Effects of Preharvest and Postharvest Treatments on Incidence and Severity of Internal Necrosis in ‘Covington’ Sweetpotato HORTTECH 04408

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Subject Category: Vegetable Crops

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*Additional index words*: *Ipomoea batatas*, storage, curing, potassium fertilizer, mowing, vine snatching, temperature.

*Summary:* Internal necrosis (IN) is a physiological disorder that affects ‘Covington’, the most commonly grown sweetpotato cultivar in North Carolina. Because IN affects the quality of sweetpotato storage roots, studies have been conducted since the first report of IN in 2006. Field studies (three in 2016 and two in 2017) were conducted to evaluate preharvest and postharvest treatments on the occurrence of IN in Covington storage roots. Four preharvest treatments consisted of combinations of high chlorine and minimal chlorine fertilizer and mowing versus not mowing prior to harvest. For postharvest treatments, 30 storage roots were obtained at harvest from each preharvest treatment plot and immediately placed in 75ºF and 85ºF rooms for duration of ½, 1, 2, 3 and 5 weeks in 2016, and ½ ,1 and 2 weeks in 2017. Shorter durations (1/2 and 1-week) coincided with industry recommendations while longer durations mimicked the challenges that some commercial facilities face when cooling down temperatures of rooms after curing. Once temperature and duration treatments were completed, roots were placed in a 58ºF storage room until cut. A control treatment was included in which harvested roots were placed in a 58ºF storage room (no curing) immediately after harvest. The storage roots from all temperature treatments were then cut 49 to 80 days after harvest (DAH), and incidence and severity of IN visually rated. Preharvest fertilizer treatments had minimal effect on occurrence of IN. However, mowing vines prior to harvest in most studies reduced IN incidence when roots were placed in storage for more than ½ week and exposed to temperatures of at least 75ºF. Lower temperature (75ºF versus 85ºF) and shorter duration (½ versus 1, 2, 3 or 5 weeks) temperatures reduced IN occurrence in ‘Covington’ sweetpotato.

North Carolina (NC) produces over 50% of sweetpotato acreage in the U.S. with 90,000 acres planted in 2017 (USDA-NASS, 2018). Covington cultivar, released by NC State University in 2005 (Yencho et al., 2008), is the most important cultivar grown in NC and accounts for approximately 90% (~80,000 acres) of the commercial acreage across the state (K. Mclver, NC Sweetpotato Commission, personal communication).

Approximately one year after ‘Covington’ was commercially available, a grower reported that 1600 tons of sweetpotato roots in storage had a disorder characterized by small brown to black necrotic areas in the flesh near the proximal end of the root which is where storage roots were removed from the stem (Schultheis et al., 2009; Jiang et al., 2015; Dittmar et al., 2018). This disorder has been named internal necrosis (IN) (Clark et al., 2013b).

Since initial reports in 2006, IN continues to be a concern across the sweetpotato industry in NC. After harvest, IN may develop as a black or brown area in the flesh close to the proximal end of the root, and in some cases results in non-marketable roots (Jiang et al., 2015) (Figure 1). Even when IN is severe, it is present only in the first third to half of the root from the proximal end.

Research has been ongoing since 2006 to better understand IN. Based on multi-disciplinary research, the following has been reported regarding IN. Sweetpotato clones differed in degree and severity of IN susceptibility, with Covington and Hatteras being the most susceptible (Clark et al., 2013a; Dittmar et al., 2010). Field studies also determined that IN is not transmitted from seed roots to transplants (Schultheis and Thornton, 2007). The hypothesis of any pathogens being associated with the occurrence of IN was discarded through serological, molecular, grafting methods and Koch’s Postulates (Golden Leaf Foundation, 2016; Quesada, unpublished data). Additional field studies determined that IN was not associated with the use of insecticides (Jiang et al., 2015) or herbicides (Beam et al., 2017). The results of these studies suggest that the cause of IN was not pesticide related and was not biological. Rather, it appeared to be a physiological disorder that occurred in certain clones.

PREPTM, (EPA Reg. No. 264-418, Bayer Crop Science, Research Triangle, NC), an ethephon compound product commonly used as a defoliator in cotton and tobacco has been evaluated as a chemical application to sweetpotato vines with the purpose of tightening the skin of the storage roots prior to harvest (Main et al., 2009; Wang et al., 2012; Jiang et al., 2015; Beam et al., 2017). Studies in 2010, 2012 and 2015 found that ethephon could be associated with the development of IN in sweetpotato, with ‘Covington’ being the most susceptible clone (Dittmar et al., 2010; Arancibia et al., 2013; Beam et al., 2017; Clark et al., 2013a; Jiang et al., 2015). Internal necrosis symptoms, however, were not solely associated with ethephon, as low incidence and less severe IN symptoms were also present when ethephon was not applied in ‘Covington’ (Dittmar et al., 2018).

Since the ethylene hormone has an important role in postharvest handling, a number of sweetpotato studies have focused on postharvest ethylene produced by the roots (Buescher et al., 1975; Kitinoja, 1987). Sweetpotatoes are very sensitive to ethylene in storage and can cause internal darkening and pithy areas (Edmunds et al., 2008). Studies have shown that exposure to 10 ppm ethylene during or after curing enhanced levels of respiration and polyphenol oxidase (PPO) enzymes as well as decreased attributes of color and flavor (Buescher et al., 1975). Even though sweetpotato is sensitive to ethylene exposure, any of the symptoms caused by the increase of respiration and PPO enzymatic activities (Buescher et al., 1975) were not like those seen with IN damage. More recent studies were conducted to evaluate the effect of high concentrations of ethylene gas during curing and storage on IN incidence in ‘Covington’ sweetpotato (Jiang et al., 2015). Results from these studies revealed IN incidence was not affected by sampling date, year, or treatment with a high concentration of ethylene gas during sweetpotato storage. Only 4% of the roots from the studies had IN symptoms at the lowest level of severity. A sweetpotato storage disorder “hardcore” has some similarities with IN, however, this disorder is chill-induced (Timbie and Haard, 1977).

Preliminary studies have investigated the effects of mowing the vines prior to harvest as a possible stressing factor that could contribute to the occurrence of IN (Golden Leaf Foundation, 2016). Also, potash fertilizer high in chloride content (KCl), was evaluated for its effect on IN in sweetpotatoes since tobacco growers have reported quality losses in flue cured tobacco (Garner et al., 1930; Skogley, 1962; McCants et al., 1967), and this fertilizer is a source of potash for both commodities. Another preliminary study evaluated the effects of storage temperatures and its duration immediately after harvest on the occurrence and severity of IN (Golden Leaf Foundation, 2016). There was evidence to suggest that IN incidence increased when roots were exposed to 75oF or 85oF for one to three weeks immediately after harvest.

As discussed earlier, many factors have been investigated and systematically eliminated or need further investigation as the cause of IN in sweetpotato. Thus, the objective of these studies was to evaluate preharvest and postharvest treatments on the occurrence of IN in Covington storage roots.

***Materials and Methods***

Three studies were conducted in 2016 at Hilltop Farms (HF) (*35°36'09.6" N 78°43'20.5" W, Middle Creek, NC 27593*), Warren Farms (WF) (*35°13'31.9" N 78°06'24.8" W, Mt Olive, NC 28365)* and the Cunningham Research Station in Kinston (KI) (*35°18'17.7" N 77°34'52.5" W, Kinston, NC 28501*). Two studies were also conducted in 2017 at WF (*5°14'18.3" N 78°20'08.9" W, Newton Grove, NC 28366*) and KI (*35°17'58.5" N 77°34'25.3" W Kinston, NC 28366*). Studies at KI were established with a two-row transplanter using transplants from seed increase beds at the Horticultural Crops Research Station, Clinton NC. Studies at HF and WF were established with transplants and planting equipment from each respective farm. Transplant dates for the 2016 and 2017 studies were between late May and late June, when most commercial sweetpotato acreage is planted (Kemble et al., 2016). Each study site had bedded rows 42 to 44 in. wide. The in-row crop spacing at all locations was 12 in. Each plot consisted of 8 rows 50 ft. long and 10 ft. alleys between the end and beginning of plots.

A randomized complete block design with four replications was used in all studies in 2016 and 2017. Layout of the field plots was the same in all studies. Treatments were in a split plot design and arranged in a 2 X 2 factorial arrangement with main plots being preharvest treatments being post plant fertilizer (fert) x preharvest vine mowing (mow), and split-plot factors being postharvest treatments of storage temperature (temperature) and storage duration (weeks).

*Preharvest Treatments*

Four preharvest treatments consisted of two vine mowing and two potash fertilizer treatments. Fertilizer treatments were applied by hand and consisted of 135 pounds per acre (lb/ac) of potassium [muriate of potash (KCl) or potassium sulfate (K2O4)]. Fertilizer type was applied two times, at 7 to 14 and 21 to 41 days after planting (DAP). Muriate of potash (0-0-60) contained high chlorine, whereas, potassium sulfate (0-0-50) contained low chlorine. Elemental sulfur was applied to all muriate of potash plots at 46 lb/ac which was the same amount contained in the potassium sulfate fertilizer. Complimentary fertilizers of basic macronutrients were applied to all plots and followed the common agricultural practices for ‘Covington’ sweetpotato (Yencho et al., 2008). Calcium nitrate (15.5-0-0) was applied twice to all plots at 30 lb/ac of N per application at the same time as potassium fertilizer treatments were applied. All plots received phosphorous (0-46-0) at 30 lb/ac at the first potassium fertilizer treatment timing. Vine mowing treatments consisted of mowed and non-mowed. All mowing treatments consisted of removing the vines using a vine shredder. The mowing equipment used at each location was a Loftness shredder (650 South Main Street. Hector MN, 55342 USA) at WF, a Bush Hog Shredder (2501 Griffin Ave. Selma, Alabama 36701) at HF and Ma PF Oelwein shredder (801 2nd Ave SE, Oelwein, IA 50662) at KI.

*Postharvest Treatments*

On the day of harvest (113 to 127 DAP), twelve (2016) and ten (2017) US No.1 bags with 30 roots (each bag consisted of 6 roots from different plants on rows 3 to 7 of each plot) were collected from each plot and then subjected to curing times of ½, 1, 2, 3 and 5 weeks in 2016 and ½, 1 and 2 weeks in 2017. Curing temperature treatments were 75ºF and 82ºF in 2016, and 75ºF and 85ºF in 2017, and 85% relative humidity each year as recommended in the literature (Edmunds et al., 2008). Once the temperature and weeks treatment were achieved (i.e. 75ºF – 2 weeks), the roots were moved to a storage room with temperature set at 58ºF. An additional treatment included a control treatment of 58ºF but was not included in the statistical analysis. An extra sample of roots was collected from each treatment and then cut in the field to see if any IN was present at harvest. Hobo data loggers (Hobo® ONSET® UX100 -003) were placed in the storage room both years to record relative humidity (% RH) and temperature (ºF).

Root samples from the studies were cut 49 to 80 DAH into 0.1-inch sections beginning at the proximal end of the sweetpotato until about ½ of the root was sampled. Incidence of IN was recorded as the percentage of 30 roots per bag that had any symptoms of IN. Severity was visually rated from the 0.1-inch cross section with the highest necrotic area of each root with IN symptoms using a grading scale of 1 to 5 (Figure 2). Previous research has shown that IN symptoms increase until about 30 DAH in ‘Covington’ but remains similar thereafter (Dittmar et al., 2018). Incidence of IN data were analyzed using Proc Mixed (SAS/STAT software, Version 9.4 M3 of the SAS System for Windows) statistical analysis. Separation of significance between treatment means was conducted using the Tukey-Kramer procedure.

**Results and Discussion**

The results are presented separately for 2016 and 2017 because responses differed between years for preharvest and postharvest treatments (Table 1). Results on IN severity were analyzed both years but few statistical differences among preharvest and postharvest treatments occurred (data not shown). Furthermore, IN incidence generally increased in a similar manner as IN symptoms; the more roots with IN incidence, the greater the IN severity (data not shown) (Figure 2). Since IN incidence better distinguished treatment differences than severity, IN incidence only is presented.

It should also be noted that the 85oF temperature treatment in 2016 was not attained even though the curing room settings were at that temperature. The hobo units placed in the curing room measured a consistent 82oF rather than the 85oF indicated by the storage room’s computer. Thus, we will reference the 85oF treatment in the 2016 studies as 82oF. The 85oF room temperature was achieved in the 2017 studies.

**2016.** Preharvest treatments were not significant in the HF study. However, the main effects of postharvest treatments (weeks and temperature) affected the incidence of IN at P=0.0060. Roots exposed to 82ºF treatment had 12% IN incidence versus 9% IN at 75ºF. It should be noted that when roots were placed into a 58ºF temperature chamber immediately after harvest and not exposed to curing or warmer temperature treatments, a 5% IN incidence was recorded. Although IN incidence was detected when roots were not exposed to curing temperatures (58 ºF), severity was minimal, 2 and 3 on a 1-5 scale, with these roots likely being marketable roots. Internal necrosis incidence increased when roots were exposed to either 75ºF or 82ºF with 2%, 6% and 10% IN incidence observed at ½, 1, and 2 weeks, respectively after curing temperature treatment. After 2 weeks IN incidence leveled off and were 12% and 10% at 3 and 5 weeks, respectively. The increase of IN incidence in ‘Covington’ roots over time when exposed to curing temperature treatments (75ºF or 82ºF) for longer periods of time agrees with preliminary work conducted in 2015 (Golden Leaf Foundation, 2016).

Significant interaction between temperature and weeks at the P=0.0062 level was observed at WF (Table 1). Internal necrosis incidence was higher at 2 and 5 weeks when roots were exposed to the 82ºF (14%) versus the 75ºF curing treatment (6% incidence) (Table 2). Internal necrosis incidence was 1% when roots were exposed to curing temperatures of either 75oF or 82oF for ½ week. As in the HF study, no increase in IN incidence was observed after 2 weeks, regardless of temperature treatment.

Response to treatments in the KI study differed from the HF and the WF studies (Table 1). With respect to IN occurrence, weeks and temperature interaction was significant (P=0.0046). These postharvest treatments interacted with various preharvest treatments. A two-way interaction between mow x weeks was observed and there was a three-way interaction between mow x fertilizer x temperature. When foliage was mowed, IN incidence remained stable ranging from 2 to 5% when exposed to curing temperature treatments from ½ to 5 weeks (Table 3). When foliage was not mowed and roots were exposed to curing temperature treatments from ½ to 5 weeks, IN incidence increased from 2 to 12% compared to when foliage was not mowed. While no statistical differences in IN incidence were measured at the other weeks (½, 1, 2 and 3), a trend of IN incidence being consistently lower when vines were mowed compared to when they were not mowed was observed.

The differences in time from mowing to harvest may be an important consideration and a possible reason for the varying response to mowing in 2016 studies as these mowing times varied due to environmental conditions (i.e., rainfall resulting in wet field conditions, so mowing was delayed). Mowing studies have confirmed that mowing vines in sweetpotato is beneficial as it increases skin toughness and enhances the sweetpotato root-skin adhesion (Schultheis, 2000; Hayes et al., 2014). A more recent study showed that use of a vine-snatcher, where vine and root were completely separated, increased skin strength and was achieved as early as 4 days after snatching, with a more significant increase after 8 days in Covington and Beauregard cultivars (Akula et al., 2019). Other researchers have studied the physiological processes in sweetpotato leaves in response to various biotic and abiotic stresses such as wounding, chilling, ozone and stress-related chemicals. One study looked at the enzymatic response to peroxidases (POD) which is implicated in physiological processes such as the defense against pathogen attacks, salt tolerance or oxidative stresses (Jang et al., 2004). Another study showed that abscisic acid (ABA) and ethephon both enhance total POD activity by approximately 50% in suspension cultures of sweetpotato (Kwak et al., 1996). Future work should consider the vine removal practices and its timing before harvest as it could be linked to the activation of enzymatic responses that could be related to the necrotic tissue found in sweetpotato roots with IN. Conditions such as temperature during harvest at each location with a subsequent difference of the temperature in the internal core of the roots (pulp temperature) could also contribute to these treatment differences.

Fertilizer treatment was a contributing factor in IN incidence as a significant mowing x fertilizer x temperature interaction was observed (Table 4). Mowed or not mowed treatments using potassium sulfate fertilizer were not significant whether curing temperature was 75ºF or 82ºF. With muriate of potash (high chlorine fertilizer) x vines mowed x 82ºF treatments, 11% IN incidence resulted compared to 5% or less for all other treatment combinations. The higher incidence of IN when muriate or potash versus potassium sulfate was used was first reported in a preliminary study (Golden Leaf Foundation, 2016).

**2017.** As in the WF study in 2016, no differences between fertilizer treatments were observed in 2017(Table 1). The preharvest mow treatment was significant at the P= 0.0035 level as was the interaction between mow x weeks at WF in 2017 (Table 2). Like the KI study in 2016, treatment response was similar in 2017 at WF with the magnitude of IN occurrence appearing to be greater in the 2017 study than in the 2016 study. In 2017, for the no mow treatment, IN incidence increased from ½ to 1 to 2 weeks, (3%, 20% and 32%, respectively). The IN incidences for the mowed treatments were also greater as weeks increased (3%, 10% and 14%, respectively) but were lower than the no mow treatment at 2 weeks. When storage roots were stored for as little as 1 week compared to ½ week, the incidence of IN increased for the not mowed treatment while IN incidence did not increase until roots were stored for 2 weeks when vines were mowed before harvest. Mowing reduced and delayed IN incidence. The main effect of temperature also had a significant impact on IN incidence (Table 1) as incidence was greater (16%) at 85ºF compared to 11% at 75ºF (data not shown). The importance of using an abbreviated, cooler than recommended curing treatment (Edmunds et al., 2008) in commercial facilities appears crucial to minimize IN occurrence in ‘Covington’.

In the 2017 KI study, a mow x temperature interaction was observed that affected incidence of IN. Incidence was highest (21%) when the vines were not mowed, and roots stored at 85ºF compared to when vines were not mowed, and roots stored at 75ºF (7%) (Table 5). Internal necrosis incidence was 10% less when vines were mowed versus not mowed and placed in an 85oF curing room. In the 2017 KI study, a three-way interaction between mow, fertilizer and weeks was observed with respect to IN incidence as both preharvest treatments affected IN incidence (Table 6). The postharvest factor weeks generally increased the incidence of IN as weeks increased from ½ to 2 weeks curing for most of the preharvest combinations. When plots were mowed and potassium sulfate fertilizer was applied, IN was less than 10% for ½, 1 and 2 weeks, while 14% IN incidence occurred at 2 weeks when muriate of potash fertilizer was applied. The preharvest mowing treatment resulted in less IN incidence in 3 of the 5 studies. In addition to potentially reducing IN incidence, mowing has the added benefit of reducing skinning of sweetpotatoes (Edmunds et al., 2008; LaBonte and Wright, 1993). Future research should evaluate when mowing should occur under a range of environments to manage IN incidence, and provide the sweetpotato industry with a way to potentially reduce IN. The 58ºF treatment resulted in very minimal incidence and severity of IN both years (3-5% in 2016 and 0% in 2017) and illustrates that curing conditions after harvest need to be carefully monitored and controlled with ‘Covington’.

These studies demonstrated that after sweetpotato roots were harvested and exposed to curing temperatures of 75ºF or 85ºF for one to two weeks, there was increased IN incidence when compared to ½ week. Very low incidence of IN with curing temperatures 75ºF or 85ºF when roots were cured for only ½ week. Curing temperatures above 80ºF (82ºF or 85ºF) are likely to increase IN incidence. The effects of lowering temperatures during curing of ‘Covington’ appears to be critical in minimizing IN occurrence. However, minimal or no curing may negatively impact the storability and other quality aspects of sweetpotatoes long term. Future research needs to evaluate the balance between maximizing sweetpotato shelf life and quality through curing time and temperature while minimizing IN.

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Unit conversion table:

|  |  |  |  |
| --- | --- | --- | --- |
| Units |  |  |  |
| To convert U.S. to S.I multiply by | U.S. Units | SI unit | To convert SI to U.S., multiply by |
| 0.4047 | acre(s) | ha | 2.4711 |
| 0.3048 | ft | M | 3.2808 |
| 2.54 | Inch(es) | cm | 0.3937 |
| 0.8921 | lb/acre | kg ha-1 | 1.1208 |
| (°F – 32) ÷ 1.8 | °F | °C | (°C × 1.8) + 32 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Effect | df | HFX |  | WF | |  | KI | | |
| 2016 | 2016 2017 | | | 2016 2017 | | | |
|  |  | *P* valueY | | | | | | |
| MZ | 1 | 0.1456 | 0.1378 | | 0.0035 | 0.0026 | | 0.0008 | |
| F | 1 | 0.8972 | 0.1378 | | 0.0847 | 0.0971 | | 0.1627 | |
| M\*F | 1 | 0.6993 | 0.3376 | | 0.1861 | 0.1130 | | 0.8026 | |
| W | 4 | < .0001 | < .0001 | | < .0001 | < .0001 | | < .0001 | |
| M\*W | 4 | 0.6505 | 0.3830 | | 0.0014 | 0.0020 | | 0.0238 | |
| F\*W | 4 | 0.9200 | 0.2342 | | 0.4630 | 0.2522 | | 0.5627 | |
| M\*F\*W | 4 | 0.5969 | 0.3264 | | 0.1805 | 0.1319 | | 0.0202 | |
| T | 1 | 0.0060 | < .0001 | | 0.0193 | < .0001 | | < .0001 | |
| M\*T | 1 | 0.2279 | 0.4667 | | 0.1557 | 0.0046 | | 0.0072 | |
| F\*T | 1 | 0.2614 | 0.1591 | | 0.9858 | 0.0565 | | 0.9312 | |
| M\*F\*T | 1 | 0.8348 | 0.6374 | | 0.3470 | 0.0429 | | 0.4980 | |
| W\*T | 4 | 0.3667 | 0.0062 | | 0.6884 | 0.5736 | | 0.0898 | |
| M\*W\*T | 4 | 0.4140 | 0.8935 | | 0.2982 | 0.5544 | | 0.5513 | |
| F\*W\*T | 4 | 0.5223 | 0.1761 | | 0.1808 | 0.5907 | | 0.9982 | |

Table 1. Type 3 tests of fixed effects from HF, KI and WF in 2016 and 2017 for treatment main effects and interactions.

Z Preharvest treatments; M = mowing, F= fertilizer.

Postharvest treatments; W= weeks, T= temperature

Y P values were significant with an α ≤ 0.05.

X Study locations; HF (Hilltop Farms), WF (Warren Farms), KI (Kinston)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | % Internal Necrosis | | | | | |
| Temperature  2016 | |  | Mowing  2017 | | |
| Duration (weeks) |  | 75ºF | 82ºF |  | Mow No Mow | | |
| 0Z |  | 0 | 0 |  | 0 | | 0 |
| ½ |  | 1 dY | 1 d |  | 3 cX | 3 c | |
| 1 |  | 2 bc | 6 bc |  | 10 bc | 20 b | |
| 2 |  | 6 bc | 14 a |  | 14 b | 32 a | |
| 3 |  | 9 ab | 8 ab |  | - W | - | |
| 5 |  | 6 bc | 14 a |  | - | - | |

Table 2. Effects of storage duration (weeks) in combination with temperature treatment or vine mowing treatment on the incidence of internal necrosis for Warren Farms, 2016 and 2017 respectively.

Z 0 weeks = Roots placed in 58ºF storage room immediately after harvest. Not included in the analysis.

Y Significant at the p≤0.05 level when letters differed between temperature x duration (weeks) across rows and columns.

X Significant at the p≤0.05 level when letters differed between mowing x duration (weeks) across rows and columns.

W Duration (weeks) of 3 and 5 weeks were not included in the 2017 postharvest study.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Weeks in StorageZ | | | | | | | | | | | | | | |
|  | | 2016 | | | | | |  | | | 2017 | | | |
| Treatment | | 0Y | | ½ | 1 | 2 | 3 | 5 | |  | 0 Y | | ½ | 1 | 2 | |
| Mowed | 0 | | 0 cX | 2 c | 5 bc | 2 c | 2 c | |  | 0 | | 3 d | 7 cd | 11 bc | |
| Not Mowed | 0 | | 1 c | 3 c | 8 ab | 4 bc | 12 a | |  | 0 | | 6 cd | 18 ab | 18 a | |

Table 3. Effects of vine mowing treatment in combination with storage duration on the incidence of internal necrosis, Kinston, 2016 and 2017.

Z Average over storage temperatures (75ºF and 82ºF in 2016 and 75ºF and 85ºF in 2017 in 2017).

Y 0 weeks = Roots placed in 58ºF storage room immediately after harvest. Not included in the analysis.

X Significant at the p≤0.05 level when letters differed between mowing x curing duration.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mowing Treatments | | | |
|  | Mowed |  | Not Mowed |

Table 4. Effects of vine mowing treatment in combination with fertilizer and temperature on the incidence of internal necrosis. Kinston, 2016.

FertilizerY  Fertilizer

Temperature PS MP PS MP

75oF 2 bZ 2 b 3 b 4 b

82oF 3 b 3 b 5 b 11 a

Z Significant at the <.05 level when letters differed between temperature x mowing x fertilizer treatment.

Y Fertilizer treatments; PS (Potassium Sulfate), MP (Muriate of Potash).

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | 2016 | | | |  | | 2017 | | | | |
|  | | Temperature | | | |  | | Temperature | | | | |
| Treatment | 75ºF | | | 82ºF | |  | | 75ºF | | 85ºF | |
| Mowed | | | 2 bz | | 3 b | |  | | 3 c | | 11 b | | |
| Not Mowed | | | 3 b | | 8 a | |  | | 7 bc | | 21 a | | |

Table 5. Interaction of vine mowing and temperature treatments on the incidence of internal necrosis. Kinston, 2016 & 2017.

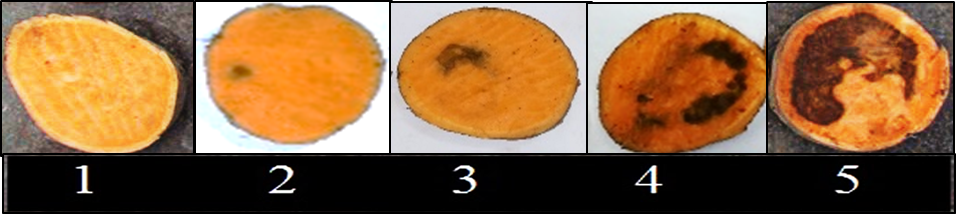
Z Significant at the p≤0.05 level when letters differed between mowing x temperature treatment within each year.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | Fertilizer  Muriate of Potash Potassium Sulfate | | | | | | | | | | | | | | | |  | | | |
|  | | | Weeks Exposed  to 75 or 85oF | | | | | | | |  | | Weeks Exposed  to 75 or 85oF | | | | | | | | |
| Treatment |  | 0Z | | | | ½ | 1 | 2 | |  | | | 0Z | | ½ | | 1 | | 2 | |
| Mowed | | 0 | | | 5 cdY | | 5 cd | | 14 abc | | |  | 0 | 2 d | | 8 bcd | | 8 bcd | | | | |
| Not Mowed | | 0 | | | 5 cd | | 22 a | 19 ab | | | |  | 0 | 7 cd | | 13 abcd | | 18 ab | | | | |

Table 6. Interaction of vine mowing, curing duration (weeks) and fertilizer treatments on the incidence of internal necrosis. Kinston, 2017.

Z Roots not exposed to high temperature treatment (75ºF and 82ºF) but placed in 58ºF storage room immediately after harvest. Not included in the analysis. Y Significant at the p≤0.05 level when letters differed between mowing x weeks x fertilizer.

Figure 1. Internal necrosis symptoms on a ‘Covington’ sweetpotato root cut from the proximal end of the root. Internal necrosis symptoms disappear and become less severe when slicing nears the center of the root.

Figure 2. Grading cards used for rating Internal Necrosis severity. 1 = no internal necrosis incidence, 2 = least severe and still marketable root, < 5% necrotic, 3 = darker necrotic tissue with limited necrotic area and still marketable, 5 to 20% necrotic, 4 = Necrotic tissue covers 21-60% of the sampled root, darker color, not marketable, 5 = Necrotic tissue covers > 60% of the sample, dark and not marketable.