ADOPT FINAL REPORT - Project #20140391

Project Identification

1. **Project Title:** Demonstration of Scarification Methods for Cicer Milkvetch Seed
2. **Project Number:** 20140391
3. **Producer Group Sponsoring the Project:** Saskatchewan Forage Council (SFC)
4. **Project Location(s):**
    - Prairie Agricultural Machinery Institute (PAMI), Humboldt, SK
    - Canada-Saskatchewan Irrigation Diversification Centre (CSIDC), Outlook, SK
5. **Project start and end dates:**
    - April 2015 – September 2016
6. **Project contact person & contact details:**
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Objectives and Rationale

7. **Project objectives:**

The objective of the project is to assess practical methods by which producers can scarify cicer milkvetch seed on-farm. Scarification is a technique used to improve the uniformity of germination in cicer milkvetch by abrading the impermeable seed coats to allow uptake of moisture from the soil.

This project will demonstrate different modes of action to scarify cicer milkvetch seeds and evaluate effectiveness by germination and vigor testing. In addition, small field plots will be used to demonstrate emergence of cicer milkvetch seedlings using different scarification techniques.

8. **Project Rationale:**

Non-bloating legumes such as cicer milkvetch are a desirable alternative to alfalfa in forage blends, but difficulty in establishing this forage is often cited as a deterrent by forage and livestock producers in using this legume. The high proportion of "hard seeds" (those with an impermeable seed coat) result in reduced or delayed germination of cicer milkvetch. Scarification of the seeds prior to seeding has been shown to increase germination and field emergence of cicer milkvetch (Carleton et al, 1971), however; seed that is scarified should be planted in a timely manner as viability is lost rapidly during storage of scarified seed. For this reason, cicer milkvetch seed is rarely sold scarified and producers wishing for optimized, uniform germination must perform the scarification on-farm just prior to seeding.

Demonstration of simple implements and methods to scarify seed on-farm will provide producers with

information to optimize seeding of this legume on their own operations, enabling them to make better use of this valuable forage crop. Simple scarification techniques that allow for more rapid and uniform germination of cicer milkvetch without causing damage will result in better establishment and more productive, healthier forage stands.

Methodology and Results

9. Methodology:

Initial development and testing of various modes of action to scarify Oxley II Cicer Milkvetch seed using different lengths of time took place at the Prairie Agricultural Machinery Institute (PAMI) in Humboldt, SK. Seeds from each of the nine treatments were sent to a laboratory for germination and vigour testing. A quick-swell test to estimate effectiveness of scarification was performed prior to sending samples for germination testing in lab. Based on literature recommendations (Carleton et al, 1971), if 30-50% of the seeds imbibe water and "swell" within 24 hours, the seeds are properly scarified.

Table 1. 24 Hour Quick-Swell Test Results by Treatment

Treatment	Sprouted Seeds (%)	Swelled Seeds (%)	Total Sprouted and Swelled (%)	Normal (no apparent effect) (%)
Control #1	4	34	38	62
Control #2	2	14	16	84
Teeter Totter 1000 X	12	35	47	53
Cement Mixer, with steel balls, 30 min	15	34	49	51
Cement Mixer, with lava rock, 30 min	5	28	33	67
Cement Mixer, with lava rock, 60 min	11	28	39	61
Freeze/Thaw, three cycles	1	16	17	83

The results of the quick-swell test were used to select the treatments that appeared to be the most promising and seed-lots were prepared from these methods and sent to the lab for germination testing. The cement mixer with steel balls treatment was not selected in spite of higher sprouted and swelled seed counts as it appeared to also cause more damage to the seeds. Based on the quick-swell method, it was determined that the three most promising modes of action or methods of scarification that could be applied on-farm were: Tumbling action: abrasive material (lava rock) tumbled with seed in a cement mixer (to be referred to as "Mixer"); frictional abrasion: a "teeter-totter" device lined with sand paper that seed was passed along (to be referred to as "Teeter-totter"); hand sanding: using a sanding sponge and applying pressure to seed by hand in a large tub (to be referred to as "Hand sander"). Photos and descriptions of each scarification method can be seen in Appendix A.

Samples were sent to Discovery Seed Labs for germination testing in February 2016. Table 2, displaying germination test results is included in Section 10 (Results).

Based on germination test results, seed batches for field demonstration were prepared on May 3, 2016 for seeding in late May. Treatments were:

1. Teeter-totter 500 times
2. Mixer with lava rock: seed at 1:1 ratio for one hour
3. Hand Sander 15 minutes
4. Control (no scarification)

Demonstration plots were sown at Outlook on May 27, 2016. Seeding was at a rate of 5 lbs/acre (5.6 kg/ha) with no seed treatment or inoculant at a depth of ¾". Each plot was 18 m by 30 m (540 m^2 per plot) for a total of 2160 m^2 (approximately 0.53 acres) for the demonstration site. Irrigation was used at a rate to promote growth only.

Seedling counts were performed on August 11, 2016 and results can be viewed in Table 3 (Section 10).

10. Results

Nine samples of scarified cicer milkvetch seed were sent to Discovery Seed Labs for germination testing in February 2016 and results are included in Table 2, below.

Table 2. Germination Test Results by Treatment Type

Treatment	#1	#2	#3	#4	#5	#6	#7	#8	#9
	Control	Mixer only	Hand sander	Teeter-totter		Lava Rock: Seed 1:1 ratio		Lava Rock: Seed 1:3 ratio	
Time/Number	N/A	30 min	15 min	500X	1000X	1 hour	2 hour	1 hour	2 hour
Germination	42	37	34	45	39	53	43	45	37
Hard Seeds	31	30	33	30	27	3	2	28	22
Germ&Hard	73	67	67	75	66	56	45	73	59
Fresh Seed	4	2	1	1	4	1	1	1	1
Abnormal	6	6	5	7	5	17	36	5	9
Dead	17	25	27	17	25	26	18	21	31

To evaluate establishment success, seedling counts were performed on August 11, 2016. Seedling counts were four random samplings per plot by quarter meter square quadrat. The Saskatchewan Agriculture Forage Specialist supervising the plots noted that very few plants were observed in the random seedling counts although there are plants evident in plots for all four treatments in the demonstration.

Seedling counts are displayed in Table 3, following page.

Table 3. Cicer Scarification Project Establishment, August 2016

Seedling Counts	Teeter-totter	Mixer	Control	Hand Sander
Count #1	0	0	0	2
Count #2	0	1	0	1
Count #3	0	0	0	0
Count #4	0	1	2	2
Average plants/quarter m2	**0**	**0.5**	**0.5**	**1.5**

Despite the results of the four samples, based on visual observation of the full plot area by the Forage Specialist, there does not appear to be any one treatment that displayed improved germination as compared to the other plots. All plots appeared to have similar plant populations and vigour. An additional year of data may be of value in determining success or failure of the scarification techniques and the Irrigation Crop Diversification Corporation (ICDC) Agri-ARM site intends to leave the plots for an additional year to see if there is improved establishment in 2017.

Extension/Promotion Activities:

- Signs were placed at the demonstration site in 2016;
- An Agronomy field day was held on August 16, 2016 at the ICDC Argi-ARM site/ Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) Research Station in Outlook, SK. Sarah Sommerfeld, Saskatchewan Agriculture Regional Forage Specialist highlighted this project. (25 attendees);
- A web video has been produced describing the project and on-farm scarification techniques. The video is posted to the SFC's YouTube Channel: https://www.youtube.com/watch?v=l2qJrnmg7d0 The project results, final report and video will be promoted on the SFC website and eNews (over 450 subscribers).

11. Conclusions and Recommendations

This project explored and demonstrated methods that producers could use to scarify cicer milkvetch seed in small batches on-farm with relatively low material requirements and little mechanical expertise required.

Based on the results of the germination tests, there was some improvement in germination as compared to a control (not scarified) when using a cement mixer with abrasive material or running the seed over sandpaper in a teeter-totter device. Along with increased germination using these methods, an increase in dead and abnormal seeds was observed for the scarified samples as compared to the control.

In order to determine if the germination test results would translate to real-world conditions, seed plots were prepared with three treatments: cement mixer with lava rock, teeter-totter and hand sanding, as well as a control. These were sown at the Canada-Saskatchewan Irrigation Diversification Centre in Outlook in the spring of 2016.

Plots were assessed for establishment success in August 2016 and based on random sampling, the hand sanding treatment had the highest number of seedlings established, followed by the control and mixer plots, and then the teeter-totter, where no seedlings were found in the sample areas. The site supervisor noted that based on visual observation the plots all appear to have similar establishment and vigour at this time and there is likely no significance to the differences observed for the seedling counts. On-farm scarification methods show no real benefit in terms of number of seeds germinating or

uniformity of germination over the control in this demonstration.

Establishment success or failure may be more evident in the spring of 2017. The ICDC Agri-ARM site is willing to leave the plots in place until spring of 2017 to re-evaluate plots and note any improvement or variability at that time.

If a producer chooses to scarify seed on-farm, he/she should be aware that only small batches of seed could be scarified with the method demonstrated, making it time-consuming to scarify a large volume of seed for large-scale plantings. If cicer milkvetch is being used as part of a seed blend for mixed forage plots at a lower seeding rate, this may not be a concern.

Due to the number of variables involved in scarifying seed mechanically on-farm, producers using this method should test the effectiveness of scarification on a small amount of seed through germination testing in a lab. This will give an indication of any improvement in germination, as well as damage to the seeds that may have occurred in the process. Producers scarifying seed on-farm should perform scarification no more than one month prior to seeding as viability of scarified seed declines over the course of a year (Carleton, A. E., Austin, R. D., Stroh, J. R., Wiesner, L. E. and Scheetz, J. G. 1971**.** *Cicer milkvetch seed germination, scarification, and field emergence studies*. Bulletin 655, July, Montana Agric. Exp. Sta., Montana State University, Bozeman, MT.).

Supporting Information

12. Acknowledgements

The Ministry's support for the project was acknowledged on signage displayed at the site and will be included on all upcoming communications.

Industry/co-operator support will be included in all upcoming communications.

13. Appendices

Appendix A – Scarification mechanisms

Appendix B - Plot diagram

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14. Abstract

This project was undertaken to assess practical methods by which producers can scarify cicer milkvetch seed on-farm. Three methods were selected based on germination tests from seed lots scarified in the lab. The scarification mechanisms demonstrated were: tumbling action: abrasive material (lava rock) tumbled with seed in a cement mixer; frictional abrasion: a "teeter-totter" device lined with sand paper that seed was passed along; and hand sanding: using a sanding sponge and applying pressure to seed by hand in a large tub. These three treatments as well as a control (not scarified) were sown at Canada-Saskatchewan Irrigation Diversification Centre in Outlook, SK in the spring of 2016. Based on random sampling, the hand-sanding treatment had the most seedlings, however plots all appear to have similar establishment and vigour as of the summer of 2016. On-farm scarification methods appear to show no real benefit in terms of number of seeds germinating or uniformity of germination over the control in this demonstration. Due to the number of variables involved in scarifying seed mechanically on-farm, producers who choose to scarify seed on-farm should test the effectiveness of scarification on a small amount of seed through germination testing in a lab. This will give an indication of any improvement in germination, as well as damage to the seeds that may have occurred in the process. These plots will be maintained until spring 2017 to observe if any improvements in establishment or uniformity occur.

Appendix A – Scarification Mechanisms

Teeter-totter mechanism

Teeter-totter is 8’ long and built as a box lined with 100 grit sandpaper. A hole was drilled through a block of wood on the bottom centre of the box and a rod runs through the block as a pivot point.

Each side was alternately raised and lowered and seed was allowed to run down the sandpaper. The entire box was covered with plastic wrap so that seed would not bounce out when operating. 500 times of lowering/raising took approximately half an hour to complete.

Cement Mixer with Lava Rock

Cement mixer was loader with 50% lava rock as an abrasive material and 50% cicer milkvetch seed. The mixer ran for one hour during this demonstration. Some dust was created so ensure this is done in a ventilated or outdoor area. Ear protection is also recommended as this operation was quite loud. One benefit of this method is that it is not as "hands-on" as other methods used and can be left to work (with supervision) rather than requiring the producer's full attention.

Hand Sanding

Hand sanding for 15 minutes in a plastic tub lined with sandpaper and using a sanding sponge of medium/fine grit. This technique is not difficult and requires few supplies but did not improve germination in this demonstration.

Appendix B – Plot layout at Canada-Saskatchewan Irrigation Diversification Centre, Outlook SK