Impact of Bulk Seed Handling on Soybean Germination Rate

Authors: Dr. Matt Darr, Iowa State University, Agricultural & Biosystems Engineering
Mr. Ben Rethmel, Bridgestone Firestone North American Tire, LLC
Mr. Randall Reeder, The Ohio State University, Food, Agricultural, & Biological Eng.

Introduction

Approximately 75 million acres of soybeans are planted every year in the United States. Recent trends in planting equipment have moved away from traditional individual row planters and toward high capacity, bulk fill grain drills and air seeders. These machines offer significant timeliness advantages given their ease of loading and large holding area for seeds. Filling these larger machines has also been simplified in recent years as many seed supply companies have offered bulk packaging rather than only single unit options. Producers now have the option to buy single containers, holding 50 or more units of seed, and load then directly into the bulk storage area of the planters.

In order to simplify the loading process, many producers have adopted the method of using a dedicated gravity wagon as a temporary seed storage location and directly filling seeders or drills from the gravity wagon. Conveyors or augers are used to transport the seed from the gravity wagon into the seeder or drill tank. The type of conveyor or auger used is a personal determination by the producer.

The first type of grain handler is a belt conveyor which uses flat belts with or without paddles to move the grain from the gravity wagon and into the seeder tank. Belt conveyers can either run flat or partially rolled inside a delivery tube. Typical belt speeds are between 5 – 8 feet per second and can convey between 10 – 15 bushels per minute. The second type of handling system is a traditional auger. This consists of a screw mechanism housed inside an enclosed tube. Augers typically operate around 500 – 700 revolutions per minute and will also transport around 10 – 15 bushels per minute. Three types of auger systems are commercially available for grain transport.

A traditional steel auger is the simplest and often cheapest variety and consists of a shaft with standard steel flighting (Figure 1). Plastic cupped augers are also available which have a wider clearance between the flighting edge and the outer tube as well as having a distinct cup at the tip of the flighting. This is designed to reduce grain damage caused by the seeds being trapped and crushed between the flighting and the outer tube. The final auger type is a traditional steel auger which has the outer inch of steel replaced with synthetic brush

bristles. Again, the brush auger design is aimed to reduce grain damage by providing a soft material between the auger flighting and the outer tube.

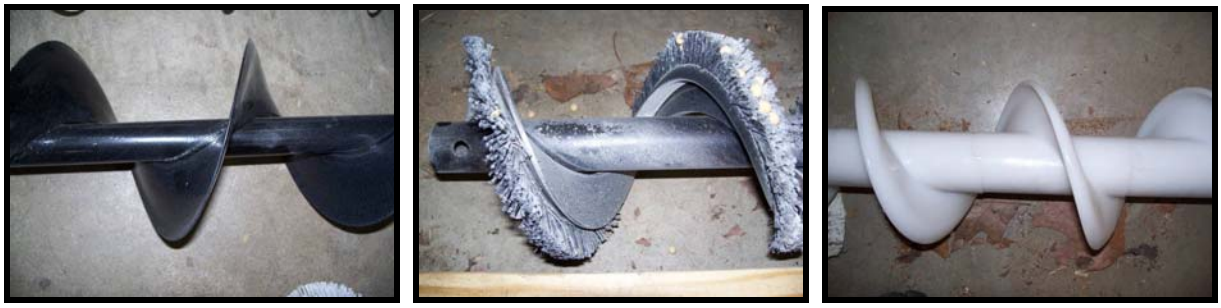

Figure 1: Section pictures of steel, brush, and plastic cupped auger designs.

With the increased use of these bulk handling systems, questions arise regarding whether they create an impact on grain quality and seed germination. The results of recent research, presented in this document, indicate that handling systems can impact grain quality and that users should be aware of these consequences before adopting a specific type of loading method. All research presented in this document was conducted at The Ohio State University by a joint partnership of the Food, Agricultural, and Biological Engineering Department and the Horticulture and Crop Science Department. Funding was provided by the Ohio Agriculture and Research Development Center, Pioneer Hi-Bred International, and Unverferth Manufacturing.

Test Methods

All four handling systems (belt conveyor, steel auger, cupped auger, and brush auger) were tested to determine any differences in soybean germination versus soybeans that were not handled through any bulk methods. Each of the handling systems was in like-new condition for all tests, thus the impact of wear and machinery quality was not a factor in this research. The specific parameters of the transport systems were:

- 16’ Brush auger, 6” diameter steel tube
- 16’ Steel auger, 6” diameter steel tube
- 16’ Plastic cupped auger, 6” diameter steel tube
- 18’ Rubber paddled belt conveyor, 6” diameter steel tube

Throughout all tests, the seed variety, seed size, seed moisture content (12.4%), testing room temperature (68°F), seed temperature (68°F), testing room humidity (30%), transport angle (35° from horizontal), and collection methods were constant. Seeds were collected at the outlet of the transport system by a grad sample method in which a two liter sample was

removed from the stream of material. For each test condition, four repetitions of sample collection were conducted.

Germination was evaluated through warm germination testing. Warm germination tests require seeds to be rolled up in wet paper towels and stored in a 77°F environment for a period of seven days. Comparisons were made both between individual conveyor types and the configuration of each system. Results are presented in units of germination percentage and a 90% confidence interval was used for all statistical analysis.

Results

Comparison between grain handling systems found that differences in germination were present when comparing bulk handled grain to a control sample that was not transported. When comparing all combinations of transport type and capacity versus the control in this study, it was found that transport systems reduce the germination rate by 5.2%.

Transport Type	Average Germination
Control	87.5
All Transport Configurations	82.3

Table 1: Comparison of average germination between bulk handled seed and control seed.

Further analysis was conducted to compare the differences between transport types under the condition of standard 10 bushels/minute flow rate. Brush and steel augers were found to be significantly different than the control when operated at 10 bushels/minute.

Transport Type	Average Germination	Statistical Category
Control	87.5	a
Plastic Cupped Auger	86	a
Belt Conveyor	81.6	a, b
Brush Auger	80.8	b
Steel Auger	80.8	b

Table 2: Statistical comparison of soybean germination for specific bulk handling systems versus the control seed for a 90% confidence interval.

When analyzing this data, the biggest surprise is the performance of the belt conveyor system which had a substantial difference in germination than the control. Further analysis of the belt system tested revealed that no padding was provided in the nose of the conveyor, thus resulting in seeds deflecting off a metal plate before exiting the conveyor. It is believed that this is the location where the majority of grain damage occurred and that this could be

improved by adding padding in this nose area to reduce the impact velocity of the seeds as they exit.

It was also found that operating speed could impact germination rate and that slow auger speeds (with the same flow rate) tended to reduce grain damage. This was believed to be the result of both a decrease in seed contact with the flighting edge due to fuller augers and a reduction in seed exit velocity which led to less damage caused by seed impact on the deflector nose.

Both brush and steel augers showed improved germination when operated at lower speeds. The plastic cupped auger did not follow the same trend, but this data may be skewed based on the overall high germination rate associated with this transport method.

Auger Type	Auger Speed	Average Germination
Brush Auger	370 rpms	85.5
Brush Auger	525 rpms	80.8
Brush Auger	800 rpms	78.5
Steel Auger	370 rpms	85.5
Steel Auger	525 rpms	80.8
Steel Auger	800 rpms	80.5
Plastic Cupped Auger	370 rpms	84.0
Plastic Cupped Auger	525 rpms	86.0
Plastic Cupped Auger	800 rpms	82.0

Table 3: Comparison of average soybean germination versus auger speed for three unique auger types.

Conclusion

Bulk handling systems for soybeans can increase productivity by reducing down time associated with refilling a planter, drill, or air seeder. Care should be taken when selecting an appropriate system to ensure that soybean damage is minimized. Based on current research, a 5% germination loss is realistic and could be even higher depending on the specific equipment used. Furthermore, operating augers at slower speeds will generally reduce soybean damage by maintaining a fuller auger and reducing the seed velocity.

Some general criteria for ensuring low grain damage pre-plant include:

1. Operate augers at low speeds and keep the mouth of the auger well supplied with grain. This will maintain a fuller auger and minimize damage.
2. Ensure that padding is used at the nose of the auger or conveyor to reduce the impact damage when seeds are deflected out the nose. Just using a plastic deflector is not good enough, as many plastics have a hardness rating comparable with metals.

3. Replace worn augers, especially if you are using standard steel augers. As augers wear you can expect grain damage to increase.
4. Keep bearings and tubes in good shape. If the auger wobbles within the tube because of either worn bearings or a worn motor mount, grain damage will increase due to increased contact with the flighting edge.