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New Technology Plant Protection from Pest Insects in Closed Environment of Georgia

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The pest organisms have increased in greenhouses of Georgia. At the same time new invasive insects, the South American tomato moth, *Tuta absoluta and* the serpentine leaf miner, *Liriomyza* sp. have introduced and damaged with other pests: the greenhouse whitefly (GHW) - *Trialeurodes vaporariorum*, the melon aphid - *Aphis gossypi*, the green peach aphid - Myzodes *persicae*, the red spider mite - *Tetranychus urticae* and thripses. At present *T. absoluta* is economic pest of tomato in greenhouses of Georgia. This insect causes great damage (80-90%). The GWF is the hazardous pest of vegetables; it develops 12 generation per year. Both insects have jointly been harmful on tomato plants. The GHW is a major pest also for ornamental plants in greenhouses. There are harmful scale insects (Coccidae) - polyphagous insect group, cause great damage to ornamental plants - the fern scale, *Pinnaspis aspidistrae*, damages - the sword fern - *Nephrolepis exaltuta*, the dragon-tree - *Draeacena draco*, the smilaxes - *Smilax exelsa*. The experiments were conducted under laboratory and greenhouse conditions - in vegetable greenhouses (village Misaqtsieli) and Centre of Ornamental Gardening, BIMEPI, Tbilisi. The natural enemy of GWF, specialized parasitoid, *Encarsia formosa* has established into the useful entomofauna of Georgia this time. The preliminary laboratory experiments were conducted on the action of bacterial preparation "*Delphin*" (1%) (based on *Bacillus thuringiensis* subsp. Kurstaki, strain SA-11) and the entomopathogenic nematode (EPN) - *Steinerma feltiae*, "Georgian strain", *Geo-nema.* The nematode suspension (500 IJs/ml) was used for treatment 15 tomato seedlings, settled by 8-12 pest larvae on each at 23-25 ℃ and 60-70% RH conditions. The mortality of tested cadavers was compared to control variants by using Abbott's formula (Abbott, 1925). The results of application biological means for 3, 5, 7, and 10 days after treatment were detected. Data was analyzed with two way ANOVA (p=0.05). The relationship of "host-parasite" *T.absoluta - S.feltia* has established. Perspectives of environmentally safe biological agent efficacy and their join application with other biological formulations in greenhouses have elaborated. *"Geo-nema"* is considered as a perspective bioformulation to control *T.absoluta* in greenhouses. At initial low density of whitefly (10-imago/plant), the biological efficacy (B.E.) of *encarsia* equals to 20%. After thrice-repeated colonization of e*ncarsia* the B.E. increases to 70%, which provides the number

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regulation of GHW on ornamental plants in the protected ground. The joint action of two biological agents - parasitoid encarsia and EPN in relation to the low population density of GHW has established. The action of EPN, *S. feltiae* on P. *aspidistrae* has established, in the case of nematode suspension 1500 IJs/ml the larvae mortality reached 85%. There were sex pheromone traps (Companies "Biobest", UK and "Tutabs", Turkey) tested to *T. absoluta* adults. The number of insects reached to 765 - 420 individuals on each trap accordingly. The yellow traps (Company "Biopest") have used monitoring for *T.absoluta*. New generation biological preparations (Prokleim, Vertameqtin forte) have used, in the case of pest population increase the chemical preparation "Aqtara" has tested. The B.E. percentage achieves to 97.8. The tested environmentally safe means will take important place in integrated pest management (IPM) system in greenhouses.

Keywords: biotechnology, insects, biocontrol

Introduction

Besides to intensive development of greenhouse farms (more than 400-500[2] ha) the diversity of pest organisms have increased during last years in Georgia. Especially it concerns to introduced new, invasive pest insects, such as the South American tomato moth, *Tuta absoluta* (Povolny) (Lepidoptera: Gelechiidae) and the serpentine leaf miner, *Liriomyza s*p. (Diptera: Agromyzidae) (Fig.1, 2). According to Ministry of Agriculture of Georgia observation data of 2011 year (internet sources), these alien pests have been added to the greenhouse invasive pests' list among other pests: the greenhouse whitefly (GHW) - *Trialeurodes vaporariorum* (Westw.), the melon aphid - Aphis *gossypi* (Glow.), the green peach aphid - Myzodes *persicae* (Sulz), the red spider mite - *Tetranychus urticae* (L.), thripses (Chubinishvili *et al.,* 2013). Since 2011 *T. absoluta* is limited spread quarantine pest to Georgia. Initially the pest revealed in tomato seedlings imported from Turkey in the Western Georgia, then it was rapidly spread the Eastern regions of country, in suburbs of Tbilisi, Mtskheta, Marneuli, Gardabani greenhouses. At present *T. absoluta* is economic pest of tomato in greenhouses of Georgia. This invasive pest insect causes great damage (80-90%). I-II instars larvae live on leaf surface at development stage. *T. absoluta* is considered as an economically damaging pest in many countries. It is distributed from South American Continent (Garcia, 1982), throughout many European countries (EPPO, 2005). In Europe, it was initially detected in the Iberian Peninsula in 2006 (Urbaneja *et al.,* 2007). Since it has rapidly moved across the Mediterranean area and has been detected in France, Italy and the United Kingdom (UK) (Desneux *et al*., 2010; Urbaneja *et al.,* 2012). Initially the control to pest was started by chemical treatments; hence, soon these methods were reduced because of rapid resistance development of the pest (Cabello *et al*. 2012). Among all control measures to *T.absoluta,* the biological means had priority in integrated pest management

(IPM) system. The GWF is the serious pest insect of vegetables, especially for tomato plants (Fig. 3). It develops 12 generation per year. Insect causes great damage by sucking sap from underside of leaves, therefore weakening plants are dried. Very often, both pests damaging tomato plants together (Fig. 4). The GHW populations have outbreak in the spring - summer period at Georgian conditions (Skhirtladze, 2003). The GHW is major pest also for ornamental plants in greenhouses (Fig. 5). It multiplies mainly in the spring and summer, damaging the fuchsia - *Fuchsia globosa*, the common privet - *Ligustrum vulgare;* the balsamine - *Impactiens balsamina*. There are also the harmful scale insects (Homoptera: Coccidae), polyphagous insect group, which cause great damage to ornamental plants. Among them the fern scale, *Pinnaspis aspidistrae* Sign. (Fig. 6) damages - the sword fern - *Nephrolepis exaltuta*, the dragon-tree - *Draeacena draco*, the smilaxes -*Smilax exelsa*.

Our research is dedicated to the development protection of vegetable crops and ornamental plants from complex pest insects by using of environmentally safe means at closed ground conditions.

Fig. 1 *Tuta absoluta* damage on tomato leaves and fruit

Fig. 2 *Liriomyza s*p.damage on tomato leaves

Fig. 3 *Trialeurodes vaporariorum* population on tomato leaves and fruits

Fig. 4 *T.absoluta* and *T. vaporariorum* simultaneous damage on tomato leaves

Fig. 5 *T. vaporariorum* on *Ligustrum vulgare* (1) and - *Punicea granatum* (2)

Fig. 6 *Pinnaspis aspidistrae* on *Ligustrum vulgare*

Materials and methods

The experiments to test biological control agents to the above-mentioned pest insects conducted under laboratory and greenhouse conditions - in vegetable greenhouses (village Misaqtsieli, Mtskheta) and Centre of Ornamental Gardening, BIMEPI, Tbilisi. *T. absoluta* damage and the average density of pest population were calculated by degree point system by using of accepted method (Dospekhov, 1979). The infested tomato leaves were collected in greenhouses and transferred to laboratory. The preliminary laboratory experiments were carried out to action of bacterial preparation "*Delphin*" (based on *Bacillus thuringiensis* subsp. Kurstaki, strain SA-11) and the entomopathogenic nematode (EPN) - *Steinerma feltiae*, "Georgian strain" (identified with Prof. P.Stock, Arizona State University, USA). The different instars larvae (8-10) were settled on 15 tomato potted plants and treated with 1% of *"Delphin"* solution. Nematode suspension (500 IJs/ml) was used for treatment 15 tomato seedlings, settled with 8-12 larvae each at 23-25℃ and 60- 70% RH conditions. In both cases (bacteria and nematode) the tomato plants were treated twice with 7 days interval and control variants applied with distilled water. The natural enemy of GWF, specialized parasitoid, *Encarsia formosa* Gahan. was tested to GHW in laboratory and greenhouse conditions. *E. formosa* at 1960 was introduced from Canada to Georgia (Batumi, Bio-laboratory), where the artificial propagation and colonization carried out in greenhouse farms mainly. Today parasitoid *encarssia* is established at beneficial entomofauna of Georgia and it plays the certain role in the number regulation of pest population (Skhirtladze, Rizhamadze, 2014). The mortality of tested cadavers was compared to control variants by using Abbott's formula (Abbott, 1925). The biological efficacy calculated by the generally accepted method (Franz, 1968). The action of biological means for 3, 5, 7, 10 days after treatment were detected. The infected larvae were observed already

after 48 - 72 hr on last application day of experiment. Data was analyzed by two way - ANOVA (p=0.05).

Results and Discussions

Entomopathogenic nematodes (EPNs) those belong to the genera *Heterorhabditis* and *Steinernema* are considered as effective biological control agents and serve as alternatives to chemical control of insect pests (Ehlers, 2007; Grewal *et al*. 2006).

The relationship of "host-parasite" *T.absoluta* - *S.feltia* is established by nematode suspension spray on tomato plants, or with soil treatment. Perspectives of environmentally safe biological agent efficacy and their join application with other biological formulations in greenhouses have elaborated. As the results show 1000 IJs/ml of "*Geo-nema"* has caused 79.2% invasion of pest larvae at laboratory conditions, hereby the biological efficacy (B.E.) of nematode suspension 1.5 million IJs/10 liter spraying achieved to 53.2 – 54.1% in greenhouses. The preliminary results of investigations on relationship between host (invasive pest, *T. absoluta*) and parasite (*S.feltiae)* have obtained. *"Geo-nema"* is considered as the perspective bioformulation to control *T.absoluta* in greenhouses, thereby obtaining of ecologically pure production is guaranteed. The elaborated environmentally safe mean will be included as an important component at IPM system. The susceptibility of bioformulation „*Geo-nema*" on the base of local EPN "Georgian strain", *S.feltiae* infective juveniles (IJs), to the invasive pest, *T. absoluta* has been studied on tomato plants in greenhouses (Chkhubianishvili, Kakhadze, Malania, 2010). At initial low density of whitefly - 10 imago/plant, the B.E. of *encarsia* local population makes 20%. After thrice-repeated colonization of e*ncarsia* the B.E. increases to 70%, which provides the number regulation of GHW on ornamental plants in the protected ground (Skhirtladze, Rizhamadze, 2009; Skhirtladze, 2010; Rizhamadze, Skhirtladze, Nazarashvili, 2015). The joint action of two biological agents - parasitoid *encarsia* and EPN in relation to the low population density of GHW has established (Skhirtladze, Rizhamadze, Chubinisvili, 2013).

The action of EPN, *S. feltiae* on *P. aspidistrae* has established (Kakhadze, Malania, Skhirtladze *et al.*, 2012; Mikaia, Skhirtladze, Rizhamadze, 2012). Individuals of *P. aspidistrae* were collected in spring-summer at the Centre of Ornamental Gardening, Tbilisi, on laurel plants, where the density of pest's habitation was 100-120 individuals per leaf in the average. Results of investigations of the interaction of *P. aspidistrae* and nematode *S. feltiae* showed, that in the case of nematode suspension 1500 IJs/ml the larvae mortality reached 85% (Mikaia,Skhirtladze, Rizhamadze, 2012).

According to the literature data, the biotechnical means - yellow and pheromone traps play the important role in practice, for the number regulation of the *T. absoluta* in the greenhouses (Salas, 2004; Cabello *et al*., 2012; Cocco *et al*, 2012; 2013). First time for Georgian conditions the sex pheromone traps (Companies "Biobest", UK and "Tutabs", Turkey) have tested to *T. absoluta* (The number of insects were 765 - 420 individuals on each trap, accordingly. The yellow sticky traps (Company "Biopest") have used for *T.absoluta* monitoring (Chkhubianishvili, Kakhadze, Malania, 2016). Biological preparations (Prokleim and Vertameqtin forte) have used to I-II instars larvae (B.E. 82.7 - 91.2) at the same case the pest population increased, when the chemical preparation "Aqtara" had been used. The biological efficacy achieved to 97.8%.

Conclusion

As the results of investigations the technology using of environmentally safe microbial, biological and biotechnical means for obtaining ecologically pure products in greenhouses of Georgia has elaborated.

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