International Journal of Horticultural Science 2008, 14 (3): 23–25
Agroinform Publishing House, Budapest, Printed in Hungary
ISSN 1585-0404

Role of organosilicone surfactant in apple scab control under scab conducive weather conditions

Holb, I. J.

University of Debrecen, Centre of Agricultural Sciences, P. O. Box 36. H- 4015 Debrecen, Hungary

Summary: Fungicides of integrated fruit production (dithianon, captan, and diclofluanid) and an organosilicone surfactant were compared in spray schedules from green tip until summer in order to control apple scab caused by *Venturia inaequalis* and to evaluate their phytotoxicity on fruit. Sixteen sprays of 1.8 kg ha^{-1} captan, 0.4 l ha^{-1} dithianon, and 1.8 kg ha^{-1} diclolfluanid significantly (P=0.05) reduced the incidence of leaf or fruit scab compared to unsprayed products. All fungicides applied with organosilicone at 0.1% resulted in lower incidence of scab on young and older leaves as well as on harvested fruit, but these were not statistically always better than fungicides applied alone. In case of diclofluanid, the fungicide applied with organosilicone at 0.1% resulted in significantly lower (P = 0.001) incidence of scab on young and older leaves. Diclofluanid applied with organosilicone at 0.1% gave the best scab control on leaf and fruit. Treatments applied with fungicides alone had no significant effect on plant phytotoxicity compared to untreated control. All fungicides applied with organosilicone at 0.1% increased (P = 0.05) fruit damage compared to untreated control or fungicide applied alone, though these were not always significantly different. In case of percentage of fruit russet, treatment of dithianon 0.4 l/ha + 0.1% organosilicone significantly increased fruit russet, while fruit russet index significantly increased in the treatment of diclofluanid 1.8 kg/ha + 0.1% organosilicone compared to untreated control. In sum, application of surfactants can help to increase efficacy of scab fungicides; and consequently, to reduce the risk of fungus infection under high scab disease pressure. This fact may also be helpful in fungicide resistance management and reduced-spray programs with accurate scab warning systems.

Key words: apple scab, fruit russet, surfactant, organosilicone, integrated fruit production, phytotoxicty

Introduction

Apple scab caused by the fungus *Venturia inaequalis* (Cke.) Winter occurs wherever apple are grown (*Blommers*, 1994) and is one of the major disease affecting apples in the Hungary. In the last three years spring and summer weather conditions were favourable for scab infections and it often provided suitable conditions for the development of severe scab epidemics (*Holb*, 2005, 2008).

In general, surfactants are present in most scab fungicide sprays to increase effectiveness of applied products. One of their functions is to lower the surface tension of the spray solution, thereby improving its retention on plant surfaces and enhancing subsequent wetting and spreading. However, surfactants with fungicides can cause russeting on apple fruits if their use is not appropriate. Though it should be clearly known that how effectively some surfactants (such as organosilicones) can decrease scab infection and disease development in years when both spring and summer weather conditions are favourable for disease development

This preliminary work aimed to evaluate some IFP fungicides applied with surfactants in their effectiveness against scab and on fruit phytotoxicity.

Materials and methods

Orchard and orchard management

The study was conducted in Mándok in Eastern Hungary in 2005 and 2006. The 4.6 ha orchard was planted in 1986 with distance of 3 × 5 m. The orchard received general fungicide programs during the year. Orchard was not irrigated and nutrition supply was applied annually with artificial NPK fertilizers. Cultivar Jonathan, Starking and Idared were planted in the orchard. Cultivar Idared was used for treatments.

Treatments

In both years, the same experiment was conducted on three fungicides and one organosilicone product. The experiment was conducted on five tree unit replicated four times.

1. untreated control;
2. untreated control with ten sprays of organosilicone (Zipper, The Netherlands) at 0.1% concentration;

3. sixteen sprays of captan (Captan 50 WP) at 1.8 kg ha^{-1};
4. sixteen sprays of captan at 1.8 kg ha^{-1} applied with Zipper at 0.1% concentration;
5. sixteen sprays of dithianon (Delan 750 SC) at 0.4 l ha^{-1};
6. sixteen sprays of dithianon at 0.5 l ha^{-1} applied with Zipper at 0.1% concentration;
7. sixteen sprays of diclofluanid (Euparen) at 1.8 kg ha^{-1};
8. and sixteen sprays of diclofluanid 1.8 kg ha^{-1} applied with Zipper at 0.1% concentration.

Leaf scab was recorded on 20 shoots on 5 June and on 300 leaves on 24 July. At harvest, all fruit were picked and counted. Fruit phytotoxicity and fruit scab were recorded on samples of 100 fruits at the same date. Scab incidence was assessed on the shoots, leaves and fruits using a scale based on that of *Croxall* et al. (1952a, 1952b). Fruit phytotoxicity were assessed to determine fruit russeting. Fruit russeting were classified based on a rasseting scale of 1–4: 1 = smooth fruit surface (score 1), 2 = 1–11% (score 3), 3 = 12–33% (score 5), and 4 = more than 33% (score 7) rough fruit surface area. To quantify russeting index (RI), the method described in *Holb* et al. (2003) was used.

Data analyses

Each observed tree was established as one observation unit. All data were subjected to analysis of variance (ANOVA) in order to find differences among the treatments. Years were combined in the analyses. Tables of means, P values and Least Significance Difference (LSD) are presented.

Results

Fruit and leaf scab incidences

Scab incidence was extremely high on fruits and older leaves in untreated plots which justified the scab conducive weather conditions for spring and also for summer (*Tables 1 and 2*). Scab incidences of all treatments differed significantly from control plots. All fungicides applied with organosilicone at 0.1% resulted in lower incidence of scab on young and older leaves as well as on harvested fruit, but these were not statistically always better than fungicides applied alone. In case of diclofluanid, the fungicide applied with organosilicone at 0.1% resulted in significantly lower (P = 0.001) incidence of scab on young and older leaves. Diclofluanid applied with organosilicone at 0.1% gave the best scab control on leaf and fruit.

Fruit phytotoxicity

Treatments applied with fungicides alone had no significant effect on plant phytotoxicity compared to untreated control (*Table 3*). All fungicides applied with organosilicone at 0.1 % increased (P = 0.05) fruit damage compared to untreated control or fungicide applied alone, though these were not always significantly different. In case of percentage of fruit russet, treatment of dithianon 0.4 l/ha + 0.1% organosilicone significantly increased fruit russet, while fruit russet index significantly increased in the treatment of diclofluanid 1.8 kg/ha + 0.1% organosilicone compared to untreated control.

Table 1 Leaf scab incidence of frungicide and organosilicone treatments against apple scab on cultivar Idared (Mándok, 2005–2006)

Treatments	Leaf scab on shoot	
	5 June	24 July
untreated	33.2	68.7
water treated + 0.1% organosilicone	28.0	62.8
captan 1.8 kg/ha	6.7	13.3
captan 1.8 kg/ha + 0.1% organosilicone	3.7	10.1
dithianon 0.4 l/ha	6.6	7.2
dithianon 0.4 l/ha + 0.1% organosilicone	3.4	5.4
diclofluanid 1.8 kg/ha	5.9	13.4
diclofluanid 1.8 kg/ha + 0.1% organosilicone	1.1	4.5
P-value	<0.001	<0.001
$LSD_{0.05}$	4.7	6.2

Table 2 Fruit scab incidence of fungicide and organosilicone treatments against apple scab on cultivar Idared (Mándok, 2005–2006)

Treatments	Fruit scab (%)
untreated	75.3
water treated + 0.1% organosilicone	78.4
captan 1.8 kg/ha	19.4
captan 1.8 kg/ha + 0.1% organosilicone	8.3
dithianon 0.4 l/ha	19.1
dithianon 0.4 l/ha + 0.1% organosilicone	10.9
diclofluanid 1.8 kg/ha	11.3
diclofluanid 1.8 kg/ha + 0.1% organosilicone	4.3
P-value	<0.001
$LSD_{0.05}$	8.6

Table 3 Fruit russet of fungicide and organosilicone treatments against apple scab on cultivar Idared (Mándok, 2005–2006)

Treatments	% of russeted fruit	Fruit russet index
untreated	3.1	3.0
water treated + 0.1% organosilicone	8.4	3.5
captan 1.8 kg/ha	6.9	2.5
captan 1.8 kg/ha + 0.1% organosilicone	4.0	3.2
dithianon 0.4 l/ha	7.6	2.4
dithianon 0.4 l/ha + 0.1% organosilicone	10.4	3.0
diclofluanid 1.8 kg/ha	4.5	3.2
diclofluanid 1.8 kg/ha + 0.1% organosilicone	8.9	3.8
P-value	0.002	<0.001
$LSD_{0.05}$	7.1	0.65

Discussion

Fruit scab results clearly demonstrated that surfactants are an important element of scab disease sprays under high scab disease pressure. Dithianon, captan, and diclolfluanid gave effective scab control as it is reported about many fungicides used in integrated control (*MacHardy,* 1996). The relatively high incidence of scab on harvested fruit is due to spray after middle of July was stopped and summer disease pressure was high.

Organosilicone combined with fungicides caused fruit phytotoxicity in some cases. but it was not practically and reduced fruit yield in 1998. *Coupland* et al. (1989) claimed that organosilicone surfactants induced less pigment linkage or less ethylene production of the plant, as a consequence they are less phytotoxic than other water-soluble surfactants. Nevertheless, it is also reported that when surfactants are applied as sprays onto leaf surfaces, organosilicone surfactants were less phytotoxic than conventional surfactants (*Zabkiewicz* et al., 1993). The results of organosilicone phytotoxicity might be partly due to the function of the penetration properties of organosilicone surfactants throughout the leaf surface. Indeed, the more rapid enhancement of the cuticular penetration of organosilicone surfactants compare to not silicone-based adjuvants (*Stevens* et al., 1991) is likely to be one of the reasons of their phytotoxicity.

In sum, application of surfactants can help to increase efficacy of scab fungicides; and consequently, to reduce the risk of fungus infection under high scab disease pressure. This fact may also be helpful in fungicide resistance management and reduced-spray programs with accurate scab warning systems.

Acknowledgements

The study was partly supported by a János Bolyai Research Fellowship and the Hungarian Scientific Research Fund.

References

Blommers, L. (1994): Integrated pest management in European apple orchards. Ann. Rev. Entomol. 39: 213–241.

Coupland, D., Zabkiewicz, J.A. & Ede, F.J. (1989): Evaluation of three techniques used to determine surfactant phytotoxicity. Ann. Appl. Biol. 115: 147–156.

Croxall, H. E., Gwynne, D. C. & Jenkings, J. E. E. (1952a): The rapid assessment of apple scab fungus on fruits. Plant Pathol. 1:89–92.

Croxall, H. E., Gwynne, D. C. & Jenkings, J. E. E. (1952b): The rapid assessment of apple scab fungus on leaves. Plant Pathol. 2:39–41.

Holb, I.J. (2005): Effect of pruning on apple scab in organic apple production. Plant Dis. 89: 611–618.

Holb, I.J. (2008): Timing of first and last sprays against apple scab combining with leaf removal and pruning in organic apple production. Crop Prot. 27: 814–822.

Holb, I.J., Jong, de P.F. & Heijne, B. (2003): Efficacy and phytotoxicity of lime sulphur in organic apple production. Ann. Appl. Biol. 142 (2): 225–233.

MacHardy, W. E. (1996): Apple Scab, Biology, Epidemiology and Management. APS Press, St Paul, Minnesota, 1–545.

Stevens, P.J.G., Gaskin, R.E., Hong, S.O. & Zabkiewicz, J.A. (1991): Contributions of stromatal infiltration and cuticular penetration to enhancements of foliar uptake by surfactants. Pesticide Sci. 33: 371–382

Zabkiewicz, J.A., Stevens, P.J.G., Forster, W.A. & Steele K.D. (1993): Foliar uptake of organosilicone surfactant oligomers into been leaf in the presence and absence of glyphosate. Pesticide Sci. 38: 135–143.