Can agroforestry reduce the need for copper?

Apple scab is caused by the fungus *Venturia inaequalis* which results in dark spots on infected leaves and fruit and can lead to defoliation. Copper compounds are used extensively in organic apple production to control scab and a range of secondary diseases (e.g. cankers, fruit rots, and foliar diseases). However, its use can have detrimental effects on ecosystems including reduced earthworm populations, a decrease in beneficial mycorrhizal interactions, and high levels of ionic toxicity to aquatic organisms and the EU foresees the complete banning of copper use by 2016.

Integrating top fruit production into an agroforestry system, where woody species are integrated with crop production (Figure 2) may have a beneficial effect on the control of plant pathogens such as scab due to a number of mechanisms:

- A greater distance between tree rows in agroforestry systems, with crops in the adjoining alleys, is likely to reduce the spread of pathogens.
- Lower densities of trees favour increased air circulation which has been shown to reduce the severity of scab by reducing leaf wetness duration.
- Regular cultivations within the crop alleys will incorporate leaf litter into the soil, reducing the risk of re-inoculation from overwintered scabbed leaves.

Materials and Methods

Research has focused on two factors that are likely to be affected by an agroforestry system approach to non-copper use:

(i) Yield and quality of apples
(ii) Emergence of primary and secondary pests and diseases

The research was carried out at Wakelyns Agroforestry, an organic silvoarable research site established in 1994 in Suffolk, UK (52.4⁰N, 1.4⁰E). The apple/arable agroforestry system is a diverse mix of 21 varieties of apple trees on M4111 rootstock interspersed with 7 timber species in north/south rows with 12 m-wide crop alleys between adjacent rows (Figure 1). The apple trees cover 2.5% of the land area in the 2 ha system. A local modern 0.6 ha organic orchard acts as a benchmark for comparison (Clarke's Lane Orchard) with 19 varieties of apples planted on M9 rootstock. Neither system uses copper to control for scab.

At Wakelyns, assessments were carried out in four plots, each plot including two tree rows and the crop alley in between, with 7-10 apple trees in each plot interspersed with timber trees. In the organic orchard, assessments were carried out in four plots, each plot consisting of two tree rows and the narrow grass alley in between. In autumn 2012, all apples harvested from each site were graded as Class I/II/processing/waste and weighed per class and variety. Pests and diseases were assessed in the plots at two points before harvest: small fruits in July 2012 and large fruits in August 2012. One sample consisted of 100 plant units chosen randomly from all trees in the plot area. Each plant unit was thoroughly inspected for eggs, insects or insect damage and diseases.

Results

Yields within the agroforestry were higher than in the orchard, even when taking into account the fact that apple trees cover only 2.5% of the area. Comparing yields with standard figures from the Organic Farm Management Handbook (Lampkin, et al. 2012) by scaling up the agroforestry tree area from 2.5% to 100% (i.e. multiplying yield by 40), the yields from the agroforestry compare favourably (Class I & II: 15.7 t/ha from the agroforestry vs. 14 t/ha from orchards at peak production).

Conclusions

Apple yields in 2012 were adversely affected by the weather, with low fruit set due to late frosts and heavy rain. Despite this, the yield from the agroforestry system even at just 2.5% cover, appeared to outperform the organic orchard used for comparison. Although no firm conclusion can be drawn from the results to date, it appears as if there may be indications of a potential positive impact on reducing scab levels within the agroforestry, and therefore reducing the need for copper.

Materials and Methods

Research has focused on two factors that are likely to be affected by an agroforestry system approach to non-copper use:

(i) Yield and quality of apples
(ii) Emergence of primary and secondary pests and diseases

The research was carried out at Wakelyns Agroforestry, an organic silvoarable research site established in 1994 in Suffolk, UK (52.4⁰N, 1.4⁰E). The apple/arable agroforestry system is a diverse mix of 21 varieties of apple trees on M4111 rootstock interspersed with 7 timber species in north/south rows with 12 m-wide crop alleys between adjacent rows (Figure 1). The apple trees cover 2.5% of the land area in the 2 ha system. A local modern 0.6 ha organic orchard acts as a benchmark for comparison (Clarke’s Lane Orchard) with 19 varieties of apples planted on M9 rootstock. Neither system uses copper to control for scab.

At Wakelyns, assessments were carried out in four plots, each plot including two tree rows and the crop alley in between, with 7-10 apple trees in each plot interspersed with timber trees. In the organic orchard, assessments were carried out in four plots, each plot consisting of two tree rows and the narrow grass alley in between. In autumn 2012, all apples harvested from each site were graded as Class I/II/processing/waste and weighed per class and variety. Pests and diseases were assessed in the plots at two points before harvest: small fruits in July 2012 and large fruits in August 2012. One sample consisted of 100 plant units chosen randomly from all trees in the plot area. Each plant unit was thoroughly inspected for eggs, insects or insect damage and diseases.

Results

Yields within the agroforestry were higher than in the orchard, even when taking into account the fact that apple trees cover only 2.5% of the area. Comparing yields with standard figures from the Organic Farm Management Handbook (Lampkin, et al. 2012) by scaling up the agroforestry tree area from 2.5% to 100% (i.e. multiplying yield by 40), the yields from the agroforestry compare favourably (Class I & II: 15.7 t/ha from the agroforestry vs. 14 t/ha from orchards at peak production).

Conclusions

Apple yields in 2012 were adversely affected by the weather, with low fruit set due to late frosts and heavy rain. Despite this, the yield from the agroforestry system even at just 2.5% cover, appeared to outperform the organic orchard used for comparison. Although no firm conclusion can be drawn from the results to date, it appears as if there may be indications of a potential positive impact on reducing scab levels within the agroforestry, and therefore reducing the need for copper.