Effect of Plant Activators on Disease Resistance and Yield in Tomato and Canola

U.R. Bishnoi and R.S. Payyavula

Department of Plant and Soil Science, Alabama A&M University, Normal, Alabama
Email ubishnoi@aamu.edu

Abstract

The use of plant activators to reduce severity of diseases in many crops has been reported. Therefore, the effect of two plant activators, Messenger? and Actigard™ was tested on three tomato *(Lycopersicon esculentum Mill)* cultivars (Mountain Pride, Floralina and Florida-47) and two canola (*Brassica napus L*.) cultivars, (Flint and 188-20B). Results showed that in tomato, Messenger? and Actigard™ decreased early leaf blight (*Alternaria solani*) severity from 8-12% and increased tomato yield from 10-13% in comparison to control. Response to activators varied among cultivars. In canola, effect of both activators on crop maturity and severity of blackleg (*Leptosphaeria maculans*) disease infection was non-significant. The activators significantly increased plant height with application of Messenger? at a rate of 567.0 g/ha. The use of Actigard™ at a rate of 53.2 g/ha resulted in an increase of 7.2% and 8.6% in number of pods/plant and 9.7% and 7.2% in seed yield, in resistant and susceptible canola cultivar respectively.

Media summary

Application of elicitor chemicals called plant activators stimulate plant genes, reduce disease infection on plants and thus increase crop yield.

Key words

Crop maturity, mustard, elicitors, *Brassica napus*

Introduction

Diseases, insects and weeds are main pests causing reduction in crop yield. In the USA losses due to diseases alone account for $9.1 billion (Anonymous 2002). novel approach to ward off crop diseases is to induce systemic acquired resistance by activating a plant's own defense system. Use of plant activators to reduce plant diseases is relatively new and very few activators are currently commercially available (Mayer *et al*., 2001). The two plant activators, Messenger? , a naturally occurring bacterial protein isolated from *Ewinia amylovora*, the fire blight pathogen was developed by Eden Biosciences Ltd, Bothell, WA with active ingredient of 3% Harpin protein and the Actigard™, a selective, systemic synthetic compound developed by Novartis Crop Production, Inc, Greensboro, NC, USA with active ingredient, 1,2,3-benzothiothiadezole-7-thio carboxolic acid-S-methyl ester, are being marketed. The research work on use of Actigard™ and Messenger? to affect disease severity in tomato and canola is limited in Southeast USA. Results from few of the experiments revealed that the activators were able to induce disease resistance (Inbar et al. 1997, Pervaiz et al. 2002 and Pradhanang, et al. 2000), whereas others have reported that Actigard™ had no effect (Damicone 2002, Louws *et al*. 2001). Because of these conflicting observations, research to evaluate the effect of different rates of Messenger? and Actigard™ on early leaf blight in tomato and blackleg disease in canola were conducted. The specific objectives were: (1) To evaluate the influence of Messenger? and Actigard™ on maturity, plant height and yield in tomato and canola. (2) To quantify the effect of different rates of Messenger? and Actigard™ on Early Leaf Blight (ELB) in tomato and Blackleg Disease (BLD) in canola.

Methods

Tomato experiment: The effects of various rates of Messenger? and Actigard™ were evaluated on three tomato cultivars; Mountain Pride, Floralina and Florida. A split-plot design, with three replicates, varieties as main plot and two rates of Messenger?, Actigard™ and control as sub-plot was used. Fifteen days after

transplanting tomato plants were sprayed with Messenger? at rates of 159.3 and 318.92 g/ha, and with Actigard™ at rates of 23.6 and 53.15 g/ha. A recommended rate of 20-10-20 grade fertilizer was uniformly applied on the experimental plots through drip irrigation. Thirty days after spraying, the severity of the disease was rated on a scale of 1 to 6 (1 = no disease, 2 = 1-3% diseased, 3 = 3-6%, 4 =6-12%, 5 = 12-25%, and 6 = 25-50% diseased). Ripe tomatoes from plants of each plot were harvested at two-day intervals and weighed. Final yield averaged over replications was calculated as t/ha.

Canola experiment: Two canola cultivars; Flint (blackleg resistant) and 188-20B (blackleg susceptible) were each planted following canola or soybean. A split-split plot design, with activator as the main factor, varieties as the sub-factor and previous crop as the sub-sub-factor and three replications was used. Plant activators were applied 4 times at 14 days interval starting when plants were at the 6-leaf stage. Messenger? was applied at 283.5 and 567.0 g/ha and Actigard™ at 23.6 and 53.15 g/ha. Five canola plants in each plot were randomly tagged to observe treatment effects on flowering date (days to 50% flowering), plant height (cm) and number of pods/plant. Blackleg disease, based on the percent of leaves infected was rated on a scale of 0 to 10, (0 = no disease, 1 = 1-10% diseased, 2 = 11-20%, and so on until 10 =91-100%). Seeds harvested from each plot were cleaned, weighed and the final seed yield was expressed as kg/ha adjusted to 8.5% moisture content.

All data were analyzed by Analysis of Variance using SPSS and SAS computer programs and means were separated by Tukey's (HSD) Test.

Results and Discussion

The analysis of variance on ELB and yield data on tomatoes revealed that the use of activators significantly reduced severity of ELB, but no effect on yield was found. (Table 1). The severity rating of 2.14 after application of Actigard at 53.2 g/ha was significantly lower than the rating of 2.46 of the control (Table 2). In canola, the analysis of variance showed a significant difference in plant height, number of pods/plant, yield and non-significant difference in maturity and blackleg disease infection among the application of activators. The resistant cultivar Flint showed significant increase in plant height in comparison to the susceptible 188-20B cultivar (Table 3).

Messenger applied at 567.0 g ha^{1} resulted in a significant increase in height compared to the control and Messenger applied at 283.5 g ha^{1}. Actigard at a rate of 53.2 g/haresulted in an increased number of pods/plant and yield compared to control and Messenger at 283.5 g/ha(Table 4). Similar results have been reported by Inbar *et al*. (1997) who found that early leaf blight in tomato was significantly reduced with the application of Actigard™. Pervaiz *et al*. (2002) also found that application of Actigard™ resulted in significantly lower disease severity. In our study a different response to two activators was found. Such differences might be due to differences in environmental or soil conditions. Damicone (2002) reported that water stressed plants respond differently to the activators. In canola, Actigard™ reduced disease severity, but the increase in yield was not significant. Similar observations were made by Louws *et al*. (2001), who reported that the tomato yield was not affected after application of Actigard™.

Application of Messenger? or Actigard™ did not effect flowering or maturity in canola. Taiz and Zeiger (1998) found that maturity in plants occurs through quickening the maturity of plant cells and that plant activators do not effect the cell maturity. In both canola cultivars, Actigard™ at 53.2 g/ha and Messenger? at 567.0 g/ha showed a non-significant reduction of black leg disease incidence compared to the control and lower rates of both chemicals. Messenger? applied at 567.0 g/ha resulted in increase of canola's plant height in comparison to the control but did not have an effect on the number of pods/plant. Contrary to this, Actigard™ applied at a rate of 53.2 g/ha produced significantly more pods/plant but had no effect on plant height.

Conclusions

- Messenger? or Actigard™ decrease severity of ELB and increases tomato yield by 10-13%.
- In canola, Actigard™ increases number of pods and yield from 8 to 9%.
- Cultivars vary for response to Messenger? as well as Actigard™ treatments.

Table 1. Mean square values from ANOVA for ELB and yield in tomato.

Source?	df	ELB	Yield
Varieties (V)	2	2.818	0.073
Activators (A)	3	5.374 †	1.152
V X A?	6	0.685	0.421

†Indicates significant difference at (α = 0.05) level.

Table 2. Effect of rates of plant activators on ELB and yield in tomato.

Traits	Control	Messenger		Actigard	
		159.3 g/ha	*318.8* g/ha	*23.6* g/ha	*53.2* g/ha
ELB rating	2.46a	2.29ab	2.13ab	2.26ab	2.14b
Yield ?	81.37a	90.30b	91.51ab	86.17a	92.59b

Means within the row sharing same letter are not significantly different

(α = 0.05) by Tukey's (HSD) test.

Table 3: Mean square values from Analysis of Variance for various traits in canola.

Source ?	df	Maturity	Blackleg	Pl. Ht	Pods/Pl.	Yield (t/ha)
Activators (A)	4	0.487	1.931	1.714	4.755 †	4.879†
Varieties (V)	1	0.171	1.241	6.687†	0.889	4.301†
Crop factor (Cf)	1	0.031	0.552	3.979†	0.198	2.452
A X V	4	1.472	0.207	1.274	0.212	0.427
A X Cf	4	0.580	0.552	0.351	0.614	0.282

V X Cf	1	0.140	0.000	0.525	0.969	0.542
A X V X Cf	4	1.332	0.690	0.527	2.120	1.650

†Indicates significant difference at (α = 0.05) level.

Table 4. Effect of rates of plant activators on various agronomic traits of canola

Traits	Control	Messenger		Actigard	
	?	283.5 g/ha	567.0 g/ha	23.6 g/ha	53.2 g/ha
Maturity	166.4a	166.8a	166.5a	166.0a	166.5a
Blackleg infection	2.75a	2.42a	2.42a	2.58a	2.00a
Plant height	119.3a	121.5a	131.5b	126.7ab	126.1ab
Pods/plant	231.7a	235.0a	238.0ab	244.2ab	251.4b
Seed yield	2840.6a	2907.0a	3004.0ab	2914.3ab	3089.8b

Means with in the row sharing the same letter are not significantly different (α = 0.05) by Tukey's

(HSD) test.

References

Anonymous (2001-2002). USDA-National Agricultural Statistics Service. http://usda.mannlib.cornell.edu .

Damicone, J (2002). Bacterial disease control on tomatoes and peppers. http://plants.okstate.edu/Pddl/PDIA1-6.pdf.

Inbar, M., Hamed, D. Ronald, M. S. Gary, L. and Richard, M. (1997). Elicitors of plant defensive systems reduce insect and pathogen densities. http://www.nal.usda.gov/ttic/tektran/data/000008/11/0000081138.html

Louws, F. J., Wilson, M. Campbell, H. L. Jones, J. B. Sahin, F. and Miller, S. A. (2001). Field control of bacterial spot and bacterial speck of tomato using a plant activator. Plant Dis.85: 481-488.

Mayer, R., Weathersbee III Alberta, I. Moshe, and D. Hamed. (2001). In vivo modulation of a citrus B-1, 3-endoglucanase by benzo (1, 2, 3 thiadiazole-7-carbothioic acid s-methyl ester (actigard). http://www.nal.usda.gov/ttic/tektran/data/000012/98/0000129881.html

Pervaiz, AA, Soltani N. Cuppels, and Lazarovits DA, G. (2002). Reduction of bacterial spot disease severity on tomato and pepper plants with foliar applications of ammonium lignosulfonate and potassium phosphate. Plant Dis. 86:1232-1236.

Pradhanang, P. M., Momol, M. T. Olson, S. M. and Jones, J. B. (2000). Management of bacterial wilt in tomato with essential oils and systematic acquired resistance inducers. http://ibws.nexenservices.com/Talks/talk_9pradha.htm.

Shoemaker, L. (1998). ActigardTM registered for use on tomatoes. http://henderson.ces.state.nc.us/newsletters/veg/00-09/.

Taiz, L. and Zeiger, E. (1998). Plant Physiology, Second Edition, Sinauer Associates,Sunderland, Massachusetts.

Wilson, J. P., Cunfer, B. M. and Phillips, D. V. (1999). Double-cropping and crop rotation effects on diseases. J. Prod. Agric. 12:198-202.