

Results on the copper minimization in organic pome fruit growing from the collaborative research project

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Abstract

The development of an effective scab control management, that uses fungicides during the scab season, which either contain no copper at all, or only a minimized amount, is the aim of the collaborative BÖLN research project 'Advanced development of a strategy to reduce respectively substitute the use of copper in the apple scab control strategy in organic fruit growing'. Research was conducted in five different locations (DLR Rheinpfalz, Klein-Altendorf; ÖON, Jork; KOB, Bavendorf; LfULG, Dresden-Pillnitz; Bio-Protect GmbH, Konstanz). Before performing field trials, alternative products and their combinations were tested under laboratory- and greenhouse conditions for their efficiency in controlling apple scab and then more thoroughly tested in field trials, if they showed efficiencies above 90 %. Overall, it can be concluded, that lime sulphur shows the highest potential to substitute copper products during the scab season. Copper hydroxide products can be placed second in their potential to reduce copper. Wettable sulphur-, calcium hydroxide- and potassium hydrogen carbonate products were found to reduce the total amount of copper to be applied per season in a limited extent.

Keywords: Apple scab, *Venturia inaequalis*, organic apple cultivation, minimization of copper

Results

Several factors form the base for copper minimization in a scab control strategy in organic fruit growing. Combined, they build the prerequisite for a successful control strategy:

- Choice of location
- Scab resistant, scab resilient cultivars
- Forecast models
- Horticultural measures
- Phytosanitary measures
- Direct measures

The aim is to significantly reduce the input of copper on agricultural areas. Part of the overall strategy to reduce the copper input is testing the direct measures.

Wettable sulphur products

Greenhouse trials

Wettable sulphur products, which were protectively applied before the inoculation, always showed very high degrees of efficiency in greenhouse trials. Artificial rain on the leaves after the coating dried, reduced the efficiency by a few percent. The rain fastness could be improved by the addition of AlgoVital Plus®, Nu-Film-P® or Trifolio S-forte® (Hinze and Kunz, 2010; Kunz and Hinze, 2014). When applied into the germination stage under artificial rain, wettable sulphur products showed results that were comparable to the ones of lime sulphur. However, the curative effect of the wettable sulphur product 'Netzschwefel Stulln®', applied only by itself, was low, but it tended to improve the curative effect of carbonates.

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Field trials

The effect of wettable sulphur as a protective coating fungicide was repeatedly tested in different combinations during the project. The tested strategies, that included wettable sulphur, regularly reached high efficiencies. The combination of wettable sulphur together with a copper product proved to be especially successful. A direct comparison of wettable sulphur and copper products, each used on its own, showed that copper is superior to wettable sulphur as a scab fungicide. However, the combination of both products was repeatedly better than the sole use of copper. The efficiency of wettable sulphur could often be improved by the combination with coating- and adhesive agents. The product Trifolio S-forte® was intensively tested with a needed quantity of 1.25 kg/ha and mch (meter canopy height). An exemplary trial from 2012 shows the improved efficiency through the addition of Trifolio S-forte® (Fig. 1).

In the scab rating of the untreated control of both, the leaves of the long shoots (86.5 %) as well as the fruit (94.0 %), a high infestation was identified. In the strategy combining the protective applications with Cuprozin progress® + Netzschwefel Stulln® and CURATIO® (lime sulphur) into the germination stage, an efficiency of 77.8 % could be achieved in the long shoot scab rating. Through the addition of Trifolio S-forte®, the degree of efficiency could be improved up to 88.8 %. In the fruit scab rating an efficiency of 87.2 % could be achieved, when applying Cuprozin progress® + Netzschwefel Stulln® and CURATIO®. Here again, the addition of Trifolio S-forte® led to an improved efficiency of 92.2 %. Since the positive effect was sufficiently observed, the product was recommended as a standard addition with applications of wettable sulphur in the primary scab phase.

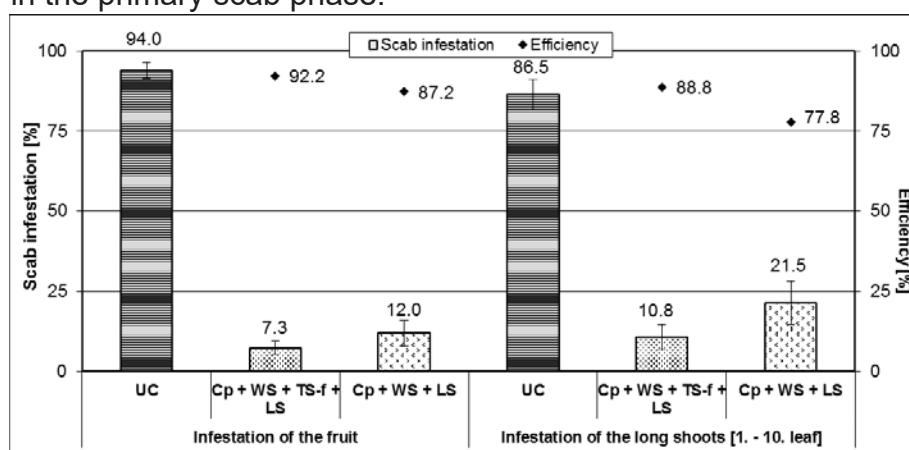


Figure 1: Scab infestation of the fruit and long shoots [%] (mean \pm SD) as well as efficiency [%] of an untreated control (UC), Cuprozin progress® + wettable sulphur + Trifolio S-forte® + lime sulphur (Cp + WS + TS-f + LS) and Cuprozin progress® + wettable sulphur + lime sulphur (Cp + WS + LS) 2012 on the cultivar 'Elstar'.

Calcium hydroxide

Greenhouse trials

Early greenhouse trials with powdered slake lime (Hydrocal®) with different application dates were not successful (Kunz and Hinze 2014). The undiluted lime water, applied protectively, had an efficiency of 85 %, but it was not rain fast. Curatively, different lime suspensions could not achieve efficiencies comparable to the ones of carbonates, as well. However, the 10 % lime milk solution, when applied into the germination stage under irrigation, could persuade with efficiencies of 94 %.

Field trials

Calcium hydroxide was thereupon tested in several trials under field trial conditions. Here, it could be shown that in some trials with low scab pressure, the product Ulmer Kalkmilch, applied into the germination stage, achieved good efficiencies, similar to the level of CURATIO®.

However, CURATIO® could achieve higher efficiencies than Ulmer lime milk in a combined strategy. The authorization of the indication scab in pome fruit is currently worked on.

Potassium hydrogen carbonate

Greenhouse trials

In the greenhouse trials, the carbonate containing products VitiSan® and Kumar® achieved the highest effects when applied curatively 24 hours after inoculation onto the dry leaf. The addition of wettable sulphur to VitiSan® tended to improve the curative effects (Kunz and Hinze, 2014), while the addition of copper products reduced the curative effects. When used protectively, the carbonate containing products were not rain fast and furthermore reduced the rain fastness of copper products. However, they had no influence on the protective effect and the rain fastness of wettable sulphur.

Field trials

During the project, products based on potassium hydrogen carbonate showed, that they can be a suitable alternative for curative treatments, when scab pressure is low to moderate. To ensure a sufficient success of control, it is crucial to use the needed quantity in accordance to the authorized recommendations, meaning 2.5 kg/ha and mch for both products. When scab pressure was high, efficiencies lay distinctly below the ones of CURATIO®. In this case an appropriately adjusted integration of both products into the scab control management would make sense. Following order of application was deemed suitable during the project:

- Preventive treatment with copper or wettable sulphur
- CURATIO® (lime sulphur) into the germination stage
- VitiSan® resp. Kumar® + wettable sulphur after the rain onto the dry leave

A direct comparison showed, that in the trial Kumar® was slightly more efficient than VitiSan®. This is obviously based on the special formulation of this product.

In the year 2016, the use of Kumar® led to noticeable phytotoxic damages on the leaves in a cultivar trial in the location Dresden-Pillnitz for the first time. A visual control showed distinct differences between the cultivars. The leaf damages were especially high on the 'Elstar' mutant 'Elshof', 'Golden Reinders' and 'Braeburn'. In most of the cultivars, only slight to no damages were visible on the fruit. Only on 'Golden Reinders' (28.5 %), 'Elshof' (12.1 %) and 'Braeburn' (8.1 %) appeared noticeably severe impairments of the fruit skin in the form of russeting-like mottling. The obviously differentiated susceptibility of cultivars should definitely be considered in practice. When applying VitiSan®, no phytotoxic characteristics could be observed until now.

Conclusion

In this collaborative project, a potential for copper reduction could be proven for potassium hydrogen carbonate-, calcium hydroxide- and wettable sulphur products. However, field trials showed, that the potential for copper reduction for these products is limited compared to products like lime sulphur, but they do build an important additional component in controlling apple scab.

References

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