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Full Length Research Paper

Effects of different fertilizations on *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae) in tomato

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***Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae) is one of the most serious pests in greenhouses. The aim of the study is to investigate the effects of foliar fertilizers, such as calcium nitrate, fulvic acid and their combinations on *L. trifolii* population and tomato yield under greenhouse conditions in spring and fall of 2009. It was shown that fulvic acid and calcium nitrate combinations had negative effect on *L. trifolii* population in growing tomato plants. In addition, fulvic acid and calcium nitrate combination increased yielding by 23%.**

Key words: *Liriomyza trifolii*, fulvic acid, calcium nitrate.

INTRODUCTION

Liriomyza trifolii (Burgess) (Diptera: Agromyzidae) is one of the most important pests in greenhouse vegetable production in Turkey (Çikman and Civelek, 2005). *L. trifolii* survives larval development in the plant leaf tissue and forms serpentine mines within the leaves. Damage is caused mostly by larvae that feed their way inside the plant-host mesophyll. Such harms cause plants to lose leaves by 98% and chlorophyll content of them with water loss being stimulated to increase (Yildirim et al., 2010). Moreover, leafminers are known to play a role in transmitting viruses as well as the damage above (Costa et al., 1958).

Chemical control is a problem, mainly because of the very high degree of inherent resistance to pesticides that exists in *Liriomyza* species. Most synthetic insecticides are toxic to animals including human beings (Calta, 2004). Although many insecticides can be used safely, a few are persistent in the environment, and a small number have multigenic, carcinogenic and teratogenic effects on human beings and domestic animals. Moreover, trials in many parts of the world have established the negative impact of broad-spectrum pyrethroids, carbamates, organo-phosphates and other chemicals against leafminer parasitoids (Saito et al., 1992).

One of the most important precautions for plants is to keep them healthy and resistant to pests and diseases. Fertilization of plants appears as the crucial way to do so. Every fertilizer is different feature considering their uses on plants such as calcium which strengthens cellular walls and membranes to enable them to gain resistance to fungal and bacterial diseases (Eraslan et al., 2007).

Currently, one of the most widely used applications in growing healthy plants is to utilize fulvic acid which is one of the three organic elements to constitute humic substances and as such accelerates cellular division thus stimulates vegetable growth and development as well as increase of cellular energy and regulation of plant metabolism to prevent nitrate compounds from accumulating in plants and increase in resistance to insects and diseases by encouraging tolerance to extreme temperatures such as heat and coldness and many other physical factors (Jackson, 1993). Meanwhile humic acid fertilizers are known to increase yielding as well (Saruhan et al., 2011).

Fulvic acid is particularly preferred in that it allows surrounding stress to decrease, helps absorb other minerals and positively contributes to harvest and quality. On the other hand, fertilization used to augment quality and yielding is known to be effective in controlling against pests as well. Previous studies focused on exploring effects of many fertilizers including nitrate, potassium, phosphorus and silicon on insects. Some fertilizing applications enable insects to be attracted while others repelled them from plants as repellent factors. For example, the more nitrate levels is the more *L. trifolii* concentration in the plant (Bethke et al., 1987). However,

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high concentrations of phosphorus and calcium create a repellent effect on *L. trifolii*, causing it to be infected less than ever (Facknath and Lalljee, 2005).

Calcium nitrate is a fertilizer that is easily soluble in water and quickly absorbed by plants. Water soluble calcium and nitrate combination is its major characteristic. Inherent nitrate content enables many other nutrients as well as calcium to be taken by plants and increases resistance to pests and diseases in addition to quality and yielding. Calcium (Ca^{2+}) is one of the nutrients which are multi - functional in plant physiology and vital for vegetative growth and development (Assmann, 1995; Marschner, 1995).

On the other hand, it is reported that increase in external calcium content could accumulate osmo-regulators in the root system and thus improve osmotic regulation as the result of interaction between Na+ and Ca^{2+} (Colmer et al., 1996). Khalafalla et al. (2010) report that applications of Calcium nitrate and Potassium nitrate through leaves eliminate negative effects of salinity in tomato plants. In the addition, Peyvast et al. (2009) found that foliar application of 6 $mmolL^{-1}$ calcium nitrate led to significant increases in quality as well as considerable number and mean weight of fruit in tomatoes regardless of optimal or insignificant yielding.

In this study concerned tried to investigate whether calcium, fulvic acid and their combinations could cause any effects on *L. trifolii* population as well as fruit quality and yield on tomato plants in greenhouse.

MATERIALS AND METHODS

In this research was conducted in two different periods, namely spring and autumn during 2009. Experiments were carried out under the greenhouse of Sultanhisar Vocational College of Profession, Aydin, Turkey. Seedlings were planted early of February in spring and transplanted in July while autumn seedlings were planted in the first week of fall and removed of December. In both periods of time when Harmony F_1 seedlings of tomato were used, pesticide and fertilizer were not applied and external leaf miner was introduced into greenhouse three times successively to achieve a desirable level of population.

In order to maintain efficiency of fertilization, fulvic acid (K-Tionic) and calcium nitrate (commercial fertilizer) were applied in doses of 150 cc/100 L water and 250 cc/100 L water respectively and combination of both given by mixing fulvic acid and calcium nitrate as well when plants grew up to 10 to 15 cm in height and the applications were also repeated two times in two week intervals. Cyromazine (Trigard 75 WP) applied at the recommended rate of 20 g/ 100 L water was treated as a positive chemical control, and only water was sprayed in control plots. Trials were set up in five repetitions according to the randomized block design.

Plants were counted following plantation of seedlings but data were started to be taken from the 4th week when early galleries were observed, after which number of live larvae was counted on each leave taken from the lower, middle and upper sections of 20 plants in every plot weekly with a total of 60 leaves. Observations made weekly during the study recorded number of live larvae in the plots where fertilizations were applied counting process was continued for seven weeks and number of live larvae found as approximate values to calculate number of larvae per plant between fertilization applications.

Yielding trials

Fruits were harvested two times in total so that all of them were picked up on every 20 plant (parcel). Finally, harvested fruits were weighed to record their weights and calculate mean yielding.

Data analysis

The obtained data were analyzed using SPSS statistical software.

RESULTS

The results of variance analysis showed that the differences among applications for number of larvae/leaf were significant for 4, 5, 6 and 7 weeks. Table 1 shows the effects of fertilization on *L. trifolii.* Similar effects were observed in the two periods when trials were conducted. It can be concluded from the process that spring and autumn interactions of applications under greenhouse conditions are non-significant.

The plots where cyromazine was applied to leaf miners showed number of larvae/leaf to be low. It is clear from spraying in the 3rd and 5th weeks that the population of the pest was in low levels in the cyromazine-applied plots during both periods. On the other hand, control, calcium nitrate and fulvic acid plots showed a significant population of *L. trifolii*. It is important to note that the fulvic acid + calcium nitrate application concerned was ranked in the group behind the cyromazine-based spraying in which the plots showed that the population have achieved a maximum of 3.45-3.60 larvae/leaf in the 7th weeks when the two trials were finished in July and December. The highest population was 3.90 larvae/leaf in the 6th week in the autumn period, which was all minimal values but those of the cyromazine application. Considering data of the last week, it is interesting that fulvic acid and calcium nitrate seemed to be different from the control group in that the value was 3.45 to 360 larvae/leaf. Therefore, we can conclude that the application is important enough to be taken into account.

Table 2 presents plant yielding obtained from the plants in the experimental plots during the study. It follows from the assessments in terms of yielding that maximum harvests in spring and autumn were also taken from the application of fulvic acid + calcium nitrate which was made in the plots with yielding of 12.36 and 12.54 kg/parcel respectively, followed by the plots applied with fulvic acid in both seasons, 11.96 and 11.98 kg/parcel.

DISCUSSION

Trials of calcium nitrate and cyromazine were included in the same group as the fulvic acid plots in autumn, while

Table 1. Effects of various fertilizations on *Liriomyza. trifolii* under greenhouse conditions (larvae / leaf; mean± S.E.).

Period	Applications	Weeks						
		1	2*	3*	4*	5*	6	7
Spring	Fulvic acid	1.10±0.69	2.10±0.32	3.15±0.37	3.55±0.36^{b}	4.45± 0.26^{c}	4.55±0.19^{c}	4.80±0.20^{c}
	Calcium nitrate	1.20±0.92	1.95±0.29	3.10±0.38	4.05±0.28^{b}	4.65± 0.32^{c}	4.85± 0.18^{c}	4.40±3.91^{c}
	Fulvic +Calcium	0.90±0.10	2.20±1.32	2.65±0.36	3.30±0.33^{b}	3.60± 0.28^{b}	3.75± 0.19^{b}	3.45±0.25^{b}
	Cyromazine	1.25±0.99	2.15±0.29	3.25±0.41	0.15±0.82^{a}	0.00±0^{a}	0.00±0^{a}	0.00±0^{a}
	Control	1.10±0.69	2.50±0.31	3.80±0.34	4.10±0.29^{b}	4.75± 0.29^{c}	4.75± 0.20^{c}	4.60±0.23^{c}
Autumn	Fulvic acid	1.10±0.69	2.10±0.32	3.25±0.36	3.65±0.38^{b}	4.40±0.19^{bc}	4.75±0.17^{c}	4.85±0.18^{c}
	Calcium nitrate	1.20±0.92	2.00±0.28	3.25±0.37	4.15±0.29^{b}	4.90±0.28^{c}	5.20±0.18^{c}	4.65±0.22^{c}
	Fulvic + calcium	1.10±0.12	2.25±0.29	2.75±0.35	3.40±0.31^{b}	3.85±0.26^{b}	3.90±0.18^{b}	3.60±0.23^{b}
	Cyromazine	1.25±0.99	2.15±0.29	3.25±0.40	0.30±0.10^{a}	0.00±0^{a}	0.00±0^{a}	0.00±0^{a}
	Control	1.10±0.68	2.50±0.31	3.65±0.32	4.20±0.27^{b}	4.90±0.30^{c}	4.85±0.22^{c}	4.85±0.25^{c}

*Fertilization was applied; **Means followed by same letter within a column are not significantly different at the 0.05 level.

Table 2. Mean yielding of the plots applied with Calcium nitrate, fulvic acid, calcium nitrate + fulvic acid, cyromazine and of control plots (kg/parcel).

Application	Spring season	Autumn season
Calcium nitrate	10.62± 0.50^{a}	10.70± 0.13^{ab}
Fulvic acid	11.96± 0.35^{ab}	11.98± 0.27^{ab}
Fulvic + Calcium nitrate	12.54± 0.17^{b}	12.36± 0.22^{b}
Cyromazine	10.64± 0.45^{a}	10.42± 0.14^{ab}
Control	10.24± 0.10^{a}	9.56± 0.27^{a}

***Means followed by same letter within a column are not significantly different at the 0.05 level.

they were in different groups in spring for tomato yield. The low yields were obtained in the control plots. Compared with controls, fulvic acid + calcium nitrate plots were 23% more efficient. Peyvast et al. (2009) reported the similar result that foliar application of calcium nitrate could increase tomato yield and yield components with high quality. Our study showed that fulvic acid and calcium added fertilizers could negatively affect development of *L. trifolii* in growing tomato plants. The greenhouse processes found that the level of *L. trifolii* population was significantly different from control especially in the plots where the combination of fulvic acid and calcium nitrates was applied. Similar results are valid in pests outside of *L. trifolii.* For example; Calcium silicate and the organic mineral fertilizer increased the mortality of nymphs and reduced the damage by *Frankliniella schultzei* (Thysanoptera: Thripidae) on tomato leaves (Almeida et al., 2009). It is known that rate of penetration of fulvic acid through leaves is high and contributes to positive growth and development of plants by accelerating cellular division. Moreover, fulvic acid is reported to prevent sodium compounds from accumulating by regulating plant metabolism (Chen and Aviad, 1990). In our study, combination of fulvic acid and calcium nitrate could have accelerated calcium uptake in particular. Such combinations of both factors had a cumulative impact on decreases in population of the pest, which is all consistent with evidence and recommend-dations by Saupe (2005) and Lalljee and Facknath (2001).

Conclusion

Development of alternative ways which are harmless to human beings and natural enemies is of priority for researchers to control *L. trifolii.* It is interesting to note that fulvic acid and calcium nitrate combination as a practice to increase quality and fertility causes *L. trifolii* population to decreases. It seems recommendable for application of fulvic acid + calcium nitrate to be combined with low-dose Cyromazine spraying in further studies in order to achieve a better result from the process made. Calcium added fertilizers are now used to amend quality and to increase yielding in the practice of growing tomato. However, it could be concluded that the combination of fulvic acid and calcium nitrate is of great use since content of nitrate and ammonium nitrate in calcium nitrate

fertilizer is seen to be a characteristic considered in controlling pests and diseases. Therefore rapid metabolizing feature of fulvic acid increases utility of calcium nitrate and neutralizes its supposedly negative properties.

From the course of population density of the pest, it is clear that pest controlling is inevitable. Although only fertilization seems not to be sufficient in controlling the pest application of fulvic acid-calcium nitrate combination can be said to be successful both in controlling the pest and in fertility.

It seems useful for further studies to focus on fulvic acid-calcium nitrate added leave fertilizers with trace elements in to increase the quality and fertility of tomato plant. Such studies should aim at effects of the above said practices on harmful populations including leaf miner as well as on quality and yielding.

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