination of Pest Status within the Territory". Taking into account the sufficient number of official reports about the presence of a harmful organism, its distribution can be characterized as "Present: only in certain parts of certain regions of Ukraine" and attributed to list A-2 of the "Insects" section [Electronic resource. Access mode: http://surl.li/iotxzo].

The pest causes catastrophic damage to tomato production in Europe, Africa and Asia [Aigbedion-Atalor, *et al.,* 2019]. *T. absoluta* has a high reproductive potential (up to 10–12 generations per year and 24–76 days per generation depending on environmental conditions) and can cause complete crop failure if left untreated. *T. absoluta* has a high migration potential and the expansion of the area with the flow of air masses and by independent flight. The speed of settlement of pest populations per year can be 60–80 km. The rapid spread of the South American tomato moth, which is quite thermophilic, indicates the warming of the climate and the adaptation of the pest to natural conditions in the southeast of Ukraine [Bilousova *et al*., 2021].

The South American tomato moth belongs to the classinsects, row *Lepidoptera*, families *Gelechidae*, genus *Tuta.* The pest development cycle includes four stages: egg, maggot, larva, imago (Figure 1). Damages tobacco, tomatoes, peppers,

Figure 1. *T. absoluta*: 1 – adult insect; 2 – egg; 3 – pupa; 4 – larva [Borzykh, *et al*., 2009]

potatoes, eggplants, nightshades, belladonna, dahlia and other decorative nightshades. This pest is often called the passing moth, because the larvae damage the leaves, stems and fruits of vegetable crops, depositing waste products there like a "mine" [Movchan, *et al*., 2016] (Figure 2).

Damage occurs early in the pest's life cycle: first-instar caterpillars feed on leaves, and with age, their damage increases, penetrating stems and petioles and damaging ovaries, green fruit, and ripe fruit. The caterpillar has a high feeding intensity and subsequently reproduces. Foliage damage by this pest causes direct economic losses that can range from 35% to 100%, especially at high population densities.

Scientists believe that the homeland of the species is South America. In 1913, the first specimen of a butterfly was found in Peru. The rapid spread of the pest began on land, thanks to human activity. It was registered in Venezuela, Bolivia, Argentina and Ecuador in the 1990-s, and in Brazil, Chile and Uruguay in 2004, and its spread continues. The species has not yet crossed the northern borders of Central America (the southernmost finds were in Panama, Costa Rica, and Haiti). In 2006, the butterfly first appeared in Spain, from where it began to spread across Europe; in 2008–2009 it was found in France, Italy, the Middle East and North Africa; in 2008–2009 it was found in France, Italy, the Middle East and North Africa [Ustinov, *et al*., 2012]. It is currently detected in the following countries on the equator of the continent, from Morocco to Egypt, and in the east, including India and China; as of 2023 in general is found in 100 countries of the world on all continents except Antarctica [Sreenivas, *et al*., 2023] (Figure 3).

Areas with a warm climate and mild, frost-free winters are optimal for long-term survival of the tomato moth. The degree of suitability decreases from south to north. Regions with a hot, dry climate (the equatorial part of Africa and the continental part of Australia, and a cold climate with frosty long winters (the northern part of Eurasia and North America) are unsuitable for the pest to inhabit [Venette, and Morey, 2020]. To prevent harmful effects on the environment

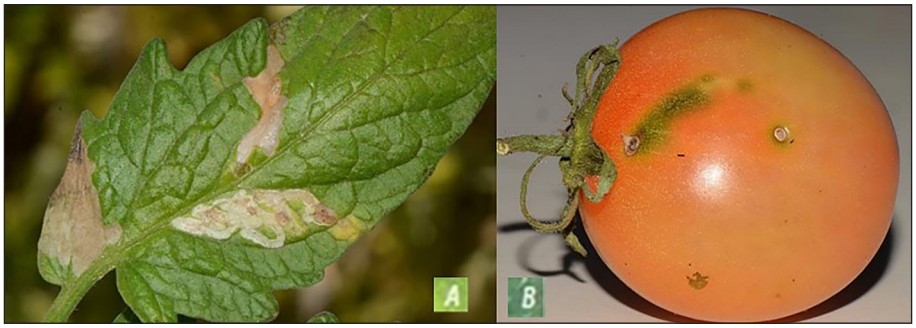

Figure 2. A – a mine on a leaf, B – damage to the fruit by goose *T. absoluta* [Movchan, *et al*., 2016]

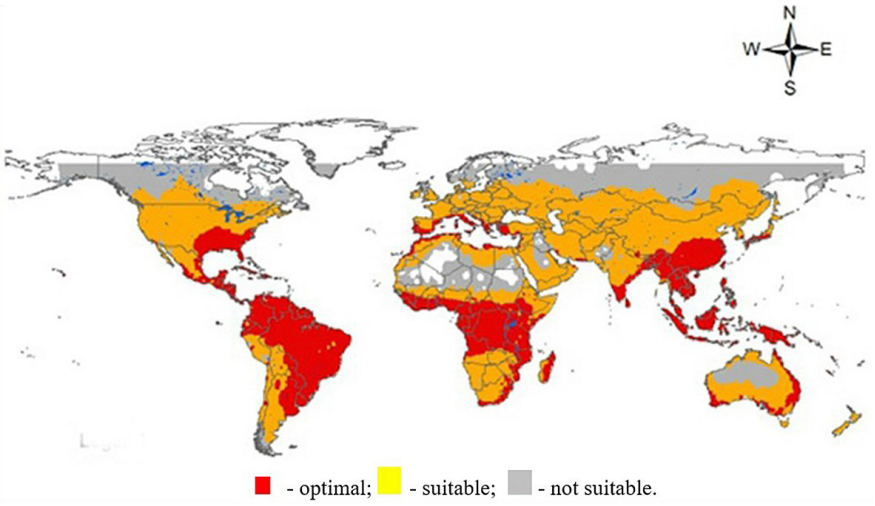

Figure 3. Suitability of different regions of the world for settlement *T. absoluta* [Bilousova, *et al*., 2021]

environment and human health, to reduce resistance, agricultural producers should reduce the use of pesticides [Gonthier, *et al*., 2023]. *T. absoluta* in cluded in the list 36 quarantine dangerous pests of vegetable crops in Ukraine. According to the EPPO, this dangerous quarantine pest is found in European countries, especially on nightshade crops such as potatoes and tomatoes. It is increasingly found on cultivated plants and plant products. Tomatoes are the main host plant of the South American tomato moth in Ukraine [Makuha, 2020]. As of December 31, 2023, the pest is widespread in 9 regions of Ukraine (Volyn, Zakarpattia, Zaporizhzhya, Donetsk, Mykolaiv, Odesa, Kherson, Khmelnytsky, Cherkasy) on an area of 6316.10 ha (Figure 4).

The most areas affected by the pest were registered in the Mykolaiv region on an area of 5316.73 ha in the Bashtansky, Pervomaiskyi, Mykolaivskyi, and Voznesenskyi districts on an area of 2052.55, 1800.00, 1289.28, and 74.9 ha, respectively. The Mykolayiv region occupies 842% of the total structure of the affected *T. absoluta* areas of Ukraine (Table 1).

In the Volyn region, the pest is registered in the Volodymyr-Volyn district on an area of 10 ha. In Zakarpattia Oblast, 11.4 ha were infected in Berehiv and Uzhgorod districts. The area of infection in the Zaporizhia region amounted to 248.06 ha in the Berdyansk, Zaporizhia, Vasylivskyi, Melitopol and Pologivsky districts on the area, respectively 79.24, 65.79, 32.00, 43.20 and 27.80

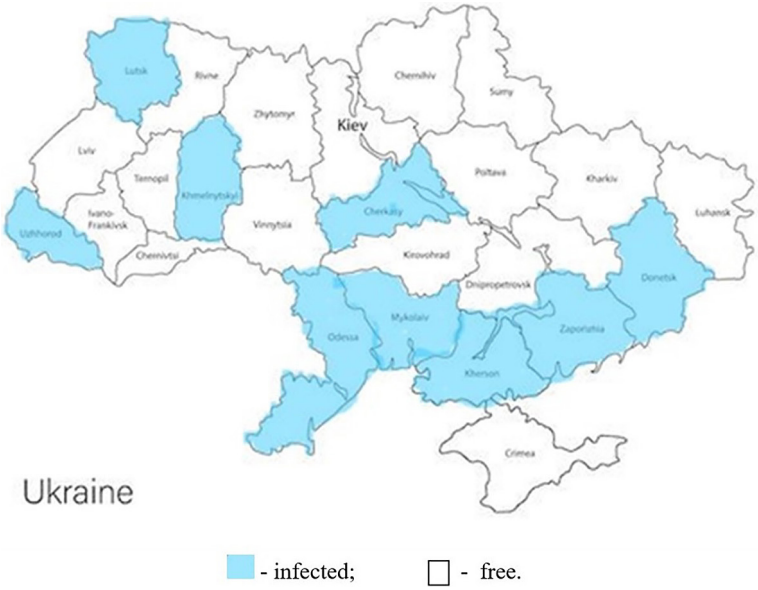

Figure 4. Distribution *T. absoluta* in different regions of Ukraine as of 2023 year

Table 1. Distribution *T. absoluta* in different regions of Ukraine as of 2023 year

No.	Regions	Infected, quantity administrative units				Area, ha				
		Bridge	Inhabited points	Homesteads plots	Households everyone forms property	On homesteads areas	IN farms all forms property	On others lands	In total	Number quarantine zones
1	Volyn Oblast	–	1	–	1	–	10.00	–	10.00	1
2	Zakarpattia Oblast	1	4	42	2	3	8.44	–	11.44	3
3	Zaporizhzhia Oblast	3	17	995	9	165.84	62.80	19.41	248.06	129
4	Donetsk Oblast	–	–	–	1	–	40.00	–	40.00	1
5	Mykolayiv Oblast	–	10	1697	–	1003.28	–	4213.45	5316.73	10
6	Odesa Oblast	2	14	336	3	72.5	62.00	–	134.50	19
7	Kherson Oblast	2	4	465	7	60.35	89.01	29.00	178.36	11
8	Khmelnytsk Oblast	–	1	–	–	–	–	463.00	463.00	1
9	Cherkasy Oblast	–	–	–	1	–	14.01	–	14.01	1
10	Total:	8	51	3535	24	1304.97	28.26	4724.86	6316.10	177

ha. In the Donetsk region, 40 ha in the Mariupol district are infected. In the Odesa region, 134.50 ha were infected in the Bolhrad, Odesa, Izmail, Podil, Rozdilnyav, Bilhorod-Dnistrovsky and Bereziv districts on the area of 15.00, 26.00, 15.00, 11.50, 5.00, 52.00, 10.00 ha respectively. In the Kherson region, 178.36 ha were infected in Beryslav, Kakhovka, Skadovsk and Kherson districts on an area of 4.00, 25.00, 149.01, 0.35 ha. Khmelnytsk region ranks second in the structure of the affected *T. Absoluta* area with an indicator of 4.2%. The pest was registered in the Khmelnytsk district on an area of 463.00 ha. In the Cherkasy region, the pest is present in the Uman district on an area of 14.01 ha. We have established the dynamics of distribution *T. absoluta* in Ukraine with 2015 to 2023 (Table 2).

From 2015 to 2023, the number of infected areas increased 7 times. The pest gradually conquers new territories, while destroying 60%–100% of the crop in a short period of time. As of December 31, 2023, the affected area was 6316.10 ha. This trend is confirmed by research conducted in the southern regions of Ukraine [Bilousova, 2023]. There is a noticeable trend in increasing the spread of the pest in Ukraine from 883.92 ha in 2015 to 6316.10 ha in 2023. The number of infected settlements increased from 6 in 2015 to 51 in 2023. The number of infected homesteads increased from 2059 to 3535, and farms of all forms of ownership increased from 5 to 24. This is facilitated by the "softening" of the climate, which provokes the appearance of new generations of pests adapted to the natural conditions of our country (Figure 5).

Over the nine years studied, the number of regions where this quarantine pest was detected increased from three in 2015–2017 to nine in 2023. The maximum number of infected regions was 10 in 2022 and 2023. Due to a complex of measures, primarily quarantine measures, it was possible to localize and eliminate the foci *T. absoluta* in the Dnipropetrovsk region on the square 42.57 ha, but in other regions the area of infection

Table 2. Distribution dynamics *T. absoluta* in Ukraine (2015–2023)

No.	Year	Infected, quantity						Area of infection, ha
		Regions	Districts	Bridge	Inhabited points	Homesteads plots	Householdsall forms property	
1.	2015	3	6	1	6	2059	5	883,9216
2.	2016	3	5	0	5	2059	3	829,9216
3.	2017	3	5	0	5	2059	3	829,9216
4.	2018	4	10	0	5	2614	7	966,5716
5.	2019	6	15	0	8	2666	12	1020,7716
6.	2020	7	26	0	27	3635	19	1190,9810
7.	2021	10	22	0	36	3376	24	4532,2256
8.	2022	10	27	8	45	3485	25	5965,8256
9.	2023	9	26	8	51	3535	24	6316,1010

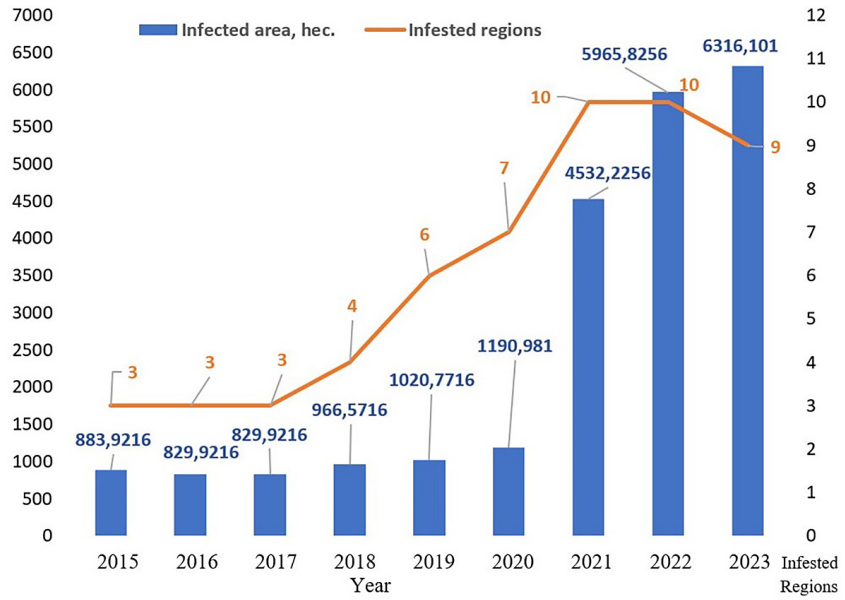

Figure 5. Distribution dynamics *T. absoluta* in different regions of Ukraine with 2015 to 2023

has increased significantly. Especially significant spread *T. absoluta* observed in the last 4 years, the affected area increased 5 times from 1190.98 ha in 2020 to 6316.10 ha in 2023.

Measures to control the spread and number of pests in Ukraine include agrotechnical, chemical and biological methods. Agrotechnical measures include plowing, application of organic fertilizers, irrigation, compliance with crop rotation, destruction of host plants and infected plants and damaged fruits. Chemical control involves the use of insecticides according to the "List of pesticides and agrochemicals approved for use in Ukraine". Specialists in Ukraine recommend using drugs based on approved active substances (abamectin, emamectin benzoate, deltamethrin). In Ukraine, there is not a single biological drug officially registered to fight against *T. absoluta*, but several biological agents are successfully used in many countries. These are predators *Nesidiocoris tenuis* and *Macrolophus pygmaeus*, which are widely used in North Africa and Europe and can be used in Ukraine [Melnychuk, *et al*., 2021].

Review of literary sources on the dynamics of distribution *T. absoluta* in the world shows that this quarantine pest is a serious invasive and harmful insect of tomatoes (*Solanum lycopersicum* L.) all over the world. The pest can cause 100% death of the tomato crop in greenhouses and in the open field, if control measures are not carried out *T. absoluta* has a high reproductive potential, ability to spread and resistance to adverse environmental conditions [El-Shafie, 2020; Aslan, 2022]. International trade always carries the risk of introducing pests to countries where they are not yet present. Invasive pest *T. absoluta* only ten years later, it spread to the entire African continent, now continuing its expansion into Asia [Mohamed, *et al*., 2022]. Since the first detection *T. absoluta* in Turkey in 2009, the pest has expanded its invasion range at a very high rate and is now spreading through Southeast Asia [Guimapi, *et al*., 2020]. The development and survival of the pest is influenced not only by temperature, but also by such factors as predation, parasitism, egg viability in the presence of entomophages [Zink, *et al*., 2020]. The insect is characterized by high reproductive potential, a wide range of host plants of the family *Solanaceae*, high harmfulness, adaptability to temperature fluctuations and the ability to acquire resistance to insecticides. Crop losses as a result of the harmful activity of the South American tomato moth can be 50–100% [Biondi, *et al*., 2018]. In addition, this pest destroys tomato plants at all stages of growth. In addition to tomatoes, it is also known about attacks on other cultivated nightshades, as well as on crops from other botanical families and uncultivated weeds [Vivekanandhan, *et al*., 2024]. In 2006, the first record of *T. absoluta* as an invasive pest in China. It was discovered on tomato fields in Ili Kazak Autonomous Prefecture, Xinjiang Uygur Autonomous Region (Ili, Xinjiang), China [Zhang, *et al.,* 2020]. In Kenya [Kinyanjui, *et al.,* 2021], *T. absoluta* has been detected on tomatoes in open and closed ground in all examined 29 districts, indicating

its widespread distribution. 9 types of natural enemies of the moth were discovered from affected leaves, with combined parasitism, species Hockeriawas the most and dominant made up 31.25%. This indicates the prospect of using natural enemies' pest for effective control of field populations *T. absoluta*. These findings form the basis of research and development of effective and sustainable pest management strategies.

Currently, the use of insecticides is the main strategy for combating *T. absoluta* in to the whole world but the hidden way of life of the larvae makes it extremely difficult to control the population with the help of insecticides. Reasons for difficulties include the following: tomato moth infection occurs at an early stage of plant development, damage to various plant parts (stem, leaves, buds, inflorescences, fruits) tomato plant morphology, which provides larval protection against insecticides [Huda, *et al.,* 2020]. The active use of insecticides contributes to the emergence of resistance in pests, an increase in the cost of production, an ecological hazard for the environment, and, therefore, there is an urgent need for the development of more ecological methods of control. Essential oils have several advantages that make them valuable alternatives for pest control [Dervisoglou, *et al*., 2023]. Studies conducted in the United States of America [Zink, *et al.,* 2020] indicate difficulties in identifying larvae and adults *T. absoluta*. Reduction of identification time of the pest will lead to faster identification at ports of entry and allow for a more effective response to the threat of entry and spread. The use of insecticides simultaneously with drip irrigation in the conditions of southern Ukraine due to their local application ensures high efficiency, not inferior in terms of the duration of the toxic effect of the drugs, compared to other methods of drug application [Melnychuk, *et. al*., 2021]. For timely detection and localization of the South American tomato moth in farms of different ownership in the south of Ukraine, it is proposed to use pheromone monitoring from May to the harvesting of tomatoes. This method is simple, accessible, and most importantly, operational, which will make it possible to increase the effectiveness of phytosanitary monitoring [Gulyaeva, and Durbala, 2022] suggest reducing the use of pesticides by agricultural producers to prevent harmful effects on the environment and human health, and to reduce resistance.

CONCLUSIONS

T. absoluta is an invasive alien species that has entered the territory of Ukraine as a result of anthropogenic factors, such as vehicles, maritime transport, containers and packaging materials, and seed material. Identification of the pest is quite difficult due to their small size, first of all you need to pay attention to this damage. For successful visual monitoring, it is necessary to know the peculiarities of the morphology of the South American tomato moth and the characteristic diagnostic signs of damage to various organs of tomatoes. The pest causes catastrophic damage to the production of tomatoes and can cause complete death of the crop, if measures of localization and elimination are not carried out. This is due to high reproductive potential (up to 10–12 generations per year), climate change towards warming (the pest is quite thermophilic), and adaptation of the pest to the natural conditions of Ukraine.

T. absoluta has a significant capacity to migrate and expand its range with the mass of air flows, as well as by flying on its own. To date The speed of settlement of pest populations per year can be 60–80 km. The pest was brought to Ukraine in 2010 with cargoes of infected tomatoes from Turkey and Syria. An outbreak of the pest was detected in the Autonomous Republic of Crimea and Odesa Region. Infected tomato crops were found both in open ground and in greenhouses. In 2012, the pest was detected in the Kherson region, the following year – in the Mykolaiv region, in 2018 – in Zaporizhzhia *T. absoluta* included in the list 36 quarantine dangerous pests of vegetable crops in Ukraine.

From 2015 to 2023, the number of infected areas in Ukraine increased in 7 times. Especially significant distribution *T. absoluta* observed in the last 4 years, the affected area increased 5 times from 1190.98 ha in 2020 to 6316.10 ha in 2023. Over the nine research years, the number of infected areas increased from three in 2015 to nine in 2023. The maximum number of infected regions was 10 in 2022–2023. In 2022, it was possible to localize and eliminate the cells *T. absoluta* in the Dnipropetrovsk region on the square 42.57 ha thanks to a complex of measures, primarily quarantine measures, but in other regions the area of infection has increased significantly.

As of 2023, the most areas affected by the pest were registered in the Mykolaiv region on an area of 5316.73 ha, which is 84.2% of the total structure of affected areas *T. absolute* area of Ukraine. In the Volyn region, the pest is registered on an area of 10 ha, in the Zakarpattia region 11.4 ha are infected, in Zaporizhia – 248.06 ha, in Donetsk – 40 ha, in Odesa – 134.50 ha, in Kherson – 178.36 ha. Khmelnytskyi region ranks second in the structure of the affected *T. absoluta* area of with an indicator of 4.2%, 463.00 ha were infected. In the Cherkasy region, the pest is present on an area of 14.01 ha.

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