OREGON STATE UNIVERSITY SEED LABORATORY

SUMMIT SEED COATINGS- Caldwell ID

Final Report – April 2010

Effect of various seed coating treatments on viability and vigor of two blends of Kentucky bluegrass

Objective

Evaluate the effect of ten different seed coating treatments (including untreated control) on enhancing final germination percentage (G), Speed of germination index (SGI) (also called germination index), and growth rate, GR [i.e., dry mater content (DM)] of two Kentucky bluegrass (KBG) blends.

Materials and Methods

Materials

Two blends of Kentucky bluegrass, blend 1 and blend 2, were used in the study.

The initial seed quality of each seed lot was evaluated by a standard germination test.

Treatments

The following treatments were used:

No.	Blend	Treatment
1	1	Untreated Control Check
2	1	1:1 Coating + Polymer 1
3	1	1:1 Coating + Polymer 2
4	1	1:1 Coating + Polymer 2 + Growth Regulator
5	1	1:1 Coating + Polymer 2 + Micronutrient
6	1	1:1 Coating + Polymer 2 + Mycorrhizae
7	1	1:1 Coating + Polymer 2 +Growth Regulator + Micronutrient

8	1	1:1 Coating + Polymer 2 +Growth Regulator + Mycorrhizae
9	1	1:1 Coating + Polymer 2 + Micronutrient + Mycorrhizae
10	1	1:1 Coating + Polymer 2 + Growth Regulator +Micronutrient +Mycorrhizae
1	2	Check
2	2	1:1 Coating + Polymer 1
3	2	1:1 Coating + Polymer 2
4	2	1:1 Coating + Polymer 2 + Growth Regulator
5	2	1:1 Coating + Polymer 2 + Micronutrient
6	2	1:1 Coating + Polymer 2 + Mycorrhizae
7	2	1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient
8	2	1:1 Coating + Polymer 2 + Growth Regulator + Mycorrhizae
9	2	1:1 Coating + Polymer 2 + Micronutrient + Mycorrhizae
10	2	1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient + Mycorrhizae

* All seed coating/treatment were prepared by Summit Coatings.

Methods

- **Two main studies were conducted**:
  1) Growth chamber study, and
  2) Greenhouse study.

Tests used to evaluate the treatments in both growth chamber and greenhouse:

To measure the effect of treatments on seed and seedling performance, the following tests were conducted:

Standard germination test (G): Four replications of 100 seeds of each treatment were planted in growth chamber according to the AOSA Rules (2009). No pre-chilling treatment or KNO_3 was applied. The standard germination test was used to establish the initial quality of each seed lot for the untreated control samples. The test periods were 28 days for both KBG blends in the growth chamber and in the greenhouse.

- In the greenhouse study, three replications (3-greenhouse trays each with 38 individual plants) were used.
    - Type of Soil: sandy soil (no nutrients were added).
    - Water regime: continuous water from the bottom tray (no water stress).
    - Temperature: 24C (+2°C day/-5°C night).

Speed of germination index (SGI) (also called Germination Index): The speed of germination test is an index of seed vigor. The faster the seeds germinate, the higher the quality of seeds and the more effective the treatment that may enhance germination. The test was conducted on the standard germination test seedlings by counting the emerged seedlings after 5 days from planting, and continuing to count the seedlings that emerged every other day in the growth chamber and every three days in the greenhouse until the end of the test period (28 days). The speed of germination index was calculated according to the procedures described in the AOSA Seed Vigor Testing Handbook, 2009 using the following formula:

$$GI = \frac{Number\ of\ normal\ seedlings}{days\ of\ first\ count} + \ldots\ldots\ldots\ldots + \frac{Number\ of\ normal\ seedlings}{days\ of\ final\ count}$$

The germination index for each treatment was compared to determine the effectiveness of the treatments.

3. **Seedling growth rate (GR) test (= dry matter test 'DM'):** The test was conducted according to the AOSA Seed Vigor Testing Handbook, 2009. The growth rate is used as a vigor index to differentiate between treatments. The dry weight of seedlings was determined at the end of the standard germination test. Four replications of 50 seedlings were randomly collected from each treatment from the growth chamber study, and 20 seedlings from the greenhouse study. Roots were washed thoroughly from soil using tap water and seedlings were allowed to dry in the oven at 100°C for 24 hours. The dry weight of each treatment was determined on the fresh weight basis.

Statistical analysis: The experimental design used was two-factor randomized complete block design. Factor A is the blend (blend 1 and blend 2), and factor B is the seed coating materials. The data was subjected to ANOVA to determine the effect of each treatment on germination, speed of germination and the growth rate. The LSD test was used to separate the means whenever the effects were significant.

Timetable: The study started in Feb 2010 and was completed in approximately two months.

RESULTS AND DISCUSSION

I. Growth chamber study

The ANOVA indicated that the seed coating treatments affected final germination percentage (G), speed of germination index (SGI) and growth rate (i.e., dry matter 'DM'content) as measured by the standard germination, the speed of germination and the dry matter content tests (Table 1). The highest final germination percentage (G) and speed of germination index (SGI) was recorded for both treatments No. 2 (1:1 Coating + Polymer 1) and treatment No. 8 (1:1 Coating + Polymer 2 + Growth Regulator + Mycorrhizae) with 91% germination for both, and SGI of 55.9 and 57.8, respectively. The lowest germination was recorded for treatment No. 7 (1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient) with 86%, however, this germination percentage was not significantly different than the germination of the most other treatments (Table 2). The SGI was recorded for the control (no coating) at 52.7, which was not significantly different from most of other treatments (Table 2). The similarity in the final germination percentage and SGI of most treatments is due to, in part, to the optimum germination conditions (temperature, moisture, and light) that were provided under the standard germination test environment. The expression of the seed coating treatments may be more pronounced under greenhouse and/or field conditions.

Table 1. Analysis of variance (ANOVA) for the effect of ten coating treatments on final germination percent, speed of germination and dry matter content of two Kentucky bluegrass blends grown in growth chamber and greenhouse.

Source of variation	df	Germination Percent		Speed of Germination Index		Dry Matter Content (Growth Rate)	
		Growth chamber	Green-house	Growth chamber	Green-house	Growth chamber	Green-house
Blends (B)	**1**	**NS**	*******	**NS**	*******	*******	*****
Coating Treatment (T)	**9**	*****	**NS**	******	*****	*******	*******
(B) x (T)	**9**	**NS**	**NS**	**NS**	******	*******	*******

*, **, *** Significant at the 0.05, 0.01, and 0.001 probability levels, respectively; NS, not significant at 0.05 probability level.

The ANOVA Table also showed that differences between blend 1 and blend 2 were not significant in both germination and SGI tests (Table 1). The initial high quality seed of both blends probably contributed to the similarity of blend 1 and blend 2 in performance.

The interactions for both the final germination percentage and the SGI were not significant (Table 1) indicating that both blends responded similarly to the coating treatments.

Table 2. Means of germination percentage and speed of germination index of ten seed coating treatments of two Kentucky bluegrass (KBG) blendes grown in a growth chamber†.

No.	Treatment	Germination (%)	Speed of Germination Index
1	Check	87 ab‡	52.7 b
2	1:1 Coating + Polymer 1	91 a	55.9 ab
3	1:1 Coating + Polymer 2	88 ab	54.4 b
4	1:1 Coating + Polymer 2 + Growth Regulator	88 ab	54.8 ab
5	1:1 Coating + Polymer 2 + Micronutrient	88 ab	53.7 b
6	1:1 Coating + Polymer 2 + Mycorrhizae	89 ab	55.2 ab
7	1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient	86 b	53.7 b
8	1:1 Coating + Polymer 2 + Growth Regulator + Mycorrhizae	91 a	57.8 a
9	1:1 Coating + Polymer 2 + Micronutrient + Mycorrhizae	90 ab	54.2 b
10	1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient + Mycorrhizae	89 ab	55.0 ab

† Means of blends 1 and 2 of KBG were averaged since ANOVA showed no significant difference of interaction between blends and treatments. Four replications of 100 seeds each were used for each observation.

‡ Within columns, means followed by the same letters are not significantly different according to LSD (0.05).

The ANOVA showed that blends, seed coating treatments and the interaction between them had significant effect on the dry matter content (Table 1). The mean of the dry matter content of blend 1, over the ten coating treatments, was better than blend 2 at 31 mg and 24 mg, respectively (data not shown in tables).

The results indicated that any of the nine seed coating treatments used in the study improved the dry matter content, i.e., the growth rate significantly over the uncoated controls (Table 3). In blend 1, the highest dry matter content was recorded for treatments No. 8 (1:1 Coating + Polymer 2 + Growth Regulator + Mycorrhizae) with 38.1 mg; and treatment No. 10 (1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient + Mycorrhizae) with 37.4 mg (Table 3).

Table 3. Means of dry matter content of ten seed coating treatments of two Kentucky bluegrass blendes grown in a growth chamber†.

No.	Treatment	Blend 1	Blend 2
		Dry Matter (mg)	
1	Check	16.3 e‡	11.4 f
2	1:1 Coating + Polymer 1	29.4 d	26.0 b
3	1:1 Coating + Polymer 2	28.1 d	23.1 de
4	1:1 Coating + Polymer 2 + Growth Regulator	29.3 d	24.6 bcd
5	1:1 Coating + Polymer 2 + Micronutrient	29.2 d	25.5 bc
6	1:1 Coating + Polymer 2 + Mycorrhizae	32.7 c	28.3 a
7	1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient	33.2 c	28.5 a
8	1:1 Coating + Polymer 2 + Growth Regulator + Mycorrhizae	38.1 a	30.0 a
9	1:1 Coating + Polymer 2 + Micronutrient + Mycorrhizae	36.2 b	22.3 e
10	1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient + Mycorrhizae	37.4 ab	23.7 cde
	LSD (0.05)	**1.89**	

† Four replications of 50 seedlings per each replication were used for each observation.

‡ Within columns, means followed by the same letters are not significantly different according to LSD (0.05).

In blend 2, the highest dry matter content was recorded for treatments No. 8 (1:1 Coating + Polymer 2 + Growth Regulator + Mycorrhizae) with 30.0 mg; and treatment No. 7 (1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient) with 28.5 mg (Table 3).

The effect of the coating treatment was clearly manifested in the rate of growth that was measured by the dry matter content at the end of the germination period (Table 3). Although the improve in the final germination and the speed of germination as a result of the coating treatments over the untreated control was marginal (Table 2), the dry matter was doubled, or more than doubled, compared to untreated seeds in both blend 1 and blend 2 (Table 3). Plants with higher growth rate usually grow better under various adverse field conditions.

II. Greenhouse study

Seed coating treatments, blends and the interaction between them affected the speed of germination and the dry matter content significantly according to the ANOVA (Table 1). While seed coating treatments did not improve the speed of germination in blend 1(Table 4), coating treatment No. 2 (1:1 Coating + Polymer 1) and No. 3 (1:1 Coating + Polymer 2) improved the speed of germination over the uncoated seeds as well as over other coating treatments (Table 4).

Coating treatments also improved the dry matter contents of both blend 1 and blend 2. In blend 1, the highest three dry matter contents were recorded for treatments 5 (1:1 Coating + Polymer 2 + Micronutrient), 3 (1:1 Coating + Polymer 2), and 8 (1:1 Coating + Polymer 2 + Growth Regulator + Mycorrhizae) with 101.5, 100.3 and 95.5 mg, respectively. In blend 2, the highest three dry matter contents were recorded for treatments 6 (1:1 Coating + Polymer 2 + Mycorrhizae), 5 (1:1 Coating + Polymer 2 + Micronutrient), and 4 (1:1 Coating + Polymer 2 + Growth Regulator) with 98.4, 93.0 and 79.3 mg, respectively (Table 4).

The highest final germination percentage (G) in blend 1was recorded for both treatments No. 2 (1:1 Coating + Polymer 1), treatment. No. 3 (1:1 Coating + Polymer 2) and No. 4 (1:1 Coating + Polymer 2 + Growth Regulator) with 89, 86 and 85%, respectively (Table 4). In blend 2, the highest germination was recorded for treatment No. 8 (1:1 Coating + Polymer 2 + Growth Regulator + Mycorrhizae), No. 5 (1:1 Coating + Polymer 2 + Micronutrient) and No. 4 (1:1 Coating + Polymer 2 + Growth Regulator) with 82, 82, and 81%, respectively (Table 4). In general, most coated seeds had higher germination than the untreated controls in both blends.

Table 4. Means of final germination percent, speed of germination index, and dry matter content of ten seed coating treatments of two Kentucky bluegrass blendes grown in a greenhouse†.

No.	Treatment	Blend 1	Blend 2	Blend 1	Blend 2	Blend 1	Blend 2
		Germination (%)		Speed of Germination Index		Dry Matter (mg)	
1	Check	77 b‡	72 ab	10.7 d‡	11.4 a	70.1 cde	45.0 d
2	1:1 Coating + Polymer 1	89 a	72 ab	14.2 a	10.7 a	84.8 abc	62.4 cd
3	1:1 Coating + Polymer 2	86 ab	70 b	13.7 ab	11.3 a	100.3 a	74.7 bc
4	1:1 Coating + Polymer 2 + Growth Regulator	85 ab	81 a	12.4 bc	10.8 a	79.7 bcde	79.3 abc
5	1:1 Coating + Polymer 2 + Micronutrient	82 ab	82 a	12.1 cd	11.7 a	101.5 a	93.0 ab
6	1:1 Coating + Polymer 2 + Mycorrhizae	82 ab	75 ab	12.0 cd	11.7 a	83.3 abcd	98.4 a
7	1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient	81 ab	74 ab	11.9 cd	11.0 a	89.1 abc	76.6 bc
8	1:1 Coating + Polymer 2 + Growth Regulator + Mycorrhizae	80 ab	82 a	11.4 cd	10.8 a	95.5 ab	76.1 bc
9	1:1 Coating + Polymer 2 + Micronutrient + Mycorrhizae	76 b	76 ab	11.7 cd	10.8 a	61.5 e	76.5 bc
10	1:1 Coating + Polymer 2 + Growth Regulator + Micronutrient + Mycorrhizae	80 ab	70 b	11.3 cd	10.8 a	63.5 de	77.0 bc
	LSD (0.05)	11.09		1.45		19.98	

† Three replications of 38 seedlings each were used for each observation on final germination percent and germination index, and three replications of 20 seedlings each for dry matter content.

‡ Within columns, means followed by the same letters are not significantly different according to LSD (0.05).

Coating Kentucky bluegrass seeds with growth regulator such as GA_3 is useful in breaking dormancy, especially in freshly harvested seeds when the dormancy level is at the highest level. Coating with the biological agent "Mycorrhizae" and/or micronutrients improved seed performance in many cases in both the growth chamber and the greenhouse studies. Seed coating + polymer 2 improved seed performance over the untreated seed in many cases as well. Coating

with the combination of micronutrients + growth regulator + mycorhrizae did not improve seed performance over using one or two of three chemicals in the coating materials. In general, if the initial quality of seeds is high, they may not need extra micronutrients because they depend on the stored food in the endosperm in the early stage of seed germination. It is worthy to note that the effectiveness of seed coating is more pronounced under field conditions than under controlled environment in a growth chamber or a greenhouse.

CONCLUSION

The various seed coating treatments used in this study improved final germination percentage, the speed of germination and the dry matter content of plants over the untreated seeds in most cases. Kentucky bluegrass 'blend 1' performed better than 'blend 2' in most tests. Coating well-developed, pure seeds with high initial seed quality add more value to the seeds than coating immature or poor seed quality or under cleaned seeds. A field study to confirm the usefulness of the coating treatments used in this experiments is recommended.