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Full Length Research Paper

The effect of fosetyl-Al application on stomata in tomato (*Lycopersicon esculentum* Mill.) plant

Ikay Öztürk Cali

Department of Biology, Faculty of Art and Science, Amasya University, Amasya-Turkey. E-mail: ilkay.cali@amasya.edu.tr. Tel.: +90358 2526230, +90358 2526231. Fax: +90358 2526222.

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In this study, a fungicide namely Aliette WG 800 (80% Fosetyl-Al) was pulverized on tomato (*Lycopersicon esculentum* Mill.) grown under greenhouse conditions and the likely effects of this fungicide on stomata of tomato were examined. Applications of Fosetyl-Al were carried out at recommended dosage (200 g/100 L water) as given on the label and two fold higher (400 g/100 L water) dosages. The fungicide applications resulted in a decrease in stomatal index compared to untreated plants whereas the numbers of abnormal and closed stomata were increased. It is thought that this condition may indirectly cause a negative effect in physiological events of the plant.

Key words: Fosetyl-Al, stomata, fungicide, tomato, *Lycopersicon esculentum* mill.

INTRODUCTION

Plant diseases in tomato plants usually cause the loss of product. The diseases caused by fungus decrease yield in quantity and quality and bring about some problems in export. Pesticides are used frequently to prevent harmful organism in plants in Turkey.It was stated in The First National Ecology and Environment congress that pesticides were used ignorantly in Turkey and there were increase in the usage of these chemicals which damaged environment (Delen and Özbek, 1994).Pesticides used for eliminating various pests which are found in agricultural environments also cause harmful effects on agricultural plants. These substances result in a toxic effect on stomata which have the most important role in some crucial functions such as photosynthesis and transpiration.Salgare and Acharekar (1990) reported that stomata in leaves were indicator of industrial pollutants. In fact, it was found that stomata were affected negatively by some chemicals in various studies.It was found that the largeness of stomata pores were influenced by Triazole fungicide in china patoto (*Solenostemonrotundifolius*, Poir., J. K. Morton) (Bora et al., 2002).According to Gupta et al. (2004), Triazole fungicide affected the number of stoma in some plants.Besides, in another study when 40 and 80 g/100 L water dosages of Equation Pro 22.5% Famaxadone + 30% Cymoxanil) fungicide were applied to tomato plant, there was an increase in the number of closed stoma in paralel to dosage increasing (Öztürk, 2006). In the present study, pesticide applications which were used frequently against diseases and harmful living organisms in agricultural areas were investigated. In the study, recommended dosage (200 g/100 L water) and double the recommended dosage (400 g/100 L water) of 80% Fosetyl-Al fungicide were applied to tomato plant which have economic importance for Turkey. The effects of the fungicide were studied on the stomata of tomato plant in the same study. Especially, the effect of high dosage of the fungicide on stoma structure was investigated.

MATERIALS AND METHODS

The study was carried out in a 970 m^2 greenhouse in the village of Karaçulha in Fethiye, Turkey. Two hundred and twenty eight seedlings were obtained from M-38 F_1 type domestic seeds. Seventy six seedlings were used per groups. The fungicide which was used in the study against *Phytophthora infestans* was Aliette WG 800 (80% Fosetyl-Al). A total of four applications were made at ten-day intervals. The applications were 200 g/100 L water as recommended by the manufacturing company on the label and 400 g/100 L water as double the recommended dosage. Plant materials for anatomical observation were obtained since the fourth application after seven days and fixed in 70% ethyl alcohol. Handmade superficial sections in leaves were obtained on upper and lower surfaces of epidermis that belonged to the control and fungicide groups.

Table 1. Effect of Fosetyl-Al on stomata number, epidermal cell number and stomatal index.

Stoma Parameters in the adaxial and abaxial surfaces of the leaf		Application groups		
		Control	**% 80 Fosetyl-Al(200 g/ 100 L)**	**% 80 Fosetyl-Al(400 g/ 100 L)**
Adaxial surface of the leaf	Stomata number (in 0.125 mm^2)	249 ^{bc}	120 ^{ac}	198 ^{ab}
	Epidermal cell number (in 0.125 mm^2)	2529 ^{bc}	2262 ^{ac}	3000 ^{ab}
	Stomatal index (SI)	8.963 ± 0.717 ^{bc}	5.037 ± 0.680 ^{a}	6.191 ± 0.692 ^{a}
Abaxial surface of the leaf	Stomata number (in 0.125 mm^2)	657 ^{bc}	540 ^{a}	516 ^{a}
	Epidermal cell number (in 0.125 mm^2)	2772	2736	2778
	Stomatal index (SI)	19.160 ± 0.790 ^{bc}	16.483 ± 0.583 ^{a}	15.664 ± 0.750 ^{a}

In the table "^{a}" indicates the significant difference between "^{a}" and control group. "^{b}" indicates the significant difference between "^{b}" and 200 ml/ 100 L group. "^{c}" indicates the significant difference between "^{c}" and 400 mL/ 100 L group.

Stomata were examined in the superficial sections of leaves. The number of epidermal cell and stomata in the 0.125 mm^2 area in 40 X 6.3' magnification were determined. Stomatal index was estimated according to according to Meidner and Mansfield's (1969) method:

$$\text{Stomatal index} = \frac{\text{Stomata number in unit area}}{\text{Stomata number in unit area} + \text{Epidermal cell number in unit area}} \times 100$$

In the study, the number of opened-closed stomata and abnormal shape stomata were also determined. A total of 400 stomata was used for measurements. Statistical analyses of the values of stomatal index in the study were made on a SPSS 11.0 for Windows Statistical Program and Multiple Range Tukey Test (Tukey, 1954) was used for variance analyses. Statistical analyses for the number of stomata, epidermal cell, opened-closed stomata and abnormal shape stomata were made on a SPSS 11.0 for Windows Statistical Program and the variance analyses were made using the Chi-Square Test, a nonparametric test widely utilized in such procedure.

RESULTS

The values of stomatal index, the number of stomata and epidermal cell in the control and the fungicide groups are given in Table 1. According to these results, stomata index for adaxial and abaxial surfaces of leaf were found to be lower than those of the control group in treated plants. This decrease was found to be statistically signifi-cant in all fungicide groups as compared to the control group. When the numbers of stoma and epidermis cell on upper and lower surfaces of leaf are examined, it is seen that the stomatal values are lower again according to control As for the values of epidermis cell for upper surface of leaf in 200 g/100 L dasage, they are lower as compared to the control whereas higher in 400 g/100 L water. Opened-closed stomata value number and results in percentage are shown in Table 2. An examination of the values of opened- closed stoma percentage in the control and application groups showed that the opened stomatal percentage decreased in both layer surfaces of leaf, but closed stoma percentage increased.When the results of abnormal stomata percentage are examined, it is be seen that the values are higher parallel to the dosage (Table 3).

DISCUSSION

In the study, it was found that 80 % Fosetyl- Al reduced stomatal indices which belong to upper and lower surfaces of leaf in all application groups according to the control. Besides, the number of stomata in the fungicide groups was decreased as compared to the control group. The decrease in the number of stomata reduced the values of stomatal index in the application groups as compared to the control. The reduction in the number of stomata in the fungicide groups resulted from the fungicide that prevented the division of main stomata cell. Tort et al. (2004) stated that Acrobat (9% Dimethomorf + 60% Mancozeb) and Sandofan (10% Oxadixyl + 56% Mancozeb) which were pulverized at label dosages on tomato plant reduced stomatal index as compared to the control. According to Prakash et al. (1978), the applications of Alachlor and Flurochloridone decreased stomatal index in fungicide groups as compared to the control. On the other hand, Tort and Dereboylu (2003) found that 2.5, 5 and 7.5 g/L dosages of Captan fu-ngicide caused a reduction in the values of stoma index in pepper (Capsi *cum annuum* L.) plant as the dosage increased. According to Öztürk (2006), the reduction which was determined in the values of stoma index in the fungicide group as compared to the control will affect some important

Table 2. Effect of Fosetyl-Al opened-closed stomata number and percentages.

Stoma Parameters in the adaxial and abaxial surfaces of the leaf		Application groups		
		Control	% 80 Fosetyl-Al (200 g/ 100 L)	% 80 Fosetyl-Al (400 g/ 100 L)
Adaxial surface of the leaf	Total stomata number	249 bc	120 ac	198 ab
	Opened stomata number	234 bc	42 ac	24 ab
	Opened stomata %	93.98	35	12.12
	Closed stomata number	15 bc	78 ac	174 ab
	Closed stomata %	6.02	65	87.88
Abaxial surface of the leaf	Total stomata number	657 bc	540 a	516 a
	Opened stomata number	597 bc	60 a	63 a
	Opened stomata %	90.87	11.11	12.21
	Closed stomata number	60 bc	480 a	453 a
	Closed stoma %	9.13	88.89	87.79

In the table "a" indicates the significant difference between "a" and control group. "b" indicates the significant difference between "b" and 200 mL/ 100 L group. "c" indicates the significant difference between "c" and 400 mL/ 100 L group.

Table 3. Effect of Fosetyl-Al on abnormal stomata number and percentage.

Stoma Parameters in the adaxial and abaxial surfaces of the leaf		Application groups		
		Control	% 80 Fosetyl-Al (200 g/ 100 L)	% 80 Fosetyl-Al (400 g/ 100 L)
Adaxial surface of the leaf	Total stomata number	249 bc	120 ac	198 ab
	Abnormal stomata number	9 bc	90 ac	192 ab
	Abnormal stomata %	3.61	75	96.96
Abaxial surface of the leaf	Total stomata number	657 b c	540 a	516 a
	Abnormal stomata number	15 bc	240 ac	426 ab
	Total stomata number	2.28	44.44	82.55

In the table "a" indicates the significant difference between "a" and control group. "b" indicates the significant difference between "b" and 200 mL/ 100 L group. "c" indicates the significant difference between "c" and 400 mL/ 100 L group.

physiological events such as ph-otosynthesis and respiration negatively.

When results of opened-closed stoma percentage are examined, it was determined that there was a reduc-tion in the percentage of opened stoma in all application group as compared to the control, but an increase in the values of the percentage of closed one. An increase in the values of closed stomata is going to affect photosynthesis of the plant negatively. It was reported that Triazole fungicide resulted in a closing in stomata which belong to Phaseolus vulgaris (Fletcher and Hofstra, 1988). According to Asere-Boamah et al. (1986), there was a decrease in stoma pore in Phaseolus vulgaris applied with Thiapenthenol. The results of the studies above are in aggrement with the results of the present study.

In the study, when percentage of abnormal stoma results were evaluated, it was seen that values increased in parallel with the dosage in all application groups according to the control. It was found that various chemicals affected stomata negatively in other studies. Turunen and Huttunen (1991) observed abnormal stomata in some plants which were affected from acid rain. Furthermore, the toxic effect of ozone brought about the loss of resistance in stomata (Moldau et al., 1990). Cireli and Önür (1983), stated that Stomp 330 E caused the development of abnormal stomata. It was also found that abnormal stomata were found in the present study.

It was established that Fosetyl-Al fungicide which was used for preventing fungous diseases brought about some changes in the structure of stoma in tomatoes in the study. The value of stomatal index and the percentage of opened stoma were lower than those in the control group while the percentage of abnormal stoma was higher. It is believed that such a negative effects in stomata which have an important role in plant life influenced physiological events in plant negatively. In consideration of the fact that ignorant use of fungicides is by no means

at minimal levels, studies that are dealing with a number of problems caused by application of fungicides at excessive dosages have gained far greater importance.

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