Final Project Report to the NYS IPM Program, Agricultural IPM 2000 – 2001

Title:
Control of Blossom, Shoot and Rootstock Fire Blight In Young, Dwarf Apple Trees Through Nutrition, Pruning and Growth Regulators.

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Type of grant:
Cultural methods

Project location(s):
Throughout the Northeast

Abstract:
Control of fire blight control on dwarf apple trees of highly-susceptible cultivars is an increasing problem in NY. Fertilizer practices can have a small but significant effect on tree growth and on shoot blight severity. In general, we found that the lower the nitrogen fertilization rate the lower the severity of fire blight infection; however, the unfertilized treatment had the poorest tree growth. High K levels alone had a similar level of fire blight infection as did the unfertilized control but much better tree growth and production. Tree growth was poor if nitrogen alone was added but if both nitrogen and potassium were added then growth was much better. The best combination of growth and the least severity of fire blight was with the high K treatment. It appears that the soils used in this experiment have adequate levels of nitrogen to produce good tree growth if supplemented with K.
The new environmentally-friendly shoot growth retardant, Apogee, has a suppressive effect on fire blight development in shoots. Our results show that it does not control blossom blight, but does significantly reduce the amount and severity of shoot blight. Although shoot blight was reduced on Apogee treated trees, rootstock fire blight and tree death were not reduced.
From a practical point of view apple growers should manage new orchards with a relatively low level of N and a relatively high level of K. This could be combined with late season applications of Apogee to reduce the risk of fire blight infection. Although Apogee will reduce shoot blight progress it does not reduce rootstock death. Growers should utilize the new fire blight resistant rootstocks from Geneva (G.16 or G.30) to prevent tree death. An integrated approach with fire blight resistant rootstocks, low nitrogen fertilization, high K fertilization and late season use of Apogee should give good tree growth and minimize fire blight risk.

Background and justification:
The NY apple industry is rapidly moving to new varieties and dwarfing rootstocks which often are highly fire blight-susceptible. In addition, the necessity of achieving rapid early production in order to quickly repay the investment of a new orchard, requires rapid tree growth which also increase susceptibility to fire blight. Although blossom blight is often controllable with bactericide sprays, summer shoot blight and rootstock blight are often not controlled well with bactericides. Improved control methods for fire blight on young apple trees of highly susceptible cultivars is an increasing need of the NY apple industry.
Previous research has shown that low tree nutritional status minimizes fire blight incidence. However, such an approach is not economically feasible with new high-density apple plantings

which must fill their allotted space as rapidly as possible. This leads growers to "push" young trees with high levels of Nitrogen. Historical data has demonstrated that high levels of N increases the vigor of trees and the amount of succulent growth which in turn increases fire blight susceptibility of these high-cost plantings. The levels of other nutrients such as K, Ca, Cu, Fe, Mg, Mn, Mo, and Zn may also be related to disease susceptibility. Previous data has shown that the incidence of fire blight infection increased as the N/K ratio increased from a low of 1.2, to the highest fire blight incidence at a ratio of 1.8. This project studied nutritional strategies for young orchards which result in rapid tree growth without high fire blight susceptibility.

A new growth regulator named Apogee (Prohexadione-Calcium) has been shown to limit fire blight development in apple shoots (Aldwinckle et al., 2000). This product is registered as a reduced risk chemical because it has very low mammalian toxicity, low propensity for crop residues, rapid dissipation in the soil, no detrimental ecological effects, and no health risk to consumer or user. Its primary horticultural effect is a reduction of shoot growth which reduces the need for summer pruning on vigorous cultivars like McIntosh. In addition, its could be used for summer fire blight control replacing the use of streptomycin for shoot blight control. This may retard the development of resistance to streptomycin. The dilemma with young trees is that although Apogee may limit fire blight susceptibility it may also limit tree canopy development which is counter to the horticultural goal of rapidly filling the space to get a return on the investment. This project studied strategies for the use of Apogee whereby significant fire blight protection can be achieved without sacrificing tree growth or yield.

Objectives:

1. Determine the relationship between apple tree nutrient status, fire blight susceptibility and rootstock death of highly susceptible varieties like Gala and Gingergold trees on M.9 using different nutritional treatments and inoculations with fire blight bacteria.
2. Develop strategies for the use of the new growth regulator Apogee for blossom, shoot, and rootstock fire blight control of apple without sacrificing tree growth or yield in the first 4 years.

Procedures:

OBJECTIVE 1: NUTRITION AND FIRE BLIGHT IN YOUNG, DWARF PLANTINGS

A replicated field plot was established at the New York State Agricultural Experiment Station in Geneva, NY in 1997 and 1998 with different nutritional treatments. The 1997 planting utilized 'Gala/M.9' trees with a spacing of 1.75 x 4 m spacing, (578 trees/acre). A similar planting of 'Gingergold/M.9' (1.0 x 4 m or 1014 trees/acre) was planted in 1998. A total of 240 trees were planted per variety, with 10 trees per plot, and 4 replicates per treatment. A series of preplant and annual nutritional treatments were applied to establish different nutrient levels of N, K and Mg. The nutrient treatments were.

1. Unfertilized control.
2. Moderate Nitrogen fertilization (33# N /acre/year).
3. High Nitrogen fertilization (100# N /acre/year).
4. High Potassium fertilization (120# K2O/acre/year).
5. High Nitrogen and High Potassium (100# N and 120# K2O/acre/year).
6. Best Cornell Recommendations (30# N, 120# K2O, 3# B, 50# Mg adjusted annually based on annual leaf analysis.).

Leaf samples were analyzed each year from each plot for both major and minor nutrient levels. In the third year after planting (1999, 2000 and 2001 for Gala and 2000 and 2001 for Gingergold) when the trees carried crops, three trees in each plot were inoculated with fire blight bacteria at full bloom and in midsummer. The blossom inoculation was done by spraying the trees with a solution containing the bacteria at full bloom. The percentage of blossom clusters killed by the bacteria was recorded 1 month after inoculation. The midsummer shoot inoculation was done by dipping scissors in a solution containing the bacteria and cutting 2 expanding leaves near the shoot tip of 10 shoots per tree. Lesion length and total shoot length were recorded. At the end of the season rootstock infections were recorded.

Objective 2 Apogee and Fire blight in Young, Dwarf Plantings

Two replicated field plantings were established in 1999 and 2000 using 'Gingergold/M.9' spaced 1.00 x 4 m (1014 trees/acre). The first planting was used to test the effect of Apogee on first year tree growth and fire blight susceptibility. A total of 180 trees were planted with 10 trees per plot and 4 replicates per treatment. The treatments were:
1. Untreated control.
2. Multiple low doses of Apogee (62.5 ppm, 4 times).
3. Standard dose of Apogee (125 ppm, 2 times).
4. Single high dose of Apogee (250 ppm, 1 time).

Each set of trees was sprayed and inoculated only in the first year and trees were left untreated in the second to determine rootstock infection and tree death.

The second planting was inoculated in 2000 and 2001 to determine the effect of Apogee on second and third year growth and fire blight susceptibility in combination with pruning and or streptomycin on the susceptibility of young trees to fire blight. A total of 1212 trees were planted, with 22 trees per plot, and 4 replicates per treatment. The experiment had 6 treatments with each treatment being applied to one set of trees in 2000 and another set in 2001
1. Untreated control.
2. Apogee at recommended dose and timings for mature trees (2 applications. of 125 ppm Apogee @ PF days and PF+14 days).
3. Cover sprays of Apogee at low dose with full recommended total seasonal dose (4 applications. of 62.5 ppm Apogee @ PF and PF+10, PF+20, PF+40 days).
4. Cover sprays of Apogee at low dose with 1/2 recommended total seasonal dose (4 applications. of 31.25 ppm Apogee @ PF and PF+10, PF+20, PF+40 days).
5. Streptomycin sprays 24 hours before and after inoculation.
6. Pruning out of infections on a weekly schedule.

Trees were inoculated with fire blight bacteria at full bloom by spraying blossoms with a solution containing *Erwinia amylovora*. In mid June and in mid July, shoot tips were inoculated by transversely cutting two leaves on each of 6 shoots per tree with scissors dipped in a10 7 cfu/ml suspension of *Erwinia amylovora* strain 273. In late June and late July lesion length and tree survival were recorded. Ten trees per plot were inoculated each year (5 trees at bloom and 5 in June plus July). Measurements included blossom blight, shoot blight, rootstock blight, yield, fruit size and canopy volume.

In 2001 the treatments were simplified as follows:
1. Untreated control.
2. Apogee at recommended dose and timings for mature trees (2 applications. of 125 ppm Apogee @ PF days and PF+14 days).
3. Apogee at 1/2 the recommended dose and timings for mature trees (2 applications. of 62.5 ppm Apogee @ PF days and PF+14 days).
4. Apogee at 1/4 the recommended dose and timings for mature trees (2 applications. of 31.25 ppm Apogee @ PF days and PF+14 days).
5. Streptomycin sprays 24 hours before and after inoculation.

Trees were inoculated on June 15 by transversely cutting two leaves on each of 6 shoots per tree with scissors dipped in a10 7 cfu/ml suspension of *Erwinia amylovora* strain 273. Lesion lengths and total shoot lengths were measured 6 weeks later.

Results and discussion:

Objective 1: Nutrition and Fire blight in Young, Dwarf Plantings

Leaf Nitrogen content with all treatments was very low in 1999 due to a severe drought while levels in 2000 were more normal (Tables 1 and 2). Among treatments, leaf Nitrogen was highest for the two Nitrogen fertilization treatments, the high Nitrogen plus high Potassium treatment and the Cornell recommend treatment. Leaf Nitrogen was generally lowest for the unfertilized control and the high Potassium treatment.

Differences in leaf Potassium level due to fertilizer treatment were generally greater than leaf Nitrogen (Tables 1 and 2). The highest leaf Potassium level was with the high Potassium treatment and the Cornell recommend treatment. The unfertilized treatment and the two Nitrogen only treatments had the lowest levels of leaf K. The ratio of Nitrogen:Potassium was inversely related to leaf K level.

The Cornell recommend treatment and the high N plus high K treatment had the largest trunk cross-sectional area (TCA) while the high N had the smallest TCA (Table 3). It appears that high Nitrogen fertilization without Potassium results in a suppression of tree growth compared to a balanced fertilization strategy.

The highest cumulative yield was with the high K treatment (Table 3) The lowest cumulative yield was with the Nitrogen fertilization treatments. Fruit size was greatest with the high N plus high K treatment or the Cornell recommend treatment and was lowest with the unfertilized treatment. Yield efficiency was highest with the high K treatment.

Fertilization treatments did not influence the percentage of blossom clusters that became infected with fire blight following inoculation (Table 4). In general inoculation of blossom clusters with fire blight bacteria during full bloom resulted in 5-20% of clusters infected with Gala and only 1-3% of clusters infected with Gingergold.

Inoculation of shoots in mid-June resulted in significant shoot blight infection (40-80% of shoot length infected). The unfertilized treatment had a significantly lower severity of fire blight infection than the high N, high N plus high K and the Cornell recommend treatments (Table 4). The high K and the moderate N treatments were intermediate. The ratio of N:K was generally negatively correlated with fire blight severity. Exceptions were the high N plus high K treatment which had a relatively low N:K ratio but had relatively high fire blight infection levels. In 1999 the N:K ratios were low indicating the lower availability of N compared to K during the drought year. In 2000 the ratios were higher yet fire blight infection levels were similar. The fertilization treatments did not affect the spread of fire blight from inoculated shoots to un-inoculated shoots nor did they influence the incidence of rootstock blight.

These results indicate that different fertilizer practices can have a small but significant effect on tree growth and on shoot blight severity. In general, with lower nitrogen fertilization rates the severity of fire blight infection was reduced; however, the unfertilized treatment had the poorest tree growth. High K levels alone had a similar level of fire blight infection as did the unfertilized control but much better tree growth and production. Tree growth was poor if nitrogen alone was added but if both nitrogen and potassium were added then growth was much better. The best combination of growth and the least severity of fire blight was with the high K treatment. This result is likely transferable to other sites with soils which have relatively high natural levels of nitrogen. With soils that are lower in nitrogen fertility a moderate level of fertilizer N and a high level of fertilizer K such as with the Cornell recommend treatment should produce good tree growth and minimize fire blight risk.

OBJECTIVE 2 APOGEE AND FIRE BLIGHT IN YOUNG, DWARF PLANTINGS

In our 1999 experiment with 1st year Gingergold/M.9 trees ,Apogee provided excellent fire blight protection when applied in early August (Table 5). The strategy behind this treatment is to wait until much of the current season's shoot growth is developed before treating with Apogee in early July. Despite waiting until July this treatment caused more growth reduction than optimal from a horticultural perspective. The economic effect of the growth reduction from Apogee would depend on the survival of the untreated trees.

With our 2000 trial Apogee had little effect on trees that were inoculated at bloom before the Apogee applications (Table 6). Apogee did not reduce the spread of blossom blight infections to adjacent shoots when it was applied post infection. It also did now reduce the incidence of rootstock infection or tree death. There was some evidence that applications of Apogee increased the incidence of rootstock infection.

When Apogee was applied before shoot tip inoculation it did result in less development of blight in the growing shoot despite relatively little effect on shoot length in the year 2000 (Table 6). When shoots were inoculated in June during the grand phase of shoot growth the development of the disease in the control shoots was much greater than when shoots were inoculated in July when shoot growth was slowing down naturally. The protection from Apogee sprays at both timing was significant. Apogee applications also reduced the spread of fire blight to adjacent non-inoculated shoots. Despite the significant protection from shoot blight development, Apogee did not reduce rootstock infection or tree death at the end of the season. This means that growers will need to use fire blight resistant rootstocks like the new resistant rootstocks from Geneva (G.16 or G.30) to prevent tree death and that Apogee should not be considered as a protection against rootstock infection and tree death.

With our 2001 trial there was a curvilinear relationship between the rate of Apogee and shoot growth or with the amount of the shoot infected with fire blight. The highest rate provided only slightly better control of shoot growth or fire blight than the lowest rate. This indicates that with young trees a relatively low rate (3oz/100 gal) is as good as the standard rates of 6 oz/100gal. The high rate of Apogee resulted in 61% shoot length infected compared with 84% in the untreated inoculated control. This modest level of control is less than in other years but must be considered in the context of the severe inoculation pressure in this block and the very susceptible variety we used. It may be that under conditions very favorable to fire blight, the protection of very susceptible varieties will require not only the use Apogee but also proper nutrition and resistant rootstocks.

Based on our work the best strategy for growers to use with young apple trees of the new highly susceptible scion varieties to reduce the risk of fire blight will be to use a multi-pronged integrated control approach. This should include the use of fire blight resistant rootstocks, low nitrogen fertilization, high K fertilization and late season use of Apogee. This approach should give good tree growth and minimize fire blight risk. The mid season applications of Apogee in early July will provide significant fire blight protection from devastating late season shoot blight infections caused by hail storms or wind storms.