# CHAPTER VII

# Use of an Electrical Conductivity Test to Predict Field Emergence of Grain Sorghum

## Introduction

Weak seeds can possess poor membrane structure, which results in greater electrolyte loss and higher conductivity measurements in their steep water (the imbibing solution). Thus high electrolyte measurements may be correlated with low vigor of the seeds and consequently a low field emergence and final stand for a wide range of species (Pandey, 1992).

With the objective of validating the above generalization for sorghum, the electrical conductivity of steep water from the seeds of the hybrids used in the 1995 and 1996 Virginia Sorghum Trials was measured. The total amount of leakage and the amount of leakage per unit seed area or mass were determined, and each of these values was compared against the field performance of that seedlot of that hybrid.

## Materials and Methods

### Theory

The electrical conductivity test is based on measurement of resistance to flow of an electric current imposed upon the seed steep water. Resistance is a function of the amount of electrolytes in solution. Pure water has a great electrical resistance, but solutions of electrolytes, which are ionic substances, allow electric currents to flow. Many cellular constituents are acids, bases, or their salts, i. e., electrolytes. Electrolyte efflux from seeds during imbibition is presumably an indication of seed cell membrane condition. Weak seeds generally possess poorer membrane structure, which results in greater electrolyte loss and higher conductivity measurements (Pandey,1992).

Conductivity is a measure of the ability of a conductor to carry an electric current. The mechanism by which an instrument measures this ability is based on the transport of ions to the electrodes when an electrical potential is applied. This measure is a function of charge concentration and mobility of the particles in the medium (Pandey,1992).

When an electrical potential is applied through a conductor, the current-voltage relationship is given by Ohm's law: $I = V/R$, where I = intensity or rate of current flow, V = Volts or electrical potential, and R = resistance to flow. The current flow is measured in amperes (A) and depends on the voltage (V) applied and the resistance (R) of the medium, which is measured in Ohms (Ω). The reciprocal of resistance is called conductance (C), where $C = 1/R$. Consequently the unit of C measurement is 1/Ω. Conductivity is calculated in accordance with the equation $C = I/V$, and the units of C are expressed as $1/\Omega\ cm^{-1}$. In the International System, this unit is equivalent to a Siemens ($S\ cm^{-1}$). Seed steep water involves small amounts of current usually expressed in μA, and therefore the conductances are usually reported as $\mu S\ cm^{-1}$.

**Conductivity measurements**

A Genesis 2000 (G 2000) seed analyzer produced by Wavefront, Inc. (Ann Arbor, Michigan) was used. The device has three main components:

a) a plastic soaking tray that contains 100 compartments or cells each with about 4 ml capacity,
b) a multi-electrode head with 100 pairs of specially designed electrodes connected to an electrical monitoring system, and
c) a seed analyzer computer program that analyzes the measurements of the electric current or resistance across each electrode pair.

When the electrode head system is placed on the tray, one pair of electrodes is submerged in each cell. An applied voltage exerts a uniform electrical potential across each electrode pair, and the computer translates the amperage into conductivities.

To measure individual seed steep water conductivity, one sorghum seed was placed in each of the 100 cells. The soaking tray was washed and rinsed with double-distilled water prior to each test run to remove ionic impurities. Prior to adding the seeds, each cell was filled with 3 ml distilled water. This ensured the full submersion of the electrodes as well as a constant volume to receive the leachate. The tray was covered with a plastic film to prevent evaporation. The seeds were to allowed to imbibe and to leach for 24 hours at 25°C. The conductivity reading was done with an electrical potential applied to each electrode pair, and the current (μA) passing through each cell's leachate was automatically recorded. The conductance value for each of the cells was automatically calculated, and the mean value and the standard deviation for 100 seeds were calculated by the Genesis 2000 software (Wavefront Inc, 1995). There were changes in the apparatus used between 1995 and 1996 testing. The nature of those changes is proprietary.

**Seed volume and area determinations**

The total seed area was determined using the assumption that sorghum seeds are spheres. The volume of 100 seeds for each hybrid was measured by water displacement in a graduated cylinder. Three repetitions were performed, and the average was taken as 100-seed volume. From the measured seed volume, the radius as a sphere was readily determined, and the seed surface area was then calculated. The electrical conductivity per $cm^2$ of seed area was determined, and regression analyses were performed to examine possible correlations between this variable and field emergence. In another analysis, electrical conductivity per gram of seed mass was regressed against emergence. Seeed mass was calculated by determining the average weight of three replications of 50 seeds, and this value was divided by the mean electrical conductivity of the seedlot to obtain conductivity per gram of seed.

**Data analysis**

For the statistical analyses, the mean conductivity value of 100 seeds was considered one replication of each hybrid for each year, and three replications of each hybrid and year were tested. A variance analysis (SAS Institute, 1993) was performed to test for significant differences among hybrids, and regression analyses were used to seek correlations between electrical conductivity and field emergence.

# Results and Discussion

**Electrical conductivity of seeds of hybrids in the 1995 Virginia Sorghum Trials**

There were differences in electrical conductivity among hybrids tested in 1995. The hybrids GW6089 and P8446 leached more electrolytes than SS160, CAR837, CAR775, and P8118 (Table 7.1). The general mean was 20.3 µS, and the CV was 15.0%. When field emergence was regressed on electrical conductivity, there was no linear association between variables with $P = 0.48$ and $r^2 = 0.023$ (Figure 7.1).

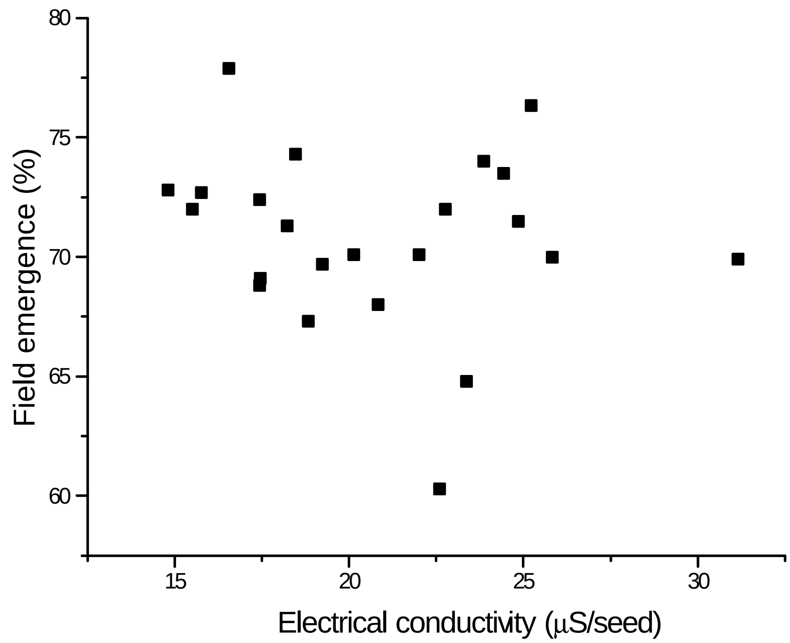



**Figure 7.1. Linear regression (ns) of field emergence and electrical conductivity per seed for hybrids in the 1995 Virginia Sorghum Trials.**

**Electrical conductivity per $cm^2$ of seed area of hybrids in the 1995 Virginia Sorghum Trials**

There were significant differences among hybrids for the amount of leachate per $cm^2$ of seed ($P < 0.0011$). CAR737, X604, and GW6089 leached more per unit of area than CAR775 (Table 7.1). The general mean of this test was 70.4 $\mu S/cm^2$, and the CV was 15.1%. The surface areas for the hybrids are shown in Table 7.2.

Field emergence was regressed against electrolyte leakage per $cm^2$ of seed area, and there was no linear association between variables, with $P = 0.141$ and $r^2 = 0.096$ (Figure 7.2).

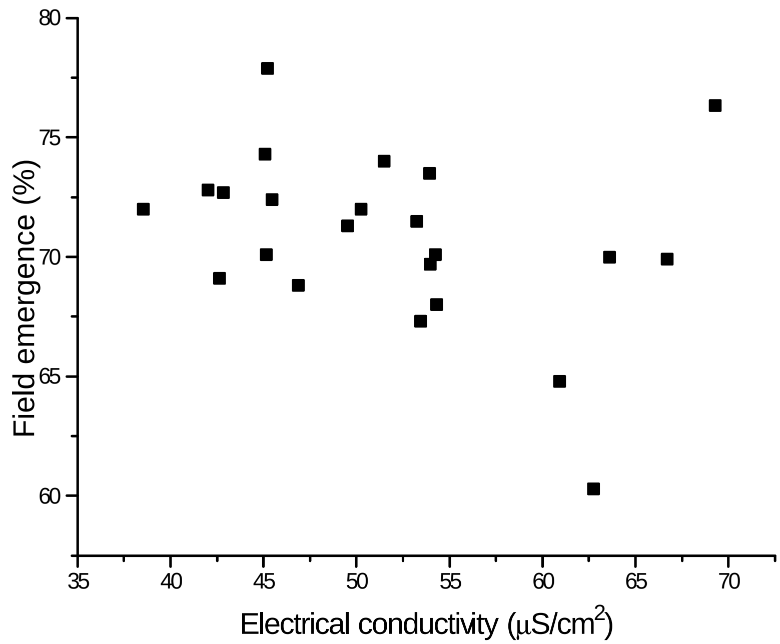



**Figure 7.2. Linear regression (ns) of field emergence and electrolyte leakage per cm$^2$ of seed area for hybrids in the 1995 Virginia Sorghum Trials.**

**Electrical conductivity per gram of seed of hybrids in the 1995 Virginia Sorghum Trials**

The electrical conductivity value per seed was divided by the average weight per seed for hybrids used in 1995. There were significant differences ($P< 0.001$) between hybrids. CAR737 leached more per gram than ten of the other hybrids (Table 7.1). The general mean was 875 µS/g, and the CV was 15.3%. The weight of seeds of each hybrid is shown in Table 7.2. The regression analysis for 1995 was not significant, with $P = 0.09$ and $r^2 = 0.127$ (Figure 7.3).

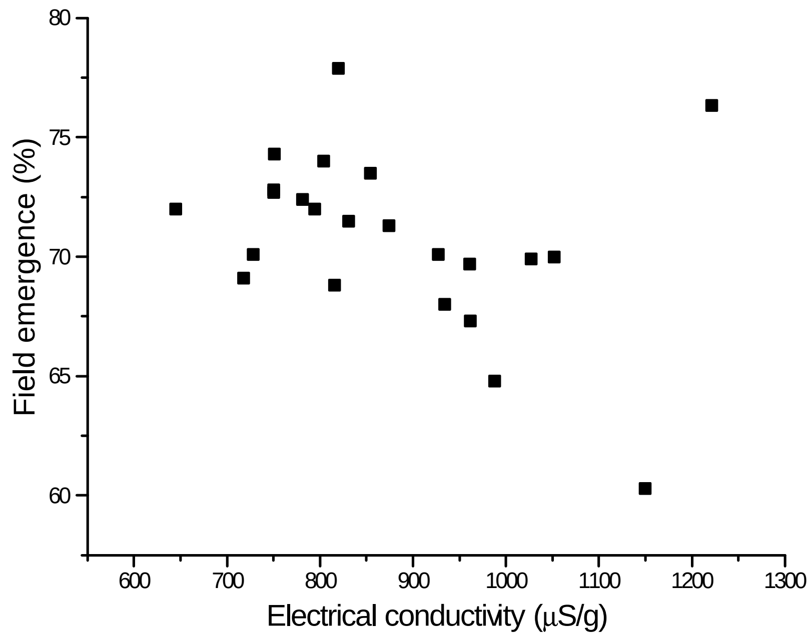



**Figure 7.3. Linear regression (ns) of electrical conductivity per gram of seed for the hybrids in the 1995 Virginia Sorghum Trials.**

**Table 7.1. Electrical conductivity per seed, per $cm^2$ of seed area, and per gram of seed measured in the steep water of the seeds in the 1995 Virginia Sorghum Trials.**

| Hybrid | per seed | | per $cm^2$ | | per gram | |
|---|---|---|---|---|---|---|
| | µS/seed | Rank | µS/$cm^2$ | Rank | µS/g | Rank |
| **GW6089** | 31.1[a*] | 1 | 89.6[ab] | 2 | 1027[abc] | 4 |
| **P8446** | 25.8[ab] | 2 | 85.2[abc] | 4 | 1052[abc] | 3 |
| **CAR737** | 25.2[abc] | 3 | 94.5[a] | 1 | 1221[a] | 1 |
| **GW1114** | 24.8[abc] | 4 | 77.2[abc] | 6 | 682[c] | 21 |
| **SS1313** | 24.4[abc] | 5 | 73.6[abc] | 9 | 643[c] | 23 |
| **SS1211** | 23.8[abc] | 6 | 70.2[abc] | 11 | 804[abc] | 13 |
| **KS936** | 23.3[abcd] | 7 | 78.4[abc] | 5 | 998[abc] | 5 |
| **CAR577** | 22.7[abcd] | 8 | 68.5[abc] | 12 | 794[bc] | 14 |
| **X604** | 22.6[abcd] | 9 | 88.5[ab] | 3 | 1150[ab] | 2 |
| **KS714** | 22.0[abcd] | 10 | 75.8[abc] | 7 | 927[abc] | 9 |
| **XS345** | 20.8[bcd] | 11 | 74.1[abc] | 8 | 934[abc] | 8 |
| **SS115** | 20.1[bcd] | 12 | 62.0[abc] | 16 | 728[c] | 19 |
| **CAR19225** | 19.2[bcd] | 13 | 72.8[abc] | 10 | 961[abc] | 7 |
| **CAR630** | 18.8[bcd] | 14 | 68.1[abc] | 13 | 962[abc] | 6 |
| **P8310** | 18.4[bcd] | 15 | 61.6[abc] | 18 | 751[bc] | 16 |
| **P8699** | 18.2[bcd] | 16 | 67.8[abc] | 14 | 874[abc] | 10 |
| **GW8046** | 17.4[bcd] | 17 | 58.6[bc] | 20 | 718[c] | 20 |
| **P8305** | 17.4[bcd] | 18 | 62.0[abc] | 17 | 781[bc] | 15 |
| **P8212** | 17.4[bcd] | 19 | 63.8[abc] | 15 | 816[abc] | 12 |
| **SS160** | 15.7[cd] | 20 | 58.3[bc] | 21 | 750[bc] | 17 |
| **CAR837** | 15.5[d] | 21 | 61.6[abc] | 19 | 820[abc] | 11 |
| **CAR775** | 15.5[d] | 22 | 52.5[c] | 23 | 645[c] | 22 |
| **P8118** | 14.8[d] | 23 | 57.1[bc] | 22 | 750[bc] | 18 |
| **Average** | 20.3 | - | 70.4 | - | 875 | - |

***** Means within a column followed by the same letter are not significantly different at 0.05 level.

**Table 7.2. Mass, surface area, and volume of the seeds in the 1995 Virginia Sorghum Trials.**

| Hybrid | Mass | Area | Volume |
|---|---|---|---|
| | mg/seed | $cm^2$ /seed | $cm^3$/seed |
| **CAR1922** | 27.5 [g h i*] | 0.266 [d e f] | 0.0200 [f g] |
| **CAR577** | 33.2 [b c d e] | 0.332 [a b c] | 0.0286 [a] |
| **CAR630** | 23.8 [i] | 0.282 [d e f] | 0.0196 [f g] |
| **CAR737** | 26.0 [h i] | 0.266 [d e f] | 0.0206 [f g] |
| **CAR837** | 25.6 [h i] | 0.252 [f] | 0.0190 [g] |
| **CAR775** | 33.6 [b c d] | 0.295 [c d e] | 0.0240 [c d e] |
| **FFR321** | 31.8 [d e f] | ** | ** |
| **GW1114** | 36.4 [a b c] | 0.342 [a] | 0.0300 [a] |
| **GW6089** | 37.1 [a b] | 0.347 [a] | 0.0303 [a] |
| **GW8046** | 30.4 [d e f g] | 0.300 [b c d] | 0.0246 [b c] |
| **KS714** | 32.7 [c d e] | 0.297 [c d e] | 0.0243 [c d] |
| **KS936** | 28.1 [f g h] | 0.281 [c d e] | 0.0223 [c d e f] |
| **X604** | 28.0 [f g h] | 0.264 [d e f] | 0.0203 [f g] |
| **P8118** | 25.5 [h i] | 0.258 [e f] | 0.0196 [f g] |
| **P8212** | 26.8 [g h i] | 0.272 [d e f] | 0.0213 [d e f g] |
| **P8305** | 29.4 [e f g h] | 0.281 [d e f] | 0.0223 [c d e f] |
| **P8310** | 31.7 [f g h] | 0.300 [b c d] | 0.0246 [b c] |
| **P8446** | 31.5 [d e f] | 0.297 [c d e] | 0.0243 [c d] |
| **P8699** | 26.4 [h i] | 0.269 [d e f] | 0.0210 [e f g] |
| **SS115** | 36.6 [a b c] | 0.324 [a b c] | 0.0276 [a b] |
| **SS1211** | 39.3 [a] | 0.339 [a b] | 0.0296 [a] |
| **SS1313** | 37.9 [a b] | 0.332 [a b c] | 0.0286 [a] |
| **SS160** | 28.8 [f g h] | 0.269 [d e f] | 0.0210 [e f g] |
| **XS345** | 28.1 [f g h] | 0.281 [d e f] | 0.0223 [c d f] |
| **Average** | 30.25 | 0.293 | 0.0237 |

* Means within a column followed by the same letter are not different at 0.05 probability level.
** Not enough seeds of FFR321 remained to measure the volume.

**Electrical conductivity of seeds of hybrids in the 1996 Virginia Sorghum Trials**

The hybrids used in 1996 showed significant differences in loss of electrolytes ($P < 0.0001$). The hybrids FFR321, SS1313, DK18, and SS115 leached more electrolytes than six others (Table7.3). The general mean of this treatment was 20.6 µS, and the CV was 11.5%. Field emergence was regressed on electrical conductivity. The results did not show a linear association between variables ($P = 0.11$ and $r^2 = 0.088$) (Figure 7.4).

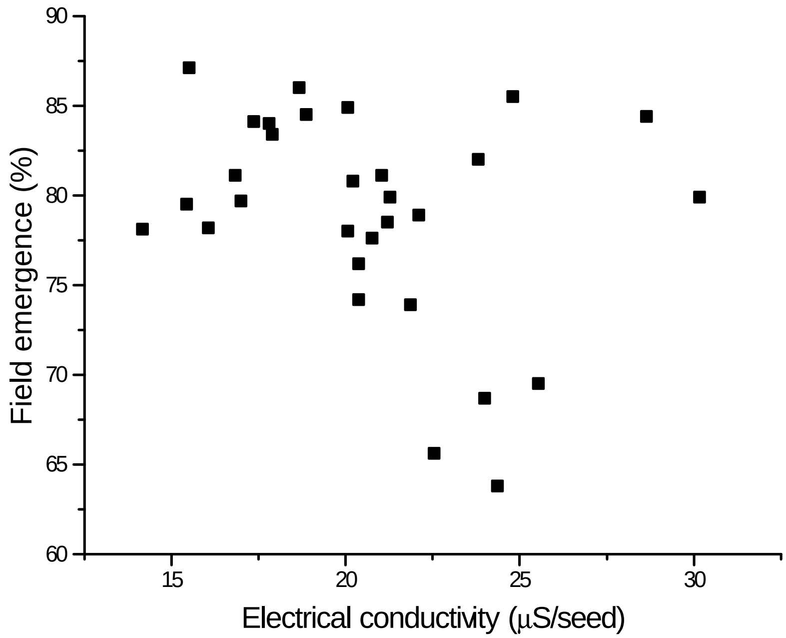
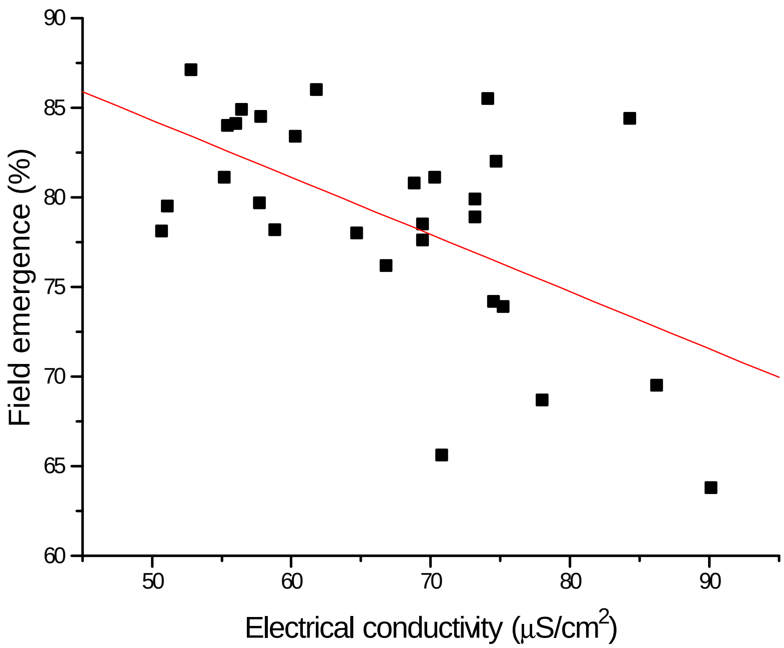



**Figure 7.4. Linear regression (ns) of field emergence and electrical conductivity per seed for hybrids in the 1996 Virginia Sorghum Trials.**

**Electrical conductivity per $cm^2$ of seeds for the hybrids in the 1996 Virginia Sorghum Trials**

There were significant differences among hybrids for leakage per $cm^2$ of seed area ($P < 0.001$). The hybrids DK40, DK18, SS1313 and DK36 leached more than P8305, P8282, and P8118 (Table 7.3). The general mean of this test was 68.8 µS, and the CV was 11.4%. The surface area of the hybrids is shown in Table 7.4.

Field emergence was regressed on leakage per $cm^2$ of seed, and the results showed a linear association between variables ($P < 0.001$ and $r^2 = 0.322$) (Figure 7.5). A predicted value of field emergence (y) can be estimated by the linear equation $y = 100.26 - 0.319x$. A predictive equation using arcsine values for field emergence is $y = 1.402 - 0.00441x$.

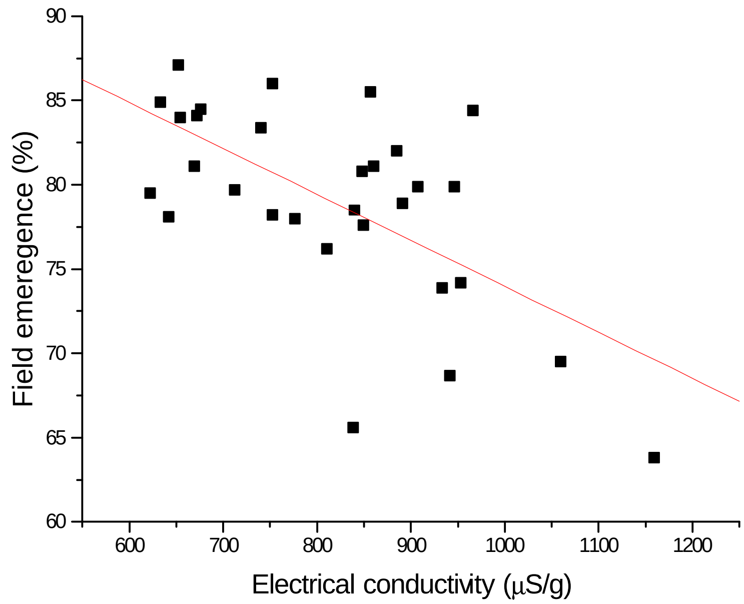



**P = 0.001 $r^2 = 0.322$ y = 100.26 - 0.319x.**

**Figure 7.5. Linear regression of field emergence and electrical conductivity per cm$^2$ of seed area of hybrids in the 1996 Virginia Sorghum Trials.**

**Electrical conductivity per gram of the seed for hybrids in 1996 Trials**

The electrical conductivity per seed was divided by seed mass for each hybrid used in the 1996 Trials. There were significant differences between hybrids (P< 0.001). The top five hybrids showed more leakage per gram than the bottom five (Table 7.3). The general mean was 812 µS/g, and the CV was 11.1%. The seed mass of the hybrids is shown in Table 7.4 The regression analysis with field emergence showed a significant relationship (P = 0.0002 and $r^2 = 0.389$) (Figure 7.6). An emergence value (y) can be estimated by the linear equation y = 101.21 - 0.0272x. Field emergence can be predicted from arcsine transformed data by using the equation y = 1.141 - 0.00037x.




**P<0.0002** **$r^2$ = 0.389** **y = 101.21 - 0.0272x.**

**Figure 7.6. Linear regression of field emergence and electrical conductivity per gram of seed for the hybrids in the 1996 Virginia Sorghum Trials.**

**Table 7.3. Electrical conductivity per seed, per cm$^2$ of seed area, and per gram of seed in the steep water of the seeds in the 1996 Virginia Sorghum Trials.**

| | per seed | | per cm$^2$ | | per gram | |
|---|---|---|---|---|---|---|
| **Hybrid** | µS | Rank | µS/cm$^2$ | Rank | µS/g | Rank |
| **FFR321** | 30.1 [a*] | 1 | ** | - | 946 [a b c] | 5 |
| **SS1313** | 28.6 [a] | 2 | 84.29 [a b c] | 3 | 966 [a b c] | 3 |
| **DK18** | 25.5 [a b] | 3 | 86.22 [a b] | 2 | 1059 [a b] | 2 |
| **SS115** | 24.8 [a b c] | 4 | 74.15 [a b c d e f] | 8 | 857 [b c d e f] | 12 |
| **DK40** | 24.3 [a b c d] | 5 | 90.1 [a] | 1 | 1159 [a] | 1 |
| **DK36** | 24.0 [a b c d e] | 6 | 78.0 [a b c d] | 4 | 941 [a b c d] | 6 |
| **GW9089** | 23.8 [a b c d e] | 7 | 74.7 [a b c d e f] | 6 | 885 [a b c d e f] | 10 |
| **KS714** | 22.5 [a b c d e f] | 8 | 70.8 [a b c d e f] | 11 | 838.8 [b c d e f] | 16 |
| **DK45** | 22.1 [a b c d e f] | 9 | 73.2 [a b c d e f] | 9 | 891 [a b c d e f] | 9 |
| **DK54** | 21.8 [a b c d e f] | 10 | 75.2 [a b c d e] | 5 | 933 [a b c d e] | 7 |
| **XS345** | 21.1 [a b c d e f g] | 11 | 73.2 [a b c d e f] | 10 | 907 [a b c d e f] | 8 |
| **P8446** | 21.2 [a b c d e f g] | 12 | 69.4 [a b c d e f] | 13 | 840 [b c d e f] | 15 |
| **CAR1202** | 21.0 [b c d e f g] | 13 | 70.3 [a b c d e f] | 12 | 860 [b c d e f] | 11 |
| **KS735** | 20.7 [b c d e f g] | 14 | 69.50 [a b c d e f] | 14 | 849 [b c d e f] | 13 |
| **CAR730** | 20.3 [b c d e f g] | 15 | 74.5 [a b c d e f] | 7 | 953 [a b c] | 4 |
| **DK55** | 20.3 [b c d e f g] | 16 | 66.8 [a b c d e f] | 16 | 810 [b c d e f] | 17 |
| **P8414** | 20.2 [b c d e f g] | 17 | 68.8 [a b c d e f] | 15 | 848 [b c d e f] | 14 |
| **SS1211** | 20.0 [b c d e f g] | 18 | 56.4 [d e f] | 23 | 633 [f] | 29 |
| **CAR627** | 20.0 [b c d e f g] | 19 | 64.7 [b c d e f] | 17 | 776 [b c d e f] | 18 |
| **CAR647** | 18.8 [b c d e f g] | 20 | 57.8 [d e f] | 21 | 676 [c d e f] | 23 |
| **SS160** | 18.6 [b c d e f g] | 21 | 61.8 [b c d e f] | 18 | 752 [c d e f] | 19 |
| **P8310** | 17.9 [c d e f g] | 22 | 60.3 [d e f] | 21 | 740 [c d e f] | 21 |
| **CAR775** | 17.9 [c d e f g] | 23 | 55.4 [d e f] | 25 | 654 [d e f] | 26 |
| **DK47** | 17.3 [c d e f g] | 24 | 56.0 [d e f] | 24 | 672 [c d e f] | 24 |
| **P8212** | 16.9 [d e f g] | 25 | 57.7 [d e f] | 22 | 712 [c d e f] | 22 |
| **CAR837** | 16.8 [e f g] | 26 | 55.2 [d e f] | 26 | 669 [c d e f] | 25 |
| **KS711** | 16.0 [g f] | 27 | 58.8 [d e f] | 20 | 742 [c d e f] | 20 |
| **P8305** | 15.5 [g f] | 28 | 52.8 [e f] | 27 | 652 [d e f] | 27 |
| **P8282** | 15.4 [g f] | 29 | 51.1 [f] | 28 | 622 [f] | 30 |
| **P8118** | 14.1 [g] | 30 | 50.7 [f] | 29 | 642 [e f] | 28 |
| **Average** | 20.6 | | 66.8 | | 812 | |

*Means within a column followed by the same letter are not significantly different at 0.05 level.
** FFR321 did not have enough seeds to measure seed volume and to compute area.

**Table 7.4. Mass, surface area, and volume of the sorghum seeds of the 1996 Virginia Sorghum Trials.**

| Hybrid | Mass | Area | Volume |
|---|---|---|---|
| | mg/seed | $cm^2$/seed | $cm^3$/seed |
| **CAR627** | 32.6 $^{defghi}$ | 0.310 $^{ef}$ | 0.0258 $^{ef}$ |
| **CAR647** | 34.3 $^{cde}$ | 0.326 $^{cd}$ | 0.0278 $^{cd}$ |
| **CAR730** | 26.5 $^{nop}$ | 0.273 $^{lm}$ | 0.0213 $^{l}$ |
| **CAR775** | 33.6 $^{defg}$ | 0.321 $^{d}$ | 0.0272 $^{d}$ |
| **CAR837** | 32.3 $^{defghi}$ | 0.304 $^{fghi}$ | 0.0251 $^{fghi}$ |
| **DK18** | 29.0 $^{klmno}$ | 0.296 $^{ijk}$ | 0.0241 $^{ijk}$ |
| **DK36** | 31.6 $^{efghIkl}$ | 0.307 $^{fg}$ | 0.0254 $^{fg}$ |
| **DK40Y** | 26.1 $^{op}$ | 0.270 $^{m}$ | 0.0210 $^{l}$ |
| **DK45** | 32.0 $^{efghIj}$ | 0.301 $^{fghij}$ | 0.0248 $^{fghij}$ |
| **DK47** | 31.7 $^{efghIjk}$ | 0.310 $^{ef}$ | 0.0258 $^{ef}$ |
| **DK54** | 31.8 $^{efghIjk}$ | 0.290 $^{k}$ | 0.0234 $^{k}$ |
| **DK55** | 30.0 $^{ijklm}$ | 0.304 $^{fghi}$ | 0.0251 $^{fghi}$ |
| **FFR321** | 40.8 $^{a}$ | ** | ** |
| **GW9089** | 33.4 $^{defgh}$ | 0.318 $^{de}$ | 0.0268 $^{de}$ |
| **KS711** | 26.0 $^{p}$ | 0.273 $^{lm}$ | 0.0213 $^{l}$ |
| **KS714Y** | 35.0 $^{bcd}$ | 0.318 $^{de}$ | 0.0268 $^{de}$ |
| **KS735** | 29.4 $^{jklm}$ | 0.298 $^{ghijk}$ | 0.0244 $^{ghijk}$ |
| **P8118** | 27.2 $^{mnop}$ | 0.278 $^{l}$ | 0.0220 $^{l}$ |
| **P8212** | 28.8 $^{lmnop}$ | 0.293 $^{jk}$ | 0.0237 $^{jk}$ |
| **P8282** | 31.4 $^{fghijkl}$ | 0.301 $^{fghij}$ | 0.0248 $^{fghij}$ |
| **P8305** | 30.7 $^{hijkl}$ | 0.293 $^{jk}$ | 0.0237 $^{jk}$ |
| **P8310** | 31.3 $^{fghijkl}$ | 0.297 $^{hijk}$ | 0.0242 $^{hijk}$ |
| **P8414** | 30.0 $^{ijklm}$ | 0.294 $^{jk}$ | 0.0238 $^{jk}$ |
| **P8446** | 30.9 $^{ghijkl}$ | 0.305 $^{fgh}$ | 0.0252 $^{fgh}$ |
| **SS115** | 33.9 $^{def}$ | 0.334 $^{bc}$ | 0.0289 $^{bc}$ |
| **SS1211** | 37.1 $^{bc}$ | 0.355 $^{a}$ | 0.0316 $^{a}$ |
| **SS1313** | 37.9 $^{b}$ | 0.339 $^{b}$ | 0.0296 $^{b}$ |
| **SS160** | 30.3 $^{ijkl}$ | 0.301 $^{fghij}$ | 0.0248 $^{fghij}$ |
| **XS12027** | 31.1 $^{fghijkl}$ | 0.298 $^{ghijk}$ | 0.0244 $^{ghijk}$ |
| **XS345** | 29.2 $^{jklmn}$ | 0.290 $^{k}$ | 0.0234 $^{k}$ |
| **Average** | 31.5 | 0.303 | 0.0250 |

***Means within a column followed by the same letter are not significantly different at 0.05 level.**
****FFR321 did not have enough seeds to measure seed volume and to compute area**

There were significant differences among hybrids for all variables measured in electrical conductivity in both years. This shows that the seeds were not equal in leakage as they imbibed.

This is not surprising, since the seeds varied in size. But, when one corrects for seed size by looking at leakage as a function of area or mass, the differences persisted. According to Pandey (1988), leakage as measured by conductivity is related to membrane disorganization. The lower the membrane integrity, the greater the electrolyte leakage in the steep water, thus the greater the conductivity measurement (Powell et al., 1984). Woodstock et al. (1985) found relationships between weathering deterioration, germination respiratory metabolism, and leaching in cotton seeds. The deterioration of membranes due to weathering was confirmed by electron microscopy of cotyledon's lipids and proteins bodies and correlated well with conductivity measurements.

In the literature, I found no reference to electrical conductivity studies with sorghum. The relationship between leachate conductivity and soybean emergence has been studied using conductivity data corrected for seed weight (Yaklich et al., 1979). The results showed a significant correlation between cultivars and between seedlots within cultivars. Electrolyte efflux into hot water was used by Pandey (1988) to predict germination and emergence of onion, french beans, and tomato. He found a high correlation for germination ($r^2 = 0.92$) and emergence ($r^2 = 0.34$), and concluded that this test is a good indicator of seed quality. In my research, the $r^2$ values for correlation between the amount of leakage per $cm^2$ and arcsine-transformed field emergence data ($r^2 = 0.322$) for the 1996 experiment agreed with Pandey (1988). On a per seed basis, the $r^2$ value was lower ($r^2 = 0.08$). The 1995 leakage data were not as well correlated with emergence, but again the $r^2$ value for leakage per $cm^2$ was greater ($r^2 = 0.096$) than leakage per seed ( $r^2 = 0.023$). The conductivity measured as a function of seed mass (μS/gram) showed correlation with field emergence ($r^2 = 0.389$) for the 1996 Trials; however, for 1995 the $r^2$ value was only 0.127. If conductivity tests were used, a reliability ranking could be established with values as a function of the seed mass being first, values as a function of the seed area being second, and values per seed being last.

In conclusion, when conductivity data were expressed per gram of seed, regression with field emergence showed somewhat better correlation than when the charge per $cm^2$ or per seed was used. The 1996 data showed greater correlations and more similarity with the results found in the literature. The poorer response of 1995 data can perhaps be attributed to the slightly different device used for that year's measurement. Wavefront Inc. made same improvements in the Genesis seed analyzer for the 1996 analyses. If the 1995 data were excluded from the analyses, it can be seen that this test can be used as a moderately good predictor of field emergence, and the measurement of amount of leakage per gram or per $cm^2$ is better than per seed.