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Research Note

Performing statistical analysis to describe the emergence of corn and sorghum in Florida using thermometer electronic sensors records

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Corn and sorghum are staple forage crops in Florida. Innovative agriculture depends on science and technology to explain biological and ecological phenomena such as field plants' emergence. This research study was conducted in Florida in 2017 using two electronic thermometers (HOBO UA-001-64, and HOBO H08-032-08). One measuring the soil temperature and the other the air temperature, respectively in the location of the experiment. An analysis of the means, normality, and a comparison of the means of the two devices were performed using statistical analyzes (t, and F analyses) to know the most accurate description of emergence according to scientific literature. A soil readout thermometer (HOBO UA-001-64) appears closest and realistic to describe the emergence of corn and sorghum in Florida.

Key words: emergence, normality, sensor, temperature

INTRODUCTION

The term germination is used in seed science to denote the germination of seeds in ideal conditions such as germination incubators. In crop science, field germination is called emergence. There is a relatively wide range of planting dates for sorghum in the southeast of the United States, mainly because the emergence of sorghum is closely related to soil temperature. It is important to ensure that good stand development needs soil temperature at a depth of 2 inches is at least 65°F (18 °C) (Vendramini et al., 2016). Also, the growth and development of the corn are primarily dependent on temperature rather than the length of the day. Successful emergence of corn requires a morning soil temperature of 55°F (12 °C) to 2-inch intensity for three consecutive days (Wright et al., 2014). Corn and sorghum are warm-season crops. Corn germination and emergence are optimal when soil temperatures are approximately 85 to 90°F (29.44-32.22 °C) (Stoll and Saab, 2013). Cool conditions during planting place considerable stress on the development of corn and the health of seedlings. This study aims to follow a logical and statistical protocol based on electronic thermometer sensors readings to explain the field emergence of corn and sorghum in Florida.

MATERIALS AND METHODS

On 12 April 2017, 3 silage corn hybrids (6640VT3P, DKC70-01, and P1197YHR) and 2 sorghum hybrids (ss2010, and Sugar Graze II) were grown in the field at Florida (A&M) University. Since planting on April 12, 2017, daily mean temperatures have been recorded at the experimental site using two sensors.

Table 1. Daily mean temperatures (°C) measured by two sensors at the field site from planting April 12 to April 22, 2017

Date	Daily Mean Temperature (°C) Sensor: HOBO UA-001-64	Daily Mean Temperature (°C) Sensor: HOBO H08-032-08
April 14, 2017	29.82363	20.67303
April 15, 2017	27.10196	21.81867
April 16, 2017	27.33942	20.79985
April 17, 2017	27.39371	21.16607
April 18, 2017	28.71996	22.37313
April 19, 2017	29.87896	23.21861
April 20, 2017	29.57075	22.41851
April 21, 2017	28.72033	22.12051
April 22, 2017	28.0685	21.79806

*Sensors records started on April 14, 2017

Table 2. Normality test using SPSS (Version 26)

Tests of Normality						
Sensor Model	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
HOBO UA-001-64	.180	9	.200*	.896	9	.229
HOBO H08-032-08	.156	9	.200*	.957	9	.767

**df: Degrees of Freedom*

The temperature was recorded every ten minutes by the sensor (HOBO H08-032-08) and the temperature recorded every hour by the other sensor (HOBO UA-001-64). Daily mean temperatures for each sensor and every day since planting until the end of April 22 2017, are shown in Table 1. The procedure compares the means of using a t-test of two separate samples. The normality test (SPSS Version 26) was performed and showed a significant (>0.05) result (table 2). The parametric test called the t-test is useful for testing those samples whose size is less than 30 (like table 1). The test of normality (table 2) for 2 digital sensors showed a significant impact (> 0.05). The data used were the means of daily temperatures.

RESULTS AND DISCUSSION

Two samples that are not at all related to each other are tested in two separate sample t-tests. The main idea behind two independent sample t-tests is to draw a statistical inference on the comparison of two separate data samples. To decide whether the variances are equal in both records (which can determine the type of t-test to be performed), a statistical test done to determine the variance. The test for variance equality is an F-test of two variance samples (Excel Tutorials Website, 2020) at a probability level of 0.05. (Table 3).

Table 3. F-test two sample for variances using Excel (2013)

F-Test Two-Sample for Variances		
Sensor Model	Sensor: HOBO UA-001-64	Sensor: HOBO H08-032-08
Mean	28.51302444	21.82071556
Variance	1.20087065	0.686866548
Observations	9	9
df	8	8
F	1.748331832	
P(F<=f) one-tail	0.223302219	
F Critical one-tail	3.438101233	

Table 4. t-test two samples assuming equal variances using Excel (2013)

t-Test: Two-Sample Assuming Equal Variances		
Sensor Model	Sensor HOBO UA-001-64	Sensor HOBO H08-032-08
Mean	28.51302	21.82072
Variance	1.200871	0.686867
Observations	9	9
Pooled Variance	0.943869	
Hypothesized Mean Difference	0	
Df	16	
t Stat	14.61257	
P(T<=t) one-tail	5.65E-11	
t Critical one-tail	1.745884	
P(T<=t) two-tail	1.13E-10	
t Critical two-tail	2.119905	

It can be noticed that the probability p=0.223302219 is highlighted. This is a one-tail p-value associated with the variance equality test. Generally, if this value is greater than 0.05, it can be assumed that the variances are equal. Thus, a t-test of two samples of equal variances must be performed (Table 4).

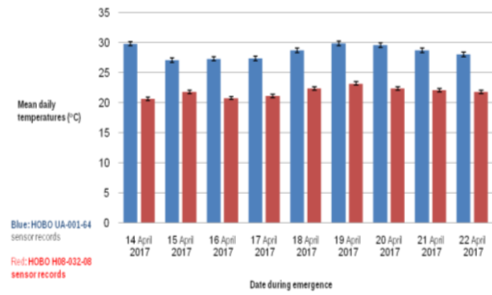

Figure 1. Mean daily temperatures (°C) recorded by two digital sensors in the field during emergence. Vertical bars show the (±) standard error of the mean (n varies).

Figure 1 shows the mean daily temperatures recorded in the field by two digital sensors during the emergence stage. The Standard Error sign (number of samples for each mean varies).

T statistical (14.61257) is higher than t critical two-tail (2.119905).

Null Hypothesis: H_0: $\mu_1 = \mu_2$

Alternative Hypothesis: H_a: $\mu_1 \neq \mu_2$

There is a significant difference between the two independent samples (sensor HOBO UA-001-64, and sensor HOBO H08-032-08) after planting (April 12, 2017) until the end of emergence (April 22, 2017) for the experimental site.

Thus, it can be concluded that the first digital sensor HOBO UA-001-64 (mean temperature 28.51302 °C) is more accurate than the second one HOBO H08-032-08 (mean temperature 21.82072 °C) concerning corn and sorghum emergence. Stoll and Saab (2013) reported that corn is a warm-season crop. Emergence is optimal when soil temperatures are approximately 85 to 90°F (29.44-32.22 °C). Cool conditions during planting place significant stress on corn emergence and the health of the seedling.

CONCLUSION

It can be concluded that the first sensor represents soil temperature rather than the air temperature in the experimental site. This study shows the importance of statistical analysis and sequencing of steps if there are means of less than 30 for a huge set of data and how they are used in describing the bio-ecological data in plant science.

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COMPETING INTERESTS

The author has declared that no competing interest exists.

ETHICS APPROVAL

Not applicable.

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