Effects of beetroot vinasse on ascospore formation and infestation of *Venturia inaequalis* in organic apple orchards

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Abstract

In earlier works, the effect of beetroot vinasse on leaf decomposition and ascospore formation was examined over several years in standardized mesh cage trials with Jonagold leaves. As published in ecofruit proceedings 2014, vinasse applied once during leaf fall in autumn leads to fastened leaf decomposition and in addition to an obvious reduction of ripe ascospores on remaining leaf material. Ascospore formation in these trials was examined twice during ascospore season with waterbath method according to Kollar (2000). To verify the good results received by waterbath method, the ascospore discharge of vinasse-treated and untreated leaves was continuously recorded using a Mycotrap spore trap during the ascospore seasons 2014 and 2015. To measure the effect of an additional vinasse treatment on resulting apple scab infestation in the field, multiple large scaled trials were additionally conducted in several ecologically managed orchards in Lake Constance area with the cultivar Jonagold. With regard to the long-distance distribution of ascospores, orchards were divided large-scale into plots with and without additional vinasse treatment. Potential effects of the vinasse treatment were recorded by measuring the amount of remaining leaf material in spring and the infestation of apple scab on leaves and fruit. In the mesh cage trial vinasse-treaded leaves discharged an obviously reduced amount of ascospores at every single infection period during the whole primary scab season compared to the untreated leaves. Furthermore, a positive effect of vinasse treatment on leaf decomposition and apple scab infestation on leaves and fruit was observed in every field trial.

Keywords: beetroot vinasse, apple scab, *Venturia inaequalis*, ascospore formation

Introduction

Within a four years trial conducted at the Kompetenzzentrum Obstbau Bodensee in Lake Constance area, a single beetroot vinasse treatment applied with 250 l vinasse and 750 l water per hectare during leaf fall in autumn resulted both in accelerated decomposition and distinct reduction of produced ascospores in remaining leaf material. These standardized trials were conducted with mesh cages using uniformly infested leaves of the cultivar ‘Jonagold’. Amount of mature ascospores in untreated and vinasse-treated leaves was measured with waterbath method twice during primary scab season. In spite of the clear and consistent results published in 16. ecofruit- proceedings (Buchleither, 2014), we decided to verify the results concerning ascospore formation using a further method. Therefore the amount of discharged ascospores of vinasse-treated and untreated leaves was trapped continuously during primary scab season with a Mycotrap spore trap over two years. With this method the number of mature ascospores discharged over the entire primary scab season could be measured and compared between the treatments. To validate the good results from the mesh cage trials in the field, multiple large scaled trials were additionally conducted on several ecologically managed orchards with the cultivar ‘Jonagold’ in Lake Constance area.

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Material and Methods

In every trial the beetroot vinasse product “Team-F vinasse” was applied once at the beginning of leaf fall in November with a concentration of 25 %. All treatments were applied with a motorized sprayer using a spray volume of 500 l per hectare and meter foliage height. To measure the effect of vinasse on ascospore formation vinasse- treated and untreated leaves were collected in an organic orchard at Kompetenzzentrum Obstbau Bodensee planted with the variety ‘Jonagold’ on rootstock M9. Both treated and untreated leaves with obvious and uniform scab infections were picked at application date, weighed and put into mesh cages to overwinter in the field. Cages with an area of 1 m^2 containing around 0.2 m^3 of leaves were used. Starting with the beginning of ascospore maturation in March, Mycotrap spore traps were placed directly over the leaf depots. During primary scab season between the end of March an middle of Mai the discharge of ascospores was recorded continuously by counting the number of ascospores on one square centimetre of plastic film discharged within 24 hours after each rain event by using a microscope. Additional field trials were conducted in several organically managed ‘Jonagold’ orchards in Lake Constance area. The orchards with sizes ranging from one to three hectare and uniformly distributed scab infestation were large-scale divided into plots with and without additional vinasse treatment. In every plot standard plant protection treatments were applied similarly during growing season. Potential effects of the additional vinasse treatment were investigated by measuring the amount of remaining leaf material in spring and the infestation of apple scab on leaves and fruits in both treatments. The amount of remaining leaf material was measured yearly at the end of March with the beginning of the primary scab season. In each plot remaining leaf material was collected at twelve randomly selected spots using a frame of 1 m^2 reaching from the middle of the tree row to the middle of the drive alley. Collected leaf material was air dried for 24 hours before weighing. To record initial infestation of apple scab before the beginning of the trial (a) and also resulting infestation of apple scab on leaves (b), 50 randomly selected long shoots per plot were examined leaf by leaf in October (a) and July (b). Infestation on fruit was determined in August by visual control of 500 fruit per plot.

Results

Effect on ascospore formation

Initial results from the preliminary trials in which ascospore formation was investigated using waterbath method according to Kollar (2000) are shown in figure 1. Represented is the amount of ascospores per gram leaf material (x 1.000) at sampling date May for the years 2011-2014. Within the four years of study, the amount of ascospores was distinctly reduced between 44 % and 70 % in the vinasse-treated leaves compared to leaves without additional vinasse treatment.

In figures 2 and 3 courses of ascospore maturation of vinasse-treated and untreated leaves in the years 2014 and 2015 are shown. The highest amount of discharged ascospores were trapped between end of April and beginning of May. In both years the amount of discharged ascospores of vinasse-treated leaves was reduced over the entire primary scab season compared to the untreated leaves. The amount of discharged ascospores was exceedingly reduced particularly in periods with intensive ascospore maturation.

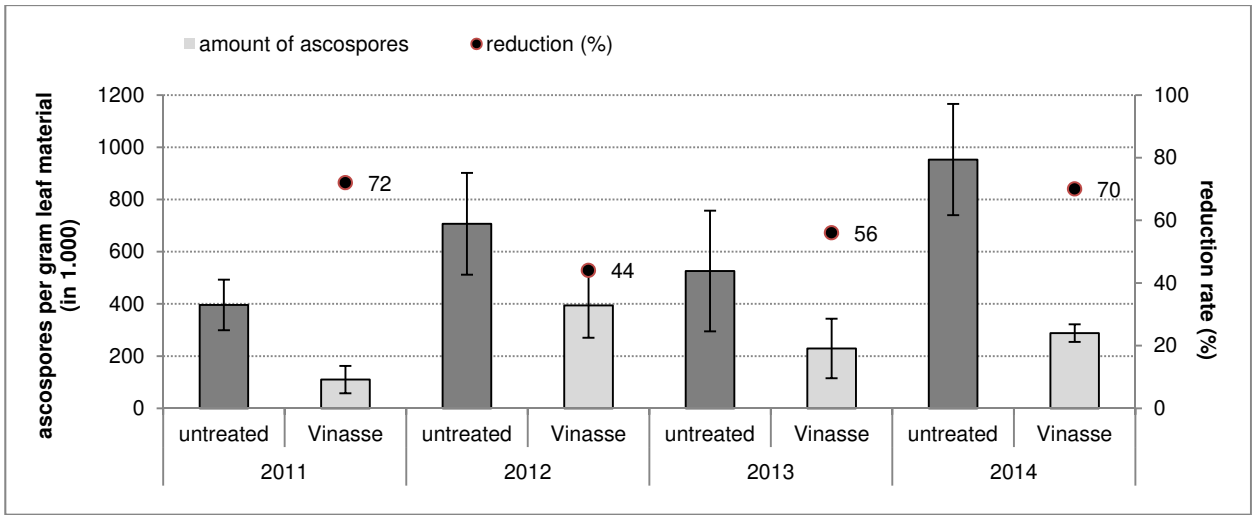

Figure 1: Mean amount of ascospores measured with waterbath analysis at sampling date May in the years 2011-2014. Error bars represent standard deviation.

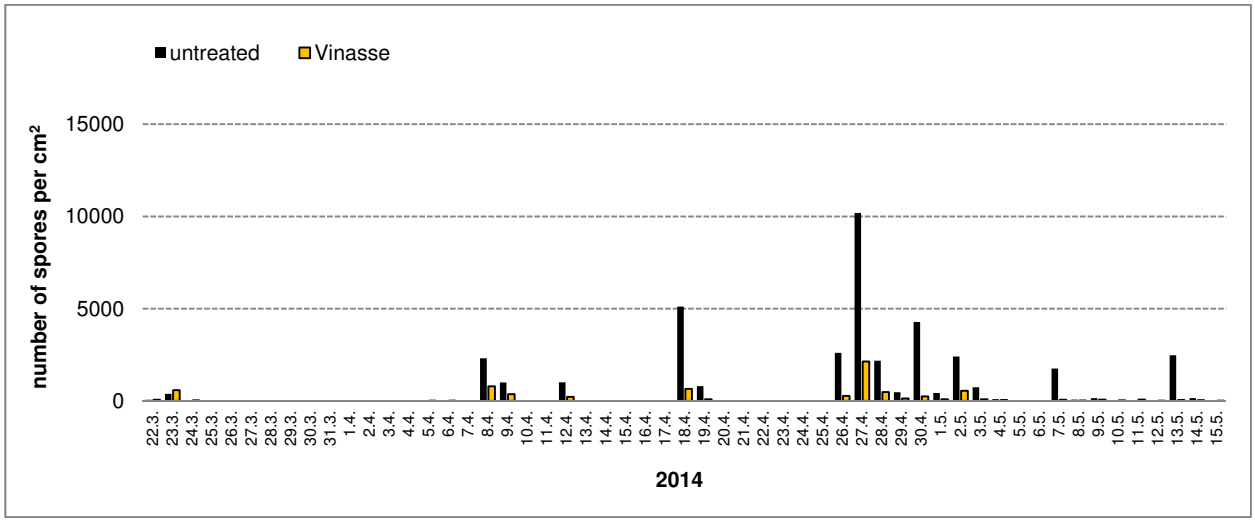

Figure 2: Number of ascospores trapped with sporetrap during primary scab season 2014.

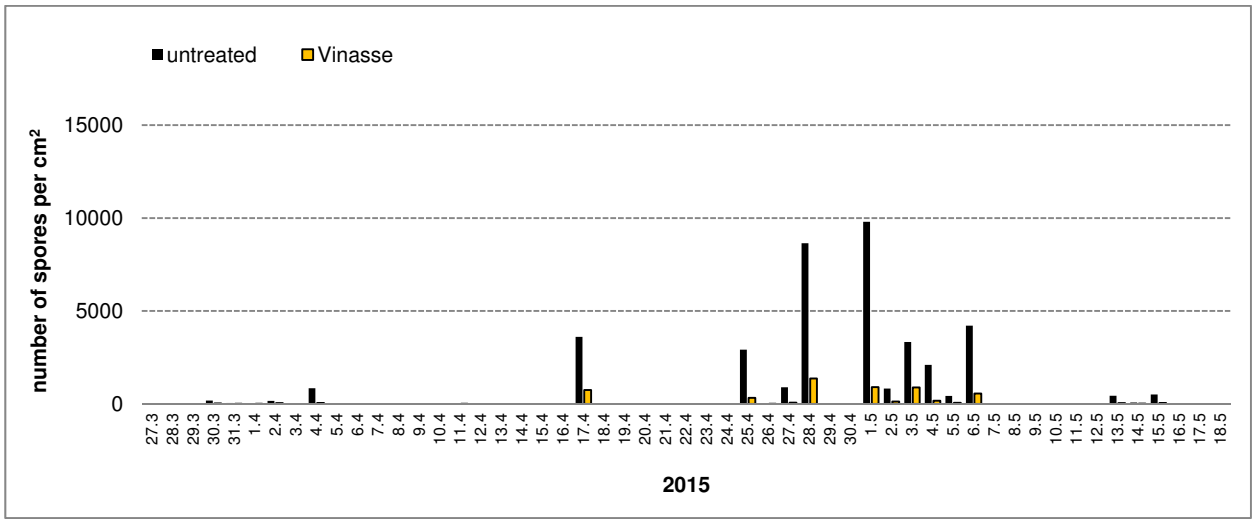

Figure 3: Number of ascospores trapped with sporetrap during primary scab season 2015.

Field trials - effect on remaining leaf material

In figure 4 the amount of remaining leaf material (g/m^2) in plots with and without additional vinasse treatment is shown for several orchards and years. The amount of remaining leaf material in March varies between the several orchards and also within one orchard due to variable climate conditions between the years. However, additional vinasse treatment resulted in reduced amount of remaining leaf material compared to the plots without vinasse treatment in every single trial. Thereby reduction rates between 25 % and 99 % were recorded.

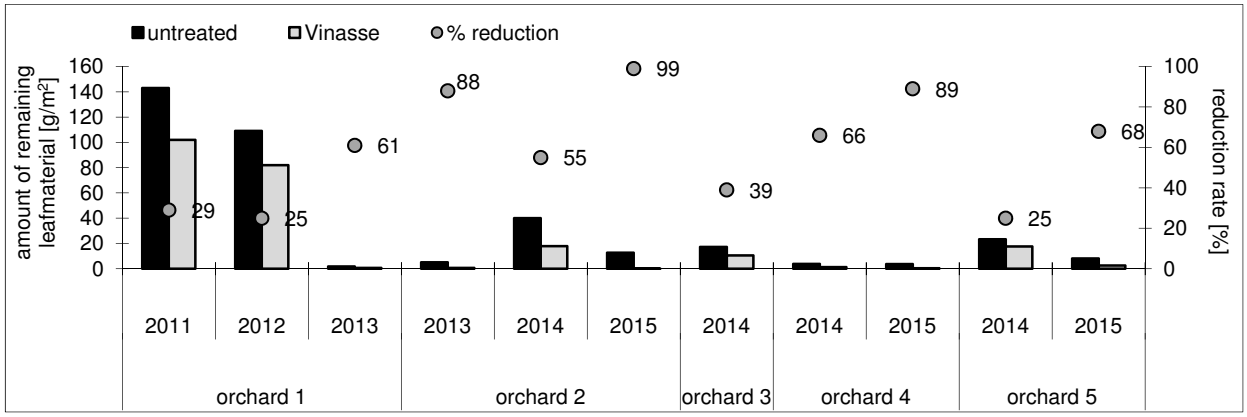

Figure 4: Amount of remaining leaf material (g/m^2) and reduction rate (%) of vinasse treated plots compared to plots without vinasse treatment in several orchards and years.

Field trials - effect on resulting scab infestation on leaves and fruit

Compared to the represented results concerning leaf decomposition, the quantity of represented results concerning apple scab infestation on leaves and fruit is lower because of differences in experimental setting. In 2014 a vacuum cleaner collecting leaves from the ground was used in addition to vinasse treatment in the field trials. Therefore it was not possible to measure the singular effect of the vinasse treatment on apple scab infestation. However, a positive effect of vinasse treatment on apple scab infestation on leaves and fruit was determined in every trial of the remaining years. Compared to the plots without vinasse treatment, amount of infested leaves was reduced between 18 % and 49 % in the vinasse-treated plots. Furthermore, also the amount of infested fruit was reduced in every plot treated additionally with vinasse.

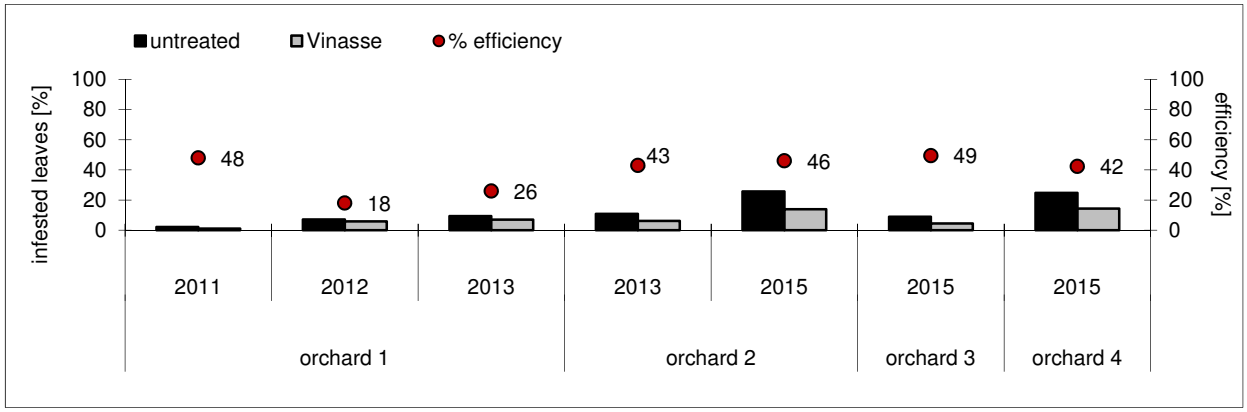

Figure 5: Amount of infested leaves (%) and efficiency (%) of vinasse treated plots compared to plots without additional vinasse treatment in several orchards and years.

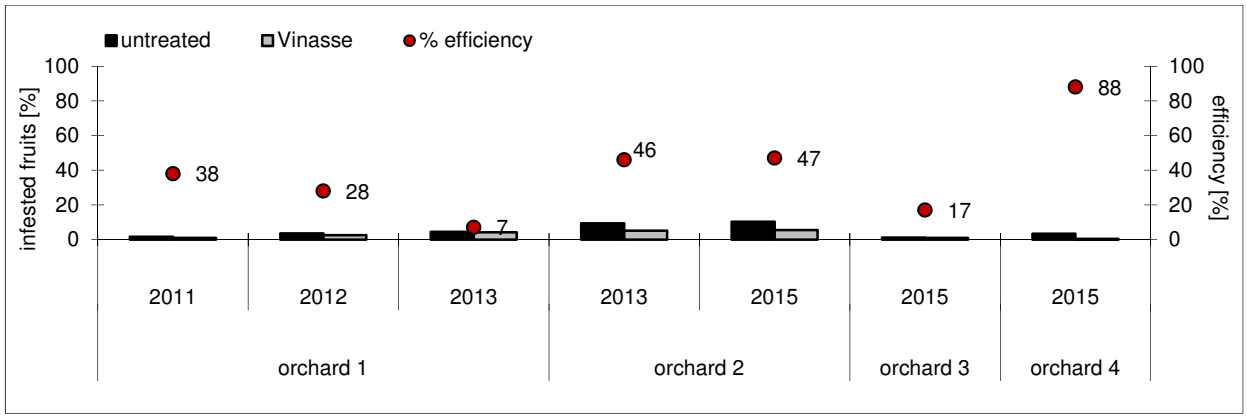

Figure 6: Amount of infested fruit (%) and efficiency (%) of vinasse treated plots compared to plots without additional vinasse treatment in several orchards and years.

Discussion

In a four years trial single application of vinasse product „Team-F-vinasse“ with 25 % concentration and a water volume of 500 l per meter crown height regularly lead to an obvious reduction of mature ascospores on treated leaves. These results were achieved by waterbath method. In further trials it was possible to verify these results with a further method using Mycotrap spore traps. Thereby it was possible to picture the ascospore maturing process over the entire primary scab season. In both years of examination it could be shown that the number of formed and discharged ascospores was obviously reduced in leaves treated with vinasse. The documented reduction of ascospores at every single infection date during the entire primary scab season proofs a sustaining influence of the vinasse treatment on ascospore formation. Together with the accelerating effect on leaf decomposition, measured both in field trials and mesh cage trials, vinasse provides an impact against apple scab. The expected effect of vinasse on apple scab infestation could be validated in large-scale field trials over several years. Independent of size, environmental influence and particular scab history of the orchards selected for these trials, a single vinasse treatment in autumn continuously resulted in reduced infestation of apple scab on leaves and fruit. Due to the wide distribution of ascospores, large-scale plot trials were necessary for this experimental setting. Hence standardized experimental setting with small plots of randomly distributed repetitions was not suitable in this case. For this reason statistic evaluations were not possible with the experimental setting used in these trials. Nevertheless the uniform results and the high number of several trials allow the conclusion that a single vinasse treatment in autumn is able to contribute to a reduction of apple scab infestation. For this reason vinasse can play a supplemental part in the overall strategy for the regulation of apple scab in organic apple production.

References

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