**INTRODUCTION**

Sweetpotatoes are grown on about 9 million hectares with average yields of 14 tons/ha. (FAOSTAT, 2001). The production is mainly distributed in warm temperate and tropical countries. Southeast Asia, mainly China, is the primary producer of sweetpotatoes accounting for more than 80% of the world production. About 15% is grown in Africa and the rest of the world accounts for the remaining 5%, with the US accounting for about 1% of the world’s sweetpotato production.

Curing is recommended within 1 to 2 hours after harvest and continued for 4 to 7 days at 80 to 85ºF and 90 to 95% relative humidity (RH) (NC Sweetpotato Commission, 2018; Edmunds et al., 2008; Loebestine and Thottappilly, 2009). Duration depends on the difference between root temperature (core temperature) and the curing temperature of the room (Edmunds et al., 2008). As roots are still metabolically active, respiring and transforming starch into sugar, heat is generated (respiration heat) and carbon dioxide is produced. Good airflow is necessary during curing to evacuate CO2 and supply oxygen so it is uniformly distributed in the room. As little as one-half cubic foot of outside air per bushel per day is sufficient for proper ventilation. Humidity during the curing and storage process is also important. RH during curing should avoid the saturation point at 100% RH, where water could condense on top of the walls, bins or sweetpotatoes increasing the risk of postharvest diseases. Proper humidity benefits wound healing and also reduces the weight loss. After the curing process is completed, temperatures are reduced to 58ºF and RH is kept at 85% to 90% for long term root storage.

The Louisiana State University Agricultural Experiment Station released ‘Beauregard’, a copper skinned, orange-flesh variety that became accessible to growers in 1987 (Rolston et al., 1987). In only a few years ‘Beauregard’ dominated the North American commercial sweetpotato market. ‘Beauregard’ produced high yields and was resistant to fusarium wilt although very susceptible to root knot nematodes. ‘Beauregard’ dominated the US market until North Carolina (NC) State University released ‘Covington’ in 2005. When grown under NC´s weather conditions and the sandier soils, ‘Covington’ produces yields equal to ‘Beauregard’, and is typically 5 to 10 days later in maturity (Yencho et al, 2008). ‘Covington’ typically sizes its storage roots more evenly than ‘Beauregard’ resulting in fewer jumbo class roots and a higher percentage of number one roots.

In the early 2000´s the US experienced an increase in demand for sweetpotatoes and a need to meet consumer´s and industry´s preferences. The USDA reported that from 2000 to 2015 the average consumption of sweetpotatoes grew from 4.2 to 7.5 lbs per capita. (USDA ERS, 2017). Increasing demand for sweetpotatoes coincides with the emerging food trends in the past years. European markets´ demands for exotic and healthy food crops (superfoods) resulted in a direct impact on the increase of sweetpotato demand. Sweetpotatoes met most of these food trends and became a product with an increasing acceptance in national (US) and international markets.

To meet this demand, sweetpotato acreage harvested in the US has increased from 83,000 acres in 1999 to 163,300 acres in 2016 (FAOSTAT DATA, 2016). This increase was mainly attributed to the NC sweetpotato industry with improved postharvest technology for year-round sweetpotatoes coupled with ‘Covington’ having an excellent acceptance by growers and customers. North Carolina currently accounts for the 55-60% of the national production with 90,000 acres planted in 2017. (USDA ERS, 2017).

Although there have been improvements in the NC sweetpotato industry such as improved storage with negative horizontal ventilation (NHV) (Boyette, 2009) and new variety releases (Yencho et al., 2008; Rolston et al.,1987) there are new challenges to be overcome. One of them is a physiological disorder that was first reported in 2006 named Internal Necrosis (IN), mainly affecting ‘Covington’ (Jiang et al., 2015; Schultheis et al., 2009; Clark et al., 2013). Covington is the primary cultivar grown in NC and is susceptible to this disorder. Internal Necrosis is of concern in the NC sweetpotato industry and can cause significant dollar losses, especially if shipped loads are rejected domestically or internationally due to this problem. Research across several disciplines has been conducted as to the cause of IN; however, no study has been able to determine a definitive solution or to consistently reduce IN occurrence. Recent studies have evaluated insecticides (Jiang et al., 2015) pathogens (Golden Leaf Foundation, 2016; Lina Quesada, personal communication) herbicides (Beam et al., 2017) and ethylene (Jiang et al., 2015) as factors that can cause IN. Only when ethylene is applied to foliage prior to harvest as a defoliant has there been substantial increased response in IN (Dittmar et al., 2010; Arancibia et al., 2013; Beam et al., 2017; Clark et al., 2013; Jiang et al., 2015).

Various preharvest treatments in the field such as mowing or the use of low levels of chlorides in the formulation of commonly used fertilizers have been associated with less occurrence of IN (Montero de Espinosa et al., 2018). These factors in combination with reduced curing and low temperature durations of the roots after harvest (<80ºF) have lessened IN incidence and severity.

The purpose of this study was to evaluate the effects of curing and storage conditions (temperature and RH) in six commercial growers’ facilities and relate their effects on the occurrence of IN. Thus, the goal of these studies was to use data obtained exclusively from commercial growers and facilities and determine which of these factors most contributed to IN. In addition, 10 temperature and RH variables were evaluated at various time intervals to determine those that best accounted for IN incidence.

**METHODS**

In order to evaluate the effects that commercial fields and storage facilities have on the incidence and severity of Internal Necrosis (IN) a two-year study (2016 and 2017) was conducted that involved six commercial sweetpotato producers. Three growers that had more frequent occurrence of IN were selected, while three growers that did not have an apparent problem with IN were selected. An initial study was conducted in 2016 in which a questionnaire was administered to determine what production and storage practices were followed by each producer and use this information to compare among growers if needed.

The growers that participated in 2016 were the same that participated in 2017, with one exception. There was one harvest time in 2016 and three harvest times in 2017 that served as replications. Three harvests in 2017 were incorporated into the study because the weather conditions in the field the day of harvest and during curing could have an impact on IN occurrence. The one harvest in 2016 was October 17, and the three harvests in 2017 were; early season (September 15), mid-season (October 15) and late season (October 23).

Roots were harvested by each grower for each harvest (4 total) from each of the six fields on the same day. Each grower provided six 20-bushel bins for the study for each harvest time

Each grower was randomly assigned a letter (U, V, W, X, Y or Z) to designate their field and storage facility (i.e. grower U on the tag meant that roots in those 20-bushel bins were from Grower U´s field. On the same tag, Facility (U, V, W, X, Y or Z) would specify where those bins were placed for curing and storage).

In order to track temperatures and RH during postharvest treatments, in 2016 three Hobo data loggers (Hobo® ONSET® UX100 -003, Onset Computer Corporation 470 MacArthur Blvd. Bourne, MA 02532) were placed inside three of the six bins. In 2017 the bins were stacked six high and Hobo data loggers were placed in each of the six bins.

Once the six 20-bushel bins were filled by each grower, the roots were transported the same day from each grower´s field and placed at a central location overnight. The bins were sorted so each grower would receive one bin from each grower´s field receiving a total of six bins (1 bin from the grower’s own field and 5 bins from the other 5 growers’ fields) the day after harvest.

In 2017 temperatures were evaluated between bulk bins within stacks to assess temperatures and RH at each bin height. If NHV was working properly, temperature differences between top and bottom bins in the stack should not exceed 3oC (Boyette, 2009). A total of six Hobo data loggers per facility and harvest were placed in each bin to measure temperature and RH. A total of 18 Hobo data loggers per facility (6 at each harvest and facility) were used to determine the effect of IN incidence by temperature and RH for each bin. Hobo units recorded temperatures (ºF) and RH (%) every 30 minutes, starting the day of harvest until the last cutting sample day, approximately 180 DAH. The stack order of bins in 2017 was randomized and so the stacking order for each grower at each facility during each harvest was random (Figure 1).

To evaluate incidence of IN, a 30-root sample was taken at four different times after harvest from each bin at each facility, with a total of 120 roots collected per bin per harvest. Samples were taken starting 60 DAH, then 90, 120 and 180 DAH.

Roots were cut in thin slices (about 3-mm thick) starting from the stem end of the root until half or 2/3 of the root was sliced. When IN symptoms were present, the slice with the highest severity score (total surface of the slice with necrotic tissue) was recorded with the help of a grading card (2 being the lowest and 5 the highest) (Figure 2). Incidence of IN was calculated as the percentage of roots with any symptoms (2 to 5) of IN in a 30-root sample (4 total samples). Hobo data loggers were kept in the bins until the fourth sample was collected from each harvest. Three out of the 108 data loggers were lost or broken during harvest 3 in the 2017 study; Facility U- Grower V, Facility X-Grower Y, Facility Y-Grower X.

In 2016, a survey with 41 questions about the preharvest and postharvest practices at each grower´s field and facilities were given to each participant. The surveys were taken to see if there were common practices that could be associated with IN at preharvest (field practices) or postharvest (facility curing and storage). The survey was used to determine any obvious difference in practices among the growers. Preharvest practices such as mowing, fertilization, herbicides and insecticides or generation of the seed used for that year´s crop was some of the information gathered from the survey. The postharvest information such as curing time and temperature targeted, also provided information as to what the intended curing treatment was compared to what growers were achieving. For 2017, no survey was conducted.

Weather data from 2016 and 2017 the day of harvest and the first two weeks after harvest for each location (facility) was obtained by different weather stations (Appendix, Tables 1, 2, 3 & 4). Although these stations were not at the exact location where the roots were harvested and stored, proximity to the growers’ locations provided a good reference for weather differences between harvests.

These data were analyzed using Proc Mixed, SAS/STAT software, Version 9.4M3 of the SAS System for Windows. The design was a 6x6 factorial with bins of sweetpotatoes from 6 growers cured in 6 different curing facilities. The experiment was replicated over time, with one harvest in a preliminary study in 2016 and 3 replications over time (harvest 1 – early season, 2 – mid season, and 3 – late season) were run consecutively in 2017. Bin temperature, RH and IN incidence were measured and analyzed. The Tukey-Kramer Method (p<.05) was used to test for differences between treatment means. The growers were not the same in both years, so 2016 data were analyzed separate from 2017. The 2016 study was a preliminary experiment and Grower\*Facility was used as the error term for testing for grower and facility differences as there was no other random factor to use. The 2017 study had 3 full replications, run consecutively, and thus the analysis could test for grower\*facility interactions.

In 2018, another study was conducted were a combination of the controlled preharvest treatments (fertilizer and mowing) and the postharvest treatment at six different facilities with apparent or no problem with Internal Necrosis were combined. The research station in Kinston, Cunningham Research Station (35°18'17.7" N 77°34'52.5" W, Kinston, NC 28501) was selected for this study. The preharvest treatments were arranged as in 2016 and 2017 studies. The postharvest treatments differed from 2016 and 2017 studies. Six facilities, three with apparent IN problems and three without apparent IN problems were selected. Each facility provided one empty 40-bushel bin and a total of 32 lugs, two per plot/treatment, with a total of 30 roots were placed inside the 40-bushel bins and delivered the day of harvest (September 28) to each of the facilities. Once in the facility, the 40-bushel bin followed the common postharvest practices carried by each of the facilities. A total of 5 Hobo data loggers were placed inside each 40-bushel bins recording temperatures and RH% every hour. Sampled roots were collected in lugs and cut for incidence and severity of IN (120 Days After Harvest, DAH). Two statistical analysis were conducted; Tukey-Kramer (P<0.05) mean separation test between mowing\*fertilizer\*facility and a correlation study.

Correlation analyses were run for all studies to determine if there was a significant correlation between bin temperature and/or RH during the first 30 days after harvest and the incidence of IN. In the 2016 study, measurements were obtained from 18 bins: 3 growers at 6 facilities. In 2017 measurements were obtained from 36 bins, 6 growers and 6 facilities, for each of the 3 replications. In 2017, three Hobo data loggers failed in 3 bins in the final rep, so the total N for the correlations was n=123. Correlations between the average temperature data at four different time periods were conducted (days 1 to 7 (01-07), days 1 to 14 (01-14), days 1 to 30 (01-30) and days 15 to 28 (15-28) after harvest). Considering previous studies at the research station facility (Montero de Espinosa et al., 2018), these time periods were selected for these commercial studies. Ten variables were included in the analysis to better understand which factors have higher correlation with the incidence of IN at each of the four-time intervals. These variables for each time interval included; difference between maximum temperature and average temperature (Diff) throughout the selected periods, average of the maximum temperatures (MaxTemp), average of the minimum temperatures (MinTemp), average temperature (AvgTemp), average of the maximum relative humidity (MaxRH), average of the minimum RH (MinRH), days that temperature remained above 70ºF (DaysTempAbove70), days that temperature remained below 60ºF (DaysTempBelow60) and days that RH remained below 80% (DaysRHBelow80). By determining which values correlated best with IN incidence, these could be used to help growers avoid, reduce and predict IN occurrence.

**RESULTS & DISCUSSION**

*2016 Incidence\*Grower\*Facility analysis*

Determination was made as to whether facilities (postharvest conditions) have a greater effect on the incidence of IN than grower practices (preharvest conditions). Grower (Grower U, V, W, X, Y and Z) and facility (Facility U, V, W, X, Y and Z) were included in the study as independent variables. The dependent variable was obtained by the percentage incidence of IN averaged across four sample times as described earlier. To confirm that sampling results were consistent across time, the variable sample (1, 2, 3 and 4) was included in the analysis both years. Results confirmed that there is no sampling effect, meaning that IN incidence between sampling 60, 90, 120 and 180 DAH was similar. These results support studies published in 2018 where data showed that IN symptoms reaches a maximum by 30 DAH and remained similar thereafter (Dittmar et al., 2018).

Both variables (Grower and Facility) significantly impacted IN occurrence. However, Facility had a higher F-value than Grower (16.48 and 2.86, respectively) meaning that the variable Facility was more impactful on the response of IN occurrence than ‘Grower’ (Table 1). The interaction between Grower\*Facility was used as the error term for testing for grower and facility differences as there was no other random factor to use. The conditions under which certain growers experienced a higher incidence of IN in some facilities and much lower in others was evaluated with a second analysis to determine the correlation of temperatures and RH with IN incidence.

Facilities U, X, Y and Z were the facilities with relatively high IN problems, with Facility Y having the most incidence of 63% (Table 2). In contrast Facility V and W had minimal incidences (2% and 3%, respectively), regardless of Grower, indicating the significant impact that facility has on minimizing IN occurrence. Even though IN incidence was 58% or more for five of the six growers in Facility Y, only 10% incidence occurred with Grower U roots in Facility Y. This indicates that there is/are grower factors or environmental conditions that can also influence IN incidence.

The different response in IN incidence from both Grower and Facility revealed that both preharvest and postharvest factors affect IN. There was variability of response from each individual grower´s storage roots (preharvest) within the same facility; i.e. Grower U roots (10%) versus 57% to 83% IN incidence from the other grower´s roots in the same Facility Y (Table 2). There were different effects that facilities (postharvest) had on the same grower´s roots; i.e. Grower Y root incidence in Facility W (1%) versus Facility U (55%). Although preharvest treatments in this study were not controlled, the postharvest temperatures and RH recorded at each facility were precise and help discern what postharvest differences may have influenced differences in IN incidence response between facilities (Figure 3). For example, Facility Y was above 85ºF for the first 7 DAH and reached 95ºF after 3 DAH, and RH was below 80% during the first 10 DAH. In contrast, Facility W temperatures were below 80ºF the entire time in storage and RH was usually above 80%. These temperatures and RH differences could explain the high IN incidence in Facility Y and low in Facility W.

Many preharvest agricultural practices have been reported to not cause IN occurrence (Jiang et al., 2015; Beam et al., 2017; Dittmar et al., 2018) while the use of ethephon prior to harvest has been reported to increase IN incidence (Dittmar et al., 2010; Arancibia et al., 2013; Clark et al., 2013). Though the survey information collected was not completed in total by all the growers, the surveys did confirm that ethephon was not applied in any of the fields where roots were sourced in which IN incidence was observed.

Other potential preharvest factors could influence postharvest response in a given facility. For example, the use of mowing or not mowing might predispose storage roots to postharvest conditions encountered after harvest. Based on the survey, mowing practice varied among growers. Grower X was the only grower that did not mow the vines prior to harvest. Grower U mowed only a few days ahead of harvest. Grower W only mowed the vine tips off about ten days before harvest. Growers Y and Z reported they mowed a week prior to harvest. The time from mowing to harvest and the method used, may be an important consideration and possible reason for the variability of the IN incidence response of different grower roots in the same facility (Montero de Espinosa et al., 2018).

*2016 correlation analysis*

The intervals 01-07 and 01-14 days after harvest showed temperature variables significantly correlated (R > 0.60) to the increase of IN incidence (Tables 3 and 4). Maximum and minimum temperatures (*MaxTemp, MinTemp*) during the first seven days affected IN incidence (both with a P <0.002). Facility Y had the highest average maximum temperatures of 88ºF and the highest IN incidence of 55% (Figure 3, Table 5). Facilities V and W had 3% and 4% IN incidence and had an average maximum temperature (*MaxTemp*) of 75ºF and 73ºF, respectively (Figure 3) for the first seven days. Average temperatures (*AvgTemp*) were also correlated to the increase of IN during the first seven days after harvest (P <0.001). Facility Y averaged 88ºF and had the highest IN incidence, followed by Facility Z with 80ºF (which had a moderate IN incidence) with the lowest being 73ºF in Facility W (Figure 3, Table 5) which had a very low IN incidence. Similar results for *Max, Min and AvgTemp* were obtained in the interval 01-14 days after harvest (Table 4).

*DaysTempAbove70* was significant (P <0.041) for the 01-07 days interval (Table 4), but not the 01-14 days interval (Table 5). This likely occurred because most facilities were able to cool temperatures below 70ºF 5 to 8 days after harvest (Figure 3). However, Facilities X and Y remained above 70ºF for 13 and 9 days, respectively, and were the facilities with the highest incidence of IN (24% and 55%, respectively) (Table 5). This variable is not as good of an indicator of IN occurrence as the *Max, Min and AvgTemp*. A 70ºF threshold might be too low to result in substantial IN incidence. Temperatures as low as 75ºF were observed to result in IN incidence but incidence was much lower than when temperatures exceeded 80ºF (Golden Leaf Foundation, 2016). Although the days above 70ºF were higher in Facility X (13 days), the IN incidence recorded at this facility was 38% lower than in Facility Y, which was exposed to temperatures above 70ºF for 9 days. In this case, higher temperatures (81ºF) in Facility Y for 9 days had a much higher impact than the exposure of 13 days to 76ºF in Facility X. Thus, this measure may not accurately reflect IN incidence.

None of the RH variables showed significant correlations at the P=.05 level during the first seven or fourteen DAH (Tables 3 and 4). Relative humidity in Facility Y remained lower (79%) than what is recommended in the sweetpotato industry (Boyce et al., 1956; Boyette and Stewart, 1994; Nabubuya et al., 2017; Boyette, 2009) and had high levels of IN (Table 3). However, RH varied considerably from recommended levels and did not correlate well with IN incidence. Rather it seems like temperatures during the first fourteen DAH are the main factor influencing IN occurrence as RH variables were not good indicators of IN. Further research should evaluate the influence of low RH during the curing process as it´s been shown to affect the physiology of the roots (Boyce et al., 1956; Jones and Rosa, 1928; Nabubuya et al., 2017; Huang et al., 2014).

The variables 01-30 and 15-28 days after harvest didn´t show any significant correlation with the incidence of IN at the P=0.05 level (data not shown). These two intervals contained a substantial amount of temperature and RH data points where the temperatures were below 60ºF and RH was mostly around the 85%. The lack of significance in these two intervals provides evidence that IN occurrence is critical during the first fourteen days after harvest. The IN incidence response found in commercial facilities agrees with controlled temperature studies at the research station (Montero de Espinosa et al., 2018.)

*2017 Incidence\*Grower\*Facility analysis*

As in 2016, a ProcMixed analysis with IN incidence as the dependent variable was used to evaluate differences between Grower and Facility. The three harvests were not included as fixed effects, rather, they were used as replicates. The IN incidence recorded in harvest (replication) 1 and 2 were higher than in harvest 3 (data not shown). Differences in IN incidence between growers were not significant (P<0.0735); however, facility was significant with a P=0.0133 (Table 6). The interaction of these two variables was not significant. Less significance for the main effects and the interaction in 2017 than in 2016 was likely due to the lower IN incidence in 2017. When compared to the 2016 (Table 2) IN incidence was; U (36%), V (3%), W (4%), X (25%) Y (63%) and Z (17%), while there was a decrease of IN occurrence in these facilities in 2017 (Table 7) (average of three harvests); U (5%), V (2%), W (3%), X (13%), Y (9%) and Z (4%). The grower main effect was not significantly different across the six growers with averages ranging from as low as 2% (Grower Y) as high as 11% (Grower Z) (Appendix, Table 5).

The variability of IN occurrence between harvests remains unclear. However ambient temperatures the day of harvest and for the first fourteen DAH may be an important factor to consider. Ambient temperatures varied between harvests; Harvest 1 (September 14) at facilities Y, V, X and Z averaged 75ºF to 78ºF during the first fourteen DAH, and facilities U and W had outside average temperatures 65 to 75ºF throughout the same period. Harvest 2 (October 4) was warmer than Harvest 1 (71ºF to 80ºF versus 67ºF to 78ºF, respectively) the first seven to ten DAH in Facility U, W and ( 71ºF to 83ºF versus 75ºF to 76ºF, respectively) in Facility Y. (Appendix, Tables 1, 2, & 3). Weather temperatures during Harvest 3 (October 22) were cooler (66ºF) than at harvests 1 and 2 in all locations. After harvest 3, weather temperature also remained low; below or at 60ºF the third day after harvest until the end of the second week after harvest. The temperature differences between harvests may play an important role since facility managers participating in the study reported that cooler temperatures during the days of harvest will directly affect the efficiency of cooling the rooms after the curing process is achieved. Ambient temperatures at harvest and the first two weeks after harvest may have contributed to the general differences in IN occurrence between harvests or replications.

*Two-year combined correlation study*

For the combined study, IN incidences were averaged across the four replications (Harvests) and the overall incidence in this study was lower than in 2016. The highest incidence was Facility Y (16%), followed by Facility X (15%) with the remaining facilities between 2% and 8 % IN (Table 8).

A consistent correlation occurred between the incidence of IN and the temperature variables in storage (*Max, Min, AvgTemp)* during the first seven (01-07) and fourteen days (01-14) when all four harvests were combined for 2016 and 2017 (Table 9, 10). The R-values are much smaller compared to 2016 as the R-values ranged from 0.24 to 0.30. This is likely to the high variability between replications in the two-year combined study. Even though R values in this analysis versus 2016 are lower, these data indicate that Facility temperature plays an important role in IN incidence. This agrees with observations made in a preliminary study in 2016 (Golden Leaf Foundation, 2016) and controlled storage room studies (Montero de Espinosa et al., 2018).

The first 01-07 days, facilities with the highest IN incidence showed maximum temperatures were 78ºF to 82ºF (Table 8). Incidence in facilities Y, X and U were 16, 15 and 8%, respectively. The maximum temperatures ranged from 74ºF to 78ºF in the facilities with low incidence (2 to 6 %). Minimum temperature (*MinTemp*) and average temperature (*AvgTemp*) during the first 01-07 and 01-14 days after harvest were also significant (Table 9). One outlier was Facility X which had a maximum of 78ºF and 15% IN incidence. Average and maximum temperatures were generally higher than in most facilities and may have accounted for the higher IN incidence compared with the other facilities.

The small differences between the maximum temperatures across the six facilities coupled with average and minimum temperatures, shows that small variations in temperature can have a great impact on IN occurrence during the first fourteen days after harvest (Table 8).

Days of exposure to temperatures above 70ºF (*DaysTempAbove70*) was significantly correlated with the incidence of IN, only during the first seven days after harvest (01-07) (Tables 9, 10 and 11). Small differences between facilities with longer exposure to temperatures above 70ºF (6.6 to 7 days) versus shorter exposure (5.1 to 5.6) shows the difference a day makes when temperatures are above 70ºF as the former increases IN occurrence (Table 8). In a recent study, exposure of storage roots for four days (½ week) to either 75 or 85ºF resulted in significantly lower incidence of IN than those exposed to the same temperatures for seven or fourteen days (Montero de Espinosa et al., 2018).

Relative humidity variables seemed to have a minimal impact on IN occurrence as days RH below 80% (*DaysRHBelow80*) was the only significant RH variable during the first seven DAH (P<0.019) (Table 9). Facility W had the highest number of days below 80% RH (1.1) followed by Facility V (0.7) (Table 8). Both of these facilities had the lowest IN incidence for the first seven days (01-07). Although there appeared to be some connection with RH and IN incidence, variables were not significant for the 01-14 (Table 10), 15-28 DAH (data not shown) and the 01-30 (Table 11) time intervals. Thus, RH had limited impact on IN incidence.

During the 01-30 period (Table 11), the difference between the maximum and average temperature (*Diff*), minimum temperature (*MinTemp*) and average temp (*AvgTemp*) were significant. It is important to point out the potential importance of the *Diff* variable since it could be a good indicator of how a facility cools during the night. *Dif*f R-value is a negative number (-0.187) thus, the lower this value is, the more IN incidence occurs. Facilities with lower *Diff* value are maintained average temperatures close to the maximum value during the entire day. Facilities U, X and Y had 2 degrees of difference compared to the 4, 3 and 4 degrees recorded in facility V, W and Z, respectively (Table 8).

In conclusion, these studies show that the Facility has a more important role in the occurrence of IN than Grower practice or preharvest conditions. Temperature is a key factor that impacts the occurrence of IN. In addition, the first seven days after harvest is the most critical time period that influence IN incidence. The variables maximum, minimum and average temperature could potentially be used in the future as an important indicator of IN occurrence risk. Additional storage studies and modeling is warranted, especially temperature, to better predict IN occurrence.

*2018 Preharvest and correlation analysis*

No significant differences were found in the preharvest (mowing & fertilizer) analysis. Only facility was significant with a P <0.0001 due to the differences in IN incidence between facilities. The correlation study showed results similar to the ones seen in the 2016 and 2017. The highest incidence was Facility X (69%), followed by Facility U (43%) with the remaining facilities between 3% and 15 % IN (Table 12).

A consistent correlation occurred between the incidence of IN and the temperature variables in storage (*Max, Min, AvgTemp)* during the first seven (01-07) and fourteen days (01-14) (Table 13, 14). The temperature R-values during the first seven days were 0.70, 0.84 and 0.82 respectively and 0.75, 0.69 and 0.72 during the first 14 days. These values show the strong correlation between temperature and incidence of internal necrosis. The higher R-values during the first 7 days after harvest show the importance that temperature management has during these first days has on IN occurrence. The same trend was also seen in the controlled studies in Chapter I where incidence of IN consistently increased when roots were exposed from ½ to 2 weeks. The relative humidity (*Max, Min and AvgRH*) during the first seven days after harvest had also a significant correlation (Table 13) with R-values (0.67, 0.40 and 0.46 respectively) lower than the ones seen with temperatures. Should be noted that for the 14 days interval, these values were not significant, suggesting that RH plays an important role during the first seven days as temperature does.

Days of temperatures greater than 70ºF (DaysTempAbove70) had no significant impact

for the first 7 days since all facilities reached temperatures above 70 (Table 13). Although, during the first 14 days, the value was significant (P<0.0001) with an R-value of 0.66 (Table 14). Days temperature greater than 80ºF (DaysTempAbove80) was significant (P<0.0001) at both seven and fourteen days with R-values of 0.80 and 0.86 respectively. The lower R-values recorded for the 85ºF (DaysTempAbove85) 0.53 and 0.49 show that 80 ºF threshold is a better predictor of IN occurrence, specially uring the first seven days after harvest.

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Table 1. Type 3 tests fixed effects, 2016.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Effect | | Num DF | Den DF | F Value | | Pr > F |  |
| Grower | 5 | | 25 | 2.86 | 0.0357 | | |
| Facility | 5 | | 25 | 16.48 | <.0001 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Grower | | | | | |  | | | | | | |
| Facility | U | V | W | X | Y | Z | | Avg. | | |  |  |
| U | 19z | 17 | 39 | 23 | 55 | 10 | | 27 | | |  |  |
| V | 4 | 0 | 1 | 2 | 4 | 2 | | 2 | | |  |  |
| W | 4 | 5 | 3 | 5 | 1 | 2 | | 3 | | |  |  |
| X | 16 | 11 | 20 | 22 | 48 | 33 | | 25 | | |  |  |
| Y | 10 | 74 | 58 | 83 | 82 | 72 | | 63 | | |  |  |
| Z | 6 | 9 | 9 | 30 | 39 | 7 | | 16 | | |  |  |
| Avg. | 10 | 19 | 21 | 27 | 39 | 21 | |  | | |  |  |
| LSDY (0.05) | 24 | | | | | | | |  |

Table 2. Average percentage of IN for each grower (column) and each facility (row), 2016.

Z Incidence of IN from the 180 sampled roots from each grower´s bin.

Y Pair wise comparisons for significance for each Grower and Facility.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Diff | |  | | Max Temp | |  | | Min Temp | |  | | Avg Temp | |  | MaxRH | | |  | MinRH |  | AvgRH | | |  | | | | | | | | | | |  | |  | | |  | |
| (R)ValueZ  P-Value |  | 0.217  0.771 | |  | | 0.673  0.002 | |  | | 0.612  0.002 | |  | | 0.637  0.001 | |  | | -0.407  0.193 |  | -0.168  0.792 | | |  | -0.380  0.312 | | | |  | | | | | | | | | | | | | |  | |
|  |  | DaysTemp DaysRH DaysTemp  Above70 Below80 Below60 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  |  |  | | | | | | | | | | |  |  |  |
| (R) Value  P-Value |  | 0.486 0.402 NAY  0.041 0.098 NA | | | | | | | | | | | | | | | | | | | | | | |  |  |  | |  |  | |  | | | |  |  | |  | |
|  |  |  |  | |  |  | |  | | | |  |  | |  | |

Table 3. Pearson correlation coefficient, N=18 for 01 – 07 DAH, 2016.

Z The value shows the linear relationship between the variable selected and the % IN Incidence that the variable

accounts for. A negative number shows an inverse relationship.

YNA means Not Applicable.

Table 4. Pearson correlation coefficient, N=18 for 01-14 DAH, 2016.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Diff |  | Max Temp |  | Min Temp |  | AvgTemp |  | MaxRH |  | MinRH |  | AvgRH | |  | | |  |  |
| (R) ValueZ  P-Value |  | 0.074  0.772 |  | 0.672  0.002 |  | 0.669  0.002 |  | 0.694  0.001 |  | -0.322  0.193 |  | -0.067  0.792 |  | -0.252  0.312 | |  | | |  |  |
|  |  | DaysTemp DaysRH DaysTemp  Above70 Below80 Below60 | | | | | | | | | | | | | | |  | | | |
| (R) Value  P-Value |  | 0.409 0.169 -0.183  0.092 0.503 0.467 | | | | | | | | | | | | |  |  |  |  | |  |

Z The value shows the linear relationship between the variable selected and the % IN Incidence that the variable accounts for. A negative number shows an inverse relationship.

Table 5. Internal necrosis incidence, temperature and RH variables during the intervals 01-07 and 01-14 DAH, 2016 and 2017.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Facility | |  | %IN | | MaxTemp | | AvgTemp | | Diff  (Max-Avg) | | MinTemp | | MaxRH | | MinRH | | AvgRH | | | Days Temp Above 70 | | Days RH Below 80 | | Days Temp Below60 | |
|  | Days 01-07 | | | | | | | | | | | | | | | | | | | | | | | | | |
| U | |  | | 17 | | 80 | | 75 | | 5 | | 72 | | 86 | | 69 | | 80 | | | 6.3 | | 1.7 | | 0 |
| V | |  | | 3 | | 75 | | 72 | | 3 | | 69 | | 82 | | 66 | | 76 | | | 5 | | 2.2 | | 0 |
| W | |  | | 4 | | 73 | | 71 | | 3 | | 68 | | 87 | | 74 | | 83 | | | 5.7 | | 1 | | 0 |
| X | |  | | 24 | | 78 | | 73 | | 5 | | 69 | | 88 | | 73 | | 82 | | | 7 | | 0.7 | | 0 |
| Y | |  | | 55 | | 88 | | 85 | | 4 | | 81 | | 83 | | 71 | | 79 | | | 7 | | 2.7 | | 0 |
| Z | |  | | 14 | | 80 | | 78 | | 3 | | 75 | | 91 | | 78 | | 87 | | | 7 | | 0.7 | | 0 |
|  | Days 01-14 | | | | | | | | | | | | | | | | | | | | | | | | | |
| U | |  | | 17 | | 72 | | 69 | | 3 | | 67 | | 87 | | 74 | | | 82 | | 6.3 | | 1.7 | | 0 |
| V | |  | | 3 | | 71 | | 67 | | 4 | | 63 | | 80 | | 64 | | | 73 | | 5.3 | | 6 | | 0 |
| W | |  | | 4 | | 69 | | 67 | | 2 | | 65 | | 89 | | 75 | | | 83 | | 6.7 | | 1 | | 0.7 |
| X | |  | | 24 | | 76 | | 72 | | 4 | | 68 | | 86 | | 72 | | | 81 | | 12.7 | | 0.7 | | 0 |
| Y | |  | | 55 | | 81 | | 77 | | 4 | | 73 | | 84 | | 71 | | | 79 | | 9 | | 3.3 | | 0 |
| Z | |  | | 14 | | 74 | | 71 | | 3 | | 68 | | 90 | | 74 | | | 83 | | 8 | | 1.3 | | 0 |

Table 6. Type 3 tests of fixed effects, 2017.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | |
| *Effect* | | *Num DF* | | *Den DF* | | *F Value* | *Pr > F* | |
| *Grower* | 5 | | 70 | | 2.12 | | | 0.0735 |
| *Facility* | 5 | | 70 | | 3.12 | | | 0.0133 |
| *Grower\*Facility* | 25 | | 70 | | 0.32 | | | 0.9990 |
| *Sample* | 3 | | 291 | | 0.39 | | | 0.7583 |
| *Grower\*Sample* | 15 | | 291 | | 1.15 | | | 0.3141 |
| *Facility\*Sample* | 15 | | 291 | | 1.34 | | | 0.1763 |

Table 7. Average percentage of IN for each grower (column) at each facility (rows) after three harvests, 2017.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Grower | | | | | | |  |  |  |  |  |  |  |  |  |
| Facility | U | V | W | X | Y | Z | Avg. | |  |  |  |  |  |  |  |  |
| U | 2z | 3 | 10 | 1 | 1 | 15 | 5 ab | |  |  |  |  |  |  |  |  |
| V | 2 | 6 | 1 | 2 | 1 | 2 | 2 b | |  |  |  |  |  |  |  |  |
| W | 1 | 4 | 4 | 5 | 1 | 4 | 3 b | |  |  |  |  |  |  |  |  |
| X | 9 | 20 | 15 | 8 | 6 | 16 | 12 a | |  |  |  |  |  |  |  |  |
| Y | 10 | 8 | 12 | 4 | 5 | 17 | 9 ab | |  |  |  |  |  |  |  |  |
| Z | 3 | 4 | 8 | 1 | 0 | 10 | 4 ab | |  |  |  |  |  |  |  |  |
| Avg. | 4 a Y | 7 a | 8 a | 3 a | 2 a | 11 a |  | |  |  |  |  |  |  |  |  |

Z Average incidence of IN from the 180 sampled roots from each of the grower´s bin.

Y Significant at the <.05 level when letters differed within Facility or Grower.

Table 8. Internal necrosis incidence, temperature and RH variables during the intervals 01-07, 01-14 and 01-30 DAH for each facility, 2016 and 2017.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Facility | % IN | | | MaxTemp | AvgTemp | Diff  (Max-Avg) | MinTemp | | MaxRH | MinRH | | AvgRH | | Days Temp Above 70 | Days RH Below80 | Days Temp Below 60 |  | |
| Days 01-07 | | | | | | | | | | | | | | | | | | | |
| U | | 8 | | 82 | 80 | 3 | 76 | 93 | | | 76 | 87 | 6.7 | | 0.3 | 0.0 |  | |
| V | | 2 | | 78 | 75 | 4 | 71 | 90 | | | 74 | 84 | 5.5 | | 0.7 | 0.0 |  | |
| W | | 3 | | 74 | 70 | 4 | 67 | 86 | | | 72 | 80 | 5.1 | | 1.0 | 0.4 |  | |
| X | | 15 | | 78 | 76 | 2 | 74 | 95 | | | 85 | 92 | 7.0 | | 0.1 | 0.0 |  | |
| Y | | 16 | | 81 | 79 | 3 | 75 | 92 | | | 79 | 87 | 6.6 | | 0.5 | 0.0 |  | |
| Z | | 6 | | 78 | 74 | 5 | 70 | 91 | | | 74 | 85 | 5.6 | | 0.4 | 0.3 |  | |
| Days 01-14 | | | | | | | | | | | | | | | | | | | |
| U | | 8 | | 75 | 73 | 2 | 71 | 89 | | | 77 | 84 | | 9.2 | 2.1 | 0.6 |  | |
| V | | 2 | | 76 | 71 | 4 | 67 | 88 | | | 72 | 81 | | 8.8 | 1.6 | 0.0 |  | |
| W | | 3 | | 72 | 69 | 3 | 65 | 86 | | | 73 | 80 | | 8.5 | 2.4 | 0.6 |  | |
| X | | 15 | | 75 | 73 | 2 | 71 | 94 | | | 86 | 91 | | 11.8 | 0.1 | 0.0 |  | |
| Y | | 16 | | 74 | 71 | 2 | 69 | 91 | | | 81 | 87 | | 7.5 | 0.7 | 0.8 |  | |
| Z | | 6 | | 74 | 71 | 4 | 67 | 90 | | | 77 | 85 | | 8.9 | 1.5 | 1.2 |  | |
| Days 01-30 | | | | | | | | | | | | | | | | | |  | |
| U | | 8 | 69 | | 67 | 1.9 | 64 | 87 | | | 75 | 82 | | 11.7 | 6.0 | 4.8 |  | |
| V | | 2 | 70 | | 66 | 3.8 | 62 | 85 | | | 71 | 79 | | 13.0 | 7.0 | 5.9 |  | |
| W | | 3 | 69 | | 66 | 2.9 | 63 | 84 | | | 72 | 79 | | 12.6 | 6.9 | 3.9 |  | |
| X | | 15 | 68 | | 67 | 1.5 | 65 | 92 | | | 84 | 89 | | 14.7 | 2.0 | 8.0 |  | |
| Y | | 16 | 65 | | 63 | 1.8 | 61 | 91 | | | 84 | 88 | | 7.5 | 0.7 | 15.0 |  | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Diff |  | MaxTemp |  | MinTemp |  | AvgTemp |  | MaxRH |  | MinRH |  | AvgRH | |  | | | | |  |  |  |
| (R) ValueZ  P-Value |  | -0.119  0.189 |  | 0.241  0.007 |  | 0.306  0.006 |  | 0.270  0.003 |  | -0.149  0.100 |  | -0.087  0.339 |  | -0.050  0.581 | |  | | | | |  |  |  |
|  |  | DaysTemp DaysRH DaysTemp  Above70 Below80 Below60 | | | | | | | | | | | | |  | | | | |
| (R) Value  P-Value |  | 0.197 0.211 -0.123  0.029 0.019 0.176 | | | | | | | | | | | | |  | |  |  |  |

Table 9. Pearson correlation coefficient, N=123 for 01-07 DAH, 2016 – 2017 combined.

Z The value shows the linear relationship between the variable selected and the % IN Incidence that the variable accounts for. A negative number shows an inverse relationship.

Table 10. Pearson correlation coefficient, N=123 for 01-14 DAH, 2016 – 2017 combined.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Diff |  | MaxTemp |  | MinTemp |  | AvgTemp |  | MaxRH |  | MinRH |  | Avg  RH | | | | | |  | | |  |  |  |
| (R) ValueZ  P-Value |  | -0.103  0.257 |  | 0.247  0.006 |  | 0.295  0.009 |  | 0.284  0.002 |  | -0.127  0.163 |  | 0.016  0.858 |  | -0.058  0.525 | | | | | |  | | |  |  |  |
|  |  | DaysTemp DaysRH DaysTemp  Above70 Below80 Below60 | | | | | | | | | | | | | | |  | | | | |
| (R) Value  P-Value |  | 0.197 0.114 -0.102  0.063 0.211 0.264 | | | | | | | | | | | | |  |  |  |  |  | |

Z The value shows the linear relationship between the variable selected and the % IN Incidence that the variable accounts for. A negative number shows an inverse relationship.

Table 11. Pearson correlation coefficient, N=123 for 01-30 DAH, 2016 – 2017 combined.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Diff |  | MaxTemp |  | MinTemp |  | AvgTemp |  | MaxRH |  | MinRH |  | AvgRH | | | | |  | | |  |  |
| (R) ValueZ  P-Value |  | -0.187  0.038 |  | 0.130  0.152 |  | 0.225  0.012 |  | 0.182  0.044 |  | -0.052  0.565 |  | 0.108  0.233 |  | 0.022  0.814 | | | | |  | | |  |  |
|  |  | DaysTemp DaysRH DaysTemp  Above70 Below80 Below60 | | | | | | | | | | | | | | |  |  | |  |
| (R) Value  P-Value |  | 0.093 0.022 -0.057  0.305 0.812 0.530 | | | | | | | | | | | | |  |  |  |  | |  |

Z The value shows the linear relationship between the variable selected and the % IN Incidence that the variable accounts for. A negative number shows an inverse relationship.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Facility | | | %IN | | MaxTemp | | | | | | Avg  Temp | | | MinTemp | | | | MaxRH | | | | MinRH | | | | AvgRH | | | | Days Temp Above 70 | | | | Days Temp Above 80 | | | Days Temp Above 85 | | | | | Days Temp Below 60 | | | | | | |
| Days 01-07 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| U | | 43 | | | | 88.5 | | | 83.6 | | | | 80.7 | | | 95.2 | | | | 79.3 | | | 90.1 | | | | | 7.0 | | | 7.0 | | | | | 5.0 | | | | 0.0 | | | | | | |
| V | | 3 | | | | 78.5 | | | 75.8 | | | | 73.8 | | | 95.8 | | | | 81.8 | | | 92.4 | | | | | 7.0 | | | 1.0 | | | | | 1.0 | | | | 0.0 | | | | | | |
| W | | 2.5 | | | | 79.4 | | | 77.6 | | | | 75.9 | | | 95.5 | | | | 86.8 | | | 92.7 | | | | | 7.0 | | | 4.0 | | | | | 1.0 | | | | 0.0 | | | | | | |
| X | | 69 | | | | 84.0 | | | 82.8 | | | | 81.7 | | | 98.7 | | | | 92.5 | | | 96.7 | | | | | 7.0 | | | 7.0 | | | | | 2.0 | | | | 0.0 | | | | | | |
| Y | | 15 | | | | 81.1 | | | 79.8 | | | | 78.6 | | | 94.5 | | | | 88.2 | | | 91.9 | | | | | 7.0 | | | 3.0 | | | | | 1.0 | | | | 0.0 | | | | | | |
| Z | | 14 | | | | 79.4 | | | 77.6 | | | | 75.9 | | | 95.5 | | | | 86.8 | | | 92.7 | | | | | 7.0 | | | 4.0 | | | | | 1.0 | | | | 0.0 | | | | | | |
| Days 01-14 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| U | | 43 | | | | | 81.4 | | | 78.2 | | | | 75.9 | | | 89.5 | | | | 77.5 | | | | 85.3 | | | | 12.0 | | | 9.0 | | | 6.0 | | | | 0.0 | | | | | | | | |
| V | | 3 | | | | | 71.0 | | | 68.6 | | | | 66.9 | | | 94.4 | | | | 85.1 | | | | 91.4 | | | | 8.0 | | | 1.0 | | | 1.0 | | | | 3.0 | | | | | | | | |
| W | | 2.5 | | | | | 74.3 | | | 72.7 | | | | 71.5 | | | 94.9 | | | | 89.0 | | | | 92.5 | | | | 9.0 | | | 4.0 | | | 1.0 | | | | 0.0 | | | | | | | | |
| X | | 69 | | | | | 81.7 | | | 80.6 | | | | 79.6 | | | 96.9 | | | | 92.2 | | | | 95.1 | | | | 14.0 | | | 10.0 | | | 2.0 | | | | 0.0 | | | | | | | | |
| Y | | 15 | | | | | 80.2 | | | 79.3 | | | | 78.5 | | | 92.7 | | | | 87.2 | | | | 90.2 | | | | 14.0 | | | 5.0 | | | 1.0 | | | | 0.0 | | | | | | | | |
| Z | | 14 | | | | | 74.3 | | | 72.7 | | | | 71.5 | | | 94.9 | | | | 89.0 | | | | 92.5 | | | | 9.0 | | | 4.0 | | | 1.0 | | | | 0.0 | | | | | | | | |
| Days 01-30 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| U | 43 | | | 70.9 | | | | 69.1 | | | | 67.8 | | | 85.5 | | | | 77.2 | | | | | 82.2 | | | 12.0 | | | | | | 9.0 | | | | | 6.0 | | | 5.0 | | | | |
| V | 3 | | | 65.0 | | | | 63.4 | | | | 62.0 | | | 93.2 | | | | 84.6 | | | | | 90.0 | | | 8.0 | | | | | | 1.0 | | | | | 1.0 | | | 13.0 | | | | |
| W | 2.5 | | | 66.1 | | | | 64.8 | | | | 63.6 | | | 92.1 | | | | 83.8 | | | | | 88.7 | | | 9.0 | | | | | | 4.0 | | | | | 1.0 | | | 16.0 | | | | |
| X | 69 | | | 71.8 | | | | 70.9 | | | | 70.1 | | | 93.9 | | | | 87.7 | | | | | 90.9 | | | 15.0 | | | | | | 10.0 | | | | | 2.0 | | | 2.0 | | | | |
| Y | 15 | | | 73.7 | | | | 72.5 | | | | 71.5 | | | 84.7 | | | | 75.0 | | | | | 79.8 | | | 22.0 | | | | | | 5.0 | | | | | 1.0 | | | 2.0 | | | | |
| Z | 14 | | | 66.1 | | | | 64.8 | | | | 63.6 | | | 92.1 | | | | 83.8 | | | | | 88.7 | | | 9.0 | | | | | | 4.0 | | | | | 1.0 | | | 16.0 | | | | |

Table 12. Internal necrosis incidence, temperature and RH variables during the intervals 01-07, 01-14 and 01-30 DAH for each facility, 2018.

Table 13. Pearson correlation coefficient, N=123 for 01-07 DAH. 2018

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Diff | MaxTemp | | MinTemp | AvgTemp | MaxRH | MinRH | AvgRH |
| (R) ValueZ  P-Value | 0.03696  0.7207 | 0.70493  <.0001 | | 0.84170  <.0001 | 0.81864  <.0001 | 0.81864  <.0001 | 0.81864  <.0001 | 0.30508  0.0025 |
|  | DaysTemp  Above70 | | | DaysTemp  Above80 | | DaysTemp  Above85 | | DaysTemp  Below60 |
| (R) ValueZ  P-Value | -  - | | 0.79577  <.0001 | | | 0.79577  <.0001 | | -  - |

Table 14. Pearson correlation coefficient, N=123 for 01-14 DAH. 2018

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Diff | MaxTemp | | MinTemp | AvgTemp | | MaxRH | MinRH | | AvgRH |
| (R) ValueZ  P-Value | 0.03433  0.7398 | 0.74773  <.0001 | | 0.68953  <.0001 | 0.72288  <.0001 | | 0.05433  0.5991 | 0.03577  0.7294 | | 0.05110  0.6210 |
|  | DaysTemp  Above70 | | DaysTemp  Above80 | | | DaysTemp  Above85 | | | DaysTemp  Below60 | |
| (R) ValueZ  P-Value | 0.66433  <.0001 | | 0.86473  <.0001 | | | 0.49039  <.0001 | | | -0.37165  0.0002 | |

Table 15. Pearson correlation coefficient, N=123 for 01-31 DAH. 2018.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Diff | MaxTemp | | MinTemp | AvgTemp | | MaxRH | MinRH | | AvgRH |
| (R) ValueZ  P-Value | -0.43163  <.0001 | 0.57198  <.0001 | | 0.58989  <.0001 | 0.58155  <.0001 | | 0.00661  0.9490 | 0.16341  0.1117 | | 0.04215  0.6834 |
|  | DaysTemp  Above70 | | DaysTemp  Above80 | | | DaysTemp  Above85 | | | DaysTemp  Below60 | |
| (R) ValueZ  P-Value | 0.29365  0.0037 | | 0.86473  <.0001 | | | 0.49039  <.0001 | | | -0.66027  <.0001 | |