Evaluation and Control of Ground Sucker Formation in Burley Tobacco Varieties

Robert Miller, Jan Smalle, and Jesse Carmack
University of Kentucky Plant and Soil Sciences Department

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Overview of Research Project:

One negative aspect of tobacco float plants is their increased propensity to form adventitious basal shoots, commonly referred to as "ground suckers". Although the growth of ground suckers is often repressed following transplanting, they sometimes continue to grow and may reach a length of 4-5 feet. This may pose significant problems when the plants are ready to cut at harvest, and may significantly reduce yields of the primary plants. There is no clear understanding as to why ground suckers are so much more prevalent in hydroponically produced transplants, but one possibility is that there is a difference in levels of specific plant hormones between traditional versus hydroponically produced transplants. Auxins are a type of plant hormone that are formed in the apical bud and promote primary shoot growth and restrict lateral branching. Another class of plant hormones is cytokinins, which are involved in cell division and shoot and root morphogenesis; they are also known to regulate axillary bud growth and apical dominance. The cytokinin to auxin ratio is known to affect the formation of axillary buds (suckers) in many types of plants, including tobacco.

The root to shoot ratio in hydroponically grown plants is much greater compared to plants grown in traditional plant beds. At transplanting, only a very small root system is maintained in plants pulled from traditional plant beds; in comparison, hydroponically produced plants have an intact root system that is much larger, with exact size determined by the size of the tray cells used to produce the plants. The primary objective of the current Research Proposal is to determine if the difference in root to shoot ratio between traditional versus hydroponically produced transplants results in a significantly different auxin to cytokinin ratio, thereby affecting the development of ground suckers. If that is found to be true, a secondary objective is to investigate whether the normal auxin to cytokinin ratio can be restored by adding auxins to the float water, thereby reducing or eliminating ground suckers when the treated plants are grown in the field.

Two tobacco varieties, TN 86 and Hybrid 403, were evaluated in laboratory, greenhouse, and field studies. TN 86 is known to have a propensity to form ground suckers, while ground suckers are rarely observed in H 403. The laboratory and greenhouse experiments investigated the basic response of tobacco plants to augmented levels of auxins and cytokinins, with the goal

being to determine optimal levels of phytohormones that may be used in commercial transplant production to minimize or eliminate ground sucker formation in field grown tobacco crops without adversely affecting overall plant growth or yield potential.

Results to Date:

Laboratory Experiments:

Seeds of TN 86 and H 403 were surface sterilized, and then plated onto Murashige and Skoog basal medium with vitamins and sucrose. The seeds were allowed to germinate for 7-10 days; seedlings of similar size were then transferred to new MS plates that contained different concentrations of auxin or cytokinin. 1-naphthaleneacetic acid (NAA) and 6-benzylaminopurine (BA) were the chosen synthetic auxin and cytokinin hormones, respectively.

To initiate the hormone sensitivity assays, differing concentrations of both hormones were investigated in an attempt to identify three levels of each hormone that resulted in three different visible impacts on growth and development. A first (low) concentration should not have any impact on growth. A second (intermediate) concentration should influence growth (root architecture, leaf color) without causing substantial growth inhibition. Finally, a third (high) concentration should cause a clear growth inhibition response without causing growth arrest. For each series of hormone concentrations, the same experimental procedure was utilized. A total of seven plates (BA Conc 1, Conc 2, and Conc 3; NAA Conc 1, Conc 2, and Conc 3; and a Control with no added hormone) constituted one replication. Each hormone treatment and control plate had four TN 86 and four H 403 seedlings mounted on the surface of the media. The plates were then placed vertically in a growth chamber set to recommended temperature, humidity, and light duration and shoot and root growth was monitored.

The response of TN 86 and H 403 to varying levels of the auxin NAA and the cytokinin BA are presented in Figures 1 – 3. At BA concentrations of 10nM or 50Nm, growth of both varieties appeared to be equally reduced in comparison to the control. At the 250 nM concentration, growth of TN 86 appeared to be reduced to a greater extent than was observed for H 403 (Figure 1). For NAA, the growth of both varieties was reduced at concentrations equal to or greater than 50 nM (Figures 2 -3). As was observed for the BA study, TN 86 was much more sensitive to added NAA than was H 403. Even at 50 nM, the lowest auxin concentration evaluated, both root and shoot growth of TN 86 was greatly reduced in comparison to H403, and in comparison to both varieties when grown on control media. This suggests that TN 86 is much more sensitive to changes in the auxin to cytokinin ratio than is H 403, which supports the hypothesis that the increased levels of ground suckers observed in hydroponically grown TN 86 plants may in fact be triggered by altered plant hormone ratios.

Winter 2014 – 2015 Greenhouse Experiments:
Pelleted seeds of TN 86 and H 403 were directly seeded into 242 cell Styrofoam float trays containing Carolina tobacco germination mix. Based on the results from the laboratory studies, the hormone treatments for the greenhouse studies consisted of 2nM, 10nm, and 50nM concentrations of NAA; 2nM, 10nm, and 50nM concentrations of BA; and a Control with no added hormone. The hormone treatments were applied 2, 4, and 6 weeks post seeding; each treatment was replicated two times, with an untreated control with each rep. Each replication consisted of one float tray grown in four gallons of water, using currently recommended hydroponic practices, and mowed at appropriate intervals. Data were collected after plants had achieved transplant size (~8 weeks) to determine the effect of the hormone treatments on growth and development. Leaf number, stem elongation, internode length, and chlorophyll content were used to determine whether or not the treated plants were developing normally compared to control plants. Five randomly selected plants from each treatment per replication (n=140 per application time) were then potted in 6.5" pots containing ProMix potting soil. After four weeks in pots, the previously mentioned data were recorded again, along with sucker counts and measurements.

The results for sucker formation in the greenhouse are presented in Figures 4 - 8. For the control plants that had no added hormones, TN 86 produced significantly more axillary shoots than did H 403 (Figure 5). In addition, the two varieties responded to the various hormone treatments in distinctively different manners (Figures 6 – 8; please note the difference in scale of the y-axis for TN 86 vs H 403). For H 403, which essentially did not produce any axillary shoots in the greenhouse control treatment and also normally does not produce a significant number of ground suckers when grown in the field, all of the hormone treatments resulted in no change or an increase in the number of axillary shoots produced in comparison to the untreated control. This suggests that the auxin to cytokinin ratio is normally in balance in hydroponically produced H 403 transplants, and any added hormone treatment actually disrupts that balance. For TN 86, all of the NAA concentrations resulted in a decrease in axillary shoot formation. However, the reduction in sucker formation was statistically significant only for the 2nM NAA treatment; this was the case regardless of when the hormone treatments were added. None of the BA concentrations appeared to be effective in reducing axillary shoot formation.

2015 Field Experiments:
TN 86 and H 403 that had been treated with hormones during transplant production were compared in field studies conducted in Lexington and Versailles, KY and Greeneville, TN during 2015. Tobacco plants of the two varieties were produced on hydroponic solutions containing three auxin and three cytokinin concentrations (Table 1). The six phytohormone levels were added to recommended hydroponic solutions at two different time intervals, two weeks after seeding and four weeks after seeding (first clipping). A split split-plot experimental design arranged in a randomized complete block with three replications was utilized for the

study. Main plots were varieties, sub plots were time of hormone treatment, and sub sub-plots were hormone type/concentration. Data were collected for number and length of ground suckers at 50 days after transplanting.

Results from the 2015 field studies are presented in Tables 2 – 4. Ground sucker pressure was extremely light at both Lexington and Woodford County in 2015, likely as a result of plentiful rainfall that occurred at both locations (Tables 2 and 3). H 403 had virtually no ground suckers at either location. TN 86 produced an average of one or two ground suckers per plant at Lexington and Versailles, respectively, but on average less than half of the plants produced suckers than grew to be more than six inches in length, so ground suckers that did form were of no consequence. At Greeneville, it was relatively drier immediately after transplanting and ground sucker formation was somewhat more prevalent (Table 4). H 403 still produced on average less than one ground sucker per plant, and virtually none of those grew to a length of six inches. TN 86 produced between one and two suckers per plant, but only one or two suckers per every ten plants exceeded six inches in length.

Although the incidence of ground suckers was extremely low in all three 2015 field studies, incidence was high enough to clearly demonstrate that none of the hormone treatments were effective in reducing ground sucker incidence. Although the results were unexpected and certainly disappointing, there are three possibilities for the lack of results. The first is that the initial concentrations of auxins and/or cytokinins were simply not high enough to affect sucker formation. The second possibility is that the initial concentrations were high enough, but that as water was added to the beds as necessary during the transplant season, hormone levels were diluted far below their initial levels. This was a possibility because much more water evaporated from float beds during April and May than occurred in December and January when the greenhouse studies were conducted; in April and May the increased evaporative demand required the addition of water to the one tray treatment beds on a near daily schedule, which could have resulted in ineffective hormone concentrations. The third possibility is that auxins, which are normally produced primarily in the apical meristem and then translocated down the stalk through phloem vessels to suppress the formation of axillary buds, cannot be effectively absorbed through the roots and translocated upward through xylem cells. In that scenario, the addition of auxins to hydroponic solutions may not be a possibility for the control of axillary buds.

Fall 2015 Greenhouse Experiments:

To test possibilities one and two, another set of greenhouse experiments was conducted in the fall of 2015. The experimental design was similar to that described for the previous greenhouse studies, with three major differences. First, only one variety, TN 86, was utilized for this second study. Second, much higher concentrations of NAA and BA were utilized; in the first greenhouse study and in the 2015 field studies, 2, 10, and 50nM concentrations were evaluated, while in the second greenhouse study the auxin concentrations evaluated were 200nM, 1000nM (1uM), and 5uM. The BA concentrations in the second study were 50nM, 200nM, and 1250nM.

Third, one application of hormones, applied approximately four weeks after seeding, was compared to repeated applications of hormone every time water had to be added to the float beds; this was achieved by adding stock solutions having the desired hormone concentrations to the beds rather than adding only water.

The results for the second greenhouse experiment are presented in Table 5. The data, which are the mean values of 10 plants for each treatment, demonstrate that higher levels of NAA do substantially reduce the formation of axillary buds in comparison to untreated control plants, but the addition of BA cytokinin has little or no apparent effect. More importantly, only one application of NAA is necessary to control the formation of axillary shoots even in plants that are approximately two feet tall. The most effective rate of NAA, 1uM, reduced the formation of all axillary shoots by 85% in comparison to the untreated control without altering the overall growth characteristics of the plants. The reduction in axillary shoots that were 1" - 6" in length were reduced by 95% in comparison to the control; this is a particularly significant result as suckers exceeding 4" – 6" in length are much more likely to continue to grow and become problematic in comparison to shoots that never exceed 1" in length. The highest rate of 5uM NAA also resulted in a significant reduction in axillary shots, but the plants were approximately 50% taller than control plants. Although the data are not shown, leaf number of the plants was not increased by the high NAA level; only the internode length was increased. This is not surprising since one of the primary functions of auxins is stem elongation.

As a result of this latest greenhouse experiment, field studies will be conducted again in 2016 utilizing NAA levels that proved to be highly effective in the greenhouse. Complete agronomic data, including yield and quality measurements, will be collected to determine whether application of appropriate levels of NAA can actually significantly reduce or eliminate ground suckers in tobacco production.

Figure 1. The effects of three concentrations of BA Cytokinin on plant growth in culture.

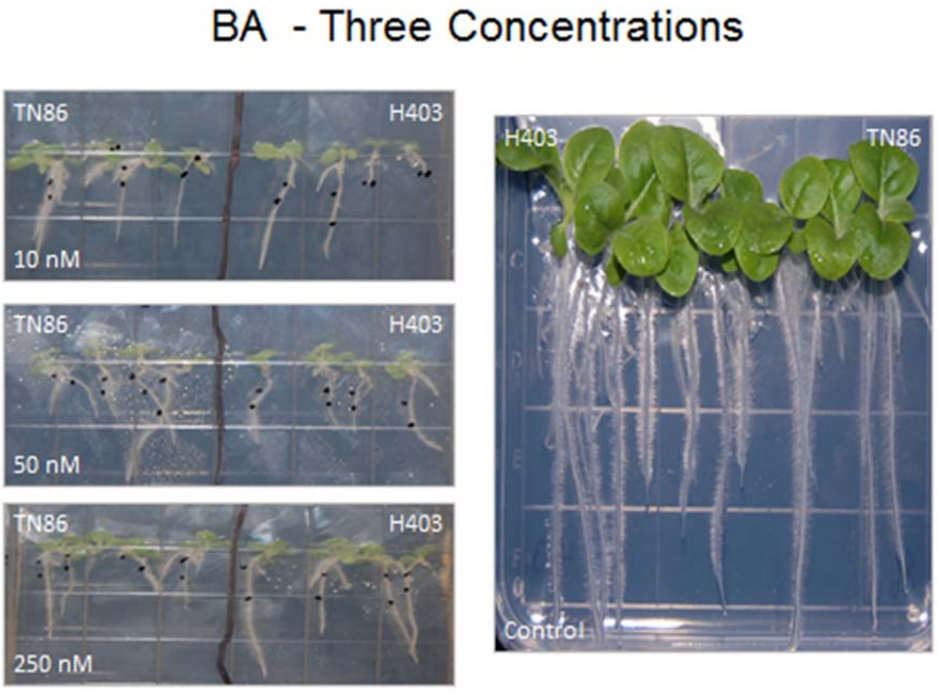

Figure 2. The effects of three concentrations of NAA Auxin on plant growth in culture.

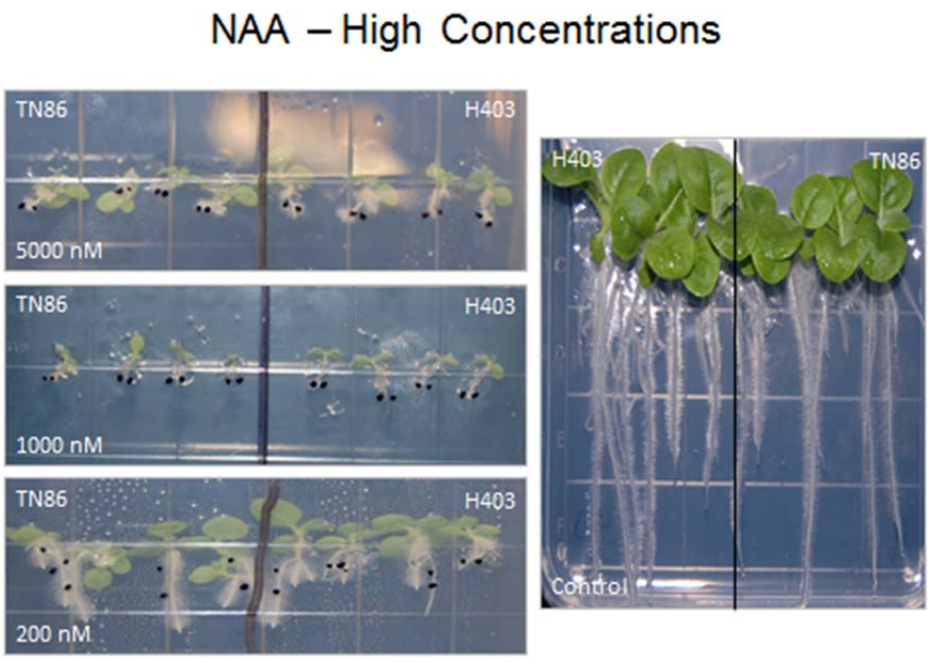

Figure 3. The effects of two concentrations of NAA Auxin on plant growth in culture.

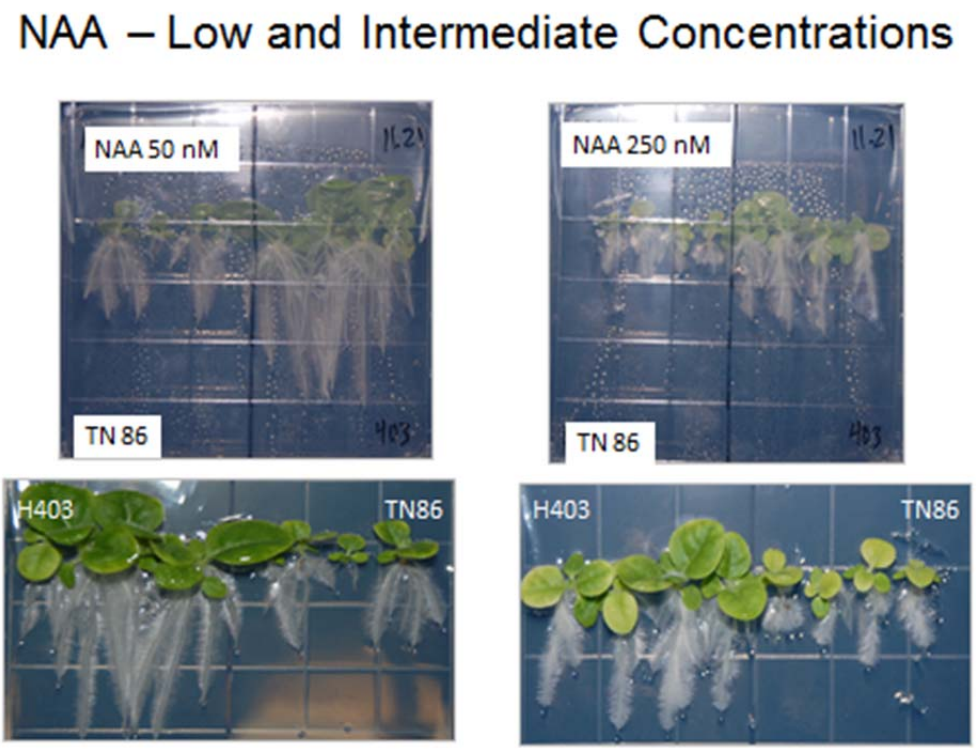

Figure 4. Relative number of axillary buds formed in TN 86 and H 403 in 2014 greenhouse experiment.

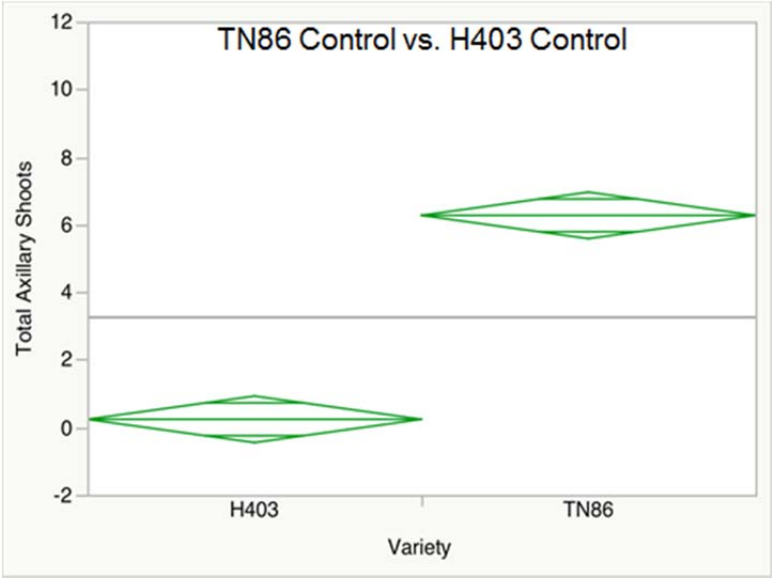

Figure 5. Effect of growth hormones add to water two weeks after seeding – 2014 greenhouse experiment.

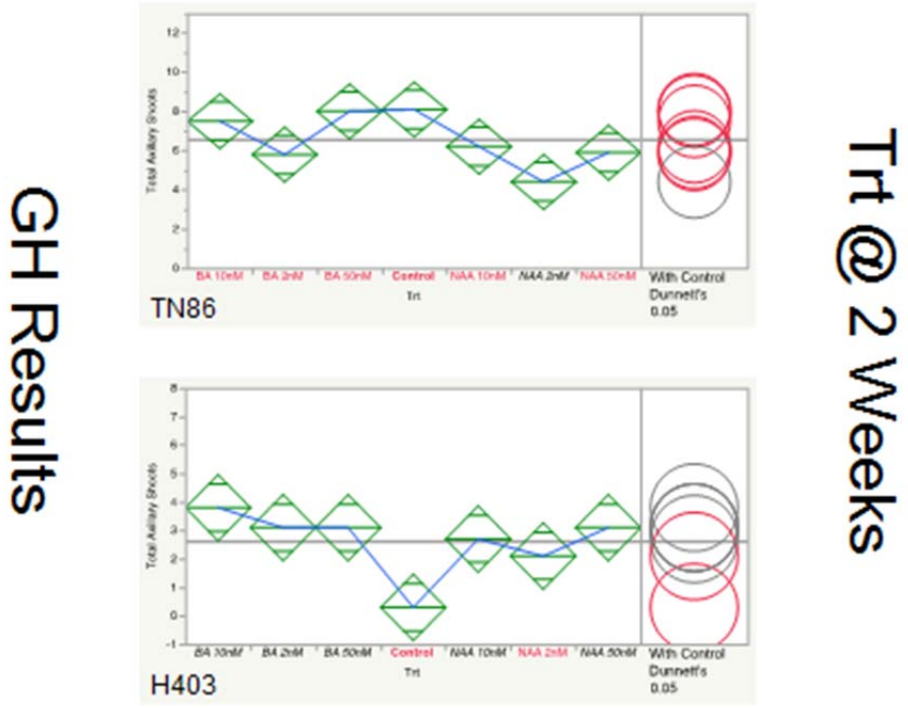

Figure 6. Effect of growth hormones add to water four weeks after seeding – 2014 greenhouse experiment.

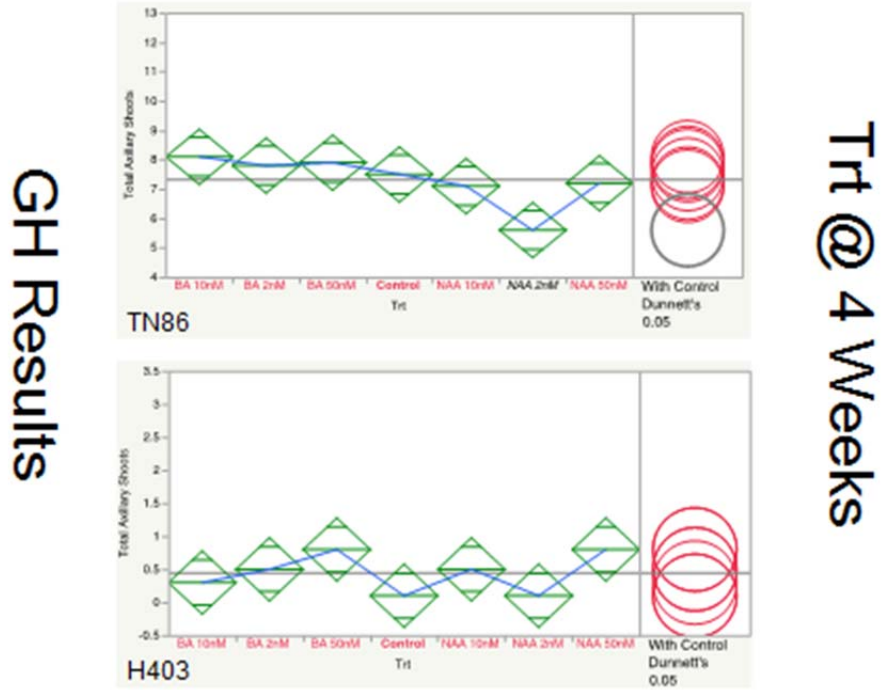

Figure 7. Effect of growth hormones add to water six weeks after seeding – 2014 greenhouse experiment.

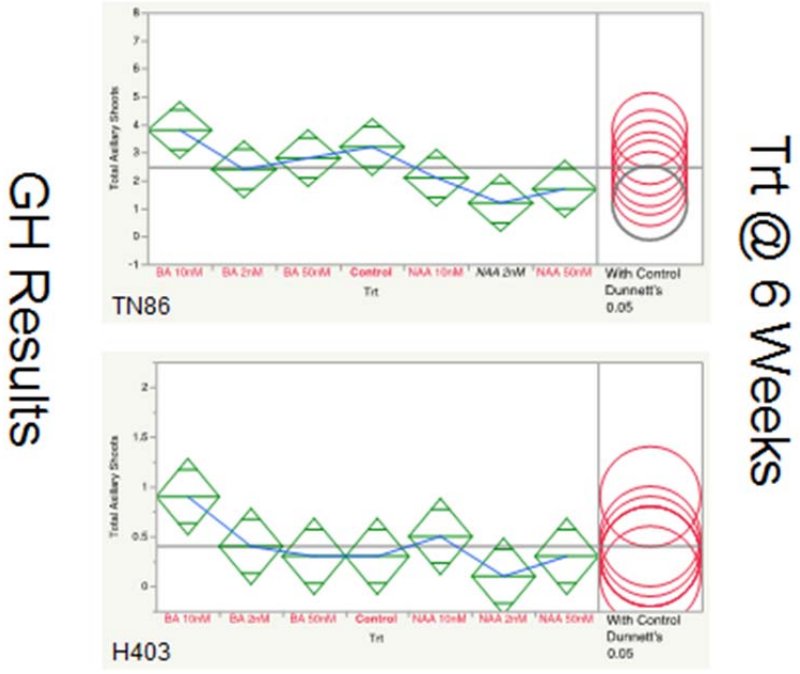

Table 1. 2015 Field Growth Regulator Study Treatments

Locations: Greeneville, TN; Lexington and Versailles, KY
Whole plots: Varieties = H 403 and TN 86
Sub-plot : Application Timing = 2 weeks or 4 weeks
Sub-Sub-plots: 7 Trtmnts = 3 Auxin rates, 3 Cytokinin rates, and Control (No horm

*** Treatment with hormone 14 or 28 days after seeding**

Whole Plots	Sub Plots	Sub Sub-Plots	Hormone
Tray No.	Treatment Date*	Treatment	Concentration
H 403-1	2 Wks	NAA-1	**2nM**
H 403-2	2 Wks	NAA-2	**10nM**
H 403-3	2 Wks	NAA-3	**50nM**
H 403-4	2 Wks	BA-1	**2nM**
H 403-5	2 Wks	BA-2	**10nM**
H 403-6	2 Wks	BA-3	**50nM**
H 403-W	2 Wks	Control	**0**
H 403-7	4 Wks	NAA-1	**2nM**
H 403-8	4 Wks	NAA-2	**10nM**
H 403-9	4 Wks	NAA-3	**50nM**
H 403-10	4 Wks	BA-1	**2nM**
H 403-11	4 Wks	BA-2	**10nM**
H 403-12	4 Wks	BA-3	**50nM**
H 403-W	4 Wks	Control	**0**
TN 86-1	2 Wks	NAA-1	**2nM**
TN 86-2	2 Wks	NAA-2	**10nM**
TN 86-3	2 Wks	NAA-3	**50nM**
TN 86-4	2 Wks	BA-1	**2nM**
TN 86-5	2 Wks	BA-2	**10nM**
TN 86-6	2 Wks	BA-3	**50nM**
TN 86-W	2 Wks	Control	**0**
TN 86-7	4 Wks	NAA-1	**2nM**
TN 86-8	4 Wks	NAA-2	**10nM**
TN 86-9	4 Wks	NAA-3	**50nM**
TN 86-10	4 Wks	BA-1	**2nM**
TN 86-11	4 Wks	BA-2	**10nM**
TN 86-12	4 Wks	BA-3	**50nM**
TN 86-W	4 Wks	Control	**0**

Table 2. 2015 Ground Sucker Study - Lexington, KY

Sucker Counts 50 Days after Transplanting

Hormone Treatment	Hormone Level	Time* Applied	Treatment Code	Number of Suckers			Treatment Code	Number of Suckers		
				<6"	6"-12"	>12"		<6"	6"-12"	>12"
Auxin	2nM	2 wks	H 403-1	0.13	0.40	0.10	TN 86-1	0.03	1.27	0.87
Auxin	10nM	2 wks	H 403-2	0.07	0.00	0.00	TN 86-2	0.40	0.63	0.47
Auxin	50nM	2 wks	H 403-3	0.07	0.33	0.20	TN 86-3	0.40	0.90	0.53
Auxin	**Mean**	**2 wks**	**H 403**	**0.09**	**0.24**	**0.10**	**TN 86**	**0.28**	**0.93**	**0.62**
CytoKinin	2nM	2 wks	H 403-4	0.03	0.03	0.07	TN 86-4	0.70	0.47	0.37
CytoKinin	10nM	2 wks	H 403-5	0.00	0.13	0.00	TN 86-5	0.27	0.73	0.87
CytoKinin	50nM	2 wks	H 403-6	0.00	0.07	0.00	TN 86-6	0.37	0.50	0.83
Cytokinin	**Mean**	**2 wks**	**H403**	**0.01**	**0.08**	**0.02**	**TN 86**	**0.44**	**0.57**	**0.69**
Water Check	**0**	**2 wks**	**H 403-W-2**	**0.20**	**0.23**	**0.03**	**TN 86-W-2**	**0.50**	**0.90**	**0.57**
Auxin	2nM	4 Wks	H 403-7	0.07	0.07	0.00	TN 86-7	0.03	1.03	0.50
Auxin	10nM	4 Wks	H 403-8	0.17	0.13	0.00	TN 86-8	0.93	0.70	0.50
Auxin	50nM	4 Wks	H 403-9	0.00	0.20	0.00	TN 86-9	0.67	0.37	0.50
Auxin	**Mean**	**4 Wks**	**H403**	**0.08**	**0.13**	**0.00**	**TN 86**	**0.54**	**0.70**	**0.50**
CytoKinin	2nM	4 Wks	H 403-10	0.00	0.03	0.03	TN 86-10	0.20	0.77	0.63
CytoKinin	10nM	4 Wks	H 403-11	0.00	0.10	0.00	TN 86-11	0.60	0.77	0.57
CytoKinin	50nM	4 Wks	H 403-12	0.10	0.03	0.00	TN 86-12	0.27	1.20	0.30
Cytokinin	**Mean**	**4 Wks**	**H 403**	**0.03**	**0.06**	**0.01**	**TN 86**	**0.36**	**0.91**	**0.50**
Water Check	**0**	**4 Wks**	**H 403-W-4**	**0.10**	**0.07**	**0.00**	**TN 86-W-4**	**1.00**	**0.47**	**0.37**

Summary

Hormone Treatment	Hormone Level	Time* Applied	Treatment Code	Number of Suckers			Treatment Code	Number of Suckers		
				<6"	6"-12"	>12"		<6"	6"-12"	>12"
Auxin	**Mean**	**2 wks**	**H 403**	**0.09**	**0.24**	**0.10**	**TN 86**	**0.28**	**0.93**	**0.62**
Cytokinin	**Mean**	**2 wks**	**H 403**	**0.01**	**0.08**	**0.02**	**TN 86**	**0.44**	**0.57**	**0.69**
Water Check	**Mean**	**2 wks**	**H 403**	**0.20**	**0.23**	**0.03**	**TN 86**	**0.50**	**0.90**	**0.57**
Auxin	**Mean**	**4 Wks**	**H 403**	**0.08**	**0.13**	**0.00**	**TN 86**	**0.54**	**0.70**	**0.50**
Cytokinin	**Mean**	**4 Wks**	**H 403**	**0.03**	**0.06**	**0.01**	**TN 86**	**0.36**	**0.91**	**0.50**
Water Check	**Mean**	**4 Wks**	**H 403**	**0.10**	**0.07**	**0.00**	**TN 86**	**1.00**	**0.47**	**0.37**
Variety Means		**TN 86**	**H 403**	**0.09**	**0.14**	**0.03**	**TN 86**	**0.52**	**0.75**	**0.54**

***After seeding**

Table 3. 2015 Ground Sucker Study - Woodford Co, KY

Sucker Counts 50 Days after Transplanting

Hormone Treatment	Hormone Level	Time* Applied	Treatment Code	Number of Suckers			Treatment Code	Number of Suckers		
				<6"	6"-12"	>12"		<6"	6"-12"	>12"
Auxin	2nM	2 wks	H 403-1	0.10	0.00	0.00	TN 86-1	0.67	0.13	0.07
Auxin	10nM	2 wks	H 403-2	0.03	0.03	0.00	TN 86-2	1.00	0.40	0.13
Auxin	50nM	2 wks	H 403-3	0.00	0.00	0.00	TN 86-3	1.33	0.00	0.10
Auxin	**Mean**	**2 wks**	**H 403**	**0.04**	**0.01**	**0.00**	**TN 86**	**1.00**	**0.18**	**0.10**
CytoKinin	2nM	2 wks	H 403-4	0.00	0.00	0.00	TN 86-4	1.47	0.03	0.07
CytoKinin	10nM	2 wks	H 403-5	0.00	0.00	0.00	TN 86-5	1.23	0.13	0.03
CytoKinin	50nM	2 wks	H 403-6	0.13	0.00	0.03	TN 86-6	1.13	0.10	0.13
Cytokinin	**Mean**	**2 wks**	**H403**	**0.04**	**0.00**	**0.01**	**TN 86**	**1.28**	**0.09**	**0.08**
Water Check	**Mean**	**2 wks**	**H 403-W-2**	**0.03**	**0.03**	**0.10**	**TN 86-W-2**	**1.43**	**0.47**	**0.10**
Auxin	2nM	4 Wks	H 403-7	0.03	0.00	0.03	TN 86-7	0.83	0.30	0.30
Auxin	10nM	4 Wks	H 403-8	0.03	0.00	0.00	TN 86-8	0.63	0.13	0.40
Auxin	50nM	4 Wks	H 403-9	0.03	0.00	0.00	TN 86-9	1.03	0.23	0.20
Auxin	**Mean**	**4 Wks**	**H403**	**0.03**	**0.00**	**0.01**	**TN 86**	**0.83**	**0.22**	**0.30**
CytoKinin	2nM	4 Wks	H 403-10	0.03	0.00	0.00	TN 86-10	1.07	0.37	0.40
CytoKinin	10nM	4 Wks	H 403-11	0.00	0.00	0.03	TN 86-11	0.87	0.13	0.50
CytoKinin	50nM	4 Wks	H 403-12	0.03	0.00	0.00	TN 86-12	0.77	0.37	0.30
Cytokinin	**Mean**	**4 Wks**	**H 403**	**0.02**	**0.00**	**0.01**	**TN 86**	**0.90**	**0.29**	**0.40**
Water Check	**Mean**	**4 Wks**	**H 403-W-4**	**0.03**	**0.00**	**0.00**	**TN 86-W-4**	**0.73**	**0.27**	**0.17**

Summary

Hormone Treatment	Hormone Level	Time* Applied	Treatment Code	Number of Suckers			Treatment Code	Number of Suckers		
				<6"	6"-12"	>12"		<6"	6"-12"	>12"
Auxin	**Mean**	**2 wks**	**H 403**	**0.04**	**0.01**	**0.00**	**TN 86**	**1.00**	**0.18**	**0.10**
Cytokinin	**Mean**	**2 wks**	**H 403**	**0.04**	**0.00**	**0.01**	**TN 86**	**1.28**	**0.09**	**0.08**
Water Check	**Mean**	**2 wks**	**H 403**	**0.03**	**0.03**	**0.10**	**TN 86**	**1.43**	**0.47**	**0.10**
Auxin	**Mean**	**4 Wks**	**H 403**	**0.03**	**0.00**	**0.01**	**TN 86**	**0.83**	**0.22**	**0.30**
Cytokinin	**Mean**	**4 Wks**	**H 403**	**0.02**	**0.00**	**0.01**	**TN 86**	**0.90**	**0.29**	**0.40**
Water Check	**Mean**	**4 Wks**	**H 403**	**0.03**	**0.00**	**0.00**	**TN 86**	**0.73**	**0.27**	**0.17**
Variety Mean		**TN 86**	**H 403**	**0.04**	**0.01**	**0.02**	**TN 86**	**1.03**	**0.25**	**0.19**

***Weeks after seeding**

Table 4. 2015 Ground Sucker Study - Greeneville, TN

Sucker Counts 50 Days after Transplanting

Hormone Treatment	Hormone Level	Time* Applied	Treatment Code	Number of Suckers			Treatment Code	Number of Suckers		
				<6"	6"-12"	>12"		<6"	6"-12"	>12"
Auxin	2nM	2 wks	H 403-1	0.77	0.00	0.00	TN 86-1	1.83	0.23	0.23
Auxin	10nM	2 wks	H 403-2	0.27	0.00	0.03	TN 86-2	2.27	0.30	0.00
Auxin	50nM	2 wks	H 403-3	0.40	0.07	0.00	TN 86-3	1.10	0.80	0.13
Auxin	**Mean**	**2 wks**	**H 403**	**0.48**	**0.02**	**0.01**	**TN 86**	**1.73**	**0.44**	**0.12**
CytoKinin	2nM	2 wks	H 403-4	0.27	0.00	0.00	TN 86-4	1.13	0.53	0.17
CytoKinin	10nM	2 wks	H 403-5	0.60	0.00	0.00	TN 86-5	1.30	0.70	0.43
CytoKinin	50nM	2 wks	H 403-6	0.50	0.03	0.00	TN 86-6	1.27	0.50	0.10
Cytokinin	**Mean**	**2 wks**	**H403**	**0.46**	**0.01**	**0.00**	**TN 86**	**1.23**	**0.58**	**0.23**
Water Check	**0**	**2 wks**	**H 403-W-2**	**0.43**	**0.07**	**0.00**	**TN 86-W-2**	**1.83**	**0.10**	**0.27**
Auxin	2nM	4 Wks	H 403-7	0.30	0.07	0.03	TN 86-7	0.93	0.73	0.13
Auxin	10nM	4 Wks	H 403-8	0.40	0.00	0.20	TN 86-8	1.53	0.50	0.03
Auxin	50nM	4 Wks	H 403-9	0.27	0.00	0.03	TN 86-9	1.87	0.63	0.03
Auxin	**Mean**	**4 Wks**	**H403**	**0.32**	**0.02**	**0.09**	**TN 86**	**1.44**	**0.62**	**0.07**
CytoKinin	2nM	4 Wks	H 403-10	0.10	0.10	0.00	TN 86-10	1.27	0.40	0.07
CytoKinin	10nM	4 Wks	H 403-11	0.37	0.00	0.00	TN 86-11	1.60	0.13	0.00
CytoKinin	50nM	4 Wks	H 403-12	0.27	0.03	0.00	TN 86-12	1.83	0.43	0.20
Cytokinin	**Mean**	**4 Wks**	**H 403**	**0.24**	**0.04**	**0.00**	**TN 86**	**1.57**	**0.32**	**0.09**
Water Check	**0**	**4 Wks**	**H 403-W-4**	**0.13**	**0.00**	**0.00**	**TN 86-W-4**	**1.87**	**0.30**	**0.13**

Summary

Hormone Treatment	Hormone Level	Time* Applied	Treatment Code	Number of Suckers			Treatment Code	Number of Suckers		
				<6"	6"-12"	>12"		<6"	6"-12"	>12"
Auxin	**Mean**	**2 wks**	**H 403**	**0.48**	**0.02**	**0.01**	**TN 86**	**1.73**	**0.44**	**0.12**
Cytokinin	**Mean**	**2 wks**	**H 403**	**0.46**	**0.01**	**0.00**	**TN 86**	**1.23**	**0.58**	**0.23**
Water Check	**Mean**	**2 wks**	**H 403**	**0.43**	**0.07**	**0.00**	**TN 86**	**1.83**	**0.10**	**0.27**
Auxin	**Mean**	**4 Wks**	**H 403**	**0.32**	**0.02**	**0.09**	**TN 86**	**1.44**	**0.62**	**0.07**
Cytokinin	**Mean**	**4 Wks**	**H 403**	**0.24**	**0.04**	**0.00**	**TN 86**	**1.57**	**0.32**	**0.09**
Water Check	**Mean**	**4 Wks**	**H 403**	**0.13**	**0.00**	**0.00**	**TN 86**	**1.87**	**0.30**	**0.13**
Variety Means			**H 403**	**0.34**	**0.03**	**0.02**	**TN 86**	**1.61**	**0.39**	**0.15**

***Weeks after seeding**

Table 5. Growth Hormone Effects on Axillary Shoot Formation In Tobacco

Greenhouse Experiment Two, Fall 2015

Treatment	Rate	Height (cm)	Suckers < 1"	Suckers 1-6"	Suckers > 6"	Total No.
Auxin Treatments						
1	NAA 5 µM 1 Time	72.0	1.1	0.4	0	1.5
2	NAA 1 µM 1 Time	51.6	0.7	0.1	0	0.8
3	NAA 200 nM 1 Time	48.4	2.3	0.6	0	2.9
7	NAA 5 µM each watering	76.7	2.8	0.1	0	2.9
8	NAA 1 µM each watering	42.0	2.3	0.6	0	2.9
9	NAA 200 nM each watering	48.4	2.3	0.5	0.1	2.9
13	Control None	46.5	0 3.2	1.9	0	5.1
Cytokinin Treatments						
4	BA 1250 nM 1 Time	53.2	2.8	1.4	0.2	4.4
5	BA 250 nM 1 Time	46.5	3.7	0.6	0	4.3
6	BA 50 nM 1 Time	53.9	3.1	1.8	0	4.9
10	BA 1250 nM each watering	49.3	3.8	1	0	4.8
11	BA 250 nM each watering	48.6	3.9	1.3	0	5.2
12	BA 50 nM each watering	46.5	4	0.6	0	4.6
13	Control None	46.5	0 3.2	1.9	0	5.1