A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

November 1993
ISSN 1188-4770
Group 6g

Research Update 704

Moisturizing Pulses to Reduce Damage

- PAMI investigates methods to reduce pulse seed damage caused by handling and processing

(Funded by: SPCDB, CAFDI, and PAMI)[1]

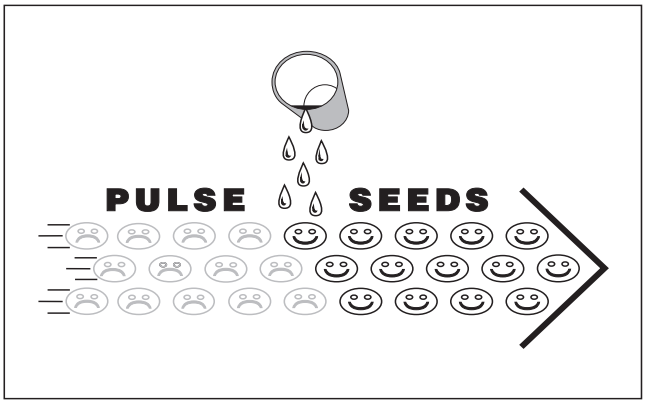
WHAT'S THE PROBLEM?

Pulse crop production is a relatively new $200 million business in Saskatchewan. Crops such as peas, lentils, and pinto beans have allowed diversification away from the conventional cereal and oil seed crops.

New technologies have been introduced to increase pulse crop productivity, but little has been done to ensure post-harvest quality control. Pulse seed damage is a major concern for producers. Damage, caused by handling and processing, greatly reduces the marketability and profit margin of the product.

Past research has shown that damage occurs during handling, processing, and subsequent seeding operations. Drill metering systems, air seeder components, and cleaning operations can each contribute up to 20% in physical or germination damage. Pulse seed damage (loss of viability) increases seeding input costs and reduces the market value as a food product.

Virtually all previous studies showed that damage was greatly reduced when the pulse seeds were at a high moisture content (MC). Researchers, using lab-scale tests, also found that pulse seeds could be moisturized (or rewet) by blowing humid air over the seeds (Humid Air Approach) or by submerging the seeds in water (Direct Contact Approach).



In 1992, the Prairie Agricultural Machinery Institute (PAMI) initiated a project to adapt those experimental findings to a full size operation, using equipment and methods that could be used by processors and producers.

NOTE: The reader is cautioned that the information in this Research Update is only a summary of the test results. For complete information, contact PAMI at 1-800-567-PAMI and ask for PAMI Report #RH0492 (cost $5.00).

IN BRIEF. . . THE CONCLUSIONS

- The Direct Contact Approach proved to be the most effective method due to its simplicity, availability of equipment (to the producer), and the advantages of using a mixing process to thoroughly coat the seeds with water.
- The Humid Air Approach (with Equilibrium Air)[2] does work but the time period required for full rewetting is quite lengthy.
- The Humid Air Approach (Saturated Air Approach) is not recommended. Lower layers of seed over-absorbed and swelled up, restricting air movement through the bin. Monitoring the system was very difficult and an experienced, subjective judgement call is required to determine when to turn off the water.
- In both cases of using moistened air, swelling seeds caused high bin wall stresses, which would need to be reduced by turning the grain in the bin.
- Canola oil is not recommended. It provided no advantages over water and, in some cases, caused more germination decrease.
- A handy "How to Rewet Pulses Using Direct Water" guide is given, for pulse rewetting, in the last section of this publication.

[1] Funding for this research project has been provided by the Saskatchewan Pulse Crop Development Board (SPCDB), as supported by the Canadian Agri-Food Development Initiative (CAFDI) of Agriculture Canada, and the Prairie Agricultural Machinery Institute (PAMI).

[2] When the "RH In" (Relative Humidity) is equal to the "RH Out", the product is in equilibrium with the predetermined moist air. This state of equilibrium will then result in the predetermined, desired moisture content of the seed.

WHAT DID WE DO?

For the purposes of this project, the pulse seeds used were: Laird lentils, Express peas, and Othello pinto beans. Starting moisture was to be 13 to 14% MC (wet basis) while the final or safe MC was to be 15 to 16%. Selected seed for the project was to have germination above 90%.

For the Humid Air Approach, PAMI used six aeration test bins. These bins were equipped with variable flow aeration systems capable of matching commonly used farm systems.

Humidity control was achieved by placing a sprayer nozzle near the fan inlet and then controlling the water flow rate through the nozzle. The RH of the mist entering the bin was controlled to test specifications.

Two strategies were used in the Humid Air Approach. The first involved adding water at a rate which would balance the RH of the air with the desired final equilibrium of the seed at the desired MC. The second method used very high levels of RH, exposing the bottom layer of seed to very moist air, saturating the seeds with excess water. The water is then turned off and the fan is used to drive the water through the rest of the seeds.

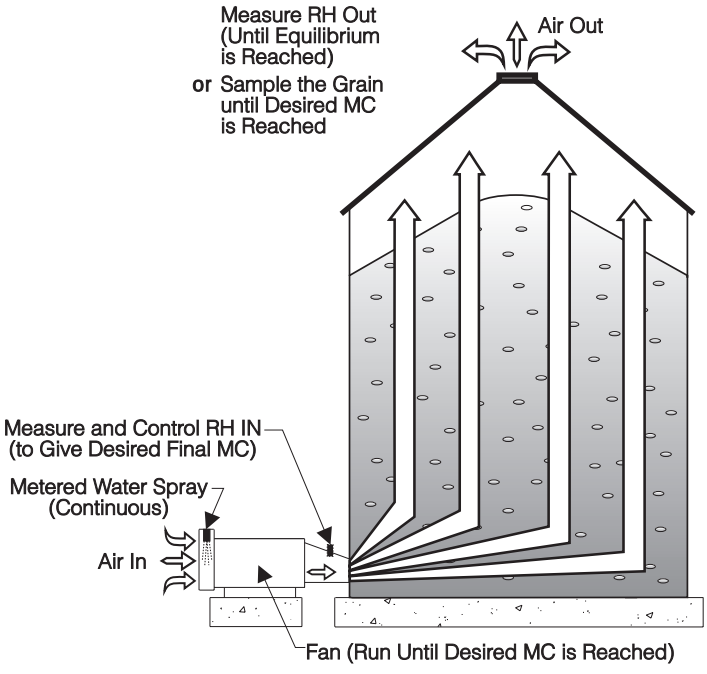
The Direct Contact Approach involved adding a predetermined quantity of water directly to the seed. Augers appear to offer the best method of applying water directly to pulse seeds. The aggressive mixing action within the auger provides a mechanism for applying water evenly to the seed coat. For wetting by Direct Contact, it is important that all seeds are in uniform contact with the added water, otherwise a long tempering period is required for the seeds to reach equilibrium moisture content.

Although belt conveyors are more gentle to pulse seeds, water would not be properly mixed with the product. Longer tempering periods and the possibility of wet spots could lead to rapid spoilage if a belt conveyor was used. The water was added with a garden hose located at the inlet of a 7 in (178 mm) diameter by 40 ft (12.2 m) steel flighting auger. A small hopper was used to hold the pulse seeds as they were flood-fed into the auger.

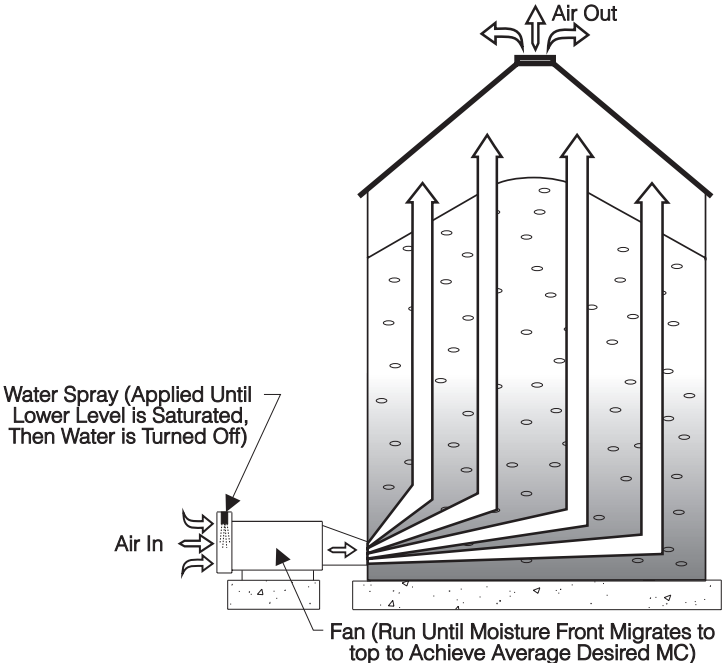
As part of the Direct Contact Approach, canola oil was used (replacing water) as a possible method of reducing damage. In theory, canola oil would not soak into the seeds, would not increase the MC, and should remain on the seed surface for a longer period. Damage tests from the canola oil trials were conducted exactly as the testing done with water.

HUMID AIR APPROACH

Equilibrium Air



Saturated Air



WHAT WERE THE RESULTS?

Humid Air Approach: The humid air approach was not a satisfactory method for rewetting pulses. When using air moistened to equilibrium RH, the time required to increase moisture content even a few percentage points was two weeks or greater. When using highly water-saturated air, the bottom layer of pulses in the bin over-absorbed and swelled up, cutting off the air flow. In both cases, as the kernels absorbed moisture and swelled, they exerted considerable stress on the bin walls and could possibly have caused wall failure.

Direct Contact Approach: Adding water directly to pulses in an auger proved to be the most effective method for rewetting pulses. The method was simplest, least expensive, and could be readily set up using common farm equipment. In a single pass through the conveyor, moisture content could be raised as much as 4.7% for Laird lentils, 3.2% for peas, and about 1.5% for beans. But if pulses are over dry (about 10% MC), they "close up" and can absorb moisture only very slowly. In this case, water must be applied in small amounts and multiple passes used, to bring them up to the desired level.

The auger, when run at about 400 rpm, caused no pulse damage even after seven passes. The auger must be flood-fed and kept full to minimize damage.

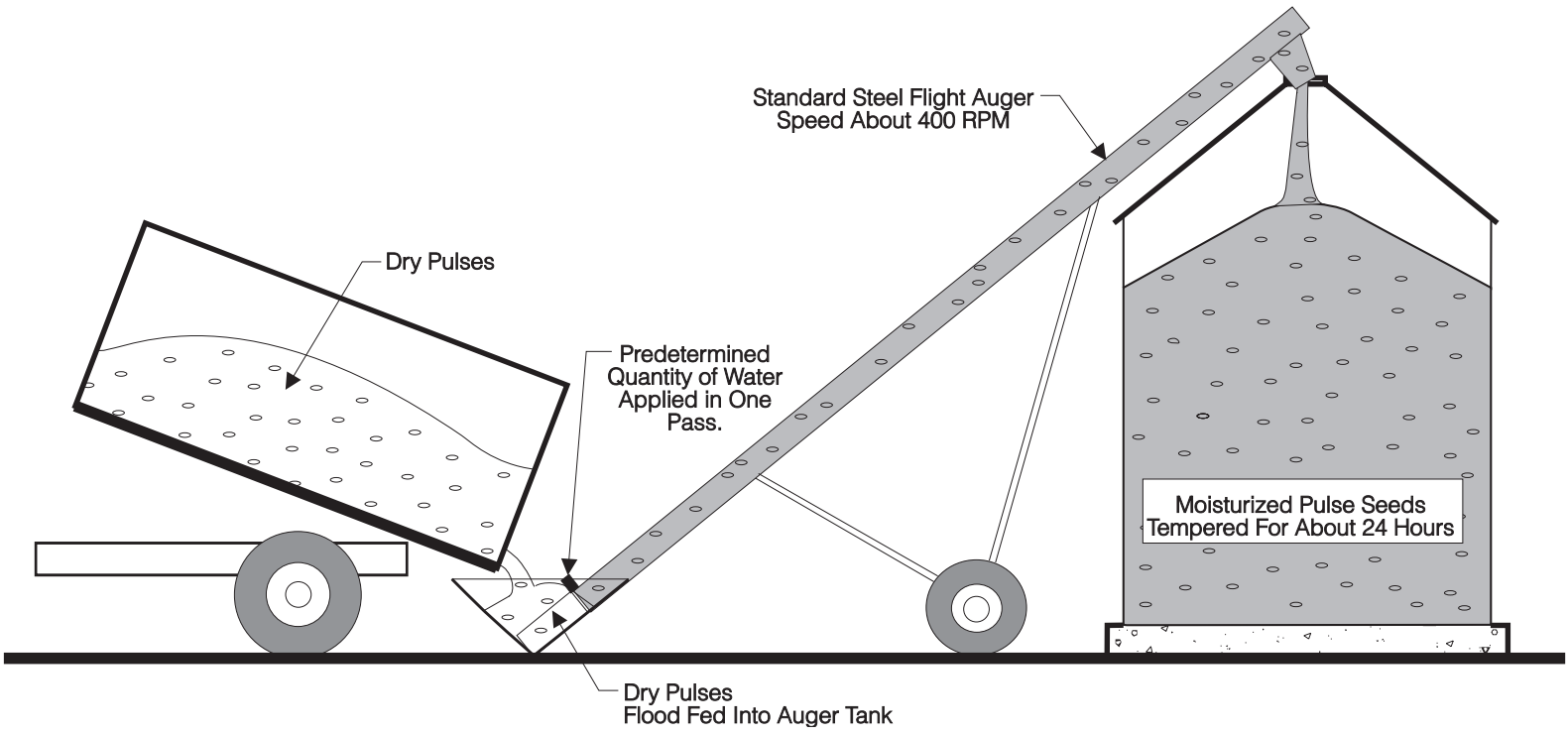
Canola oil, as a rewetting substance, did not produce any significant benefits. In lentils and beans, canola oil caused a slight increase in physical seed damage, and for lentils decreased germination. In peas, canola oil helped to decrease physical damage slightly but also decreased germination.

FURTHER INFORMATION

For detailed information, contact PAMI at 1-800-567-PAMI and ask for the following report (cost $5.00 per copy):

- "Moisturizing Pulses to Reduce Damage", PAMI #RH0492 - Sponsor: Saskatchewan Pulse Crop Development Board as supported by the Canadian Agri-Food Development Initiative (CAFDI) of Agriculture Canada.

DIRECT CONTACT APPROACH



HOW TO REWET PULSES USING DIRECT WATER APPLICATION

1. Determine the amount of pulses to be passed through the auger in a single batch. For example, use a truck box full, where the bushels can be readily estimated using box measurements.

2. Determine the amount of time required to empty the truck box through the auger. Remember to run the auger at a reduced speed (about 400 rpm).

3. Determine the incoming moisture content of the pulse seed. Also, decide which final moisture content is required.

4. Using the table provided, determine the amount of water that must be applied to the pulses while emptying the load. Divide this number by the box emptying time to get the required water flow rate.

5. Adjust the water hose accordingly and begin.

Example: An incoming 450 bushel load of peas has a moisture content of 12%. They must be rewet to 15%. The auger to be used will empty the box in 11 minutes.

From the table, determine that from initial 12% MC to final 15% MC requires 21 gallons per 100 bushels.

For our example:

$$\frac{21 \text{ gallons}}{100 \text{ bushels}} \times 450 \text{ bu} = 94.5 \text{ gallons}$$

are needed. If our box empties in 11 minutes, a water flow rate of

$$\frac{94.5 \text{ gallons}}{11 \text{ minutes}} = 8.6 \text{ gallons per minute}$$

is needed.

To set the hose at this flow rate, use a 5 gallon pail and a stop watch. It will take 35 seconds to fill the pail:

$$\frac{5 \text{ gal}}{8.6 \text{ gal}} \times 60 \text{ sec} = 35 \text{ seconds}$$

6. After 24 hours, always sample the bin to ensure that the desired moisture content has been reached and that the pulses are not overwetted, which could cause spoilage.

TABLE 1. Water Addition Chart...Used to determine the water required to raise the moisture content (MC) of pulse seeds through an auger (in one pass) to a desired moisture level.

Initial MC % \ Final MC %	10	11	12	13	14	15	16	17	18
	Gallons of Water Added per 100 Bushels of Pulses								
10	--	7	14	21	28	--	--	--	--
11			7	14	21	28	36	--	--
12				7	14	21	29	36	--
13					7	14	21	29	--
14						7	14	22	29
15							7	14	22
16								7	15
17									7

NOTE: Any water, added to a potential foodstuff, must be considered fit and safe for human consumption.

The procedure to using the following table is:
1. Find initial MC in the left-hand column (i.e. 13%).
2. Follow across to the right until directly below the desired MC in the top row (i.e. 15%).
3. Read gallons of water for every 100 bushels of pulse seeds wetting (i.e. 14 gallons per 100 bushels).

ALBERTA FARM MACHINERY RESEARCH CENTRE

3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:
P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080