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Efficiency of different doses of insectofungicidal biopreparation (Gaupsin) against phytophthora of tomato in Adjara, Georgia

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Abstract

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During 2019 and 2020 the field study was conducted at In Khelvachauri district (village Sameba) of Adjara, Georgia. Blight caused by *Phytophthora infestans* and *Ph. parasitica* is an important disease of Tomato *(Lycopersicon esculentum* Mill.). Study was aimed to determine the efficacies of different doses of biopreparation of Gaupsin against Phytophthora of tomato. Five tomato varieties (*Jina, Florida 47, Shady-Lady, Adlia* and *Choportula)* were sown in five replications with one standard check in tunnel. Gaupsin were applied after 7 days intervals. Disease data was recorded after ten days interval from flowering stage to onward. Average yield of each variety was calculated afters pickings.

Studies show that over both years, all doses of gaupsin reduce disease severity compared to untreated plants. The highest reduction in the disease was achieved by applying gaupsin 12 mg/ml and 14 mg/ml of water at an interval of 7, 14, 21 and 28 days. Plants had increased leaf, shoot, fruit and root biomass. Among the five cultivars tested, *Jima* produces higher yields (6150 g) per plant, followed by *Florida* 47 (6000 g) and *Shady Lady* (5150 g) compared to *Choportula* (4300 g) and *Adlia* (3750 g).

Overall results revealed that weekly sprays of gaupsin at 12 mg/ml of water were cost effective and eco-friendly for the management of *Phytophthora* blight of tomato.

Based on a general analysis, it is very clearly shown that the investigation is an important step towards developing plant bioprotection strategies for antifungal activity against the important phytopathogen. That can be beneficial for farmers and researchers who involve in agriculture.

Keywords: phytophthora; gaupsin; sprays; tomato varieties; yield

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is the second most important remunerable solanaceous vegetable crop after potato. Tomato is commonly consumed in our daily life and it is a good source of antioxidants (Sgherri et al., 2008). With high nutritional value, it provides a balance source of Vitamin A, C and E needed to maintain good human health (Olaniyi et al., 2010). Varied climatic adaptability and high nutritive value made the tomato cultivation more popular in the recent years. At present, in Georgia average production of tomato is 9.8 tons per hectare which is quite low as compared to other tomato growing countries such as USA (89.33 t/ha), China (52.98 t/ha), Egypt (43.53 t/ha), Turkey (36.44 t/ha), India (21.30 t/ha) and Pakistan (10.51 t/ha) (Gondal et al., 2012; Shainidze, 2009, 2014). Tomato crop is vulnerable to infect by bacterial, viral, nematode and fungal diseases. Among the diseases, *Phytophthota* leaf blight of tomato caused by *Phytophthota infestans* and *Ph. Parasitica* (*Ph. nicotianae*) is the worst damaging one that cause reduction in quantity and quality of the tomato crop. *Phytophthora* is an oomycete or water mould, not a fungus. Although they look like fungi, *Phytophthora* species are related to algae. In the study areas (Adjara) the *Phytophthora* in the field causes considerable yield losses, ranging from 60 to 100% (Shainidze et al., 2015). This disease is controlled mainly with agro chemicals. However, the world wide trend towards environmentally-safe methods of plant disease control in sustainable agriculture calls for reducing the use of these synthetic chemical fungicides. In an attempt to modify this condition some alternative methods of control have been adopted. Recent efforts have focused on developing environmentally safe, long lasting and effective biocontrol methods for the management of plant diseases.

It is now known that various natural bioproducts can reduce populations of pathogens and control disease. A number of biopreparations toxic to several plant pathogenic fungi. In recent decades, significant progress has been made in their use for the biological protection of plants from pathogens (Weller et al., 2007; Mercado-Blanco et al., 2007). At the Institute of Microbiology and Virology of the National Academy of Sciences of Ukraine, the complex biopreparation "Gaupsin" based on two strains of *Pseudomonas chlororaphis* subsp. *Aureofaciens* (V-111 and V-306), which inhibits the growth of phytopathogenic bacteria and fungi, was created and patented in Ukraine in 2005. Biopreparation based on this strain was patented by the Swedish company Bio Agri AB under the trade name Cedomon, registered and used in many European countries (Tombolini et al., 1999). According to the US Environmental Protection Agency conclusion, *P. chlororaphis* strains are non- pathogenic and non-toxic to humans, biota and environment biopreparation possesses antimicrobic, antifungidalny, entomopathogenic and rostostimuliruyushchy action.The biological product is not toxic for the person and animals, do not collect in plants, the soil, does not influence taste of the grown-up production (Kiprianova et al., 2017).

P. chlororaphis belong to one of the most active producers of antibiotic substances among various species of pseudomonads (Aroma et al., 1964; Bernd et al., 2008; Chincholkar et al., 2013). Gaupsin containing strains of this species are widely used throughout the world for plants protection of fungal diseases. *Pseudomonas chlororaphis* subsp. *aurantiaca* is able to colonize the root-system of several crops and behaves as an excellent growth promoter in wheat, alfalfa, soybean, sugar beet, cornand so on. (Shanahan et al., 1992; Duffy & Défago,1999; Mandryk et al., 2007; Carlier et al., 2008; Rovera et al., 2008; Kiprianova et al., 2011; Rosas et al., 2005, 2006, 2009, 2012; Mehnaz, 2013; Rovera et al., 2014; Shahid et al., 2017). Inhibits a wide range of phytopathogenic fungal species including *Macrophomina phaseolina, Rhizoctonia* spp., *Fusarium* spp., *Alternaria* spp., *Pythium* spp., *Sclerotinia minor, Sclerotium rolfsii* and so on. (Carlier et al., 2008; Rosas, 2001; Rovera et al., 2008, 2014; Andrés et al., 2017). Gaupsin promotes the transition of the hardly soluble nutrients in the soil to the state assimilable for plants; suppresses pathogenic microorganisms by excreted indole acetic acid, promotes the propagation in soil of rhizobia, fixing atmospheric nitrogen through them and providing the plants with atmospheric nitrogen. In one year, 200 – 300 kg of nitrogen is accumulated per hectare. Gaupsin, as a bacterial fungicidal preparation, also exhibits the insecticidal propertiesests. Its use is effective in the processing of containers and boxes (Gabrilovich et al., 1989; Kuznetsov et al., 2006; Goral et al., 1999; Nagornaya et al., 2015; Mikeladze et al., 2021).

Gaupsin is an effective means for protection of orchards against moths and fungi. A method for production of Gaupsin in the liquid form with a titer of not less than 1 x 10 (10) cells/ml under aeration conditions was elaborated.

The universal dvukhshtammovy preparation of broad action intended for processing of gardens, berry-pickers, vineyards, kitchen gardens, fields, melon cultures, and also for protection of houseplants against mushroom diseases and wreckers. Gaupsin perfectly proved in greenhouse facilities. After spraying, the preparation remained on apple leaves for seven days. The efficiency of gaupsin (1:50, for strong defects 1:40) against diseases was 90 – 92%, against wreckers of 92 – 94% (Gondal, 2012; Kiprianova et al., 2017). Consequently, present study was aimed to determine the efficacies of different doses of biopreparation (Gaupsin) against *Phytophthora* of tomato.

Materials and Methods

Description of the Experimental site

The field study was conducted at In Khelvachauri district (village Sameba) Adjara, Georgia. The site is laid at an altitude of 123 m.a.s.l. Climate Adjara is well known for its humid climate and prolonged rainy weather, although there is plentiful sunshine during the Spring and Summer months. Average summer temperatures are between 22 – 24°C. The soil type where the plantation was located was yellow earth.

Experimental varieties of tomatoes

The object of the study were 5 varieties of tomatoes (Jina, Florida 47, Shady-Lady, Adlia and Choportula), which were currently under production and differed in their resistance levels to late blight.

Experiment growing seedlings and transplanting

Seedlings of tomato for the field experiment were raised on 5 seedbeds with 1 m width and 4 m length and 15 cm height for each variety. Seedbeds were separated by 60 cm. The seeds were sown at a depth of 0.5 cm in 30 rows with intra-row spacing of 15 cm in each nursery bed. Grass mulch was applied on each nursery bed and removed after the eedlings emerged. The nursery beds were weeded and irrigated as deemed necessary. Seedlings were transplanted at 25 and 20 days after sowing in 2019 and 2020 cropping season, respectively.

Experiment to combat late blight of tomatoes

Various doses (2 mg/ml, 6 mg/ml, 10 mg/ml, 14 mg/ml) of the insectofungicidal biological preparation Gaupsin were used against tomato *phytophthora*. Thus, there were 25 treatment combinations of 5 tomato varieties along with five gaupsin spray frequencies. Gaupsine application treatments were done by hand sprayer consisting of a boom with two at regular intervals of 10, 17, 24 and 31 days. Tomato late blight severity was recorded from 11 pre-tagged plants in the middle 5 rows of each plot starting from the first appearance of the disease symptoms.

Disease Assessment

Disease severity it was ratted using a 0 to 9 disease scoring scale; where, 1 = no infections; 2 = 1–10% leaf area infected; 3 = 11–20% leaf area infected; 4 = 21–30% leaf area infected; 5 = 31–40% leaf area infected; 6 = 41–50% leaf area infected; 7 = 51–60% leaf area infected; 8 = 61–70% leaf area infected; and 9 = 71–100% leaf area infected as described by Horneburg & Becker (2011).

Disease severity scores were converted into percentage severity as follows:

$$\text{Disease Severity (\%)} = \frac{\text{Area of Diseased Tissue}}{\text{Area of Diseased Tissue}} \times 100.$$

The severity grades were converted into percentage severity index (PSI) for analyses as indicated by Wheeler (1969):

$$\text{PSI} = \frac{\text{Sum of numerical ratings}}{\text{No.of plants scored x maximum disease score on scale}} \times 100.$$

The relative disease severity reduction on untreated and treated plots of the treatment combination was calculated as follows:

$$\text{Relative disease severity reduction (\%)} = \frac{\text{untreated treated}}{\text{untreated}} \times 100.$$

Statistical analysis

Recorded data were subjected to statistical analysis using ANOVA of SAS statistical data analysis software. Duncan's multiple range tests was used to determine the most significant treatment (Steel, 1997).

Results and Discussion

Long-term observations have shown that the first signs of late blight appear leaves even before the flowering of the tomato. late blight pathogens spread under a wide temperature range from 4°C to 27°C, optimal conditions 19°C–23°C, humidity or high relative humidity 82 – 100%. Similar results are also obtained from other studies (Mateeva et al., 1985; Bahariev et al., 1988; Nakov et al., 2007; Alexandrov,

Fig. 1. Affected organs (82–100%) of tomatoes in an untreated area

2011). Leaves the diseased plant wither and die off; the root system of gradually turns brown; brownish spots appear on the stem near the soil surface; infected fruits become soft and their surface is covered with grayish-black mycelium. Some disease, noresistant varieties tomato, have been observed to dry out within a day (Figure 1).

Figure 2 shows that different doses insectofungicidal biologicpreparation (Gaupsin) against tomato late blight significantly reduced the severity of the disease. Data regarding percent disease severity in different varieties 7 days after the application of gaupsin demonstrated that minimum disease (28%) was recorded in Jina followed by (29%) in Florida 47 and Shady-Lady (30%) by the application gaupsin 10 mg/ml of water. Disease severity recorded by the application of 14 mg/ml was almost same as hat of 10 mg/ml of water. The response of all other cultivars fungicide treatment 8 mg/ml and 6 mg/ml of water was also satisfactory as compared to control but less than 10 mg/ml of water. In the control plants, this percentage was high and reached 53.6%.

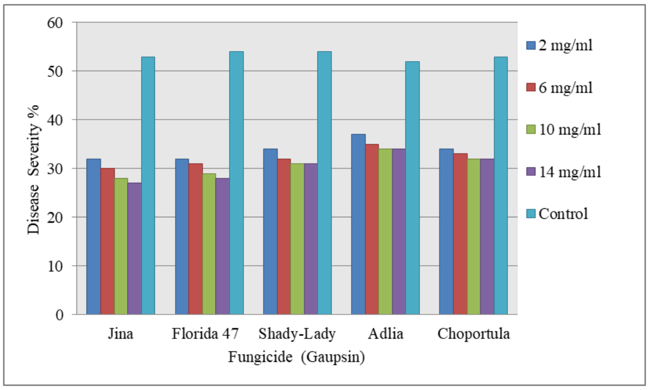

Fig. 2. Disease severity of five tomato cultivars 7 days after the application of biopreparation (Gaupsin), on the average for 2019 and 2020

Figure 3 illustrates the fungicidal effect of 14 days after the application of gaupsine. Minimum disease severity (26%) was recorded in Jina followed by (27%) in Florida 47 by the application gaupsin 10 mg/ml of water. Disease severity recorded by the application of 14 mg/ml was almost same as hat of 10 mg/ml of water. All other gaupsine treatments were less effective as compared to 10 mg/ml of solution.

Disease severity percentage 28 days after the application of gaupsin treatments revealed that biopreparation 10 mg/ml of solutionshow maximum disease reduction (19%) in variety Jima followed by (20%) in Florida 47. All other biopreparation treatments were less effective. Among all

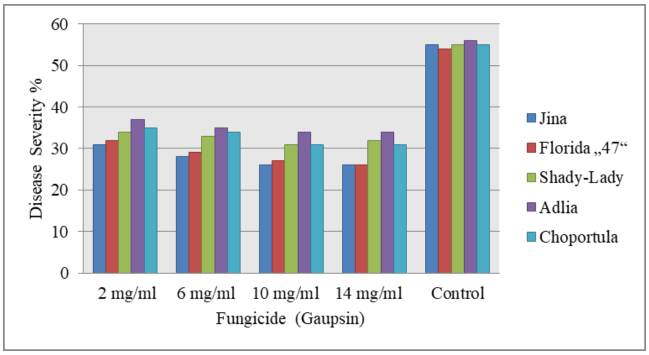

Fig. 3. Disease severity of five tomato cultivars 14 days after the application of biopreparation (Gaupsin), on the average for 2019 and 2020

five varieties, Jima and Florida 47 remained best as compared to Shady-Lady, Adlia and Choportula as shown in Figure 4.

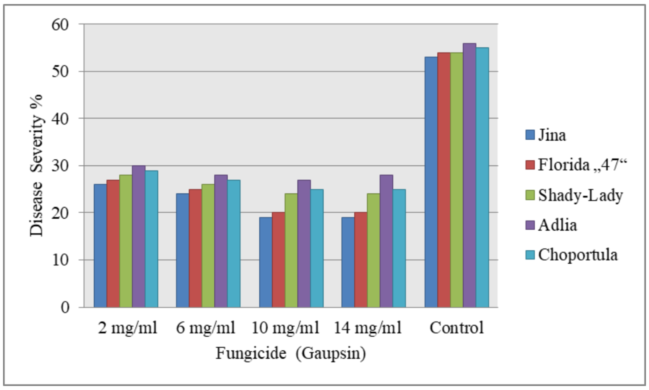

Fig. 4. Disease severity of five tomato cultivars 28 days after the application of biopreparation (Gaupsin), on the average for 2019 and 2020

As shown in the Ttable 1 show that Among the five cultivars tested, Jima produces higher yields (6150g) per plant, followed by Florida 47 (6000 g) and Shady Lady (5150 g) compared to Choportula (4300 g) and Adlia (3750 g).

Overall results revealed that weekly sprays of gaupsin at 12 mg/ml of water were cost effective and eco-friendly for the management of *Phytophthora* blight of tomato.

Based on a general analysis, it is very clearly shown that the investigation is an important step towards developing plant bioprotection strategies for antifungal activity against the important phytopathogen. That can be beneficial for farmers and researchers who involve in agriculture.

Table 1. Average yield of each variety from one tomato bush, 2019–2020

Tomato varieties	2019				2020				Average			
	2 mg/ml	6 mg/ml	10 mg/ ml	14 mg/ml	2 mg/ml	6 mg/ml	10 mg/ml	14 mg/ml	2 mg/ml	6 mg/ml	10 mg/ml	14 mg/ml
Jima	5400	5600	6900	6950	4400	4800	5400	5400	4800	5200	6150	6175
Florida 47“	5300	5500	6800	6880	4300	4700	5200	5360	4600	5100	6000	6120
Shady-Lady	4500	5200	5900	5900	3700	4600	4400	4420	4200	4900	5150	5160
Adlia	3800	3900	4200	4250	3200	3800	3300	4120	3500	3620	3750	4185
Choportula	4200	4300	4500	4500	3800	3900	4100	4300	4000	4100	4300	4400
Control	1080	900	970	990	600	850	830	640	840	875	900	815

Conclusions

The use of chemicals against plant pathogens deteriorates the environment. The present concern of the sci¬entists is to find a sustainable solution to the above problem. Therefore, emphasis has been laid on eco-friendly alternative to biopreparation for crop protection. Biopreparation have great potential to overcome plant pathogens as they comprise of biologically active compounds which limit the disease. Further research is required for making biopreparation available to the farms either individually or integrated with bio control agents.

Results of the present study showed that all gaupsin treatments significantly controlled the infection on tomato as compared to untreated control. There was a significant difference in all the treatments. Application of gaupsin 10 mg/ml and 14 mg/ml of solution showed best result.

Among the five cultivars tested, Jima gave maximum yield (6150 g) per plant under the gaupsin application 10 mg/ml of solution followed by Florida 47 (6000 g), Shady-Lady (5150 g), Choportula (4300 g) and Adlia (3750 g), that the harvest and economic efficiency respectively are increasing.

Based on a general analysis, it is very clearly shown that the investigation is an important step towards developing plant bioprotection strategies for antifungal activity against the important phytopathogen. That can be beneficial for farmers and researchers who involve in agriculture.

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