Organic tobacco production is a growing segment of the tobacco industry in North Carolina. However, little research has been done on organic methods for controlling tobacco pests. We performed field trials at the Upper Coastal Plain Research Station (UCPRS) in Rocky Mount, NC and the Lower Coastal Plain Research Station (LCPRS) in Kinston, NC to test the efficacy of various organic insecticides against key tobacco pests: tobacco flea beetles (Epitrix hirtipennis), tobacco budworms (Heliothis virescens), green peach aphid (Myzus persicae), and tobacco/tomato hornworms (Manduca sexta/quinquemaculta). As flea beetle populations were not high enough in the field to facilitate treatment, we tested pesticide efficacy against flea beetles in the laboratory on pesticide-treated leaf disks. At UCPRS, tobacco budworm populations were significantly reduced by Dipel (Bt) as compared to the check treatments, but not lowered below the threshold of 5% of plants infested with at least one budworm. At LCPRS, budworm populations were not significantly different in Dipel treated plots than in the untreated control, but Entrust treatments were reduced below threshold. None of the materials tested were effective at lowering green peach aphid populations. For late season hornworm control, Dipel reduced hornworm populations below threshold. These studies provide baseline data about organic pesticide efficacy, and reveal a need for future work on timing of sprays and better integrating cultural and biological control practices with pesticide use in organic tobacco.


Experiments were conducted at the Highland Rim Research & Education Center near Springfield TN in 2011 to 2013 to evaluate the effects of excessive temperatures during fire-curing on TSNAs in dark fire-cured tobacco. Two identical barns were filled with 360 sticks each of PD7318LC dark tobacco each year. Traditional fire-curing methods were used in one barn (“normal barn”) with maximum temperatures not intended to exceed 135 F at any time during fire curing. In the second barn (“hot barn”), fires were built to exceed 160 F during part or much of the cure. In one set of experiments conducted in 2011 and 2012, fires in the hot barn were normal except for those occurring during the leaf drying stage, where temperatures reached 190 F in 2011 and 166 F in 2012. Leaf samples were collected at the end of curing in this first set of experiments. In another set of experiments conducted in 2012 and 2013, high temperature firing was used during much of the cure from the end of yellowing through leaf drying, with temperatures reaching 180 F in 2012 and 172 F in 2013. In this second set of experiments, leaf samples were collected after each firing and corresponded as much as possible to end of yellowing, color setting, leaf drying, finishing, and end of cure (takedown). In the first set of experiments, average total TSNAs from the hot barn were 2.8X higher in 2011 and 2.3X higher
in 2012 than average total TSNAs in the normal barn each year. In the second set of experiments, average total TSNAs from the hot barn were 4.8X higher at the end of yellowing, 5.4X higher after color setting, 11X higher after leaf drying, 7X higher at finishing, and 9.9X higher at takedown than TSNAs from the normal barn in 2012.

Key words: TSNA, fire-curing, excessive heat


Field experiments were conducted at the University of Kentucky Research & Education Center near Princeton KY in 2013 to evaluate the effect of crop maturity and use of burlap during field wilting on TSNA in dark fire-cured tobacco. Trials included Narrowleaf (NL) Madole LC (low converter) and TR Madole HC (high converter). All tobacco was transplanted June 4, 2013 and managed under standard production practices. 100 sticks (50 sticks NL Madole and 50 sticks TR Madole) were harvested at either 4.5 weeks or 9 weeks after topping and fire-cured for 5 weeks. Although barn temperatures were hotter during the early cure, due in large part to much cooler outside temperatures during the late cure, TSNA were higher in the early cure of NL Madole LC (4.83 ppm in early cure vs. 3.56 ppm in late cure). Time of harvest/maturity did not have a significant effect on TSNA in TR Madole HC, although numerical TSNA levels were also slightly higher in the early cure. In a separate experiment at late harvest, NL Madole LC and TR Madole HC were harvested, spiked on sticks, and stacked in piles of 5 sticks each and either covered with burlap for 48 hours or left uncovered to field wilt. Meters were placed within the middle of each covered and uncovered pile to measure temperature and relative humidity every hour within each pile during field wilting. Meters were then removed as tobacco was picked up, housed, and fire-cured similarly to previous experiments. Piles covered with burlap had maximum and average temperatures that were approximately 3 F and 1 F cooler, respectively, than uncovered piles. Use of burlap covering during field wilting did not affect fire-cured TSNA in either variety.

Key words: dark fire-cured tobacco, maturity, field wilting, burlap, TSNA


The objective of this study was to test our recommendation to growers not to cut or house wet tobacco. The design was a split-split plot, with two cutting treatments, (1) cut wet (2) cut dry; four housing treatments, (1) protected indoors on a railwagon, housed dry (2) exposed outdoors but kept dry, housed dry (3) stucked out in the field; exposed to wetting, housed wet (4) stucked out in the field; exposed to wetting, housed dry; and two varieties, high and low converter selections of TN 90. The study was grown in two years; 2011 and 2012. In 2011, the tobacco was set late and consequently, curing conditions were unfavorable and tobacco specific

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nitrosamines (TSNAs) were low, with no significant differences between any of the treatments. In 2012, the tobacco was set early, curing conditions were more favorable, and TSNAs were higher (10-11 ppm for the high converter TN 90 vs. 3-4 ppm in 2011). There were no significant differences between cutting treatments for any of the variables, either for 2012 or for the years combined. Housing treatments had no significant effect on total TSNAs, and small but inconsistent effects on the individual TSNAs. Where there were differences, there were generally higher TSNAs in the sticked out treatments, and the sticked out, housed wet treatments were the highest of all. Total alkaloids were lower in the sticked out treatments, in both varieties. We speculate that this is because some of the alkaloids on the leaf surface were dissolved off by rain or fog. There were small but inconsistent differences in nitrate and nitrite, with a general trend towards lower nitrate and higher nitrite in the sticked out treatments. Cutting and housing wet tobacco appears to have less effect on TSNAs than anticipated, but more data are needed to determine the trend. (Reprinted with permission)

Key terms: tobacco specific nitrosamines (TSNAs), cutting, harvesting, housing

13. Richmond, M.D., W.A. Bailey, and R.C. Pearce. Preliminary evaluation of curing environment and TSNA accumulation within dark air-cured tobacco. Paper presented at the 46th Tobacco Workers’ Conference, 2014. 1205 Hopkinsville Street, University of Kentucky Research & Education Center, Princeton, KY USA. Email: mitchell.richmond@uky.edu

Significant variability in cured leaf TSNA content is commonly observed when sampling within dark air-curing barns. This variability may be due to inconsistency in the curing environment within different areas of the barn. A graduate student study was initiated in 2012 through support from a CORESTA Study Grant to evaluate if leaf TSNA content is related to microenvironmental conditions in the barn. Low converter (LC) and high converter (HC) selections of TR Madole dark tobacco were cured in barns near Princeton and Lexington, Kentucky. Temperature and relative humidity were measured at 27 locations within each barn for the entire cure. TSNA content was determined for 20 leaves housed in each location within the barn. During the initial 2012-2013 curing season, average TSNA accumulation across each barn and selection was nearly twice as high at Lexington compared to Princeton (3.61 µg/g at Lexington and 1.88 µg/g at Princeton). Within TR Madole LC, average TSNA content was 0.39 µg/g at both locations, but TSNA within TR Madole HC was 6.82 µg/g at Lexington and 3.37 µg/g at Princeton. Within TR Madole HC at Lexington, TSNA content averaged 5.86 µg/g in the top tier, 7.19 µg/g in the middle tier, and 7.41 µg/g in the bottom tier. Within TR Madole HC at Princeton, TSNA content averaged 4.40 µg/g in the top tier, 2.92 µg/g in the middle tier, 2.80 µg/g in the bottom tier. Differences in average TSNA between Lexington and Princeton is likely associated with the average number of hours during the cure that exceeded 80% relative humidity, which was 407 hours at Lexington and 131 hours at Princeton. Correlation between TSNA and relative humidity between individual locations within each barn will be discussed.

Key terms: TSNA, Dark Air-cured Tobacco
20. Rhodes, G.N., Jr. and T.D. Israel. **Educational efforts to reduce the impact of off-target herbicides in tobacco and other high value crops.** Paper presented at the 46th Tobacco Workers Conference, 2014. The University of Tennessee, 2431 Joe Johnson Drive, Knoxville, TN 37996 USA. Email: nrhodes@utk.edu.

Each year we continue to experience off-target movement of agricultural chemicals, particularly pasture and right-of-way herbicides, to fields of tobacco and other high value crops. While these herbicides are valuable tools for weed management, off-target damage can result in lost productivity for growers, expensive fines and/or lawsuits, and bad publicity for the industry. In order to support the sustainable production of tobacco and other high value crops and continued availability of these herbicides, programs are needed to promote proper stewardship. In 2011, we began a comprehensive educational program that stresses the importance of proper stewardship with the use of pasture and right-of-way herbicides. The program has two fundamental goals: to help reduce the occurrence and impact of off-target damage to tobacco and other sensitive, high value crops; and to help with the diagnosis of suspected cases of off-target damage. The initial work began with tobacco and later expanded to include cotton, tomato and grape. Funding was obtained via grants from Philip Morris International, Altria Client Services, Dow AgroSciences and DuPont Crop Protection. Herbicides we are addressing include 2,4-D, dicamba, aminopyralid, aminocyclopyrachlor and picloram. Plants of each crop were grown in a greenhouse, and then they were treated foliarly with low rates of each herbicide to induce symptoms. Treated (and untreated) plants were photographed at various times following treatment to produce a library of still images for use as diagnostic aids. Also, time-lapse photography was used to create videos for each crop and herbicide combination to show the development of symptomology over a 14 day period. At the center of this effort is the program website, herbicidestewardship.utk.edu. At this website, visitors can find the still images, time lapse videos and fact sheets, and other useful information. (Reprinted with permission)

Key terms: herbicide stewardship, crop injury symptoms.


Topping of burley tobacco improves leaf yield and quality characteristics. Manual topping of burley tobacco requires approximately 17 worker hours per hectare. The use of growth regulators to chemically “top” burley tobacco has been reported to have some potential. Previous studies found that chemical topping was most effective when the growth regulator was applied prior to bud elongation. With conventional burley varieties this often resulted in significant yield losses, but chemical topping appeared to be feasible with non-flowering burley types. Recently released burley varieties have later maturity and higher leaf numbers making them potentially better suited to chemical topping. In this study burley variety KT-210 was grown and chemically topped with systemic and local systemic growth regulators. All chemical topping treatments were applied at early button stage and were found to be effective for arresting the development of the flower. Sucker control was similar to manually topped tobacco sprayed with a combination of systemic and local systemic growth regulators. The yield of the chemically topped tobacco was not significantly different from the yield of manually topped. Tobacco
buying interests tended to grade a higher proportion of the lead from chemically topped plant into a tip grade, thought there was a slight tendency for the upper stalk leaf to receive a lower quality mark. The results of this test suggest that chemical topping of newer burley varieties may be feasible, but additional work is need to confirm these results.


The burley tobacco hybrids KT 209LC and KT 210LC are considered to be late maturing because they flower 10-14 days later than the older varieties, but they also have a higher leaf potential (HLP), producing six to ten more leaves. Currently, growers are recommended to top their crop when 10 - 25% plants are in flower, leaving 22 to 24 leaves and the uppermost leaf six to eight inches long. If growers attempt to follow this recommendation for these newer varieties, they will either remove up to six expanded leaves and therefore reduce yield potential, or, if only the flower plus one or two leaves are removed, more than 24 leaves will remain on the plant with the consequence of longer stalks that are difficult to handle, more leaves that increase stripping costs, and cutting and curing delayed by 7 – 14 days. A third possibility is to top these HLP varieties earlier, when leaves 22 – 24 are six to eight inches long. To test this latter approach, two HLP hybrids, KT 206LC and KT 210LC, were topped on the same day and to the same number of leaves as two low leaf potential varieties, KY 14 x L8 and KT 212LC. In another treatment, only the flag leaf plus one or two leaves were removed when 25% of the HLP varieties were in flower. All treatments were harvested 28 days after topping. There was no difference in yield between the early low-topped and the later topped HLP hybrids, although the early topped had a lower proportion of tip grades because they had six fewer leaves. These data suggests that these HLP varieties could be chemically topped without any adverse yield effects, the shorter stalks would be much easier to handle, and sucker control would be improved. (Reprinted with permission)

Key terms: yield potential, leaf potential


Individual agronomic management effects on burley tobacco air-cured leaf yield and chemistry have been well studied. However, the basic and common mechanism of these agronomic management’s effects, such as N fertilization rate, cropping and tillage style, is still not clear. Long term study of tillage and rotation management practices in burley tobacco production was established in a Bluegrass-Maury silt loam soil (fine, mixed, active, mesic Typic Paleudalf) at central Kentucky since 2007. In 2012, when every plot all entered into tobacco sequence, three N fertilization rates were applied in split plot, including 0,125 and 250 lbs N/acre. In-situ resin-core method was involved to check soil available N supply, and air-cured leaf yield, TSNAs, Nicotine and other leaf chemicals content were analyzed as well. Our result showed that those yield and leaf chemistry parameters were significantly correlated with soil available N supply. Therefore, our conclusion suggests that agronomic management might affect burley tobacco air-cured leaf
yield and chemistry by changing soil available N supply during the growth period. (Reprinted with permission)

Key terms: soil available N, mechanism, burley tobacco, yield, leaf chemistry.


Non-invasive, rapid methods based on portable sensors can simplify some everyday tasks of tobacco growers, such as irrigation and harvest schedules, provided a previous, careful calibration phase has been carried out. After 3-yrs tests at Fattoria Autonoma Tabacchi of Città di Castello (FAT) Italy, results indicated that Infra-red thermometer (IRT) measurements of leaves in full sun, carried out at noon, are in good correlation with tensiometers, and can be used to determine best time for irrigation, on a field basis. This technique is relatively inexpensive, easy, user’s friendly for growers, and avoids empiricism in the irrigation technique, therefore leading to a better water use efficiency. IRT permits to determine also the best time to begin treatments both in case of sprinkler and micro-irrigation. To investigate tobacco maturation, a fluorescence-based sensor, Multiplex, was used in the present study. This sensor, already used in grapes and fruit crops to assess phenolic maturity, represents a rapid and non-invasive tool to test flavonols and nicotine derivatives in fresh and cured tobacco leaves. The activity carried out in 2012-2013 on Virginia Bright and Kentucky tobacco crops at FAT and OPTA-Città di Castello compared Multiplex field measurements and HPLC/DAD/MS analyses of the hydroalcoholic extracts of the same tobacco leaves, both in different varieties and experiments, to investigate maturation progress, in order to calibrate Multiplex results. On our knowledge, this is the first time this equipment has been used on tobacco to not-destructively investigate maturation and leaf composition. (Reprinted with permission).

Key words: Portable sensors, Infra-red thermometer, Fluorescence-based sensor, Multiplex


Extended periods of drought are not uncommon in the flue-cured tobacco production area of South Carolina during the growing season. Timely application of sufficient volumes of water during critical phases of crop development can have a dramatic impact on tobacco leaf chemistry, quality, and yield. Given the available ground water supply of this area and the appealing rate of return on the cost of investing in center pivot irrigation equipment, many producers have increased their acreage under irrigation. While this irrigated land is most commonly used to produce more drought sensitive crops, tobacco still remains a viable crop to consider in a rotation on irrigated land. We conducted a study at the Pee Dee Research and Education Center in Florence, SC to assess flue-cure tobacco production under center pivot irrigation at various irrigation regimes and nitrogen fertility rates. Measurements were taken for soil volumetric
water content and soil temperature at depths of 0.5, 1, 1.5, and 2’ and for leaf chlorophyll content, leaf light reflectance, leaf chemistry, yield, relative value, and quality index. Irrigated zones were set to have 0.5” or 1” of water applied upon soil volumetric water content falling below 10 percent at a depth of 12” in the zones set for 1” of irrigation. Excessive rain in the 2013 growing season prohibited us from applying any irrigation. Various nitrogen rates were applied in the form of calcium nitrate 18 days after transplanting at 65, 75, 85, and 95 lbs of nitrogen per acre. Yields were 2,377, 2,335, 2,503, and 2,474 lbs of cured leaf per acre for the aforementioned nitrogen rates respectively but were not statistical different. Quality index was 75, 81, 79, and 79 for the 65, 75, 85, and 95 lbs nitrogen rates respectively with significant statistical difference (p = 0.05) observed between the 65 and 75 lbs rates. The longstanding recommended nitrogen fertility rate for the region of 75 lbs of nitrogen resulted in the highest average for quality index among those tested in this study.

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Key words: Irrigation, nitrogen


Effective management of black shank, caused by *Phytophthora nicotianae*, requires a basic understanding of the pathogen and disease cycle. Traditional depictions of the black shank disease cycle are static and targeted to a limited audience. We wanted to enhance the information available and the understanding of the disease, particularly by online users. We created a website (http://go.ncsu.edu/blackshank) and interactive disease cycle to provide a more dynamic and engaging way for users to learn about black shank. These resources include multimedia elements such as images and videos of the pathogen and disease symptoms. Content on the website is organized in an easy to use format, and a glossary tool is included to explain plant pathology terminology. A main feature on the website is an interactive guide to the black shank disease cycle. This tool, which requires Adobe Flash, is easily navigated using clickable elements on the screen. Information on each stage in the cycle is presented in slides that include text, images, and/or videos. Time-lapse, real time, and animation videos demonstrate the dynamic nature of disease and help to explain concepts that are difficult to visualize. Our multimedia resources can be used in a variety of educational scenarios including classroom instruction and training workshops. (Reprinted with permission)

Key terms: black shank, multimedia, education, website


Black shank, caused by the soilborne oomycete *Phytophthora nicotianae*, is an important disease of tobacco in most tobacco growing regions around the world. Several disease management
strategies are available for disease control, but they often place selection pressure on the pathogen population. *Phytophthora nicotianae* has a high level of genotypic diversity that allows the population to quickly adapt to changes in the host and environment. In this study, the level of genetic diversity and geographic patterns associated with genotype distribution were determined for a *P. nicotianae* population in tobacco growing regions of NC, KY, VA, and GA. A total of 453 isolates were collected from infested tobacco fields in the four states sampled. Five genes, ITS46, beta-tubulin (BT), elongation factor (EF), NADH, and COXII, were sequenced in each isolate and used to find single nucleotide polymorphisms (SNPs) among individuals. The greatest numbers of SNPs were found in the COXII region for isolates from NC and VA, and in the EF region for KY and GA isolates. Genotypic variability was high, with multiple genotypes recovered in each state. Some genotypes were found in multiple states. The level of detected genetic variation was the highest in GA with one new clade for every 10 isolates, followed by VA with one new clade for every 14 isolates, and in KY with a new clade for every 22 isolates. The high level of diversity found among isolates helps the pathogen population quickly shift to adapt to changes in their environment like the deployment of resistant hosts. Determining the level of genetic variability in the pathogen population and how distinct genotypes are distributed can assist in making management decisions in the future.


Black shank, caused by the soil-borne pathogen *Phytophthora nicotianae*, is one of the most devastating diseases in many tobacco-growing areas worldwide. Host resistance is considered as an efficient, economic and environmental friendly means of combating this disease. A random amplified polymorphic DNA (RAPD) marker was identified to be closely linked with the gene of interest in 2002 by Johnson et al. We converted the RAPD marker to a sequence characterized amplified region (SCAR) marker BSSCAR1 which is more user friendly. The burley tobacco TKF2002 showed high resistance to race 0 black shank. To localize the race 0 resistance of black shank, a F₂ segregating population was derived from the cross between TKF2002 and the susceptible parent TKF4321. More than 480 simple sequence repeat (SSR) marker were used (about 20 SSR evenly distributed on each chromosome) to screen the parents TKF2002 and TKF4321. A genetic map was constructed and the race 0 black shank resistance in TKF2002 was localized on the chromosome 20. This is the first genetic map of black shank resistance in burley tobacco. A repulsion-phased marker PT52961 was detected to be closely linked with the gene of interest. Combining with the coupling-phased marker BSSCAR1, the heterozygotes and homozygotes can be easily distinguished. This results will highly facilitate the selection of black shank resistance in tobacco breeding programs.

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Key terms: black shank, resistance, marker, breeding.

Three tobacco cultivars having different sources of resistance to *Phytophthora nicotianae*, NC 71, SP 225, and K 326 were untreated or treated with Ridomil Gold (1 pt/A X3), Zorvec (QUG 42) (19.2 oz/A X3), or Persidio (4 oz/A X3) in a Tobacco Black Shank Nursery. NC 71 has php gene for resistance to Race 0; SP 225 has php gene for resistance to Race 0 and multigenic FL 301 resistance to both Race 0 and Race 1; and K 326 has only low resistance to Race 0 and Race 1. Test materials were applied at plant, 1st cultivation and layby. Plots were evaluated for vigor, growth, disease incidence and yield. Vigor ratings and height measurements made during the season indicate no phytotoxicity with the rates and application timing of the fungicides. All of the chemical applications reduced disease when compared to the untreated cultivars. NC 71, K 326, and SP 225 had 51%, 68%, and 41% disease in the non-treated check. NC 71 had 14%, 7%, and 26% disease with Ridomil Gold, Zorvec and Presidio, respectively. K 326 had 29%, 33%, and 33% disease with Ridomil Gold, Zorvec, and Presidio respectively. SP 225 had 20%, 2%, and 6% disease with Ridomil Gold, Zorvec, and Presidio respectively. We suggest that some cultivar/fungicide combinations may be better than others to manage tobacco black shank. The availability of new fungicides with different chemistry and cultivars with different sources of resistance will provide growers with better management strategies for black shank. (Reprinted with permission)

Key terms: resistance, fungicides, *Phytophthora nicotianae*


Presidio is a new fungicide being developed by Valent U.S.A. Corporation for control of black shank (*Phytophthora nicotianae*) and blue mold (*Peronospora tabacina*) in tobacco. Presidio (fluopicolide) belongs to the chemical group pyridinylmethyl-benzamides with a mode of action code of B5 and a Fungicide Resistance Action Committee (FRAC) Code of 43 (sole member). Presidio is systemic when soil applied and locally systemic when foliar applied. Use rate for black shank and blue mold control will be 0.125 lb ai/A. Presidio can be applied in the transplant water, at first cultivation, or at layby for black shank control. A maximum of two applications can be made, but back-to-back applications are restricted. Presidio can be applied via ground or aerial application for blue mold control. A maximum of two applications can be made with a minimum interval of seven days between applications. For blue mold control, Presidio must be tank mixed with a labeled rate of another fungicide, with a different mode of action that is active on the target pathogen. No tank mix partner is required for black shank control. No tobacco injury has been observed in any university trial to date when Presidio at 0.125 or 0.250 lb ai/A was applied in the transplant water, at first cultivation, and/or at layby or when applied at 0.125 lb ai/A foliar. In university trials, Presidio gave black shank control that was equal to Ridomil
Gold. Presidio gave blue mold control that equal to Quadris. Valent anticipates a tobacco registration for Presidio in April 2015. (Reprinted with permission)

Key words: Presidio, fluopicolide, black shank, blue mold, *Phytophthora nicotianae*, *Peronospora tabacina*


The objective of this study was to assess the relative efficiency of a prototype solar flue-curing barn that utilizes heat collected in a plenum around the outer metal wall of the barn to preheat the air going into the barn and burner. Part of this assessment entailed creating a thermodynamic profile of the barn during the curing process to determine temperature uniformity throughout the barn. Ambient outdoor temperature and weather conditions were recorded. The goal was to better understand the prototype barn system as a whole. Prior work conducted at Blackstone, VA over a three year period with identical prototype barns indicated the solar barn required less fuel for heating, averaging 12.25 lbs of cured leaf per gallon of liquid propane compared to conventional barns of similar make which averaged 10.66 lbs of cured lead per gallon of liquid propane. The solar assisted barn shortened the overall curing time over similar standard barns. Preliminary work conducted at Florence, SC over a three year period resulted in averages of 10.56 and 12.16 lbs of cured leaf per gallon of liquid propane for the prototype and standard barns respectively but was deemed inconclusive due to fresh air intrusion that hindered the prototype barn from reaching and maintaining the maximum temperature range required in the latter stage of the curing process. Average electrical consumption per cure at the Florence location during the study period was 1719 and 1604 kW for the prototype and standard barns respectively. Further work is planned in Florence to modify the air inflow system to reduce the infiltration of unheated air.

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Key words: Solar curing, alternate energy source


The objective of this study was to compare the efficiency of Bulk-Tobac tobacco curing systems in South Carolina. Studies were conducted on different barn types at two locations over two years. At location 1, three DeCloet barns were used for comparison; while at location 2, two Long barns were used. At location 1, Bulk-Tobac heat exchangers and burners were located in Bulk-Tobac barns, while at location 2 the Bulk-Tobac heat exchangers and burners were located in the Long barns. All barns were equipped with automatic damper controls and a gas meter. The Bulk-Tobac barns required AL 425-25 meters, while the check barns needed an AL-
425-10 meter to measure propane usage. There were 2-10 cures of tobacco in each barn at location 1, while there were 5 cures in each barn at location 2. All barns were uniformly loaded with similar tobaccos. At location 2 all barns were eight box barns, while at location 1 the Bulk-Tobac barns had 10 DeCloet boxes while the DeCloets had 10-12 boxes. Comparisons were made on fuel usage and pounds cured leaf per gallon of fuel used. At location 1 propane usage was 350 gallons per cure for the Bulk-Tobac barns compared to 333 gallons for the DeCloet barns. Cured leaf per gallon of propane was 7.23 lbs per gallon for the Bulk-Tobac barns compared to 8.18 for the DeCloet barns. At location 2 the Bulk-Tobac’s proved superior to the Long barnes with a fuel usage of 194 gallons per cure and a curing efficiency of 16.6 lbs per gallon compared to 280 gallons of propane and a curing efficiency of 11.4 lbs per gallon of fuel used for the check barns. In summary it appears that the Bulk-Tobac system performs satisfactorily.

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Key terms: curing efficiency, Bulk-Tobac curing systems, fuel savings, cured leaf/fuel volume.


Two heating systems were investigated to evaluate the potential curing costs savings with the additional benefit of minimizing tobacco-specific nitrosamines (TSNA) levels in the cured leaf. One system utilized a woodchip fired hot water system to generate heat for the curing process. The boiler is centrally located and hot water was circulated to the curing barns. Utilization of a woodchip fired hot water system reduces curing cost by utilizing a lower cost fuel than LP gas and it removes all combustion products from the barn. Thermal energy cost for curing was approximately $0.02 to $0.04 per pound of cured leaf based on woodchip prices ranging $25 to $30 per ton. The high initial cost is prohibitive for some growers and the pay-back period can be reduced if the system is utilized for more applications throughout the year. The second system utilized a variable firing rate gas burner to reduce thermal cycling and potentially extend the life of the heat exchanger. Thermal cycling of the indirect-fired heat exchangers causes material fatigue which results in cracks allowing combustion gases to enter the curing environment. Typical burner duty cycles range approximately 4 minutes on and 1 1/2 minutes off during leaf drying, which is the point in the curing process that requires the most heat. The variable firing rate (VFR) burner can automatically adjust the heat output based on the barn thermal load. As a result, the burner operates continuously during parts of the curing process and minimizes thermal cycling. The number of cycles can be reduced from 7% to 72% with a VFR burner compared to a conventional burner. Fuel savings varied from location, but the thermal cycling was reduced at all locations.

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Key terms: variable firing rate, heat exchanger, woodchips, biomass, thermal cycling, TSNA

The energy performance of three different make of new curing barns (Long, World Tobacco, and Tytun) was evaluated during the 2013 season at the same on-farm location. Instrumentation was implemented to monitor the total energy consumption each cure for the new barns and two existing barns for comparisons. All barns were loaded the same day with similar quality and quantity of tobacco. Automatic ventilation control was also utilized on all the barns. Averaged over 8 cures, the fuel efficiency was 15.35, 14.94, and 17.26 pounds of cured leaf per gallon of LP gas (lb/gal) for the World Tobacco, Long, and Tytun barn, respectively. The existing Long and DeCloet barns averaged 13.25 lb/gal and 12.64 lb/gal, respectively. Based on the seasonal average fuel consumption the costs savings between the three new barns ranged 0.3¢ to 1.0¢ per pound cured leaf. Comparing the new barns with the existing barn of similar capacity resulted in a cost savings ranging 1¢ to 2¢ per pound cured leaf. This savings is based on $1.10 per gallon of LP gas, but as fuel prices increase the savings will also increase. The average length of cure was 181, 172, and 156 hours for the three new barns compared to 206 hours and 184 hours for the two existing barns. Minimum differences, if any, were observed in the cured leaf quality from any of the new barns. The independent energy performance assessment is valuable information to all growers making decisions on curing infrastructure changes. Additionally, the information can help manufacturers with developing and implementing innovative changes to improve overall barn performance.

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Key terms: curing, energy, efficiency, barns.


Numerous widely adopted mechanization developments and practices adopted since the 1970’s reduced the manual labor requirements for producing burley tobacco by approximately half for efficient producers, from over 300 to close to 150 worker*hours/acre, depending on practices used. These major developments include the adoption of small-bale packaging, the transition from plant beds to float bed systems, use of field curing structures, the use of stripping aids, and the adoption of big-bale packaging. Other labor-reducing developments that occurred during that time period that were proven in effectiveness but not widely adopted for various reasons include two-tier height economy barns, mechanical topping, cable hoist housing systems, no-till transplanting, and various different mechanical harvesting systems. An analysis of labor requirement and cost data from cited references shows the labor reductions for the various mechanization developments along with the savings or added costs per pound of tobacco based on a standard yield and prevailing wage rates and equipment and facilities costs at the time of the development. Most of the widely adopted mechanization developments resulted in savings to the
producer. Of the developments that were not widely adopted, whether or not there was savings or additional costs depended in some cases on whether or not the cost of traditional housing facilities was considered. Most mechanical harvesting developments resulted in added cost, in some case substantially higher. Up-to-date labor rates and mechanization costs are needed for the various operations and methods currently used for burley tobacco production. It is hoped that the results of this analysis, as well as from analyses based on updated data, can be useful to producers, researchers, and the industry in evaluating current practices and future mechanization efforts to help reduce labor requirements and improve profitability.

Key terms: burley, mechanization, labor, costs


Field experiments were conducted at the West Farm of Murray State University near Murray, KY in 2012 and 2013 to evaluate dark-fired tobacco response to potassium application rate and timing. Soil test K indexes were in the low range both years, and K$_2$O recommendations were 290 lbs K$_2$O/A in 2012 and 260 lbs K$_2$O/A in 2013. In addition to these recommended K$_2$O rates, treatments included 50% of the recommendation (145 lbs K$_2$O/A in 2012 and 130 lbs K$_2$O/A in 2013) and 150% of the recommendation (435 lbs K$_2$O/A in 2012 and 390 lbs K$_2$O/A in 2013). Each of these three rates were applied either broadcast 1 day prior to transplanting or band-applied (2 bands per row) 7 days after transplanting. A control that received no K$_2$O was included in each year. Mild potassium deficiencies that were more pronounced in the dry 2012 season were seen for several weeks in the control plots but no differences were observed were potassium was applied. Although not statistically significant, small trends were seen for increased yield and increased quality grade index as potassium rate increased for either application timing in 2012. These trends were not seen during the excessively wet 2013 season.

Key words: dark fire-cured tobacco, potassium


The incidences of suspected cases of Boron (B) deficiency have increased recently in Kentucky tobacco fields, potentially due to changes in management practices. The symptoms observed in the field include; hollow stalk, stunted growth, deformed bud formation or no bud formation, small slits on the underside of the leaf midrib and uncontrollable breaking of the midrib approximately two inches from the stalk. B is a micronutrient tobacco needs in minute amounts; as result there are concerns that the addition of B could cause toxicity. Solution cultures and field trials aided in researching two objectives 1) establish critical points for B sufficiency, 2) develop field strategies to aid in the mitigation of B deficiency. A response to the addition of B has been observed in solution culture, but critical points have not been established. Limitations including algae contamination in solution, trace-levels of B in reagents and matrix effects in analytical
methods have limited early trials. Field trials, at four locations in 2013, yielded no deficiency symptoms. However, toxicity was observed when the addition of .50lb B/A was applied via transplant water treatment. It is recommended that additions of B should be made with caution. Further research is required to understand B deficiency in burley and dark tobacco.


Doubled haploid is a plant breeding method used to hasten the process of production of homozygous lines from heterozygous parents. The great advantage in using this method is the time saving in the breeding process. The two ways to produce doubled haploids used in this study was the anther derived haploids (ADH) and maternally derived haploids (MDH). The objective of this research was to evaluate the most efficient method in developing doubled haploids in burley tobacco, regard to the agronomic performance of doubled haploids. Ten lines of ADH and 10 lines of MDH were produced and the agronomic performance of each method was compared with the inbred source cultivar TN 90LC. The experiment was carried out in 3 locations during the growing season of 2013 using split plot design. The variables evaluated were: plant height at 50 days after transplanting, plant height after topping, leaf length, leaf width, number of leaves per plant and yield. For plant height 50 days after transplanting, the ADH lines were shorter than inbred lines and MDH taller than inbred at 0.10 level of significance. For plant height after topping, the same trend appeared. Leaf length was not different among the 3 methods. The inbred line had wider leaves than both ADH and MDH methods. There was no difference in number of leaves per plant between the inbred line and the doubled haploids. Yield (in kilograms per hectare) of ADH lines was significant lower than the yield of inbred line; the yield of the MDH method did not differed statistically from the inbred lines. (Reprinted with permission)

Key terms: breeding, efficiency, agronomic performance


The main objectives of a tobacco breeding program are to continually improve yield and disease resistance while maintaining or enhancing leaf quality. The availability of genetic variation affects our ability to do this, and can enhance opportunities for success. Diploid progenitor species of Nicotiana tabacum could be a source of desirable genetic variability. Direct hybrids between flue-cured tobacco and diploid relatives will never be commercially viable, however, due to low cured leaf quality. A number of pathways exist for transferring genetic material from the diploid relatives to cultivated tobacco. One method is the creation of synthetic tobaccos followed by direct hybridization with Nicotiana tabacum. We investigated the possibilities of transferring favorable alleles influencing growth rate from synthetic tobacco to cultivated tobacco. Growth rate is of special interest to develop faster growing and higher yielding cultivars.
We also estimated the realized heritability for growth rate on an individual F2 plant basis, and investigated the possibility of recombination on all chromosomes in one population derived from a synthetic tobacco x natural tobacco cross. To estimate heritability of growth rate, we first space planted approximately 288 F2 plants along with neighboring parental lines, and then selected the top and bottom 5% of that population based on an adjustment for growth rate using nearest parent correction. The following year, the selected F2:3 families were evaluated in replicated testing at three locations. Realized heritability for growth rate on an individual plant basis was calculated to be $h^2 = 0.14$. This is low, but growth rate is a complex trait and these were individual F2 plants. To investigate relative rates of recombination we genotyped the entire F2 population. Relative to a $N. tabacum \times N. tabacum$ cross, we observed smaller recombination distances, shorter pairwise distances, and a reduced overall map length for the $N. tabacum \times$ synthetic tobacco cross. This could influence the potential for successful gene introgression from the diploid relatives to flue-cured tobacco. (Reprinted with permission)

Key terms: synthetic tobacco, recombination, realized heritability, growth rate.

57. Lewis, R.S., K.E. Drake, and D.P. Eickholt; Accelerated inbreeding in tobacco with selection for black shank resistance. Paper presented at the 46th Tobacco Workers’ Conference, 2014. Campus Box 7620, Crop Science Department, North Carolina State University, Raleigh, NC 27695. Email: ramsey_lewis@ncsu.edu.

Rapid inbreeding is advantageous for reducing the duration necessary to complete a breeding cycle and for increasing the amount genetic gain per year. Constitutive expression of the Arabidopsis gene FLOWERING LOCUS T ($FT$) has been shown to reduce generation time in tobacco and other crop plants. In this research, we investigated the utility of a modified single seed descent (SSD) breeding method where transgenic expression of $35S:FT$ was used to reduce generation time during inbreeding. $35S:FT$ was maintained in hemizygous condition during inbreeding and null segregants were isolated in the F4:5 generation to create non-transgenic F5:6 lines that were produced in nearly half the time that would have been required using conventional SSD. Opportunities for selection among $35S:FT$ plants during inbreeding were demonstrated by selecting for quantitative levels of resistance to black shank. Sets of lines derived from the selection process showed significantly greater levels of resistance as compared to random lines, and produced higher frequencies of highly resistant genotypes. The system was extended to rapidly transfer polygenic black shank resistance into the genetic background of TN 90SRC. In limited testing, derived BC3F4 families exhibited higher levels of resistance than TN 90SRC, TN 90LC, KT 206LC, and KT 209LC.

Key terms: Black shank resistance, plant breeding, flowering time

Black shank is usually the most important disease affecting tobacco production in the U.S. Genetic variability is needed that can affect resistance to multiple races of the black shank pathogen and that can be combined into cultivars that also provide high yields of cured leaf with acceptable quality. We had previously identified molecular markers associated with an introgressed N. rustica genomic region (designated as Wz) found to contribute to resistance to multiple isolates of the black shank pathogen. Research described here focused on use of DNA markers to transfer Wz into the elite genetic background of flue-cured tobacco cultivar ‘K326’ and to develop nearly isogenic lines and hybrids with and without the race 0 immunity gene Php. Derived materials were evaluated in multiple environments for black shank resistance, yield, and quality characteristics. Wz was observed to positively affect resistance in all disease environments tested. Genotypes in which Wz was combined with Php exhibited the highest levels of resistance. Evidence of a negative relationship with yield and/or quality was not observed. Data suggest commercial value for Wz in tobacco breeding programs with the goal of developing high-yielding tobacco cultivars with resistance to multiple races of the black shank pathogen. Further investigations are necessary to determine the durability of Wz-mediated resistance, however.

Key terms: Black shank resistance, plant breeding, flue-cured tobacco

66. Taylor, S.V. and C.E. Sorenson. Systemic imidacloprid and its effect on tobacco budworm parasitism in flue-cured tobacco. Paper presented at 45th Tobacco Workers’ Conference, 2014. Department of Entomology, North Carolina State University, Campus Box 7613, Raleigh, NC 27695-7613. Email: svtaylor@ncsu.edu

This presentation summarizes the work to date on a study that examines how the rate of tobacco budworm infestations and parasitism are affected by the use of systemic imidacloprid in flue-cured tobacco. The toxocological affects of imidacloprid to two hymenopteran parasitoid species and the potential for developmental exposure of the parasitoid to imidacloprid sequestered inside the host are discussed.

68. Reay-Jones, F.P.F., B.A. Fortnum, and D.T. Gooden. Management of Tobacco Budworm and Tobacco Hornworm in Tobacco in South Carolina. Paper presented at 45th Tobacco Workers’ Conference, 2014. Clemson University, Pee Dee Research and Education Center, 2200 Pocket Road, Florence, SC 29506 USA. Email: freayjo@clemson.edu

Tobacco budworm (TBW), Heliothis virescens F. (Lepidoptera: Noctuidae), and tobacco hornworm (THW), Manduca sexta L. (Lepidoptera: Sphingidae), are consistent pests of tobacco in South Carolina. Trials were conducted at the Pee Dee Research and Education Center in Florence, SC, to evaluate transplant water and foliar applications of insecticide for TBW and THW control. Tests included untreated and treated tobacco with transplant water applications of chlorantraniliprole and cyantraniliprole, and foliar applications of chlorantraniliprole, flubendiamide, spinosad, chlorantraniliprole + lambda-cyhalothrin, emamectin benzoate, and a Bt insecticide. After transplant, 10 plants per plot were randomly selected and examined on every leaf weekly for live TBW or THW larvae; insecticides were applied at the 10% live larvae threshold. In 2012, transplant water applications of chlorantraniliprole and cyantraniliprole
not prevent infestations from reaching the threshold at 6 weeks after transplant, which was the same date as the untreated control; however, TBW or THW larval densities were generally greater in untreated tobacco. In 2013, infestations of TBW or THW larvae did not reach threshold for 10 weeks after transplant in plots with transplant water applications of chlorantraniliprole (5 oz/ac), compared to three weeks in the untreated control. Seasonal control of TBW or THW larvae was achieved with the higher rate of chlorantraniliprole (7 oz/ac) in transplant water. Foliar applications of chlorantraniliprole, chlorantraniliprole + lambda-cyhalothrin, and flubendiamide showed longer residual activity than spinosad, emamectin benzoate and a Bt insecticide. (Reprinted with permission)

Keywords: chlorantraniliprole, cyantraniliprole, flubendiamide

70. Chappell, T.M., H.J. Burrack, and G.G. Kennedy. TSWV Incidence in Tobacco is Influenced by Weather over Multiple Years Due to Effects on Thrips and Abundance of Virus Sources. Paper presented at 46th Tobacco Workers’ Conference, 2014. Department of Entomology, North Carolina State University, Campus Box 7613, Raleigh, NC 27695-7613. Email: tmchappe@ncsu.edu

Study of TSWV in tobacco shows that weather a year in advance of cropping has an effect on disease incidence. This effect is apparently due to the dependence of TSWV incidence on the presence of virus in the landscape leading to the time of cropping. We present TSWV incidence data to show that abrupt decreases in incidence between years are observed, but abrupt increases of the same magnitude are not. This is consistent with the finding that TSWV incidence in tobacco is part of a multi-year cycle, requiring multiple conditions for high incidence. It also suggests that build-up of these conditions over the year prior to cropping is required for high incidence, but no such build-up is required for an abrupt decrease in disease incidence to occur. Details of these conditions, their dependence on weather, and implications for risk forecasting will be presented.

73. Fortnum, B.A. and P.D. Peterson. Harvester modification to reduce mechanical transmission of R. solanacearum. Paper presented at 46th Tobacco Workers’ Conference, 2014. Clemson University, Department of Entomology Soils and Plant Sciences, Pee Dee Research and Education Center, Florence, SC. Email: bfrtnm@clemson.edu

Mechanization both in leaf (multipass harvester) and flower (topping) removal has contributed to the spread and severity of bacterial wilt in North and South Carolina. When a mechanical harvester removes an infected leaf the bacterium can contaminate defoliators, gleaners and leaf guides. The contaminated harvester components can then move the bacterium to adjacent healthy plants, increasing the severity of disease. The objectives of the present trial were to evaluate a modified harvester designed for the ability to reduce stem injury and transmission of the bacterium to healthy stem or leaf scars and to evaluate the application of C10 fatty alcohol to defoliators, gleaners and leaf guides for suppression of transmission of the bacterium. Stationary rubber leaf guides on the multi-pass harvester were replaced with a continuous rubber belt that moved with the stem as the harvester moved down the row. Tobacco stalks contained less stem bruising and reduced mechanical transmission and infection of stalk tissues when a continuous belt replaced stationary leaf guides in both years of the study ($P = 0.05$). The use of C10 fatty
alcohol disinfectants applied to defoliators, gleaners and leaf guides during the harvesting process significantly reduced the transmission of *R. solanacearum* in both years of the study (*P* = 0.05).

Key terms: Bacterial wilt, mechanization


Bacterial wilt disease caused by *Ralstonia solanacearum* is a major limiting factor in the successful production of flue-cured tobacco in the southeast U.S.A. Mechanical transmission of the bacterium during flower and leaf removal plays a significant role in the spread and severity of bacterial wilt and also occurs when maleic hydrazide (MH) is applied to arrest axillary shoot growth. Previous studies indicate MH can suppress the severity of bacterial wilt based on application timing. The present field studies evaluated the effect of MH rates and application methods on *R. solanacearum* establishment and disease development following mechanical transmission of the bacterium during harvesting. Plants (K346) were grown under standard agronomic practices. Plots consisted of rows 15.2 m long with a 1.2m row spacing. Experimental design was a randomized complete block with four replications and repeated in time. Isolates of *R. solanacearum* were grown on nutrient agar and suspended in deionized water at 2x10^6 cells/ml for inoculation. Inoculation was performed by misting harvester defoliators and gleaners with isolate suspension before harvesting individual rows. Plants were assessed weekly for disease severity and rated on a 0 to 5 scale. There were 12 total treatments: an inoculated control; non-inoculated control; 3 different MH (Royal MH-30 EC) rate applications each with 4 different methods of application. Data collected suggest that lower rates of MH than the standard 1.5 gal/A application and MH application to stem tissue in addition to foliar sprays can reduce mechanical transmission of *R. solanacearum* during leaf harvest.

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Key terms: disease, bacterial wilt, mechanization, harvesting.


Research confirmed that sporangiospores on blue mold diseased tobacco do not survive leaf curing. Also, the pathogen does not produce oospores in US tobacco. These observations have resulted in the export of US produced tobacco to China. Other research demonstrated that US tomato varieties do not host the blue mold pathogen. This resulted in the opening of export markets in Japan and Taiwan to US produced tomatoes. Currently, Japan has a phytosanitary barrier in place that prohibits the import of US produced eggplants and peppers. This is because
the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan is of the opinion that eggplants and peppers are hosts of the blue mold pathogen. The American Phytopathological Society does not list blue mold as a disease of eggplant or pepper. Blue mold has never been observed on eggplant and pepper plants or fruit growing under natural conditions in the field in the US. Eggplant and pepper fruit were tested by following an inoculation protocol. Fruit from numerous samples of commercially produced varieties of eggplants and peppers from CA, FL, NC and NJ were inoculated and did not develop blue mold. Thirteen eggplant, 12 bell and 13 hot pepper varieties were inoculated and did not develop blue mold. Calyx and stem tissue attached to inoculated fruit did not develop blue mold. Also, inoculated wounded and immature fruit did not develop blue mold. These results and field observations demonstrate that US produced eggplants and peppers do not host the blue mold pathogen. (Reprinted with permission)

Key terms: blue mold, pathogen survival, eggplants, peppers, tomatoes, tobacco

77. Wu, X., Y. Bao, X. Sui, N. Martinez, D. Li, R. Miller, and S. Yang. Genetic mapping of blue mold resistance in burley tobacco. Paper presented at 46th Tobacco Workers’ Conference, 2014. Department of Plant and Soil Sciences, University of Kentucky, Lexington, KY 40546, USA. Email: syang2@uky.edu

Blue mold, caused by the downy mildew pathogen Peronospora tabacina, is one of the most important foliar diseases of cultivated tobacco worldwide. Given the economic cost and possible negative environmental effects of long-term fungicide application, utilization of host resistance to blue mold is a preferred strategy. In order to map the gene of interest, a F2 segregating population was derived from the cross between TKF2002 (susceptible to blue mold) and TKF432 (resistant to blue mold). More than 500 plants were inoculated with the blue mold pathogen. Plants with extreme phenotypes were selected for the marker test. More than 250 simple sequence repeat (SSR) markers were screened between TKF2002 and TKF4321. Seven polymorphic markers were selected to screen the F2 population. The genetic map was constructed based on the combination frequency among markers. The blue mold resistance was localized on chromosome 7. This is the first genetic map of blue mold resistance in burley tobacco. One repulsion-phase marker PT61472 was identified to be closely linked with the blue mold resistance. Combined with the coupling-phase marker BMSCAR1, homozygous and heterozygous resistant plants can be easily distinguished. This results will highly facilitate the selection of blue mold resistance in tobacco breeding programs. (Reprinted with permission)

Key terms: blue mold, resistance, marker, breeding.

76. LaMondia, J. A. and B.D. Eitzer. Strategies to control blue mold and reduce fungicide residues in cigar wrapper tobaccos. Paper presented at the 46th Tobacco Workers’ Conference, 2014. The Connecticut Agricultural Experiment Station, Valley Laboratory, 153 Cook Hill Road, Windsor, CT 06095 USA. Email: James.LaMondia@ct.gov.

Blue mold, caused by Peronospora tabacina, has occurred in Connecticut annually since 1996. Cigar wrapper leaves require excellent disease control, but ideally control should be achieved with low fungicide residues remaining in cured leaves. We applied dimethomorph (DMM) fungicide to broadleaf or shade-grown wrapper tobacco in field plots and evaluated both efficacy against blue mold and fungicide residues in cured harvested leaves in 2012 and 2013. In
broadleaf, DMM was applied to plants either as 4, 4, 6, 6, and 4 oz Forum per acre in weeks 2 through 6 or as 4 oz/acre in weeks 2 through 7. Plants were stalk cut and cured in week 9. Fungicides were extracted from cured leaves using a version of the QuEChERS procedure and analyzed by liquid chromatography/mass spectrometry. Blue mold control was significantly better when higher rates were applied early, and DMM residues were 2.6 ppm compared to 5.9 ppm in 2012 and 4.2 versus 6.4 ppm in 2013 for applications where higher rates were applied early compared to 4 oz applied from week 2 to week 7. In shade tobacco in 2012, applications of 6, 6, 6, 6, 2, 1, 1, 1, and 1 oz/acre Forum weekly from week 2 through 10 were compared to 10 weekly applications of 3 oz/acre from week 2 to 10. Leaves were primed from weeks 7 through 12. Numbers of blue mold-free leaves harvested from plots where higher fungicide rates were applied early were 281 compared to 141 leaves from plots with weekly applications of 3 oz/acre Forum. There were no significant differences in DMM concentration in cured leaves. Extended blue mold control with low residues will require the use of multiple fungicides in shade tobacco and will be difficult due to conducive environmental conditions and the extended harvest period. (Reprinted with permission).

Key terms: dimethomorph, fungicide, Peronospora tabacina


Three species of root-knot nematodes (Meloidogyne incognita, M. arenaria, and M. javanica) have long been a problem in tobacco production around the world. Meloidogyne incognita has historically been the most economically significant root-knot nematode species on tobacco in Virginia. However, with most commercial varieties now containing a resistance gene to races 1 and 3 of M. incognita (Rk1), M. arenaria has emerged as the most common root-knot nematode pathogen in Virginia tobacco fields. The objective of this study is to determine if homozygosity for both Rk1 and Rk2 increases resistance to M. arenaria compared to the presence of either gene alone. Six tobacco cultivars were used: C371G (susceptible), NC 95 and SC 72 (homozygous for Rk1), T-15-1-1 (homozygous for Rk2), and STNCB-2-28 and NOD 8 (homozygous for both Rk1 and Rk2). Six plants of each variety were grown in a greenhouse and inoculated with 5,000 M. arenaria eggs. Egg mass counts, egg counts, and a gall rating by weight were obtained from roots 60 days after inoculation. Plants with Rk1 alone, and Rk1 and Rk2 together significantly reduced root galling, egg masses, and eggs than the control variety. Combining Rk1 and Rk2 genes further reduced galling (significantly in 1 of 4 trials), egg masses (significantly in 2 of 4 trials), and eggs (significantly in 1 of 3 trials). A better understanding of the specific effects of Rk1 and Rk2 on root-knot nematode parasitism could help plant breeders improve tobacco resistance to M. arenaria.

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Key terms: nematode, root-knot, resistance.
Expression of an apoplast-directed, phylloplanin-GFP fusion gene confers fungal resistance against *Peronospora tabacina* disease in a susceptible tobacco. Paper presented at 46th Tobacco Workers’ Conference, 2014. Kentucky Tobacco Research and Development Center, 1401 University Dr., Lexington, KY 40546, Email: amihaylo@uky.edu

Tobaccos and certain other plants secrete phylloplanin glycoproteins to aerial surfaces where they appear to provide first-point-of-contact resistance against fungal pathogens. These proteins can be collected by water washing of aerial plant surfaces, and as shown for tobacco and a sunflower phylloplanins spraying concentrated washes onto e.g., turf grass aerial surfaces can provide resistance against various fungal pathogens, in the laboratory and field. These results suggest that natural-product, anti-fungal phylloplanins may be useful as broad-selectivity fungicides. An obvious question now is can a tobacco phylloplanin gene be introduced into a fungal-disease-susceptible plant to confer endogenous resistance. Here we demonstrate for the first time that introduction of a tobacco-phylloplanin gene - as a fusion with the green fluorescent protein (GFP) gene - targeted to the apoplastic space did confer increased resistance of disease susceptible host tobacco to infection by *Peronospora tabacina*, the blue mold pathogen, and that this resistance is stable in homozygous plants through at least the T4 generation. In addition, we argue that our study is also novel in that the effects of T-phylloplanin-GFP expression on fungal resistance were compared in transgenic plants where fusion proteins were targeted to the cell wall versus the cytoplasm. Here we report that wall targeting has advantages over cytosolic targeting in that it appears to confer higher and more stable resistance. Endogenous protection against pathogenic fungi would reduce the need for applying chemical fungicides, thereby reducing the level of their residues, and contributing to risk reduction.

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Key terms: phylloplanin, resistance, GFP, apoplast.

82. **Moore, J.M., F.S. Turpin, T.W. Phillips, and M.D. Toews.** Mitigation of cigarette beetle infestation at tobacco receiving stations. Paper presented at the 46th Tobacco Workers’ Conference, 2014. Department of Crop Sciences, Coastal Plain Experiment Station, University of Georgia, Tifton, GA 31794, USA. Email: jmmoore@uga.edu

Cigarette beetle, Lasioderma serricorne (Coleoptera: Anobiidae), is a cosmopolitan pest of dried plant products including cured tobacco, nuts, herbs, spices, and processed grain products. Developing larvae burrow into foodstuffs and contaminate it with pupal cocoons, frass, and bodies. We investigated the use of mating disruption to mitigate these insect populations before they require fumigation. In each of four tobacco receiving stations, male cigarette beetles were monitored using sex pheromone baited sticky traps while female oviposition was monitored using small cups filled with attractive media. Halfway through the storage year, two receiving stations were provisioned with custom made pheromone dispensers that passively released synthetic sex pheromone to confuse males and prevent them from locating and mating with females. Data show that deployment of pheromone dispensers resulted in an immediate shutdown of captures in the sticky traps and very few progeny in oviposition cups. These results
suggest that mating disruption should be further developed as an insecticide free control tactic for mitigating cigarette beetle populations inside tobacco receiving stations.


Splitworm infestation soon after transplanting in untreated plots of a planned foliar insect control on-farm demonstration on the Wooten farm in Jeff Davis County, Georgia in 2012 was greater than normal for this early stage of growth. Plants in plots treated with Coragen applied in the transplant water at the labeled rate of 7 oz/A was found not to have any splitworms or splitworm damage. Coragen has been labeled for three years for control of lepidoptera including tobacco budworm, tobacco splitworm and hornworms on tobacco plants. Splitworm infestation of tobacco is usually observed in more mature tobacco plants as mines in the leaves creating a window pane appearance in the leaves. However, this infestation occurred thirty days after transplanting and in addition to creating mines in the leaves many of the plants suffered damage to the buds resulting in prolific sucker growth causing problems with harvest and a reduction in yield and quality of the leaf harvested and cured from these plants.

88. Ji, P., A.S. Csinos, L.L. Hickman, and U. Hargett. Evaluation of efficacy and application methods of QGU42 (Zorvec™, oxathiapiprolin) for management of black shank on tobacco. Paper presented at the 46th Tobacco Workers’ Conference, 2014. Department of Plant Pathology, Coastal Plain Experiment Station, University of Georgia, Tifton, GA 31794, USA. Email: pji@uga.edu.

Black shank caused by *Phytophthora nicotianae* is responsible for serious yield and quality reduction in tobacco production. Application of effective fungicides continues to be a significant component in developing integrated disease management programs. Studies were conducted in 2010-2013 to determine the efficacy and application methods of a new fungicide, QGU42 (Zorvec™, oxathiapiprolin), for management of black shank under field conditions. QGU42 was applied using different methods and application rates ranging from 2.4-38.6 fl oz/acre were evaluated. In the experiment conducted in 2010, application of QGU42 (2.4 fl oz/acre) prior to transplanting in conjunction with applying QGU42 at 19.2 fl oz/acre in transplant water and 2.4 fl oz/acre at 1st cultivation and layby was the most effective in disease reduction. In 2011, the two most effective treatments were: 1) application of QGU42 through transplant water (4.8 fl oz/acre) and at 1st cultivation and layby (38.6 fl oz/acre); 2) application of QGU42 (4.8 fl oz/acre) prior to transplanting in conjunction with applying QGU42 at 19.2 fl oz/acre at 1st cultivation and layby. In 2012, QGU42 applied prior to transplanting (4.8 fl oz/acre) and at 1st cultivation and layby (9.6 fl oz/acre) was among the most effective treatments. In 2013, application of QGU42 through transplant water at 38.6 fl oz/acre, or QGU42 applied through transplant water at 19.2 fl oz/acre and at planting and layby, reduced disease significantly compared with the non-treated control. These treatments also increased tobacco yield significantly compared to the non-treated control. Across the experiments conducted in the 4 years, QGU42 was effective in reduction of black shank at a rate as low as 2.4 fl oz/acre and
appeared to be more effective than mefenoxam in managing this important disease. (Reprinted with permission)

Key terms: oomycete, chemical control, disease management


Root-knot nematodes have been a problem in Virginia tobacco for many years. A few currently available tobacco cultivars are susceptible to attack by all root-knot nematode species, the vast majority are homozygous for Rk1 alone, and an increasing number are homozygous for Rk1 and either homozygous or heterozygous for Rk2, a gene introduced into cultivated tobacco from a land race of N. tabacum in Zimbabwe. In some cases, resistance due to these genes is mostly uncharacterized. Little information is available on the effect that two resistance genes (Rk1 and Rk2) have on root-knot nematode reproduction than just one gene alone, and how the resistance works. This experiment was meant to serve as a method to study nematode parasitism within the first 24-72 hr of parasitism. Small numbers of freshly hatched M. arenaria juveniles were applied to days-old tomato and tobacco seedlings growing in sand-filled microcentrifuge tubes. Tomato seedlings were used as a model system to develop methods to evaluate resistance mechanisms against root-knot nematodes in flue-cured tobacco. Individual seedlings were transferred to sand in microcentrifuge tube filters, and within 24 hr were infested with hand-picked Meloidogyne arenaria juveniles. Varying infestation densities (1, 10, 25, 40 nematodes/plant) and observation times (24, 48, 72 hr) after infestation were evaluated to optimize visual observation of nematode penetration. Percent penetration was highest with 25 nematodes per plant observed 72 hours post-infestation. Due to this model system, differences in penetration or parasitism during early feeding can hopefully be evaluated on tobacco.

(Reprinted with permission)

Key terms: nematode, root-knot, resistance.


Tobacco growers are besieged by advertising for products claiming to promote the growth of the crop or provide protection from pests and crop stress. Some products have legitimate uses and are backed by appropriate replicated research trials that have proven their efficacy for specific claims. Other products have not been sufficiently tested and often rely on testimonial evidence that the product performs as claimed. Products such as these may use dubious explanations for their mode of action and the impact they have upon plants. While it is virtually impossible to test all such products it is important to occasionally help growers sort out legitimate products from the ones that are simply a waste of money. The objective of the field trials discussed in this poster was to provide data from replicated field trials to aid tobacco growers in evaluating
growth enhancing products. Trials were conducted over a three years period with products from several manufacturers. In some cases products were tested at recommended fertility levels and at reduced fertility levels to see if the products would be effective when plants were under nutrient stress. During these trials the growth enhancement products did not result in cured leaf yield increases. In most cases the leaf yield under reduced fertility management was not significantly different from the recommended fertility levels, suggesting that fertility was not the yield limiting factor in these trials.