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PAMI *Research Update*

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Comparison of Alternative Mechanical & Chemical Top-kill Methods for Seed Potatoes

Potato growers from the southern U.S. and some parts of Europe consider seed potatoes grown in northern latitudes to produce more vigorous and higher yielding crops than seed potatoes from more southern climates. While the exact reasons for this Northern Vigor™ are not known, they are presumed to be due to reduced levels of seed-borne disease and/or some physiological characteristics of the seed tuber itself.

Mechanical Top-kill of a Potato Crop

Because of this competitive advantage, seed potato is a high value crop with considerable potential for Saskatchewan. However, input costs are high (as much as $5000/ha [$2000/ac]), so effective management is necessary to optimize returns. An important component of effective management is the efficient and diligent harvest of the seed potato.

Since seed potatoes are generally stored longer than table potatoes, it is important that they are fungus-free and have a good skin to resist disease and spoilage during storage. Top-killing of the plant foliage prior to harvest induces tuber maturity and accelerates skin set. This is especially important with late maturing varieties grown under the relatively cool, short growing seasons common to Saskatchewan. Pre-harvest top-killing also has other advantages including the reduction of fungal diseases, reduction of insect infestations, tuber sizing, stabilization of tuber solids, and fewer trash-related harvesting problems.

Top-killing can be achieved through chemical or mechanical means, or a combination of both. Reglone is the chemical normally used for desiccation, but using Reglone by itself can be slow and costly. For this reason, using mechanical means in combination with Reglone as a desiccant is being considered by many producers.

At a Glance

Advantages of pre-harvest top-killing of seed potatoes:

- Induces tuber maturity
- Accelerates skin set
- Reduces incidence of fungal disease
- Reduces insect infestations
- Controls tuber sizing
- Stabilizes tuber solids
- Reduces trash-related harvesting problems

There are a variety of mechanical options for top-killing. Vine pullers pull the stolon from the tuber. Rollers crush the stems and flatten the vines to accelerate drying. Crop shredders, which employ flails, cut and remove the vines simultaneously. This method is becoming increasingly popular across North America.

Shredders have advantages over pullers and rollers. They cut and remove the potato vines instantaneously allowing tuber maturation to begin immediately. In addition, their flails distribute the vine residue evenly over the field. The degree of success with flailing depends on the vigour of the crop, vine mass, and the efficiency of the machine.

Figure 1. American-designed Alloway Shredder

The treatment that included flailing first, followed by a single application of Reglone either the same day or the next, was the least costly operation and showed no reduction in yield or in other agronomic performance. Both shredders tested performed adequately.

THE PROJECT

There has been a lack of information in Saskatchewan concerning the comparative performance and economic consideration for choosing a shredder for use on seed potatoes. In the falls of 2000 and 2001, PAMI and the Canada/Saskatchewan Irrigation Diversification Centre near Outlook conducted a project for the Saskatchewan Seed Potato Growers Association comparing the performance of two styles of shredders when used in combination with various treatments with Reglone.

The two types of flails tested were an American-designed Alloway shredder (**Figure 1**), and a European-designed AMAC LK4 shredder (**Figure 2**). Both machines were rear-mounted.

Eight combinations of shredding and/or Reglone applications were used – three with the AMAC, three with the Alloway, and one treatment with two applications of Reglone only (**Table 1**). The Russett Burbank cultivar was chosen because it has become one of the most popular cultivars for both seed and commercial markets, and because of its profuse vine growth and late-maturing characteristics.

Three sets of analysis were conducted - engineering, agronomic, and financial.

Table 1. Treatments.

Treatment Plan	Code
Flail + Reglone 0.5 L/ac (1.3 L/ha) on the same day or the next day	FR
Reglone 0.8 L/ac (2.0 L/ha) + Flail after partial vine kill (5 to 7 days) + Reglone 0.8 L/ac (2.0 L/ha) on the same day	RFR
Reglone 0.8 L/ac (2.0 L/ha) + Reglone 0.8 L/ac (2.0 L/ha) after partial vine kill + Flail after 5 to 6 days.	RRF
Reglone 1.0 L/ac (2.5 L/ha) + Reglone 0.8 L/ac (2.0 L/ha) – use as much water as possible up to 100 gal/ac (1,100 L/ha)	RR

Figure 2. European-designed AMAC LK4 Shredder

Engineering Assessment

Work Rate

The rate of work is the amount of work conducted – area covered – in an hour, and is a function of cutting width and travel speed. The work rate of each machine was based on using four rows and the work rates were recorded per foot of machine for equal comparison. Each machine was run at 3.2, 6.4 and 9.6 km/h (2, 4, and 6 mph) to determine the most effective speed. There was no difference in the work rate between the two types of flails. Work rates were: 3.2 km/h – 1.0 ha/h, 6.4 km/h – 2.0 ha/h, and 9.6 km/h – 3.0 ha/h.

Quality of Work

The desirable result of flailing would be to have the majority of the vine cut from the stalks and directed into the furrows between the rows, with approximately 15 cm (6 in.) of the stalk remaining sticking out of the ground. This leaves enough of the plant to absorb the Reglone which kills the plant and stops its growth, preventing excessive foliage that may require additional chemical applications or interfere with harvest.

At 3.2 km/h (2 mph), both machines operated well in all conditions. At 6.4 km/h (4 mph), reduction in the cut quality was noticed with both machines. At 9.6 km/h (6 mph), the operators had concerns about properly controlling the machines, and the quality of cut was reduced very noticeably for both.

Visually, the AMAC appeared more effective at cutting the vines and directing them into the furrows away from the hills. This appearance is likely because the AMAC flails were of multiple lengths and shaped to follow the contour of the hills whereas the Alloway flails had a non-varying length of flail. (This visual difference did not translate into a difference in yield.)

There were differences in the quality of work with each machine between the years, leading investigators to conclude that crop and associated conditions can have as much impact on the quality of cut as the differences between machines.

Another consideration was how the treatment affected the subsequent harvest operation. In a survey, potato producers were ask to identify their top-kill method and to rate their problems with harvest such as vine tangling. Those who used a shredder reported considerably fewer "major problems" than those that used only a chemical treatment, indicating that mechanical flailing has benefits for harvesting.

Power Requirements

The Alloway machine tested was a 6-row machine whereas the AMAC was a 4-row machine. (Alloway does offer 4-row models, but the tested unit was purchased second hand by the producer from an area where 6-row units are the norm. A 4-row unit was not available for the test, so the 6-row machine was used, but in a 4-row configuration.) Even after calculating the power requirements for the Alloway as a 4-row machine, its power needs were still more than double than the AMAC. The reasons for this difference may be differences in design and machine weight (770 kg [1,700 lb] for the AMAC vs 1,640 kg [3,600 lb] for the Alloway).

The AMAC was comfortably handled by a 52 kW (70 hp) tractor, while the Alloway required a tractor of about 93 kW (125 hp) and benefited from the extra forward weight of a front wheel assist to counter balance the equipment. These differences could translate into significant differences in capital costs. However, it must be noted that a 4-row Alloway (as opposed to the tested 6-row model) would weigh about 30% less, and require a smaller tractor. It was the weight of the shredder, not the power requirement, that primarily determined the tractor size.

Power requirements increased with speed for both machines. For the Alloway, more power was required for greener vines while the AMAC did not seem to be affected.

Engineering Assessment Summary

- No difference in work rate between the two machines.
- Slower speed produced better shredding.
- Power requirements increased with speed.

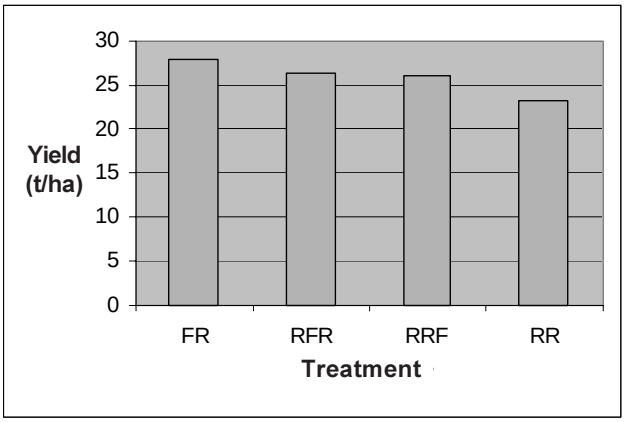

Figure 3. Treatments and Yields.

"A statistically significant difference" refers to the statistical probability of a difference being real. From an agricultural research point of view, the convention is that differences are only significant if the probability of it being true is 95% or greater.

Agronomic Results

Although there were some differences in yield and grade between the years, overall there were no statistically significant differences. **Figure 3** illustrates the average yields per treatment over the two years. No distinction between shredders has been made.

Agronomic comparisons suggested little or no difference between any of the treatments. Average tuber size and tuber specific gravity were not significantly affected by the treatments. Overall, there were no significant differences in the impact on skin set, bruising, stem end browning, storage loss and disease incidence between any of the treatments.

Visible differences observed in the quality of cut between the two machines did not translate into any difference in yield (**Figure 4**).

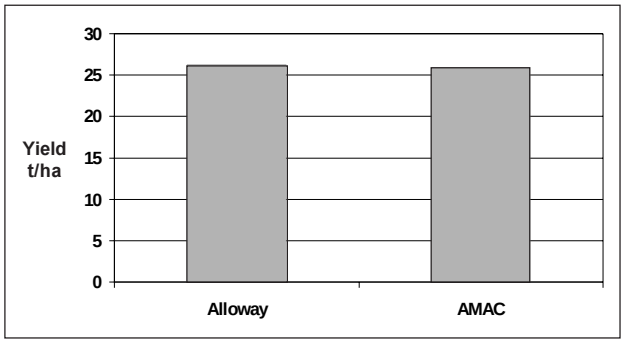

Figure 4. Flailing and Yield.

Financial Results

Financial comparisons showed that the Alloway had a slightly higher operating cost, primarily because it needed a larger tractor.

Treatment costs were calculated as $19.10/L ($87.00/gallon) for Reglone, $14.70/ha ($6.00/acre) for aerial spraying and $29.64/ha ($12.00/acre) for flailing.

The treatment involving flailing (either shredder), then a single application of Reglone either the same day or the day following was the least costly of the four treatments (**Table 2**).

Table 2. Cost/Area Comparisons.

Treatment	Flailing (Average of $29.64/ha for the two machines)	Reglone @ $19.10/L	Aerial Spraying @ $14.70/ha	Total cost/ha
FR	$29.64	$24.83	$14.70	$69.17
RFR	$29.64	$76.40	$29.40	$135.44
RRF	$29.64	$76.40	$29.40	$135.44
RR	-	$85.95	$29.40	$115.35

A 50-page detailed report on top-killing methods for potatos (Report 5100H) is available from PAMI. A shipping and handling charge will apply.

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