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SUCKING INSECT'S PEST MANAGEMENT IN ORGANIC ROSE PRODUCTION

Rumyana Georgieva[1]*, Ivan Manolov[1], Svetlana Manhart[1], Siegrid Steinkellner[2], Stefan Möth[2]

[1]Agricultural University – Plovdiv, Bulgaria
[2]University of Natural Resources and Life Sciences, Vienna, Austria
***Corresponding author's Email: georgieva.rumyana.88@abv.bg**

Abstract

Sucking insects are the most common pests and could affect a wide range of cultural and wild plants. They possess a big reproductive potential and under favourable climatic conditions can cause considerable damages on agricultural crops. Some of the sucking insects show resistance to chemical pesticides, which additionally makes their control difficult. To investigate the effect of natural pesticides on the population of some sucking insects in a two year`s field experiment was conducted in the region of the village Kliment on five years`s old organic rose plantation. The following products have been included in the investigation: Limocide® (60 g/L orange oil) NeemAzal® T/S (Nime-substance – 2.5 %) and 4 % bee glue solution. The field experiments were arranged according to the block method in four replications and plot size of 18 м^2 (21 plants per variant). The population density of sucking insects varied depending on the climate conditions. The product Limocide® and the 4% bee glue solution managed to control the invasion of the two-spotted spider mite *Macrosiphum rosae L*. and proved their effectiveness against *Thrips tabaci* as well. The product that contain as azadirachtin as an active substance showed an unsatisfactory percentage of effectiveness against the target insects. The 4% bee glue solution has a great potential, and its mechanism of action needs to be further investigated.

Keywords: biological control, sucking insects, roses

INTRODUCTION

Organic farming is a priority in the agricultural development policy in Bulgaria and one of the highlights of the common agricultural policy. Encouraging farmers to apply organic farming contributes simultaneously to environmental and biodiversity protection, strengthen of agroecosystems, and provides opportunities for future generations to benefit from the preserved nature. One of the most desirable characteristics needed in the cultivation of oil-bearing rose, is the resistance of plants. According to Kovacheva et al. (2010) *Rosa damascena* is not resistant to major diseases and pests. In conventional systems, the control of diseases and pests is achieved through chemical treatments but in organic rose production, other approaches are used (Chalova et al., 2017). Rose plants could be attacked by various pest which are able to reduce their flower`s growth, as well as the quality of the essential oil (Golizadeh et al., 2017). *Tetranychus urticae* Koch is an important generalist species that can cause considerable damages on many host plants including oil-bearing roses (Jafari et al., 2021, Jalalvandi et al., 2015). Aphids are considered as the most encountered sucking insects with a frequency of circa 77% according to a survey distributed among rose producers from the Lakes region of Turkey (Yilmaz et al., 2015). *Macrosiphum rosae* L. and *Rhodococcus perrornatus* Cockerell & Parrott were evaluated as the most economically harmful pests in a study performed on oil-bearing rose plantation in Isparta, Turkey (Demirözer et al., 2011). In addition to deforming leaves and flowering stems, aphids serve as a vector of various viruses (Chau & Heinz, 2004). Moreover, the aphid's infestation could affect the biochemical composition of the rose plants (Singh et al., 2014). The control of sucking insects could be very difficult because of the developed pesticide resistance, fast development rates and high fecundity potential (Hoyt et al., 1985, Norboo et al., 2017). In Bulgaria, the use of commercial products for control of diseases and pests on organic oil-bearing rose is not scientifically justified, instead, it is determined by the availability of products on the market, consultations with company representatives and self-experience of rose growers. Therefore, the development of organic rose-growing systems requires scientific support to achieve the goal of sustainable agriculture. The aim of the present study is to compare the effectiveness of two organic plant protection products, as well as the potential of 4 % bee glue solution to control the population of the most important sucking insects in organic rose plantations. The present study provides information on the insecticidal action of propolis, which, so far, has been poorly studied.

MATERIALS AND METHODS

Field experiment

The study was conducted in an organic rose plantation situated in region of the village Kliment (*W: 42.59699739096776, L: 24.682717358466093*) part of the Rose valley of Bulgaria for two consecutive years – 2022 and 2023. In the experiments were used five-years-old Damasc Rose (*Rosa damascena* Mill.) plants. The soil cultivation in the spring was consisted of plowing of the inter-rows at a depth of 18-20 cm. Until the blooming period, the soil has been cultivated twice at a depth of 5-6 cm. In order to improve the nutritional regime of the plants a 2% solution of the leaf fertilizer Acramet Ultra® (N – 12.5%; PO_5 - 5.7 %; KO - 11%; S-2.9%; B-0.35%; Cu- 0.025%; Mg-0.48%; Mn-0.028%; Zn-0.125%; Fe - 0.026%; Mo-0.024%; and ultratrace elements – cobalt, chromium, vanadium) was applied twice in April with 15 days` interval in between. The weeds were controlled mechanically. With the last tillage in autumn, the field was fertilized with 20 t ha^{-1} organic manure. In order to adjust the pH value, the soil was limed before the last cultivation in October 2022 (ground limestone in a dose of 3 t ha^{-1}). The plantation was not irrigated.

The effect of three biological products was investigated: Limocide®, NeemAzal® T/S and 4 % bee glue solution at a dose of 200 ml ha^{-1}, applied individually and in the following combinations: Limocide® + 4% bee glue solution, NeemAzal® T/S+ 4% bee glue solution. The products were applied three times with 10 days` interval in between during the spring period before the harvest of the rose petals. The description of the products is presented in Table 1.

The field experiment was arranged according to the randomized block method in four replications and plot size of 18 $м^2$ (21 plant per variant). Rows were at 3 m apart with 0.40 m inter row space.

The bee glue solution was prepared according to the method of Ildeniz et al. (2004) – 40 g of finely ground propolis were soaked in 100 ml of 80% ethanol. The extract was obtained by maceration and regularly shaking of the solution at room temperature. After 7 days of maceration the extract was filtered.

Insects sampling

The density of mites, aphids and trips was estimated by the washing method of Boller (1984). From every variant were collected 20 rose leaves and petals and then stored overnight in bottles filled with water and detergent. Afterward the contents of the bottles were rinsed through a sieve with a mesh diameter of 63 µm, which allows pest to be separated from the water. Then the different densities of sucking insects were counted at 25X magnification with a stereomicroscope. Population density was recorded immediately before the treatments and then on the 3rd, 5th and

7th days after the treatments, while recording the number of living insects from each variant. In 2022, the insect density was measured on 20th of April, as the first treatment followed on the same day. The measurements in 2023 started on 7th of May, when the products have been applied. The effectiveness was calculated with the Henderson/Tilton formula (Lambrev, 2010). The data presented in tables 3-5 display the average values. During the study period no phytotoxic reactions have been recorded on leaves or other parts of the plants. The data was processed by ANOVA analysis of variance with significance level 0.05.

Soil conditions

According to Todorova et al. (2020) the soils in the Rose Valley are represented by deluvial noncalcareous sediments and are classified as *Fluvisols*. Soil samples were taken twice on each experimental year from 0-30 cm depth. During the study period the reaction of the soil was acid ranging from 4.37 to 5.74 for the first and the second year, respectively. The content of available nutrients is represented in Table 2.

Table 1. Description of the applied biological products

Product name	Manufacturer	Active substances	Applied amount
NeemAzal® T/S	Trifolio-M GmbH	azadirachtin A - 1%; azadirachtin B, C, D, D-0.5 %; Nime-substance – 2.5 %	0.3 %
Limocid ®	Vivagro	60 g/L orange oil	2000 ml ha^{-1}
4% bee glue solution	self-prepared	propolis	200 ml ha^{-1}

Table 2. Content of available nutrients in the soil

Year	pH	Mineral nitrogen, mg kg^{-1} soil	P_2O_5,mg 100 g^{-1}	K_2O, mg 100 g^{-1}
2022	4.37	14.47	12.67	16.60
2023	5.74	15.68	12.85	17.27

The mineral nitrogen content was determined by Kjeldahl method as the values ranged between 14.47 to 15.68 mg kg^{-1} for the first and the second year, respectively. Available potassium and available phosphorus content were evaluated using the Egner-Riem method. In terms of mobile phosphorus content, the values were in the range of 12.67 mg 100 g^{-1} in 2022 to 12.85 mg 100 g^{-1} in 2023. The content of available potassium ranged between 16.60 mg 100 g^{-1} and 17.27 mg 100 g^{-1}.

Weather conditions

The climate in the region is continental and is characterized by mild winters and cool and prolonged spring. During flowering, the sheltered valley contributes to the formation of abundant dew, which protects the essential oil from evaporation. The annual rainfall in the first year was 141.4 mm lower than the norm for the region. In 2023, the amount of rainfall was 1016.6 mm, which exceeds by 84.8 mm the norm of the area. More abundant and prolonged rainfall in the second year led to the reduced population density of the pests studied. The climatic conditions during the study period are presented in Figure 1.

RESULTS AND DISCUSSION

The treatment with Limocide® decreased the population of *Thrips tabaci* up to 90% during the second year of investigation, which highlighted the product as the most effective one (Table 3). When combined with the bee glue solution the effectiveness ranged between 82 and 74%, Applied individually the bee glue solution managed to reduce the population of the thrips with 50% on average. For the study period, the product NeemAzal®

T/S seemed unsatisfactory with an effectiveness varying between 25 and 29%. The combined treatment NeemAzal® T/S +4% bee glue was of medium effectiveness against the target insects when comparing to the control.

The higher rainfall in 2023 could be the reason for the lower population density of aphids observed in the control variants (Table 4). Several researchers reported that the climate conditions and geographical location could affect the pest population dynamics (Hidalgo et al. 2013, Razdoburdin et al. 2014, Amin et al. 2017). High temperatures could reduce *Macrosiphum rosae* L. populations (Ahmed & Aslam, 2000). In the present research, the population density of the sucking insects was higher in 2022 when the climate conditions were more favorable. The evaluation of the factors influencing the feeding behavior, as well as the population density, are object of further investigation. Achimón et al. (2022) compared the insecticidal potential of different citrus essential oils and reported that orange essential oil is the most effective against *Rhyzopertha dominica*, *Oryzaephilus sp*. and *Sitophilus granarius* applied as fumigant – LC50=89.39, 94.50, and 163.64 µL/L air, respectively.

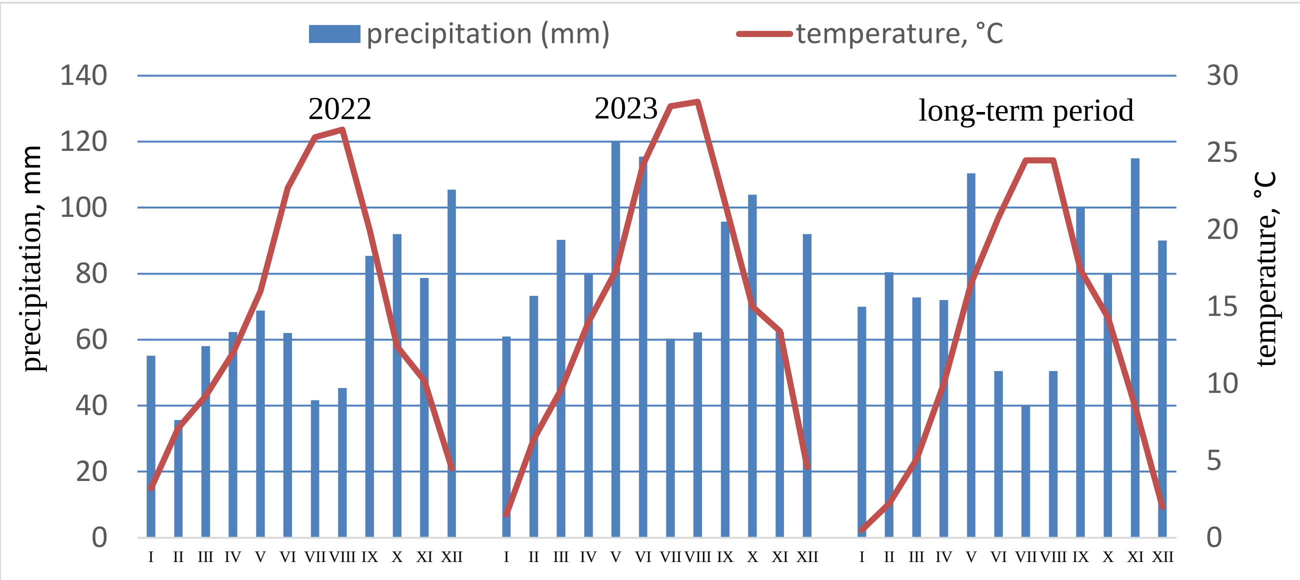

Figure.1. Climatogram during the vegetation period of *Rosa damascena* Mill.

Table 3. Percentage of effectiveness (% E) of the tested products against thrips

Variants	Number of *Thrips tabaci*							
	2022				2023			
	3 DAT	5 DAT	7 DAT	% E	3 DAT	5 DAT	7 DAT	% E
NeemAzal® T/S	74^{d}	70^{d}	88^{d}	29	65^{d}	73^{d}	69^{d}	25
Limocide®	15^{a}	18^{a}	16^{a}	85	9^{a}	12^{a}	8^{a}	90
4% bee glue	59^{c}	49^{bc}	55^{bc}	48	41^{b}	40^{b}	53^{c}	53
NeemAzal® T/S r+4% bee glue	37^{b}	40^{b}	45^{b}	63	34^{b}	31^{b}	35^{b}	64
Limocide® +4% bee glue	19^{a}	16^{a}	22^{a}	82	17^{a}	23^{a}	33^{b}	74
Control	105^{f}	98^{e}	126^{e}		87^{e}	93^{e}	98^{ef}	
LSD $_{0.05}$	*18.62*	*17.54*	*19.81*		*17.32*	*17.85*	*18.30*	

Legend: the effectiveness is compared to control treatment; values with the same superscript letters do not differ significantly; DAT- days after treatment.

In the present study, the product Limocid® based on orange oil was able to control the aphid population most successfully, when applied individually. The combined treatment with the bee glue solution managed to decrease the aphid's population with 80% on average. The bee glue solution was more effective against aphids then against thrips, as the reduction of the population reached 62%. Applied individually NeemAzal® T/S was with the lowest efficiency. Many authors observed increased mortality of several aphid species like *Aphis glycines* Matsumura (Kraiss & Cullen, 2008), *Toxoptera citricida* Kirkaldy (Tang et al., 2002), *Brevicoryne brassicae* L. (Pavela et al., 2004) *Myzus cerasi* Fabr. (Andreev et al., 2008) and *Aphis spiraecola* Patch. (Andreev et al., 2012), when exposed to neem products. Atanasova et al. (2014) reported 30-45% mortality of *Macrosiphum rosae* L. after application of NeemAzal® T/S. The same results were confirmed by Bartelsmeier et al (2022).

In terms of mite control, the product Limocide® keeps a leadership position with the highest effictiveness of 86% for the study period (Table 5). Both combined treatments managed to reduce the population density of *Tetranychus urticae* with more than 70%. When applied against the two-spotted spider mite NeemAzal® T/S demonstrated better results and managed to reduce the population density by 40-41%. The bee glue solution has a medium effectiveness.

Table 4. Percentage of effectiveness (%, E) of the tested products against aphids

Variants	Number of *Macrosiphum rosae* L.							
	2022				2023			
	3 DAT	5 DAT	7 DAT	% E	3 DAT	5 DAT	7 DAT	% E
NeemAzal® T/S	150^{e}	166^{f}	177^{f}	30	128^{d}	122^{d}	145^{e}	31
Limocide®	22^{a}	19^{a}	25^{a}	91	22^{a}	18^{a}	25^{a}	88
4% bee glue	83^{c}	85^{c}	86^{c}	64	71^{b}	73^{b}	76^{b}	61
NeemAzal® T/S r+4% bee glue	71^{b}	85^{c}	80^{b}	67	65^{b}	72^{b}	70^{b}	63
Limocide® +4% bee glue	45^{a}	40^{a}	48^{a}	81	41^{a}	33^{a}	45^{a}	79
Control	224^{g}	237^{g}	246^{g}		186^{f}	182^{f}	202^{g}	
LSD $_{0.05}$	*30.12*	*28.85*	*28.54*		*28.40*	*29.10*	*28.26*	

Legend: the effectiveness is compared to control treatment; values with the same superscript letters do not differ significantly; DAT- days after treatment.

Table 5. Percentage of effectiveness (%, E) of the tested products against mites.

Variants	Number of *Tetranychus urticae*							
	2022				2023			
	3 DAT	5 DAT	7 DAT	% E	3 DAT	5 DAT	7 DAT	% E
NeemAzal® T/S	94^{c}	85^{c}	107^{d}	40	64^{c}	58^{bc}	82^{c}	41
Limocide®	19^{a}	22^{a}	18^{a}	88	17^{a}	14^{a}	20^{a}	85
4% bee glue	57^{b}	64^{b}	69^{bc}	60	47^{b}	41^{b}	60^{b}	58
NeemAzal® T/S r+4% bee glue	42^{a}	38^{a}	45^{b}	74	30^{a}	23^{a}	26^{a}	77
Limocide® +4% bee glue	36^{a}	44^{a}	57^{b}	72	34^{a}	27^{a}	44^{b}	70
Control	162^{f}	155^{f}	158^{f}		116^{e}	108^{e}	121^{e}	
LSD $_{0.05}$	*26.78*	*26.30*	*25.64*		*22.30*	*22.45*	*21.38*	

Legend: the effectiveness is compared to control treatment; values with the same superscript letters do not differ significantly; DAT- days after treatment.

There is a limited information about the application of propolis for the needs of the agricultural pest management (Bankova & Popova, 2023). In most cases, phenolic acids and flavonoids were responsible for the insecticidal effect of the bee glue solution (El-sayed & Emam, 2021, Omar et al., 2016). El-sayed and Emam (2021) investigated the effect of bee glue extract applied in 5 different concentrations on the two-spotted spider mite population and the results showed that 2000 ppm of the extract achieved the highest mortality in all stages of *Tetranychus urticae* development. Omar et al (2016) observed on *Tetranychus urticae* and *Tetranychus cinnabarinus* a moderate mortality effect (LC_{50}) by the bee glue water and ethanol extrac at dose of 13.579 ppm and 15.881 ppm, respectively. Amer & Nafea (2011) reported mortality effect (LC_{50} and LC_{90} – 0.282 and 5.987%) of the Egyptian honeybee propolis on 4th instars larvae of pink bollworm, cotton leafworm and cowpea aphid. The water extract of propolis was toxic (LC_{50} 13.579 ppm) to tomato leafminer *Liriomyza sativae* (Marouf et al., 2021).

CONCLUSION

The product based on orange oil extract (Limocide®) was most effective against all sucking pests included in the investigation and could be recommended for the needs of the organic farming management. Treatment with 4 % bee glue solution showed promising results, but in order to achieve better insecticidal effect further investigations with different active doses of the extracts and a wider range of test organisms need to be performed. The product containing azadirachtin as active substance (NeemAzal® T/S) showed an unsatisfactory effectiveness.

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