The evaluation of Integrated Weed Management practices to control chicory infestation in the pastures and hay ground of conventional and organic agricultural operations

What is Chicory?

Common chicory (Cichorium intybus) is a biennial or perennial, warm-season, herbaceous plant of the dandelion family. There are a number of cultivated, planted varieties of chicory. One variety, if grown under carefully managed conditions, can be as nutritious as other forage crops including alfalfa. However, once the plant "bolts" (grows from the leafy stage into three to six-foot-high stems), the feed and food values drop. If not managed, as we have observed, chicory has a tendency to encroach into field and prairie areas and can become a problem. Chicory has now been listed as a noxious weed in some states and British Columbia. In 2019, chicory was listed as an invasive, noxious weed in Lawrence County of South Dakota.

Why Control Chicory?

Some plant species are desirable, to a point. Chicory is such an example. When the plant is young and tender, it may be palatable to livestock. But as it becomes more mature and the plant changes from a leafy, succulent mass to a three-foot nearly leafless stem, livestock tend to avoid it. If left alone, it will then produce an abundance of seeds that can grow into more chicory plants that can choke out other more productive plants. It is not uncommon for us to observe areas of chicory in which the plants have become so numerous that there is a nearly complete absence of grasses or forage plants.

What is IWM?

IWM is a method that includes mechanical, chemical, cultural, and biological techniques, combined together over the course of a growing season. The key to IWM is not relying too heavily on one method over another. The initial and subsequent prevention of the spread of weeds and their seeds enhances the effectiveness of IWM.

Our project measured the effectiveness of IWM practices while gauging the results against a standard of sustainability, with a focus on the four pillars mentioned below.

The Question of Sustainability

According to SARE (www.sare.org/what-we-do/what-is-sustainable-agriculture), the four central pillars of sustainable agriculture are:

- **Productivity**: Grow enough food and fiber to meet humanity's needs
- **Stewardship**: Enhance the quality of the land, water and air; and make the most efficient use of nonrenewable resources
- **Profitability**: Maintain the economic viability of farms and ranches
- **Quality of Life**: Promote the resilience and well-being of producers, their families and society as a whole.

How is IWM Sustainable?

Just about any ag producer, big or small, can use IWM. By blending and incorporating IWM strategies into realistically-doable applications, producers can find an effective, ecologically-sound, and financially-viable solution that is suitable for nearly any agricultural operation. Thus, these options are also sustainable over the long-term, as enhanced quality and production of the land, balanced resource stewardship, and an improved bottom line become more plausible.

Conventional Vs. Organic Processes

Our project was focused on researching and evaluating methods that could be recommended to either conventional or organic producers. The following is an overview of the results we gathered over the course of our two-year project.

Biological

OUR METHODS: To formally study and document efforts in a way we could meaningfully and clearly share with others, we researched the results of grazing animals in varying conditions: size of pastures, density of chicory population, stages of chicory growth, and so forth.

OUR FINDINGS: In a broad sense, grazing with animals is clearly an important component of a sustainable operation. It can supply the producer with profitable financial resources through livestock production for replacement breeding stock, food, and fiber. The proper utilization of livestock in an ag operation provides benefits to the land and soil health. In fact, in pasture and range country, a planned, rotational grazing program with animals regularly proves to be essential, and the recommendation to use animals in a sustainable agricultural operation cannot be

overstated. Therefore, generally speaking, the IWM biological/grazing control fulfills the essential pillars of sustainability: productivity, stewardship, profitability, and quality of life.

However, if the primary reason for grazing animals (whether cattle, goats, or sheep) is specifically to control unwanted plants, and especially noxious, perennial weeds, our studies and results indicate there are limitations to using only the biological/grazing control. Grazing may provide some immediate, temporary results to control chicory. However, we found that unless the problematic area is subjected to continual, almost excessive grazing, the chicory has a likelihood of experiencing regrowth and will continue to spread.

By itself, and because of the reproductive nature of chicory (via seed and from existing plants, with growth stimulated by grazing or mowing), grazing falls short of a long-lasting solution. It is merely a stopgap control measure that (at least specific to our study of chicory) fails to sufficiently reduce or eliminate the weed problem. If the animals are removed for any length of time, the plants will undoubtedly rebound, reflower, and reproduce. That, as we observed, could lead to the problem of spreading and infesting nearby fields and pastures. Loss of production, restricted marketability of crops, and reduced profit result. Therefore, we are reluctant to recommend grazing alone as a long-term sustainable IWM principle to either conventional or organic producers.

Mechanical

OUR METHODS: We mowed various plots at varying heights (3”, 6”, 9”, and 12”) and monitored the chicory’s regrowth over the course of two mowing seasons.

OUR FINDINGS: As with grazing, mechanical methods may perhaps be useful for some weed varieties, but not so with chicory because of its specific nature. Mowing chicory encourages it to regrow, and repeated mowing often results in more robust, not less, chicory population numbers. In order to effectively prevent the chicory from spreading to other parts of a field or beyond to other fields, the plants must be repeatedly mowed or pulled.

From a production and profitability aspect, if a field is to be used for hay, it may be possible to harvest an early crop by cutting the field for hay before the flowers develop. Most states’ noxious weed laws prohibit the spreading of weed seeds, not the non-seed-producing portion of the plant. Therefore, a crop may be cut early, processed, and sold. This is assuming the number of chicory plants is not too excessive, as we have routinely found that animals will refuse to eat the cured chicory plants due to their unpalatability. Many of our forage customers will understandably reject the hay if there is an excessive number of weedy plants remaining in an animal’s feed bunk. From a sustainability aspect, profit obviously suffers.

In our semi-arid environment, we have observed that once the first cutting is removed from the field, the chicory quickly regrows, re-bolts, and develops new flowers. This is often well before the other grasses and most alfalfa plants reach a sufficient height to produce a worthwhile second harvest. To mitigate additional weed infestation once the chicory reproduces flowers, the field must be mowed again to prevent the flowers and seeds from maturing. Therefore, along with the chicory, the grasses and alfalfa forage are prematurely cut and are unavailable for a second harvest. More concerning, repeated mowing of forage prevents the desirable plants’ structure and roots from fully recovering prior to being recut. The root structure is placed in danger of becoming weakened and the potential future yield of the field eventually suffers, further affecting productivity and profitability. All of this leads us to conclude that the IWM mechanical/mowing /hand-pulling method, when employed alone, is a poor candidate for a truly sustainable solution to chicory weed control.

Cultural

OUR METHODS: We attempted to plant a cover crop into two individual plots of a test field, one chemically treated and the other non-treated, to determine if the cover crops could choke out an infestation of chicory.

OUR FINDINGS: When properly applied (timing, methodology, suitable machinery, etc.), cultural methods are obvious options to consider, whether for an organic or conventional system. However, by themselves, they may not be the cure-all in certain circumstances, especially if the process is beginning with a heavy infestation of weeds. Just as with mowing or grazing, maintaining these methods may take the operation years into the future, if a producer has the weed problem under control. But, specifically speaking of chicory, if the infestation of weeds is severe to begin with, it may be prudent to take other steps first. Our experience has yet to prove to us that any non-chemical approach to a severe weed problem will, in a sustainable way, reduce the problem to a satisfactory degree.

Chemical

OUR METHODS: With the extremely valuable assistance of the South Dakota State University Extension Weed Science Coordinator (Mr. Paul Johnson)

and Research Managers/Field Specialists (David Vos and Jill Alms), a comprehensive herbicide study was completed. As part of these trials, we examined options for both conventional and organic producers. The table to the right lists the herbicides we tested.

OUR FINDINGS: The 15 herbicides were applied at different chemical concentrations, and in a mixture equivalent to a rate of 20 gallons of chemical mix per acre. All herbicide types showed results, except Plateau, which is actually SAFE to use on chicory.

A key objective of the project was to find one or more herbicide applications that would offer options to control chicory and other unwanted weeds in fields with broadleaf forages (alfalfa) by controlling the chicory but not eliminating the alfalfa. Three herbicides in particular (Clarity, Cimarron Plus, and Garlon 4 Ultra) effectively suppressed the chicory but allowed the alfalfa and clover to recover to an adequate degree, not unscathed but sufficient enough to allow regrowth of the forages. Garlon 4 Plus had the least adverse effect on the alfalfa and clover.

NOTE OF CAUTION: These results were observed in older stands of alfalfa (such as ours, which are 20+ years old). We are reluctant to state what results we might have seen in newly-planted forages. We are NOT recommending that producers employ this method of weed control on large portions of their pastures or hayfields without first thoroughly testing the results themselves. If a farmer or rancher is curious about how it may work on their fields, we suggest testing a SMALL area, an acre or less, to avoid a highly regretful situation.

The effectiveness of applying what could be termed "organic chemicals"—specifically 6% vinegar and pure alcohol/ethanol—to chicory-infested test plots proved less successful. These were also applied at the same rate of 20 gallons of chemical mix per acre. However, the difference between the herbicide and organic chemical mixes was the herbicide concentrates were dissolved in water according to label instructions. The organic compounds were not diluted but applied full-strength. Unfortunately, the application of vinegar and ethanol proved to have no controlling effect whatsoever on chicory.

Ideally, from what many believe to be a "sustainable" approach for the environment, being able to have an effective IWM program absent of chemicals is a desirable goal. However, unless a producer is fortunate to have an entirely weed-free environment without a threat of infestation from outside sources, removing chemical IWM methods from their toolbox could have adversely consequential results.

We should emphasize that this is true of our growing conditions, environment, moisture totals, and other factors for our part of the country. A producer living where moisture is more abundant and where tillage and/or row crop agriculture are workable options could perhaps resort to more reliance on mechanical, biological, or cultural IWM controls only. Every producer needs to adapt methods to their circumstances. Overall, we can recommend that chemical IWM can make a meaningful contribution.

2019-2020 Chicory Herbicide Results

Date Sprayed: 6/28/2019
By SDSU Ag Research Mgr/Specialists

Dates Checked:
7/26/2019 (SDSU Cooperative Extension Weed Science Coordinator)
9/11/2019 (SDSU Cooperative Extension Weed Science Coordinator and 3 Members South Dakota Weed Commission)
7/15/2020 (SDSU Ag Research Mgr/Specialists)

Chemical	Label Per Acre Rate	Applied Per Acre Rate	Results on Chicory C=Control PC=Partial Control S=Suppression None=No Control NL=Not Labeled	Results on Alfalfa and Clover (NOTE: The alfalfa and clover are matured stands - 20+ years old. Results are NOT TRUE INDICATION of potential impact on younger stands 5 years or younger.)
Control	N/A	N/A	N/A	N/A
Escort XP	0.33 to 0.50 oz wt/ ac	0.5 oz wt/ac	C	Seriously Stunted Alflafa and Clover
Escort XP	0.33 to 0.50 oz wt/ ac	1.0 oz wt/ac	C	Nearly Eliminated Alfalfa and Clover
2,4-D Amine	1.0 to 2.0 qt/ac	2.0 qt/ac	C	Nearly Eliminated Alfalfa and Clover
Milestone	4.0 - 6.0 fl oz/ac	2.5 fl oz/ac	C	Seriously Stunted Alflafa and Clover
Clarity	2.0 pt/ac	1.5 pt/ac	C	Good Recovery of Alfalfa and Clover
Clarity and 2,4-D Amine	2.0 pt/ac & 1.0 to 2.0 qt/ac	1.0 pt/ac & 1.0 qt/ac	C	Seriously Stunted Alflafa and Clover
Opensight	1.5 to 2.0 oz wt/ac	2.0 oz wt/ac	C	Eliminated Alfalfa and Clover
GrazonNext HL	1.5 to 2.1 pt/ac	2.0 pt/ac	C	Nearly Eliminated Alfalfa and Clover
Tordon and 2,4-D Amine	0.5 to 4.0 pt/ac & 1.0 to 2.0 qt/ac	1.0 pt/ac & 1.0 qt/ac	C	Nearly Eliminated Alfalfa and Clover
Cimarron Plus	0.3 to 0.5 oz wt/ac	0.5 oz wt/ac	C	Good Recovery of Alfalfa and Clover
Cimarron Max Part A Cimarron Max Part B	0.5 oz wt/ac & 1.0 qt/ac	0.5 oz wt/ac & 1.0 qt/ac	C	Nearly Eliminated Alfalfa and Clover
Garlon 4 Ultra	2.0 to 16.0 pt/ac	1.5 pt/ac	C	Good Recovery of Alfalfa and Clover
Capstone	4.0 to 6.0 pt/ac	5.0 pt/ac	C	Eliminated Alfalfa and Clover
Tordon	0.5 to 4.0 pt/ac	1.0 pt/ac	C	Nearly Eliminated Alfalfa and Clover
Method	8.0 to 18.0 oz wt/ac	4.0 oz wt/ac	C	Eliminated Alfalfa and Clover
Plateau	Not Labeled - Can SAFELY be used to control weeds IN chicory plots	4.0 oz/ac	NONE, NL	NONE - Safe to Use

Preventative

OUR METHODS: The primary preventative step we take on our farm is refusing to market any chicory-infested hay harvested on our farm. In the event we feed this hay to our own livestock, we feed the bulk of the weed infested hay during the winter when the animals spend more time in their barns and smaller holding pastures. There, we can control and effectively deal with weed re-infestation if it happens. Similarly, the manure from the animals is composted to aid in reducing viable seed as well. Even so, we only apply infested manure on fields where we are not reluctant to use chemical control.

Another action we take is cleaning machinery before moving to a non-infested field in order to avoid unintentionally spreading chicory. Overall, we also are meticulous in monitoring the weed problem on our entire farm.

OUR FINDINGS: The essence of preventative IWM methods is doing what is reasonable, necessary, and responsible to keep weed problems contained in such a manner as to be able to assure the applications of other IWM practices are as successful and long-lasting as possible. Preventative measures should not be viewed as a sole replacement for other IWM methods but a means of "insurance" for the producer to reap the benefits of the efforts for as long as possible.

Final Thoughts

Our project was quite broad, intentionally encompassing many aspects of IWM all at once being testing independently and simultaneously. Our being able to answer the question of how each IWM control approach will contribute to sustainable agriculture clarified our focus and mapped the direction we will move forward with in the future.

Some final thoughts for our fellow farmers and ranchers to consider:

- IWM is not a one-method approach. It is most effective when applied as a holistic program of all IWM principles.
- Before starting a new weed management program, read, research, and study ideas that seem reasonable for your operation. What works in one part of the country may be completely unrealistic in another.
- Determine the goals you want to achieve. It's difficult to map where one WANTS TO GO if it isn't known where one WANTS TO BE.
- Define level of control to be achieved. Do you want a quick stopgap measure, a suppression of the weed to keep its presence in check, a reduction of the problem, or an all-out elimination of the weed? Each level is attainable with IWM.
- Share ideas, successes, and failures. Each presents an opportunity for someone to learn.

Butte Vista Farm

This two-year research project was funded by the North Central Region--Sustainable Agriculture Research and Education (SARE) program. It was completed by Doug and Carol Pavel, owners of Butte Vista Farm, a 200-acre farm located in Lawrence County, South Dakota, on the northern foothills of the Black Hills. The chemical trials were conducted with the collaborative efforts of the Pavels and South Dakota State University's Cooperative Extension Weed Science department. For questions regarding the project, please visit https://projects.sare.org/project-reports/fnc19-1187/ or https://www.buttevistafarm.com/ or email buttevistafarm@gmail.com.

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