Evaluation of the Effects of Moisturizing Snap Bean Seed to Reduce Mechanical Damage

Bart (Bo) Wink

Introduction

- **Education:**

BA in Liberal Studies with an emphasis on Biological Sciences and Entomology (1996); California State University, Stanislaus (Turlock, CA)

- **Work Experience:**

1996-1999 – Research Technician, Sunburst Plant Disease Clinic (Turlock, CA).

1999-2005 – Research Associate, Pioneer Hi-Bred International, Inc. (Woodland, CA). Primary focus included disease screening and serving as Drought Trait Development and Integration project member.

2005-Current – Seed Production Agronomist / Snap Bean Breeder / Product Evaluation Scientist, Syngenta Seeds (Nampa, ID and DeForest, WI).

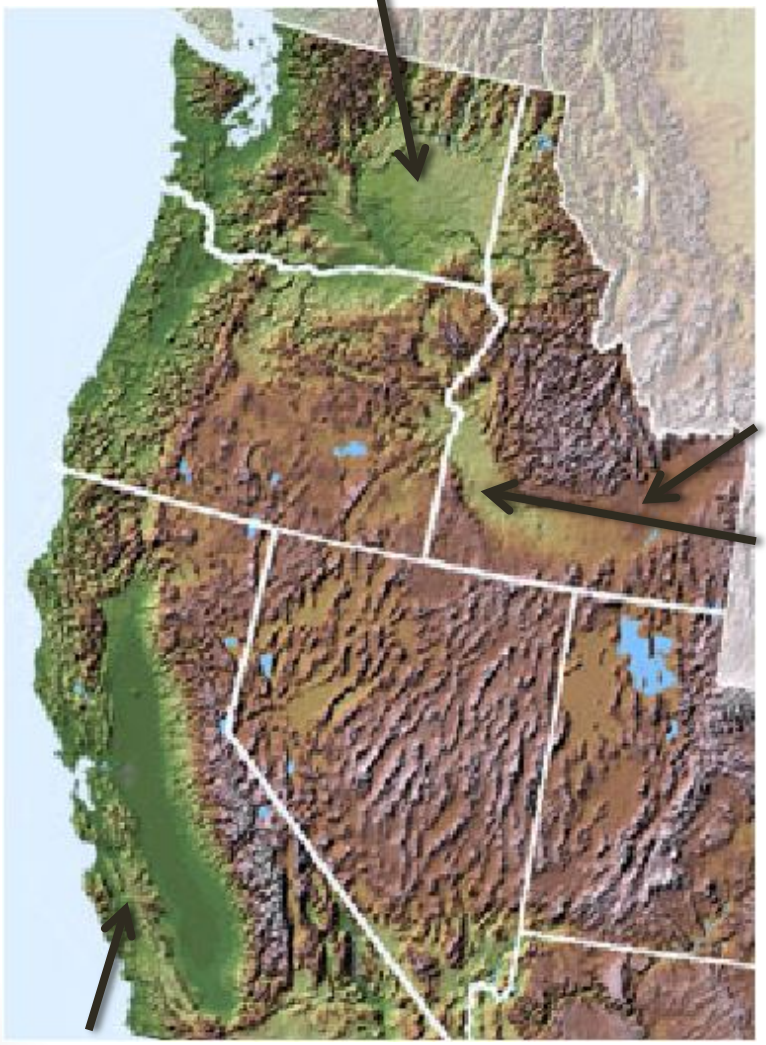
Introduction

- **Family:**

Raised on ranches, or around the cattle business, in Wyoming, Arizona, California, and Texas. My family still operates the family ranch 90 miles east of Sturgis, South Dakota.

Married to Lisa for 15 years, and we have two sons (Austin and Garrett). We currently reside in De Forest, Wisconsin.

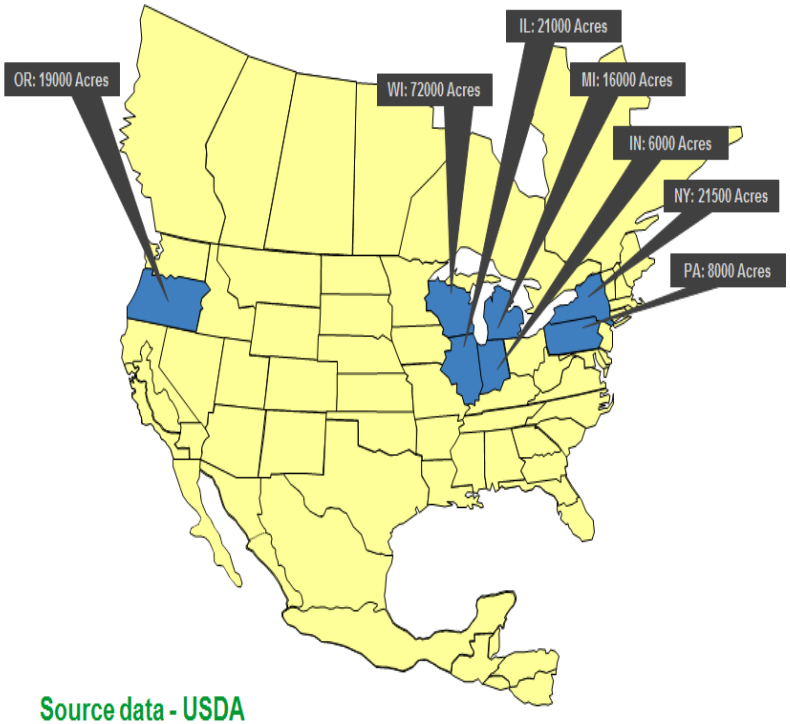
Primary Production Areas and Practices of Snap Bean Seed



- Planting typically takes place between late-May through mid-June, after soil temperatures have reached and maintain 50° F.
- Excessive moisture during planting may lead to delayed emergence and greater incidence of soil-borne pathogen (*Pythium*, *Fusarium*, *Rhizoctonia*) problems.
- Target plant populations vary with seed size but may range from 90k live seeds/acre to 140k live seeds/acre.
- Counter-season/rescue production in Chile.

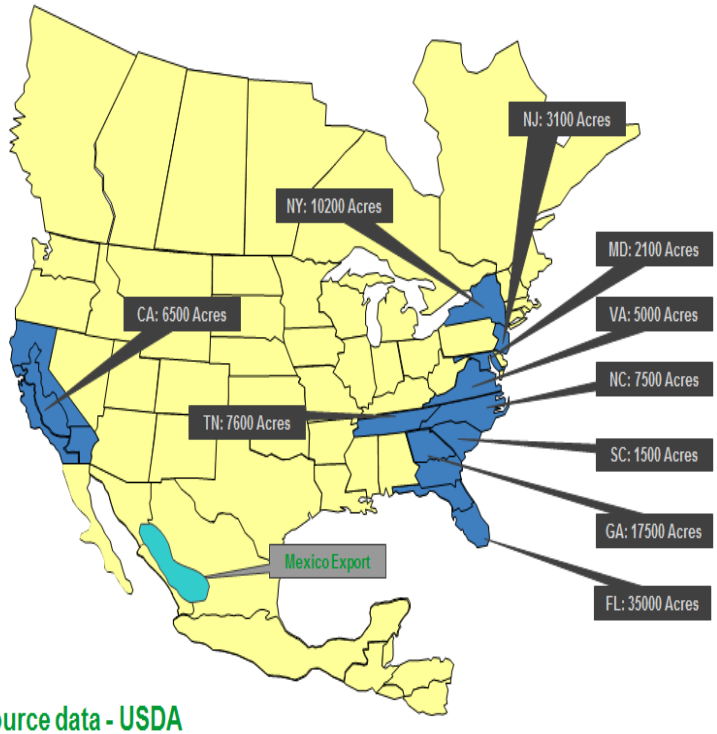
Primary End User Growing Regions in US

Primary Processor (canning/freezing) Growing Areas



Source data - USDA

Primary Fresh Market Growing Areas



Source data - USDA

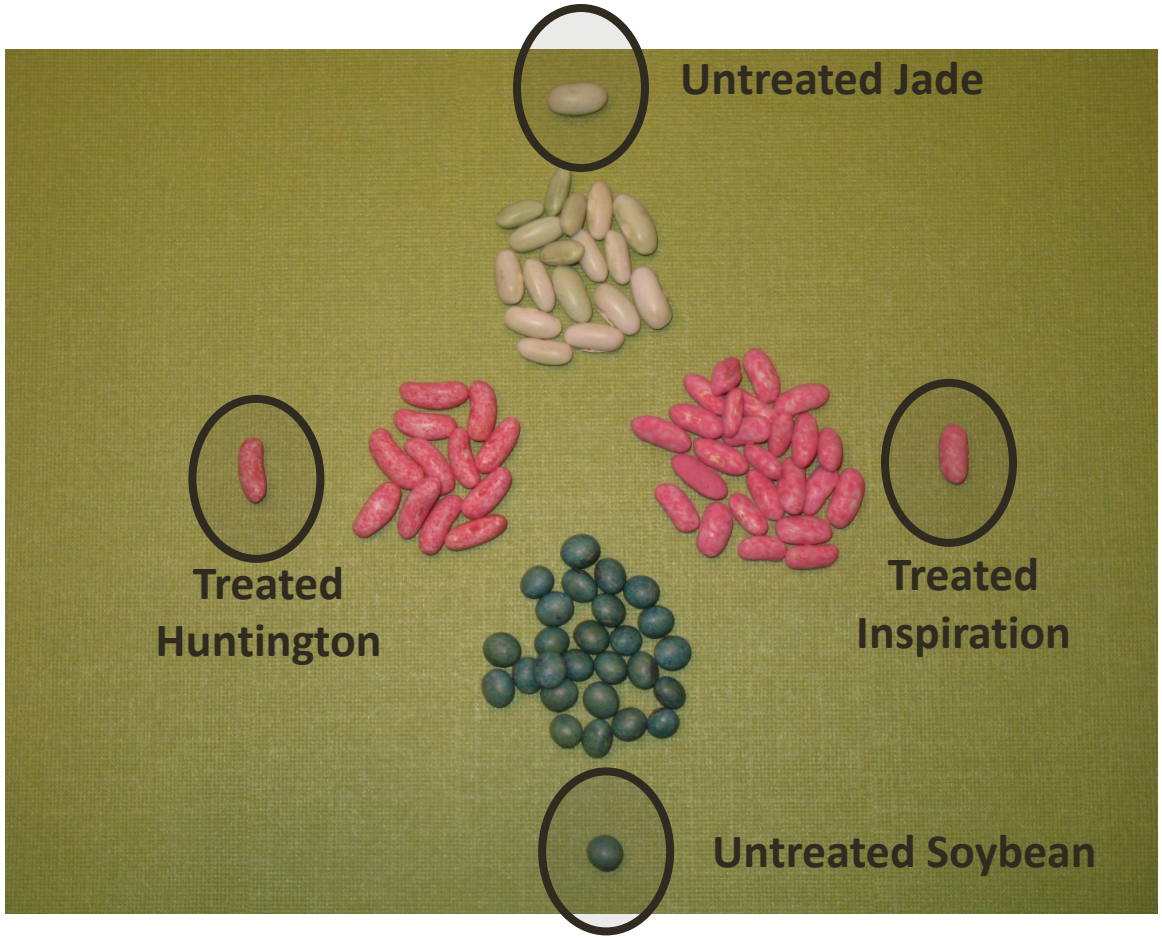
Introduction to the Snap Bean Seed Production Practices

Unlike soybean seed crops (which are direct-harvested with a combine in the field), snap bean seed crops are cut and windrowed to allow the vines to dry down enough to pass through the rotor of the combine effectively.

Seed crop being cut and windrowed

Crop being harvested with a rake-up head

Visual Differences between Soybean Seed and Snap Bean Seed types



Introduction to the Snap Bean Seed Production Practices

In the process of snap bean (*Phaseolus vulgaris* L.) production, seed moisture content prior to harvest and conditioning is an extremely important component contributing to the final, overall quality of the finished product.

Snap bean seed crops which are cut at seed moisture content deemed to be:

- ‘high’ (16-20%) for some combines:
  - windrows need to be left in the field for long periods of time
  - sometimes turned with a hay rake, prior to combine harvest.
- ‘too low’ (<10%), there is an increased risk of seed damage and deterioration of seed quality.

Introduction to the Research

The moisturization of snap bean seed is not uncommon to the industry, though the real need for, and correct timing of, moisturization are the questions which led me to undertake this study.

Research Objectives:

- To determine if seed moisturizing has a beneficial effect in reducing mechanical damage through conditioning and other handling processes.
- To attempt to determine if seed moisturizing prior to planting has any beneficial effect on overall emergence.
- To attempt to determine if there are any detrimental effects on the shelf life of the seed after a moisturizing event.

Materials and Methods

Five Syngenta snap bean lines with diverse genetic backgrounds were selected to be tested for this study. Variety names and brief descriptions are detailed in the table below.

Entry Number	Variety Name	Variety Description
1	Jade	Fresh Market type; four sieve, 6 inches long, primarily grown in Western U.S. and Mexico
2	Prevail	Fresh Market type, four sieve, 5.75 inches long, primarily grown in Southeastern U.S.
3	Inspiration	Fresh Market type, four sieve, 5.75 inches long, primarily grown in Southeastern U.S.
4	Huntington	Processor type (canning/freezing), five sieve, 5.75 inches long, grown in Midwestern and Eastern U.S., Eastern Europe, and Chile
5	SB4481	Processor type (canning/freezing), 4.5 sieve, 6 inches long, developed for MW and Eastern U.S.

Materials and Methods

- While our company's protocol for moisturizing large lots of seed dictates that the seed bins be placed into a large moisturizing chamber.
- The environment maintains 75% relative humidity and 75° F, for a period of 2-3 days (depending on initial seed moisture and seed size),
- These facilities were not available for this study. Hence, a small unit needed to be constructed in an attempt to replicate these conditions, and increase the percent moisture (%) of the selected samples.

Materials and Methods

The chamber for this study was constructed out of galvanized steel legs, with a heavy tarp enveloping all four sides. The chamber was placed in a greenhouse and the temperature of the greenhouse was maintained at 75° F. Once constructed, a small humidifier was placed into the chamber.

Exterior View of Moisturizing Chamber

Interior View of Moisturizing Chamber (with humidifier)

Humidifier

Materials and Methods

- Five pounds of the selected seed samples (chosen for their diverse genetic backgrounds) were put into mesh bags and placed into the chamber for a period of six hours, with the exception of the '**Lo Moist**' samples, which were not moisturized in any way.
- After this time, it appeared that too much moisture was accumulating on the seed coats too heavily, so the seed was removed and placed into a growth chamber, in which the temperature was 77° F with a relative humidity of 94.4%, for two full days.

Materials and Methods

- After two days in the growth chamber, the samples were removed and placed into ambient air conditions (73.2° F) for 30 minutes to allow any exterior moisture to evaporate before moisture content readings were collected.
- Moisture content was collected with a Dickey-John mini-GAC seed moisture tester.
- 200 seeds were collected from each of the sample bags and shall be referred to as the '**Hi Moist**' samples from this point forward.
- The mesh sample bags were then returned to the growth chamber for an additional three days, removed and allowed to dry in identical ambient conditions as described above.
- Moisture content samples were again collected with the mini-GAC. 200 seeds were removed from each sample bag and shall be referred to as the '**V-Hi Moist**' samples from this point forward.

Materials and Methods

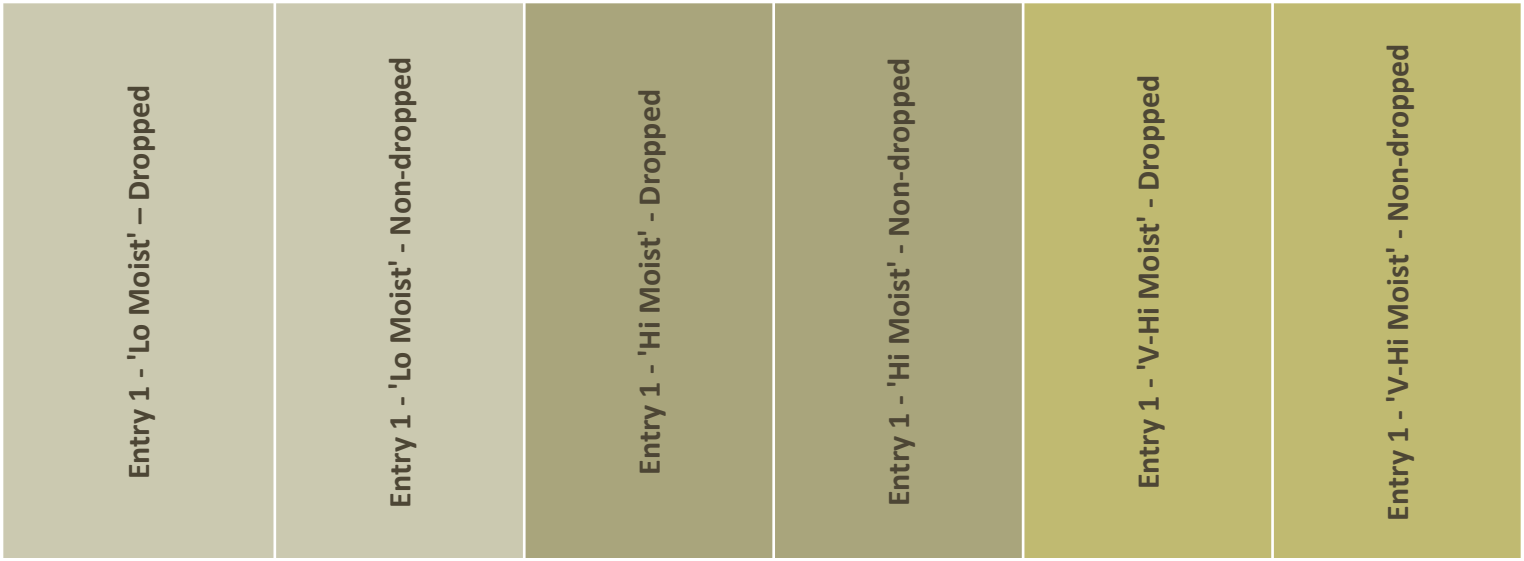
Four packets of 50 seeds/treatment were counted out from each **moisturizing group**.

- '**Lo Moist**' – samples from initial bulk seed, prior to moisturization.
- '**Hi Moist**' – samples which spent six hours in the moisturizing chamber and 2 days in the growth chamber
- '**V-Hi Moist**' – samples which spent six hours in the moisturizing chamber and 5 days in the growth chamber

- **Mechanically damaged seed:**
  - **'Non-dropped'** samples - two of the 50-seed packets from each sample group were not mishandled in any way.
  - **'Dropped'** samples - two of the 50-seed packets from each sample group were dropped 48" through a square tube onto a tin plate placed at a 45° angle.

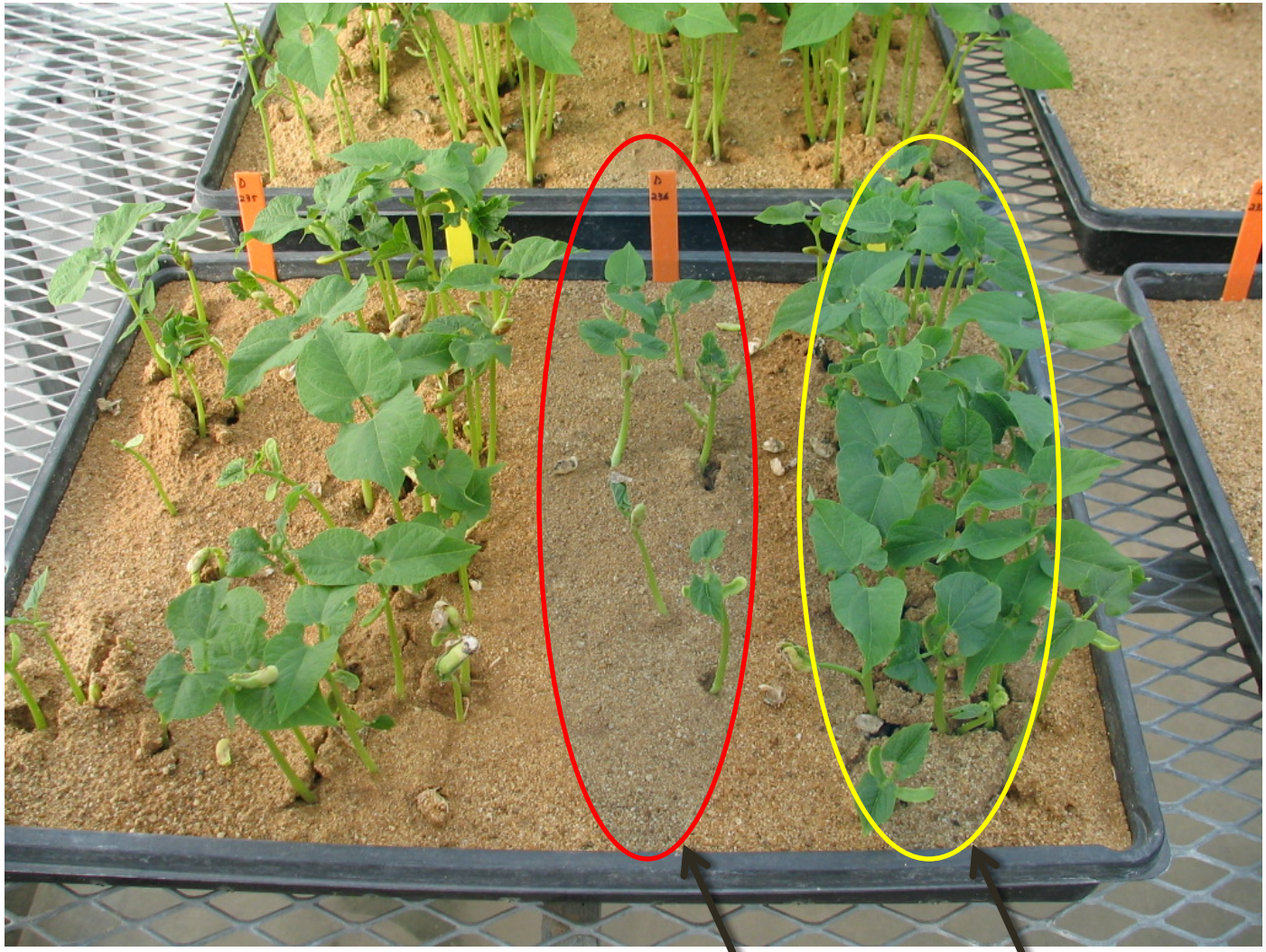
Materials and Methods

- Two replications of each of the samples were then planted into cool sand trays, along with standard checks for seedling germination in the following pattern:



- Ten days after planting, each planted sample was evaluated for the number of emerged seedlings to determine percent germination (%) values.

Example Image of Mechanical Damage Evaluation Test



Dropped Samples Non-Dropped Samples

Materials and Methods

Shelf Life Concerns:

Inclement weather during the planting season or changes in market demand, can require growers/seed companies to store and manage seed that was intended to be planted during a given growing season.

Seed from the V-Hi samples were allowed to sit in ambient office condition, around 73° F, for a period of eight months and four 50-seed samples were removed.

- two 50-seed samples were not mishandled in any way
- two 50-seed samples were dropped 48 inches, as previously described
- both groups of seeds were planted (along with check varieties – historical varieties which have been used in this test hundreds of time, thus we can use these checks to determine the quality of the test) in conditions similar to those of the original plantings.

Ten days after planting, samples were evaluated for seedling emergence and will be referred to as '**Recurrent**'.

Results and Discussion

Changes in percent seed moisture among the various moisturizing treatments for the five snap bean lines.

- Note that the minimum increase in percent seed moisture induced was 3.82% (Jade) and the maximum increase was 5.52% (SB4481). The mean increase in percent moisture induced across all varieties was 4.67%. An average of 2.95% seed moisture was induced, across all varieties, within the first three days of moisturizing.

Entry Number	Variety Name	Percent Moisture (%) at planting of 'Lo Moist' seed (storage moisture after harvest)	Percent Moisture (%) of 'Hi Moist' seed (after three days of moisturizing)	Percent Moisture (%) of V-Hi Moist' seed (after six days of moisturizing)	Percent Moisture (%) increase of Samples after moisturizing
1	Jade	10.76	14.17	14.58	3.82
2	Prevail	9.96	12.30	15.40	5.44
3	Inspiration	10.60	13.93	14.43	3.83
4	Huntington	10.16	14.17	14.90	4.74
5	SB4481	10.13	11.80	15.65	5.52
	Average of Set	10.32	13.27	14.99	4.67

Results and Discussion

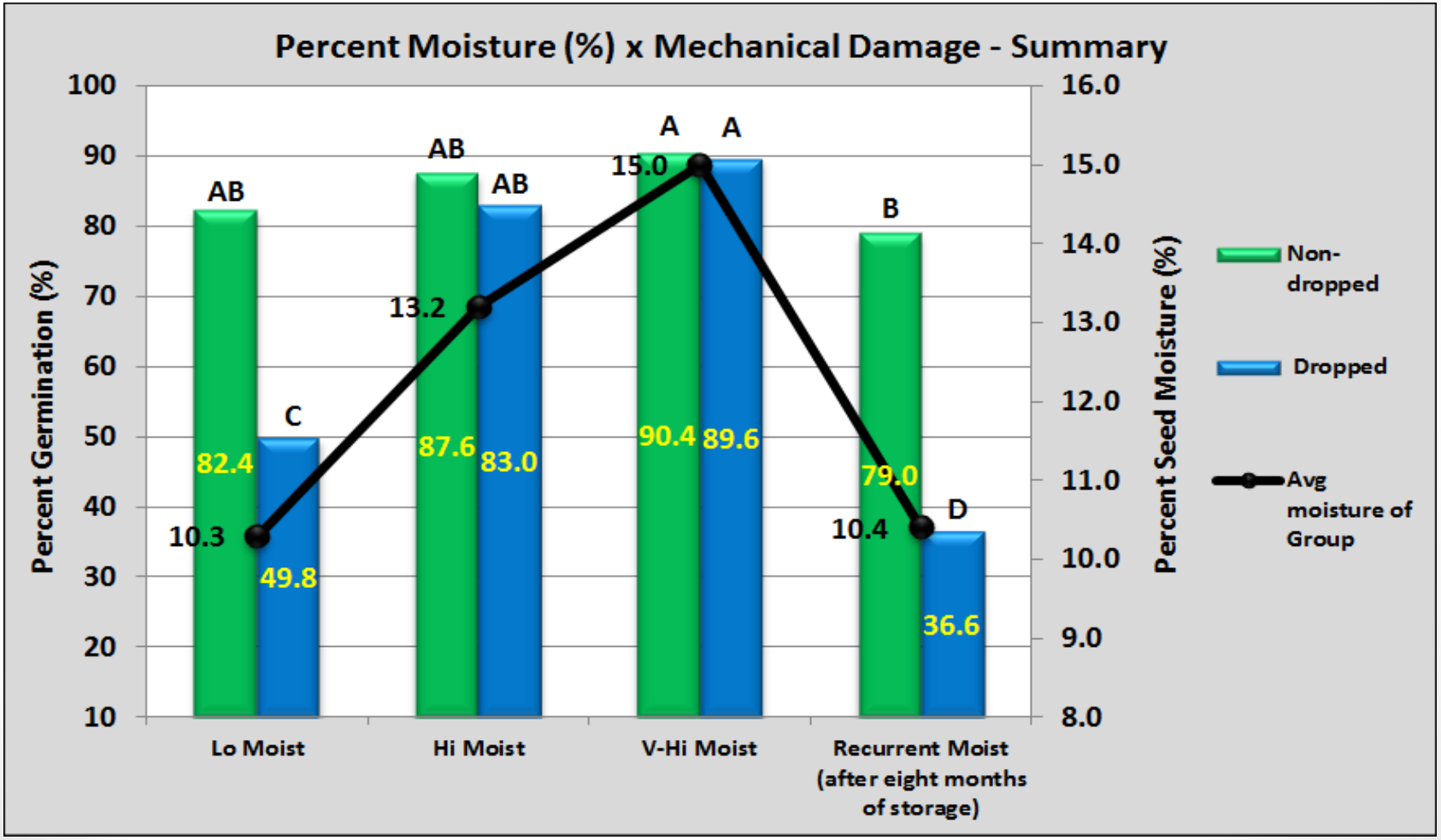
Moisture loss, over time (eight months), of Shelf Life evaluation – 'Recurrent' samples.

Note that the average moisture loss, across all varieties, was 4.61%. The greatest moisture loss over eight months was observed in the variety Prevail (5.80%), and the least amount of moisture loss was observed in the variety Inspiration (3.13%).

Entry Number	Variety Name	Percent Moisture (%) of 'V-Hi Moist' seed (after six days of moisturizing)	Percent Moisture (%) of 'Recurrent' seed after eight months of storage	Percent Moisture (%) loss of 'V-Hi Moist' seed samples after eight months of storage
1	Jade	14.58	10.20	4.38
2	Prevail	15.40	9.60	5.80
3	Inspiration	14.43	11.30	3.13
4	Huntington	14.90	10.60	4.30
5	SB4481	15.65	10.20	5.45
	Average of Set	14.99	10.38	4.61

Results and Discussion

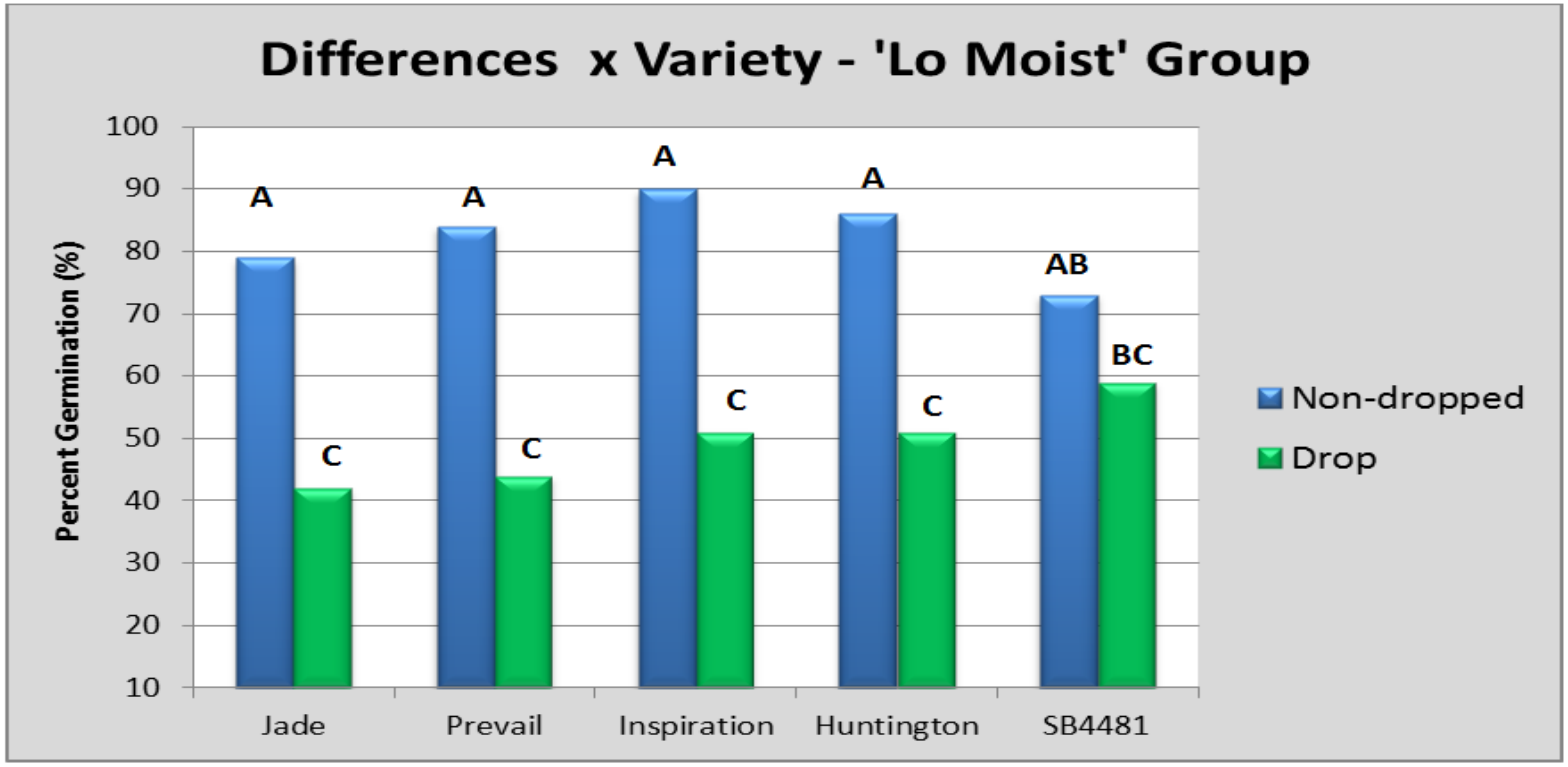
Significant increases in germination and resistance to mechanical damage were observed among the 'Dropped' samples of, both, the 'Hi Moist' and 'V-Hi Moist' samples in this test. Additionally, significant decreases in germination and resistance to mechanical damage were observed after eight months of storage within the 'Recurrent' samples.



Bars containing the same letter are not significantly different at the alpha = 0.05% level.

Results and Discussion

- Another goal of this test was to try to determine any effect of moisturization on various genetic backgrounds, in an attempt to improve resistance to mechanical damage through breeding efforts.
- All varieties within the 'Lo Moist' group (average moisture = 10.32%) – with the exception of SB4481 – displayed significant differences between the 'Dropped' and 'Non-dropped' samples.



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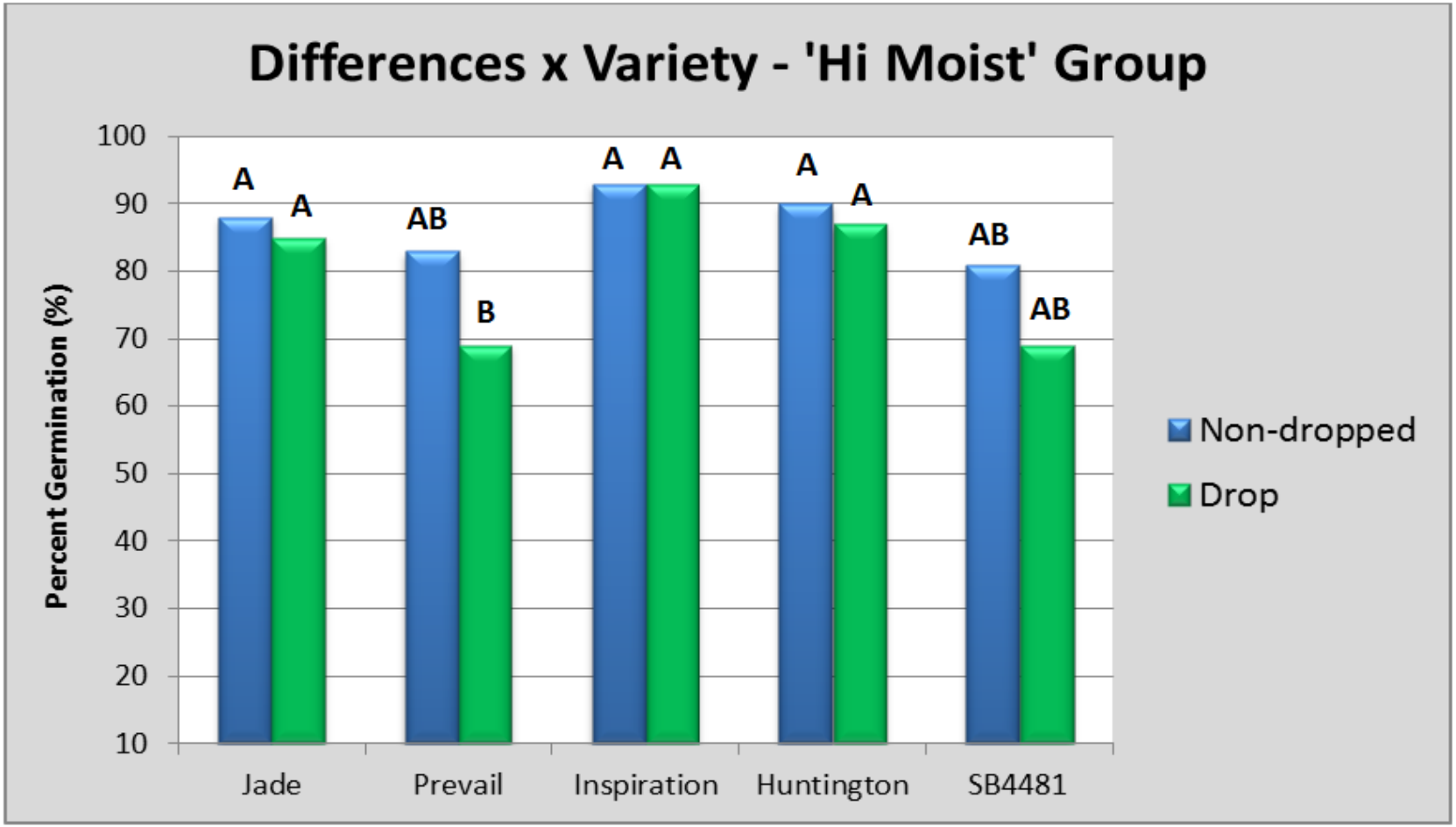
Results and Discussion

- All significant differences between the 'Dropped' samples and the 'Non-dropped' samples, among varietal groups, vanished within the 'Hi Moist' samples (average moisture = 14.32%).



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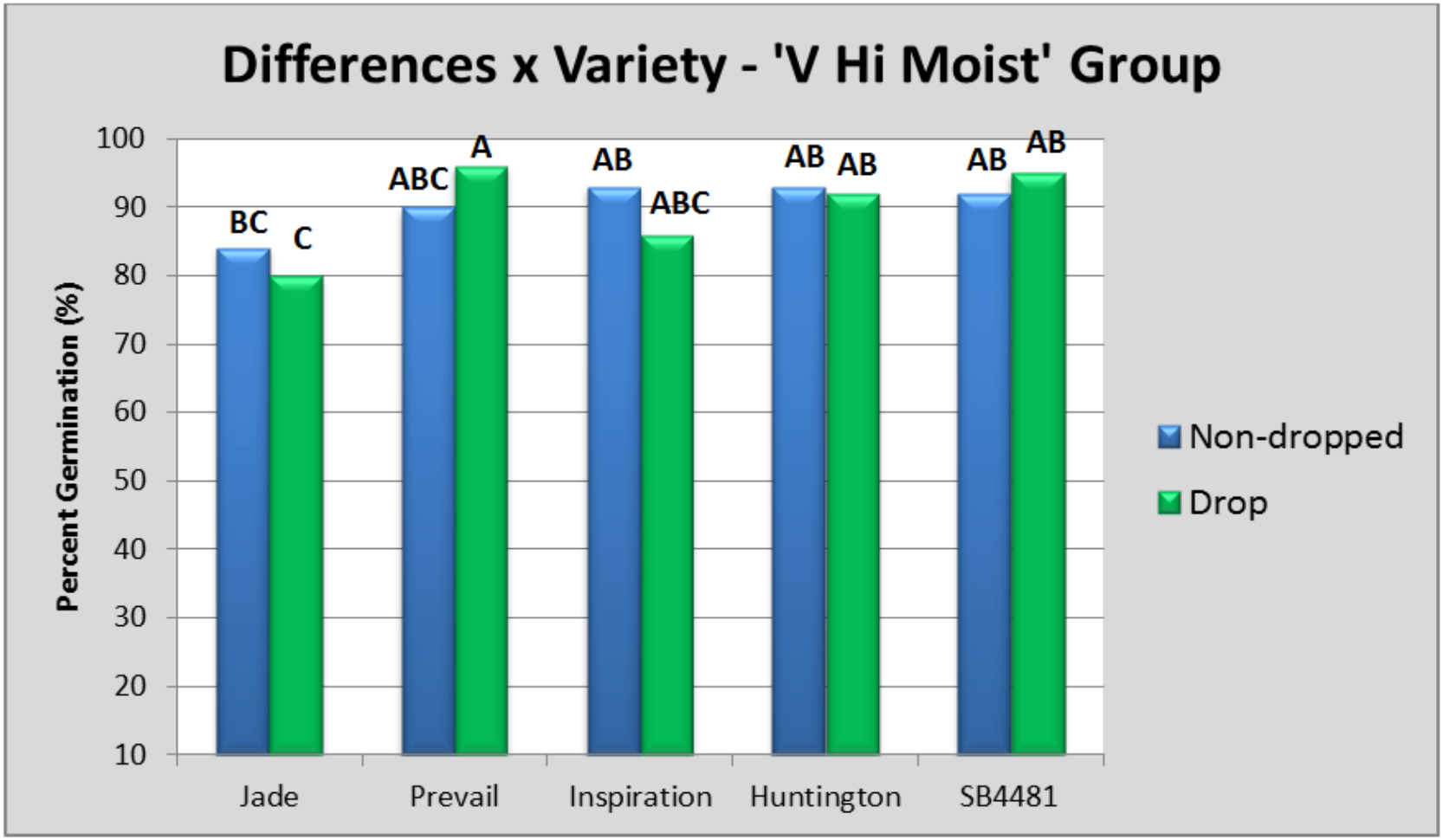
Results and Discussion

- Within the 'V-Hi Moist' (average moisture = 14.99%) group, there were also no significant differences observed between 'Dropped' and 'Non-dropped' samples, among varietal groups.



Bars containing the same letter are not significantly different at the alpha = 0.05% level.

Results and Discussion

Potential Production Realities of the 'V-Hi Moist' group

- Until recently, most of the equipment being used could not effectively harvest snap bean seed crops at those moisture levels (~15%).
- Introduction of John Deere's STS® combine, as well as, Pickett's pull-type combines, such as the Double Master Plus® have improved this situation within snap bean growing regions as they are able to harvest at higher moisture levels than the, traditional, Case IH Axial-Flow® designs.

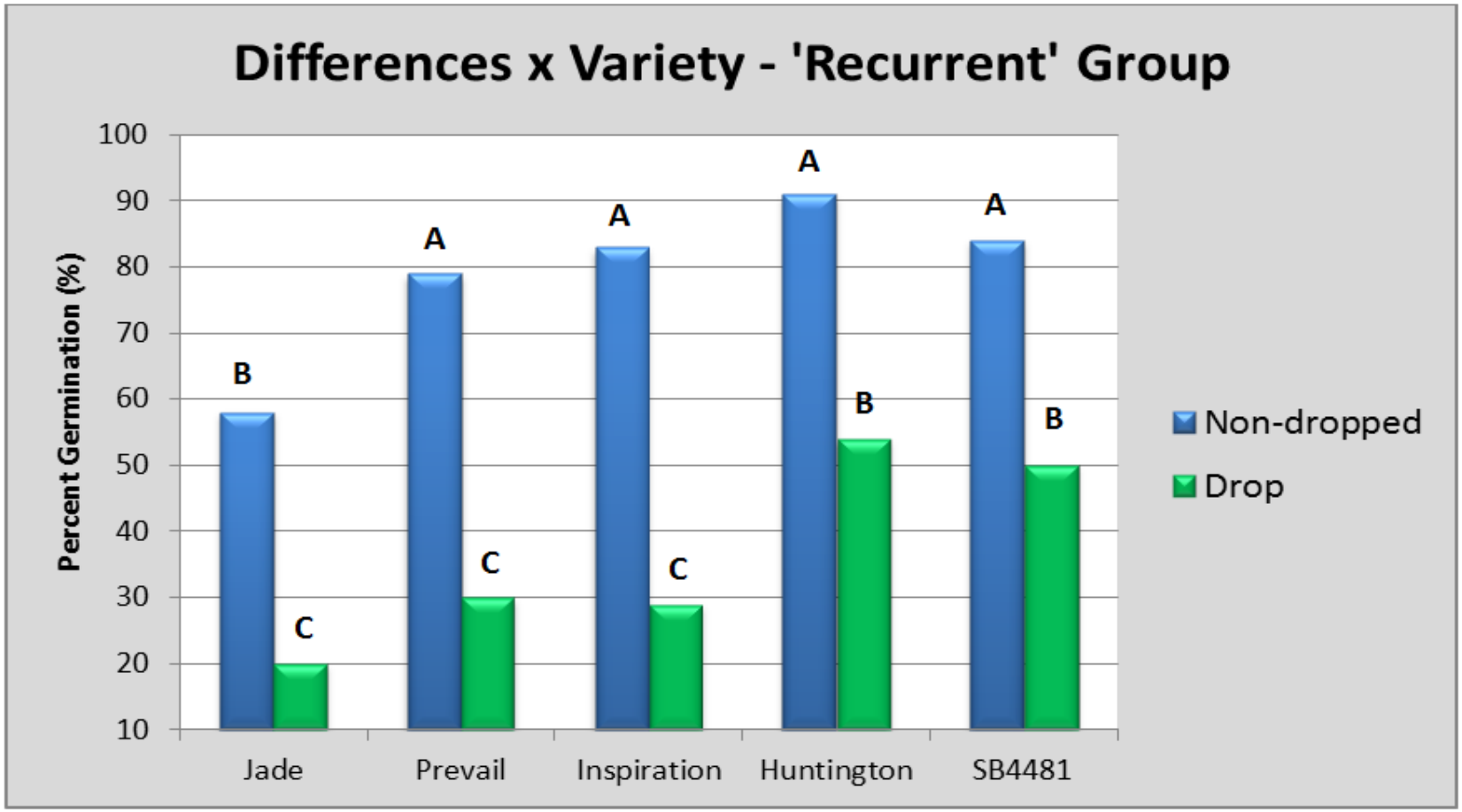
Results and Discussion

- **Typical combine types used for snap bean seed harvest**

1) **Case IH Axial-Flow® combine (124-180 hp)**
2) **Pickett Double Master Plus® combine (no return system, high speed rotor)**
3) **John Deere STS® combine (265-323 hp)**

Results and Discussion

- Within the 'Recurrent' sample groups, those simulating 'carry-over' seed, significant differences were observed between the 'Dropped' and 'Non-dropped' samples within all varietal groups.



Bars containing the same letter are not significantly different at the alpha = 0.05% level.

Summary

- In summary, this experiment showed that snap bean seed of five lines displayed an increase in germination rate, as well as, decreased incidence of injury through controlled mechanical damage when moisturized.
- These data should be thoughtfully considered by snap bean seed companies, particularly when managing seed lots with moisture contents around 10% or lower, as the observed decrease in seed germination may be significant.

Next Steps? Continuation of Research.

- The need to determine the correct timing of moisturization still needs to be determined.
  1) Is it better to moisturize prior to conditioning in an attempt to decrease mechanical damage within the seed plant, or
  2) Should seed be moisturized upon order placement to reduce the risk of carrying 'primed' seed within inventory?

- Further analysis of true combine ability to harvest at traditionally high moisture contents. As the number of STS and Pickett combines becoming available, can seed companies target harvest moistures that reduce/eliminate the need for further moisturization?

Acknowledgements

I would like to recognize and thank the following individuals for their continued support and guidance through this process. Without their help, the completion of this project would not have been possible.

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