

# MOISTURE CONTENT AND TEMPERATURE EFFECTS ON THREE-DAYS-OLD MAIZE AND SOYBEAN SEEDLINGS USING SVIS

R. R. Otoni<sup>1</sup> and M. B. McDonald<sup>2</sup>

<sup>1</sup> Department of Agriculture, University Federal of Lavras, 37200-000, Lavras, MG, Brazil (e-mail [ribasotoni@yahoo.com.br](mailto:ribasotoni@yahoo.com.br))

<sup>2</sup> Department of Horticulture and Crop Science, The Ohio State University, Columbus, Ohio, 43210-1086, USA

## INTRODUCTION

High quality seeds are essential when improved crop production is desired. Seed analysis is an important aspect of seed quality assurance. Unfortunately, many differences in test results remain among laboratories hindering standardization of germination testing. The OSU Seed Vigor Imaging System (SVIS) was developed to provide a standardized seed vigor assessment process, avoiding differences among laboratories, and reducing the excessive time to acquire results that will result in reducing current errors made by humans. However, other germination variables can also alter final results, such as moisture content of the paper towels and germination temperature. The objective of this study was to determine the optimum moisture content for paper towels and the appropriate germination temperature for maize and soybean seeds. These results will be important in further standardizing seed germination and vigor tests.

## MATERIALS AND METHODS

One lot of hybrid maize (*Zea mays* L.) and one lot of soybean (*Glycine max* (L.) Merr.) seeds were used. Seven (100, 96, 92, 89, 83, 74 and 66% water/paper towel) different moisture contents for maize and eight (100, 97, 93, 90, 82, 79, 70 and 61% water/paper towel) moisture contents for soybean and also three different germination temperatures (24, 25 and 26°C) were studied. Five replications of 40 seeds each for maize and four replications of 50 seeds each for soybean (200 seeds total) were planted in paper towels at the appropriate moisture content using two medium weight paper towels on the bottom and one medium weight paper towel on the top of the seeds. The rolled paper towels were placed inside a plastic bag and covered with another plastic bag to retain moisture. All rolled towels were placed in a germinator at 25°C ( $\pm 1^\circ\text{C}$ ) for all moisture treatments and at the appropriate temperature when temperature effect was studied. After 72 h germination, growth, uniformity and overall vigor of the seedlings were evaluated using SVIS described by Hoffmaster, et al. (2003) for soybean and by Hoffmaster, et al. (2005) for maize. The entire study was repeated once with similar results.

## RESULTS AND DISCUSSION

**Moisture:** No difference in SVIS parameters (growth and overall vigor) was found for soybean seedlings until the paper towels were at a moisture content of 79% (Table 1). Decreases in the moisture content of the paper towels after this value caused a significant reduction in growth and consequently in overall vigor, since the vigor indices are dependent on the growth values (Table 1). For maize, the greatest growth of the seedlings occurred when the moisture content of the paper towels was 96% (Table 2). The reduced growth of the seedlings at 100% saturation of the paper towels may be attributed to flooding or anoxic effects. Maize is particularly susceptible to excess water (Fausey, Van Toai and McDonald, 1985). After 96% water/paper towel, decreases in moisture caused decreases in growth and overall vigor (Table 2). This study shows that maize seedlings are more sensitive to variations in moisture content than soybean seedlings. SVIS indices are a quantitative measure of seedling growth since a scanner objectively captures an image that is then processed by computer software (Hoffmaster, et al., 2005). These results demonstrate the importance of paper moisture content during the germination test, from the soaking of the paper towels, to seed planting and germination, to scanning. These differences may not be detected in routine seed testing for standard germination because the interpretations of the results are done by a human and are not as accurate as those obtained by a scanner.

**Temperature:** Maize and soybean seeds showed greater growth and overall vigor at the higher temperature (26°C) (Table 3). However, no significant difference was found with uniformity except for 24°C in maize (Table 3). No significant differences in growth and overall vigor were observed for both crops between 24 and 25°C (Table 3). For both crops, the recommended temperature for germination is 25°C (ISTA, 1999), which can vary  $\pm 1^\circ\text{C}$ . This study shows that this recommendation is acceptable if the temperature is less than 1°C from the recommended 25°C. However, when the value is 1°C more than 25°C, a significant difference in growth and overall vigor indices occurred. When comparing a 2°C difference between 24 and 26°C, there was a significant difference in seedling growth and overall vigor index for both crops. Because SVIS results are objective and precise, it is important to know that a difference of 2°C can produce a significant difference in seedling growth. These temperature differences clearly produce seedlings of different size (Table 3).

## REFERENCES

- Fausey, N.R., Van Toai, T.T. and McDonald, M.B. (1985). Response of ten corn cultivars to flooding. *Transactions of the American Society of Agricultural Engineers* **28**, 1794-1797.
- Hoffmaster, A.L., Fujimura, K., McDonald, M.B. and Bennett, M.A. (2003). An automated system for vigor testing three-day-old soybean seedlings. *Seed Science & Technology*, **31**, 701-713.
- Hoffmaster, A.L., Xu, L., Fujimura, K., McDonald, M.B., Bennett, M.A., and Evans, A.F. (2005). The OSU Seed Vigor Imaging System (SVIS) for soybean and corn seedlings. *Journal of Seed Technology*, in press
- International Seed Testing Association (1999). International Rules for Seed Testing. *Seed Science & Technology*, **27**, Supplement, 178 and 182.

**Table 1.** SVIS parameters (growth and overall vigor) at 100, 97, 93, 90, 82, 79, 70 and 61% water/paper towel in soybean seedlings after 72 hours germination.

| Moisture Levels (%) | SVIS Parameters   |               |
|---------------------|-------------------|---------------|
|                     | Growth            | Overall Vigor |
| 100                 | 598a <sup>†</sup> | 737a          |
| 97                  | 598a              | 731a          |
| 93                  | 616a              | 744a          |
| 90                  | 599a              | 721a          |
| 82                  | 570a              | 719a          |
| 79                  | 413b              | 622b          |
| 70                  | 355c              | 571c          |
| 61                  | 313c              | 570c          |

<sup>†</sup> Within column, numbers with different letters are statistically different at  $p \leq 0.05\%$ .

**Table 2.** SVIS parameters (growth and overall vigor) at 100, 96, 92, 89, 83, 74 and 66% water/paper towel in maize seedlings after 72 hours germination.

| Moisture Levels (%) | SVIS Parameters   |               |
|---------------------|-------------------|---------------|
|                     | Growth            | Overall Vigor |
| 100                 | 439b <sup>†</sup> | 569ab         |
| 96                  | 490a              | 595a          |
| 92                  | 441b              | 567ab         |
| 89                  | 433bc             | 561bc         |
| 83                  | 394c              | 534c          |
| 74                  | 305d              | 455d          |
| 66                  | 286d              | 464d          |

<sup>†</sup> Within column, numbers with different letters are statistically different at  $p \leq 0.05\%$ .

**Table 3.** SVIS parameters (growth, uniformity and overall vigor) at 24, 25 and 26°C in maize and soybean seedlings after 72 hours germination.

| SVIS Parameters | Temperature °C    |      |      |         |      |      |
|-----------------|-------------------|------|------|---------|------|------|
|                 | Maize             |      |      | Soybean |      |      |
|                 | 24°C              | 25°C | 26°C | 24°C    | 25°C | 26°C |
| Growth          | 531b <sup>†</sup> | 459b | 734a | 612b    | 573b | 731a |
| Uniformity      | 832b              | 861a | 859a | 867a    | 872a | 870a |
| Vigor           | 621b              | 579b | 765a | 739b    | 722b | 800a |

<sup>†</sup> Within row, numbers with different letters are statistically different at  $p \leq 0.05$

## CONCLUSION

This study has shown the effect of two important seed testing variables, moisture and temperature, on the growth of maize and soybean seedlings that must be carefully monitored during the conduct of standard germination and vigor tests to assure standardization of reported results. It has also defined the appropriate moisture and temperature parameters when differences in seedling growth are found.