ARMICARB® - trials against apple scab, recommendations and developments in other cultivars

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Abstract

ARMICARB® got the registration against apple scab in Germany 2013. The active ingredient is potassium hydrogen carbonate, but the clue is the special formulation. The trials show the potential of ARMICARB in the late apples scab season after bloom. The last years many trials were conducted with ARMICARB against apple scab throughout Europe. But there are many different systems within Europe to calculate the amount of product to be used per ha. In Germany we use a system which is defined by the canopy height. The normal canopy height is between 2 m and 3 m. The registered dose rate for ARMICARB is 2.5 kg/ha and per canopy height, but limited to 5 kg/ha. The question was whether it is enough to use 5 kg at higher trees as well or do we need a higher dose rate. It could be shown that 1.5 kg per ha and per canopy height (4.5 kg/ha at a canopy height of 3 m) was efficient enough under the conditions of 2012 and 2013 to get a protection of the crop as good as a standard IPM product in a protective spraying schedule.The curative effect of ARMICARB was tested 2013 in potted trees and showed a good short term efficacy up to 11 hours after infection.

Spiess-Urania Chemicals GmbH is also developing ARMICARB® in many other cultivars as it is considered as a product without residues and low impact to the environment.

Keywords: ARMICARB, apple scab, potassium hydrogen carbonate, Germany.

Introduction

Apples scab (*Venturia inaequalis*) is a major problem in producing apples. The most important infection time is during ascospore release from spring until end of bloom. In many cases the control is not perfectly in organic production. So there is a need to control apple scab also in the later season after bloom. To show the potential of ARMICARB it is compared with an IPM product used commonly. In organic production there is also a need to limit the use of sulfur. Since 2012 ARMICARB is registered against apple scab after bloom.

There are many trials conducted with ARMICARB throughout Europe the last years showing that ARMICARB is working efficiently. Jamar *et al*. (2007) showed that the formulated product ARMICARB was more effective than bicarbonate alone. But there are different systems to calculate the dose rate to be applied. In some countries there are even only one dose rate independent from tree size.

The normal canopy height in apple orchards in Germany is between 2 m and 3 m. The registered dose rate is 2.5 kg/ha and per canopy height, but is limited to 5 kg/ha. The question was whether it is enough to use 5 kg at higher trees as well or do we need a higher dose rate. A dose rate of 1.5 kg/ha and per canopy height gives 4.5 kg at a canopy height of 3 m. This is below the limit of 5 kg/ha even at higher trees.

The objective of the trial was to evaluate whether a dose rate of 1.5 kg/ha/m with ARMICARB gives a protection for the crop as good as the higher dose rate of 2.5 kg/ha/m which might be applied to trees up to a canopy size of 2 m. A dose rate of 2.5 kg/ha/m would give a dose rate of 7.5 kg/ha at 3 m canopy height whereas a dose rate of 1.5 kg/ha/m will give 4.5 kg/ha for a canopy of 3 m (see figure 1).

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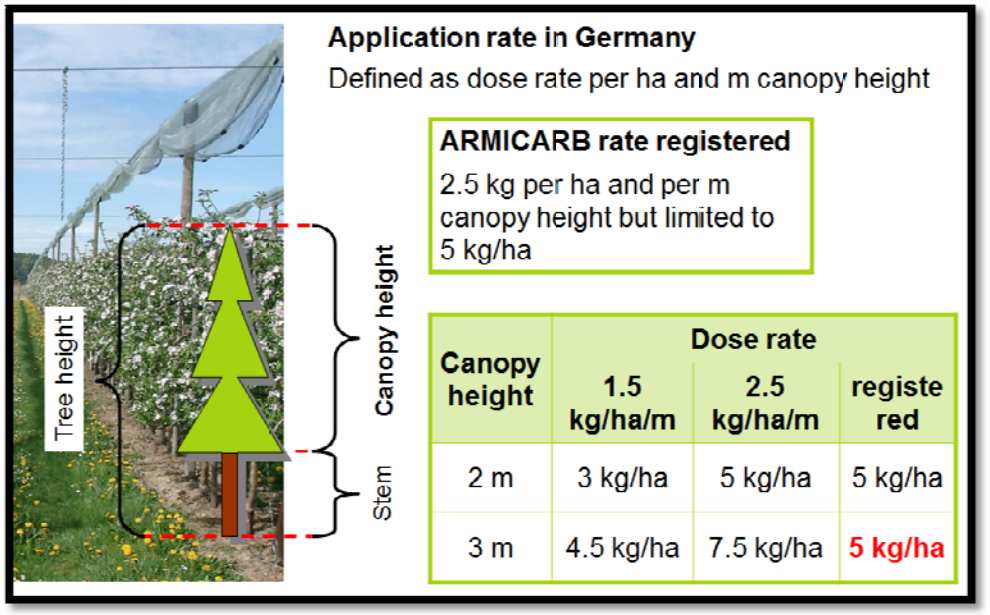

Figure 1: Application rate in Germany is defined as a dose rate per ha and per canopy height. Because of the limitation to 5 kg/ha you are only allowed to use 5 kg/ha independent of the canopy size if it is higher than 2m. According to the German system you should apply 7.5 kg/ha at a canopy height of 3 m if there would be no limitation in the dose rate.

Material and Methods

In 2012 and 2013 we set up trials in North Germany (Neuenfelde) in the cultivar 'Jonagold'. The trial design is a randomized block with 4 repetitions. Each plot had 8 trees and the untreated plots were randomly placed within each block.In both years the primary apple scab season was covered by a weekly spraying schedule of Delan WG (a.i. Dithianon) from BBCH 54 until BBCH 71 at the registered dose rate of 0.25 kg/ha and per m canopy height.

In 2012 Delan WG was applied over all plots despite untreated at the following dates: 10th April, 17th April, 24th April, 2nd May, 9th May, 16th May and 24th May. Important infection periods in the primary season occurred in 2012 from 9th April to 13th April, 21st April to 23th April, and in beginning of May from 3th to 5th and 9th to 11th of May. The trial started at BBCH 72. The products were sprayed in a 10-14 day schedule depending on the amount of rain and official recommendations. In 2012 the trial started at 4th of June followed by sprayings at 15th June, 27th June, 9th July, 21st July and at 3rd August. The summer rain led to heavy infestations in the untreated plots.

In 2013 the season started later than the year before and we also wanted to bring some disease pressure into the orchard and missed the first important infection period knowingly. So Delan WG was applied over all plots despite untreated at the following dates: 23rd April, 3rd May 10th May, 17th May, 25th May and 4th June. Important infection periods in the primary season occurred in 2013 from 15th April to 16th April and in beginning of May from 7th to 8th and 18th to 31st of May. The trial started again at BBCH 72. The products were sprayed in a 10-14 day schedule depending on the amount of rain and official recommendations. In 2013 the first spraying was done 14th June followed by sprayings at 26th June, 6th July, 18th July, 31st July and at 16th August. In 2013 there was a heavy primary scab season. Due to the decision to skip the first infection period we got much scab pressure into the orchard. Unfortunately the rain continued during the summer

season. So we got a very good untreated plot but also the IPM plot was not as good as supposed.

The product under evaluation was ARMICARB at 2 dose rates as well as the combination of ARMICARB with sulfur. All plots despite untreated were sprayed against scab in the primary season with Dithianon (standard IPM) at the registered dose rate at the time noted above. As ARMICARB is a well formulated product it was applied in both years in a protective spraying scheme at an interval of 10 to 14 days depending on the falling rain in between.

The data were entered into the ARM-program (an integrated research trial management software by Gylling Data Management, Inc.) to calculate the statistics. Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls). Mean comparisons were performed only when AOV Treatment P(F) is significant at mean comparison.

The curative efficacy was tested at the research station Esteburg, Jork in North Germany. Potted Golden Delicious were inoculated at 11th June 2013 and afterwards treated at different time intervals after infection was calculated. So we could evaluate the efficacy at 6, 11 and 25 hours after infection. Five trees for each treatment were cut back to the stem. The developing shouts were inoculated and treated. The maximum number of sensitive leaves to apple scab per shout is 8. Each leave is assessed at a level of 0 (no infestation) to 5 (heavy infestation<=100 % of leave area). The infestation rate is calculated by concerning the infestation level compared to the total number of leaves investigated. The number of shouts multiplied by 8 (max. number of leaves which may be infested by apple scab per shoot) gives the total number of leaves assessed. ARMICARB was tested at a dose rate of 0.5 %.

Results

First trials were conducted by Spiess-Urania Chemicals GmbH in 2012. We compared in 2012 (see table 1) the efficacy of ARMICARB against a standard IPM product in the summer season against apple scab. ARMICARB was tested in two dose rates and the lower dose rate together with sulfur at a dose rate of 1 kg/ha and canopy height. For leaf scab as well as for fruit scab we found a very good efficacy at both dose rates. The addition of sulfur didn't show any effect. All treatments did not differ significantly from each other's despite untreated. ARMICARB showed a very as good efficacy even at the lower dose rate.We could also see a low efficacy against powdery mildew of about 30 % in all plots where ARMICARB was used. Also on powdery mildew the sulfur did not increase the efficacy. All treatments did not differ significantly concerning powdery mildew.

Table 1: Efficacy (ABBOTT) of ARMICARB against apple scab in 2012 at Neuenfelde ('Altes Land') in Jonagold. 6 applications in June and July at a 10-14 days interval. Leaf scab was assessed at 18th of July whereas fruit scab was assessed at 23rd of August 2012.

Trial	Treatment	Dose rate kg/ha/m	Leaf scab %	Fruit scab %	Efficacy leaf %	Efficacy fruit %
1	Untreated		24.8 a	70.7 a		
2	ARMICARB	1.5	0.6 b	0.0 b	97.6	100.0
3	ARMICARB +	1.5	0.7 b	1.3 b	97.4	98.1
	Sufran Jet (sulfur)	1.0				
4	ARMICARB	2.5	0.6 b	1.3 b	97.6	98.1

As the trials in 2012 show that ARMICARB at a dose rate of 1.5 kg/ha/m is efficient enough under normal summer conditions we set up the trial in 2013 with this dose rate and tested two different formulations of sulfur in combination with ARMICARB.

In 2013 we had a very high infestation already in the primary season as well as during the summer season. So even in IPM as spraying interval of 7-14 day was too wide to perform well. We found many scab spots at the long shoots at the leaf position number 13-15 in all plots. The average efficacy in 2013 was around 50 % and there was no significant difference between IPM and ARMICARB plots. The liquid sulfur (not available yet) performed slightly better but there was no significant difference (see table 2).

Table 2: Efficacy (ABBOTT) of ARMICARB against apple scab in 2013 at Neuenfelde ('Altes Land') in Jonagold. 6 applications in June and July at a 10-14 days interval. Leaf scab was assessed at 23rd of July whereas fruit scab was assessed at 5th of September 2013 because of the late season.

Trial	Treatment	Dose rate kg/ha/m	Leaf scab %	Fruit scab %	Efficacy leaf %	Efficacy fruit %
1	Untreated		96.4 a	99.5 a		
2	ARMICARB	1.5	44.6 b	62.0 b	53.6	38.2
3	ARMICARB +	1.5	47.5 b	54.0 b	50.6	46.2
	Sufran Jet (sulfur)	1.0				
4	ARMICARB	1.5	39.2 b	45.5 b	59.4	54.8
	Liquid sulfur	1.0				

Also in 2013 ARMICARB was applied in a protective scheme. As we had a high scab pressure from primary season leave and fruit scab have very good developed. We could find leave scab at the same position of the long shoots in all plots. It shows that a spraying schedule of 10-14 days under hard disease pressure is even in the summer too long when new leaves are still developing.

Table 3: Testing the curative efficacy ARMICARB against apple scab. Variety 'Golden Delicious', Inoculation on 11th September 2013. Maximum Number of leaves per shoot which may be infected (N=8). Esteburg – Obstbauzentrum Jork.

product concentration	Sum °C hours	Num. shouts	Number of infested leaves / severity stage					Degree of infest.
			1 <=20 %	**2** <=40 %	**3** <=60 %	**4** <=80 %	**5** <=100 %	
untreated		31	7	22	8	21	113	58.39
Armicarb 0.5 %	140 / 6	15	4	3	1	0	0	2.17
	255 / 11	14	6	8	1	3	0	6.61
	507 / 25	13	5	6	7	2	20	24.23

The trial at the research station Esteburg (table 3) showed the curative potential of ARMICAB. Until 11 hours after infection it gives good efficacy. Later it is not reliable any more. This kind of trial gives a very high disease pressure. The research station conducts trials like this already since years. If the degree of infestation is below 10 % you normally can find up to 100 % of efficacy in the open field.

Discussion

The trials showed the good performance of ARMICARB in a protective spraying system even at a dose rate of 1.5 kg/ha/m (dose rate per canopy height). This gives a standard dose rate of 3 kg/ha at a tree height of 2 m and a dose rate of 4.5 kg/ha when using it at trees at a canopy height of 3 m. The maximum registered dose rate is 5 kg/ha. Sprayings in June and July give best performance and is also the best timing with regard to the safety.

In these trials the addition of sulfur did not show any significant effect on the efficacy on apple scab as well as on powdery mildew. So especially under hot summer conditions we do not recommend the use of sulfur as it may increase the occurrence of sun burn under our conditions.

In potted trees ARMICARB showed 2013 good curative efficacy until 11 hours after infection. This result fits quite well to the data Milling *et al*. (2012) showed on apple seedlings of Golden Delicious until 8 hours with decreasing efficacy later on. Unfortunately within 11 hours after infection the leaves are most likely to be still wet. In other countries it is known that the application of ARMICARB on wet leaves may reduce compatibility and phytotox symptoms may occur.

Further trials also showed the known Issue of phytotox on different varieties. The observed variety ‘Jonagold’ did not show problems with phytotox on leaves or on the fruits. In the variety ‘Elstar’ we observed phytotox on leaves when using ARMICARB more than 3 times. In the variety ‘Golden Delicious’ we found russeting after several applications of ARMICARB. Compiling all experiences together we can state that using ARMICARB during June and July may be stated as a save application when concerning the sensitivity of the different varieties. In sensitive varieties like ‘Elstar’ ARMICARB should not be used more than 3 times during the season.

ARMICARB has also a good efficacy against powdery mildewin hops according to Welte (2012). Milling *et al*. (2012) showed good results in berries and vegetables. Therefore new registrations are on the way and may be granted soon.

®Armicarb is a registered trademark of Church & Dwight USA, Inc.

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