AN EVALUATION OF VOLUNTEERING OATS IN NEW SEEDINGS OF ALFALFA

by

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I dedicate this paper to my parents for what they have done for me throughout my school life.

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INTRODUCTION

In Wisconsin and northern states, spring seedings of legumes and legume-grass mixtures are generally made with a small grain companion crop, primarily oats. This practice seems to have some advantages as well as some disadvantages compared to seeding without a companion crop.

The practice of seeding with a companion crop is widespread in this part of the country in spite of forage seedling failures due to the companion crop.

Probably one of the most prominent reasons for using oats as a companion crop is the control of weeds normally attributed to the companion crop. It has been said that if alfalfa is seeded alone it may have a "companion crop of weeds" which is even more harmful than the small grain crop. Another advantage of the small grain crop comes from the fact that it provides a reasonable return from the land as forage or grain crop. While the forage crop is being established, the oats may be harvested for grain, silage, hay or utilized as pasture.

In contrast to these benefits, some disadvantages are claimed for the oat nurse crops such as the competition for light, moisture and soil nutrients in the early stages of growth of the forage crop.

Conditions should be as favorable as possible for a healthy establishment of the seedlings especially in early spring and competition for light appears to be the main point of concern. Forage seedlings are usually tall and slender as they reach out for light for proper photosynthetic activity before the oat plants are harvested.

Another problem which undoubtedly causes great harm to the new seeding is the lodging of the oat plants. Lodging is difficult to control

and is more severe under conditions of high nitrogen fertilization and high moisture accompanied by strong winds. Seedlings then become reduced in number by the smothering effect of the lodged oat plants. Since it has been difficult to select varieties of oats that will resist lodging under these conditions, the problem still persists. Lodging is a serious fault of oat companion crops for the lodged plant material may reduce light significantly and produce damp conditions favorable for disease organisms.

To avoid this harmful smothering effect of the nurse crop the oats should be removed early for hay, silage or pasture. At this stage of development the feeding value of the vegetative parts of the oat plants is high, the forage seedlings have plenty of time to grow and the grain is not developed enough to volunteer if shattered. Also, with new herbicides, forage crops may be seeded without a companion crop. These chemicals control weeds and cause very little or no harm to the forage crops. Chemicals such as 2,4-DB and EPTC (Eptam) have been used successfully with alfalfa seeded without a companion crop.

Whether the use of herbicides to control weeds in new seedings is an economically feasible operation has not yet been established. Therefore, the use of oat nurse crops is still the most popular system of establishing new alfalfa seedings in Wisconsin and the North Central states and harvesting the oat crop for grain is also the prevailing practice by most farmers. Dairy farmers place a high value on the straw for bedding and the grain for livestock feeding.

Harvesting the companion crop for grain often creates another problem due to the volunteering small grain plants produced from shattering of seeds during harvest. This problem has increased considerably with the advent of modern combines. Considerably more grain is shattered now than

during the period when grain was harvested by grain binders. When grain is harvested by combine, harvest must be delayed until the grain is dry enough to store. With grain binders and stationary threshers, grain could be harvested early and dried some in the shocks. The grain shattered in the field will germinate under favorable moisture conditions, producing a very competitive crop. Heavy growth of volunteering oats is a fairly common scene in new alfalfa seedings during the fall months. In the majority of cases, the rapid growth of the oat plants crowds the alfalfa seedlings, causing not only a reduction in the stand but also a probable reduction in the capacity of the remaining legume plants to store normal food reserves during the fall months for winter survival and vigorous spring growth.

The amount of volunteering oats is related to lodging of the oat plants, time of harvest and efficiency of combining. The quantity of shattered oats is therefore a function of lodging and skill of the combine operator. Lodging undoubtedly makes harvest more difficult and shattering often occurs before harvest.

The straw from the combine is typically placed in windrows after which it is baled and hauled from the field. The straw may remain in the field for several days in damp weather during which time conditions are favorable under the windrows for germination. It is almost impossible to adjust the combine so that some grain does not come out in the straw. Usually enough grain is left on the field to cause a volunteering problem if weather conditions are favorable for germination and growth.

Clipping or grazing the volunteering oats has been practiced by some farmers. Mowing the oat growth in the late summer when there is less

probability of injury to the legume seedlings may not be successful since at this time the oat plants are still very small and the growing point will generally not be removed and consequently new growth will soon occur. Delay mowing or grazing until mid-September through October may be detrimental to the legume which is making fall growth for winter survival. At this time one must decide whether the effect of the volunteering oats is more detrimental to the legume compared to removing the growth at this critical period.

Grazing or clipping after mid-October does not harm the legume since food reserve accumulation has already occurred. However, clipping or grazing should be regulated to leave at least a 4-inch stubble to catch snow during the winter, a beneficial condition for the legume from the standpoint of winter survival.

The use of herbicides to prevent germination of shattered seed is still in the experimental stage but could well be one of the best approaches to prevent this difficulty.

There is limited research done in relation to the problem of volunteering oats. Therefore, to obtain more information on the subject some field and laboratory studies were conducted during the summer and fall of 1967 at Madison and Arlington, Wisconsin.

LITERATURE REVIEW

In spite of the obvious nature of this problem in new seedings of forage crops, the evaluation and control of the volunteering grain has been largely overlooked.

The magnitude of the problem of volunteering oats is a function of the lodging condition of the field before harvest. Nordin and Frey (8) have recognized the importance of this subject and have done some studies to determine how much harm can be caused by lodging to new seedings of alfalfa. They found that severe lodging of oats, a few days before heading greatly reduced the alfalfa stand, leaving not more than three plants per square foot as compared to 16 where the nurse crop was not lodged. In the same study they also verified that yield was considerably lower in the next year where plots had been lodged during early heading.

Scholl (10) in studies done at Ames, Iowa, also found significant reduction in stands of new alfalfa seedings due to lodging of the oat companion crop. He also found that volunteering oats caused a substantial damage to the new seeding particularly when moisture was limited. He observed that the heaviest volunteer oat growth took place when forage seedings were found deficient in the summer of the seeding year. When fields were again prepared by discing and the forage crops were reseeded, growth and development of the volunteering oats was favored.

The detrimental effect of volunteering oats has been recognized by Griffeth (7). He observed that heavy stands of volunteering oats in

September from seed thrown over by the combine killed many of the alfalfa seedings, resulting in a reduced stand next spring.

When managing volunteering oats in alfalfa fields, one has to take into consideration the fall management of the legume. A vast number of studies have confirmed that high carbohydrate accumulation in the roots of the legume during the fall months is highly correlated with a high degree of winter survival and consequently higher yields in the next year. Silket et al. (11) have recommended avoiding cutting and grazing alfalfa during the period between the first week in September and mid- to late-October. They found that cutting or grazing during this time forces the plants to produce new growth and consequently use part of the carbohydrates already stored in the roots. They also state that at least eight inches of top growth is necessary during that period for maximum accumulation of food reserves. The same has been found by Grandfield (6).

The importance of fall management of alfalfa has been recognized for nearly half a century. Graber et al. (5) found that during the stage of late dormancy, in late October, the average percent of total available carbohydrates (TAC) in the roots of alfalfa, under normal conditions, is somewhere between 37 and 40% and if the legume is clipped or grazed during September or October this amount will be substantially reduced predisposing the legume to winter injury. Bula and Smith (2) found that alfalfa begins to develop cold resistance in early- to mid-September and this important process continues through the fall until late November. The removal of the top growth or other conditions of stress during this period will slow or stop the process until enough

top growth is again obtained. In more recent studies, Smith (12) has shown that when the average percentage of total available carbohydrates in the roots and crowns of new seedlings of uncut alfalfa plants in November was 39%, the average winter kill by next May was 24%. In contrast, when carbohydrate reserves were 29% as a result of being cut in mid-September and mid-October, 71% of the plants died over winter.

Of course, light condition plays a very important role in the carbohydrate accumulation through photosynthesis. Gist and Mott (3) concluded, from experiments in controlled climate chambers, that root and top growth of alfalfa was substantially reduced under low light intensity conditions as compared to considerable growth under high light intensity conditions.

It is already known in the light of a number of studies that a few herbicides have some promise for controlling grassy weeds in legume seedings. Gasset (4) found excellent control of grassy weeds and some broadleaf weeds with little injury to the legume when a mixture of 1 lb of 4-(2,4-DB) amine salt and 2 lbs of dalapon per acre was applied to a 2-3 inch growth of alfalfa.

Oats have been shown to be very susceptible to the Triazines. Becker (1) has shown that pre-emergence application of Simazine and Atrazine were very toxic to oats. Peters (9) states that when dalapon is applied to seedling annual grasses before they have reached the 3 to 4 leaf stage, good control can be expected, and if the rate of application does not exceed 2 lbs per acre (acid equivalent) there will be little injury to alfalfa.

The writer was not able to find literature reporting research that was done specifically to evaluate the damage to new forage seedings caused by volunteering small grains. Neither could he find literature on control of small grain seedlings by chemical or cultural methods.

MATERIALS AND METHODS

The present studies were conducted during the summer and fall of 1967 at the Mandt Farm, near Madison, Wisconsin, at the Arlington Farms, near Arlington, Wisconsin, and at the Lancaster Experimental Station, at Lancaster, Wisconsin.

Attempts were made to study conditions similar to those occurring on the average farm of the area as to the establishment of new seedings of alfalfa. In all selected fields, alfalfa was seeded in the early spring with oat companion crops.

During the months of June and July some of the fields were observed as to the lodging conditions. All fields ranged from moderate to severely lodged (Fig. 1).

Due to the somewhat cool summer, harvest of the oat crop for grain was made, in most fields, during late July and early August. At that time there were relatively good moisture conditions in most fields but following harvest an unusually dry period occurred for at least 25 days. However, it appears that there was sufficient moisture in the soil for grain germination.

Directly after harvest with combines, counts were made to estimate the amount of grain shattered. These counts were made within windrows and between windrows to find out the difference in shattering (Fig. 2). Quadrats were used for this purpose and new alfalfa seedings were sampled at Lancaster, Arlington and Madison.

In an attempt to appraise the effect of some herbicides on the volunteering oats and on the legume, a field trial was conducted at Arlington. Five herbicides were tested for different dates and rates of application. The treatments were set up in a randomized complete block

design with four replications. Alfalfa was seeded with oats as companion crop in early spring and the grain crop was removed in late July. The herbicides tested were: Simazine, Atrazine, Sinbar[1], GS-14254[2] and NC-3363[3]. Simazine, Atrazine and Sinbar were applied in early August (pre-emergence to oats) plus a mid-September application (still pre-emergence for most but post-emergence for some oats). GS-14254 and NC-3363 were applied only in mid-September. From early August through mid-September humidity was low; after that soil moisture became more favorable. Plots were harvested in mid-November and the percent control of volunteering oats as well as the injury to the legume were estimated by comparing each treatment with the check where no chemical was applied and where oat germination was normal. Results of this first year's trial are shown in Table 4.

A large field which was severely lodged before harvest of the grain was selected for further investigations. In this field, a heavy growth of volunteering oats took place as shown in Fig. 3. Plants were dug in mid-September and the dry weights[4] of the components of the mixture were compared within and between windrows.

In order to determine the effect of the volunteering oats on the number and size of the roots of alfalfa in the late fall, plants were dug in mid-November. Total available carbohydrates (TAC) stored in the roots of the legume were also determined comparing plants within and between windrows. For these determinations, the above samples were used. They were oven dried under constant temperature[5], ground and analyzed

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[1]A Uracil compound still in experimental phase.
[2]A Triazine compound still in experimental phase.
[3]A Chlorflurazole compound also in experimental phase.
[4]Samples were dried to a constant weight at 135° F.
[5]38° C.

for TAC, incubating with Takadiastase for 44 hours and proceeding with the Shaffer-Somoggi method.

A replicated trial, with several herbicides and mowing treatments, to control volunteering oats, was superimposed on a new seeding of alfalfa after the oat crop was removed for grain without shattering. Oats was then surface-seeded in a split-plot design at rates of 4, 8 and 16 bushels per acre. The oat control treatments were the sub-plots in four replications. These plots were abandoned finally after several methods of bird control failed to prevent severe differential grain removal by large blocks of sparrows. These plots will have some value for determining the effect of the herbicides on the alfalfa seedlings in the spring of 1968. However, the oat stands were too variable for use in this report.

	Bu/Acre[2]	Range Bu/Acre[3]
Within Windrows	8.08	3.83 - 10.96
Between Windrows	4.93	3.56 - 7.40
Average	6.55	3.70 - 9.20

1. In fields ranging from moderate to severely lodged.
2. On the basis of 35 lbs to the bushel.
3. Variations were found to be extreme in some cases, chiefly within a given field, indicating that shattering is not uniform throughout the field.

RESULTS

1. Amount of grain shattered

The amount of grain shattered was found to be variable between fields and within a given field. Variability between fields depended more on the extent of lodging. Variation within fields depended upon position in relation to windrow and on differences due to extent and nature of lodging.

Table 1 shows the average and the range of the amount of grain shattered. (A few unusually high quadrat counts were excluded in computing the averages.)

Table 1. The amount of oats, available for volunteering, found within and between windrows following combine harvesting[1]. Madison, Wisconsin, 1967.

	Bu/Acre[2]	Range Bu/Acre[3]
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Fig. 1: A characteristic scene with lodged oats in new seedings of alfalfa from heading through harvest in Wisconsin. The lodged oat plants not only will kill some of the alfalfa seedlings but also will make combining more difficult, giving rise to shattering of grain.

Fig. 2: Oat straw being placed in windrows for bailing Shattering is concentrated in these windrows. these windrows are left in the field for severa days, because of damp weather, conditions fa germination of oat grain will be more favorable

Fig. 3: A heavy growth of volunteering oats after a killing frost in November. The higher concentration of plants within windrows will kill some of the alfalfa seedlings and weaken the remaining legume plants which are accumulating food reserves for winter.

The concentration of shattered grain in the windrows was found to be almost twice that found between windrows. This is attributed to the fact that straw and grain that comes out in the straw are concentrated in the windrow and to the handling of the straw being prepared to be baled as is shown in Fig. 2. An average of 6½ bushels per acre was found to be shattered. Since the oat grain yield in the state of Wisconsin is between 55-60 bushels per acre, it indicates that about 10% of the oat grain crop was lost through shattering in these fields which were assumed to be average in yield. This loss from shattered grain, added to the harmful effect of the volunteering oats on the new seeding, may account for a substantial loss which normally remains unnoticed by the farmer.

II. Effect of the volunteering oat growth on the legume in early fall.

The field selected to measure the effect of the volunteering oats on the legume seeding was a typical mixture of alfalfa and ladino clover. This field was severely lodged before grain harvest and there was a heavy growth of volunteering oats during the fall. Such a field is shown in Fig. 3. The extent and effect of the heavy oat growth on the legumes is shown in Table 2. Within windrows where the oat growth was crowding the legume (Fig. 3) there was a very substantial reduction in the dry weight of ladino clover (whole plant) and in the dry weight of alfalfa roots in contrast with between windrows where the oat growth was considerably reduced. These measurements were taken approximately two months after removal of the grain crop and the detrimental effect is already obvious. At this stage the legumes have started to accumulate food reserves in their roots. The shading effect of the heavy oat growth is certainly

Table 2. The amount of volunteering oats and its effect on the amount of alfalfa and ladino clover present in mid-September. Madison, Wisconsin, 1967.

	lb/Acre[1]
Between Windrows	
Volunteering oats[2]	287
Ladino clover[2]	264
Alfalfa[3]	240
Within Windrows	
Volunteering oats	3070
Ladino clover	58
Alfalfa	62

responsible for the reduced light reaching the legume plants, consequently legume plants are tall and slender with a thin root. Also, at this stage the "choking" effect of the heavy growth of oats within windrows has already killed some of the weaker plants.

III. Effect of the volunteering oats on the legume in the late fall.

By mid-November, the legume plants are generally ready to face the adversities of the winter if conditions are normal. At this point the amount of total available carbohydrates stored in the roots of the legume is of major concern.

1. Dry weight - dried to constant weight at 135° F.
2. Whole plants.
3. Alfalfa roots - 3½ inches of upper tap root.

Table 3 shows the level of total available carbohydrates (TAC) in alfalfa plants within and between windrows.

The effect of the heavy volunteering oat growth in the legume within windrows is obvious. Not only the number of plants is reduced per unit area but also they are reduced in size (Fig. 4 and Table 3). Plants between windrows are not only higher in number but also are larger. This caused a great difference in the amount of TAC stored per plant within and between windrows. A significant difference was observed (Table 3). Legume roots within windrows stored nearly 33% total available carbohydrates whereas roots of plants between windrows stored nearly 37%. At this time of the year, under normal conditions in Wisconsin, the average TAC stored in the roots of alfalfa has been found to be nearly 40% (6). So it is evident that there was a depression in growth and TAC storage probably due to a reduced light and probably nutrient competition from the heavy oat growth. These harmful effects together may result in weak legume plants and reduced stands in the spring of the next year (Fig. 6).

Table 3. Mid-November plant, DM and TAC in roots[1] of alfalfa in a volunteer oats infected field. Madison, Wisconsin, 1967.

	Av. number of plants/2 sq. ft.	Av. root DM/plant (gm)	Av. root % TAC*	Av. TAC per plant (mg)
Within Windrows	19	0.17	32.9	56
Between Windrows	30	0.27	36.6	98

* Significant at 5% level. CV = 6.8%

1. All roots for determination of DM and TAC were cut to 3½ inches in length (½ inch of crown and 3 inches of roots).

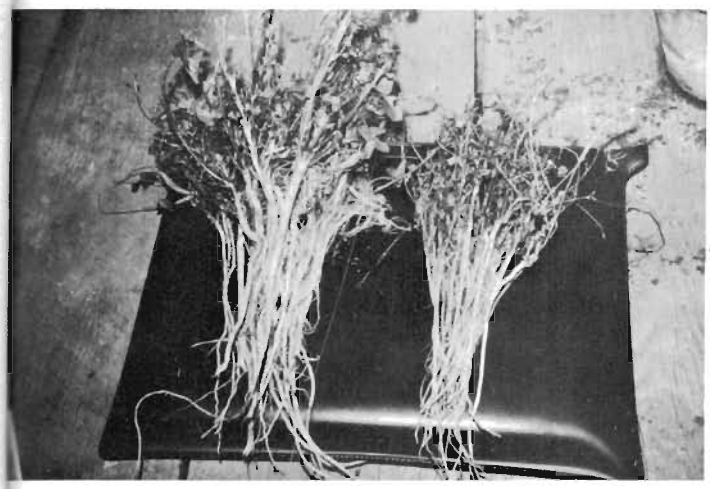

Fig. 4: Typical samples of alfalfa plants dug from between windrows (left) and within windrows (right). Plants within windrows are not only reduced in size but also in number. Plants were collected in mid-November and each bundle represents an area of two square feet.

Fig. 5: Chopping the heavy volunteering oat growth from the windrows in the late fall will provide some forage but damage to the seeding has already occurred.

Fig. 6: A substantially reduced stand of alfalfa in the early spring resulting from a heavy growth of volunteering oats in the fall of the preceding year. The light colored strips represents the windrow area. Lodging occurred the previous year on the right side of this field.

IV. Chemical control of the volunteering oats.

Results of the 1967 trial only are shown in Table 4. This experiment is to be repeated at least two more years.

The growth of the volunteering oats in the check plots and on the plots where herbicide gave poor control was not sufficient to evaluate effects on the alfalfa. Oat plants were sufficient in number for competitive effects but very short probably due to the dry period during September. However, the results show that there was good control of oats by Simazine, Atrazine and Sinbar whether the application was made early in August or late in September. Significant differences due to rates of application for each chemical was not observed in this first trial. GS-14254 also gave control of the oats.

As far as the injury to alfalfa by the different herbicides and different rates of application are concerned, again no substantial difference was observed. Also, height of the legume showed no influence in the results. The legume was fairly resistant to the herbicides except for NC-3363 which not only gave poor oat control but also was toxic to the legume. There were some unexpected variations among rates of application for a given herbicide on percent injury to alfalfa but this was probably due to experimental variations. These variations may be checked by repeating the experiment. Nevertheless, whether the herbicide was applied early in August or late in September, the results obtained are promising and repetition of the trial seems very worthwhile.

Table 4. Results obtained from a preliminary trial in an attempt to control volunteering oats in new alfalfa seedings. Arlington Experimental Farm, Wis. 1967.

Spraying Date	Chemical	Rate lbs/A	Height of Alfalfa Plants at Spraying	% Oats Control*	% Alfalfa Injury*
8/7/67	Simazine	1	3-5"	98	16
"	"	1 1/2	"	100	11
"	"	2	"	100	9
"	Atrazine	1/2	"	81	11
"	"	1	"	99	18
"	Sinbar	1/2	"	86	7
"	"	1	"	98	19
9/20/67	Simazine	1	7-8"	99	11
"	"	1 1/2	"	100	4
"	"	2	"	95	3
"	Atrazine	1/2	"	99	13
"	"	1	"	100	16
"	Sinbar	1/2	"	100	14
"	"	1	"	100	6
"	GS-14254	3/4	"	84	13
"	"	1 1/2	"	99	14
"	NC-3363	1	"	9	35
"	"	2	"	8	19
	Check	-	-	-	-

*Estimated by comparing each treatment with the check.

SUMMARY AND DISCUSSION

Oats is one of the most important crops in Wisconsin. Its acreage (nearly 2 million acres) is second only to corn of all grain crops. In most of this acreage it is seeded as a companion crop to new alfalfa seedings and the usual practice is to harvest oats for grain. The Wisconsin Department of Agriculture Statistical Service has recently reported a decrease in the acreage of oats along with an increase in the acreage of alfalfa. Since alfalfa is the most important crop in the state in terms of acreage, and since some of the disadvantages of oats as a companion crop outweigh the advantages, it appears that this is probably one of the reasons for this acreage decrease.

Lodging undoubtedly is the major problem with this grain crop. Up to the present time, crop breeders have not been successful in developing oat varieties or strains that are non-lodging under all conditions. Such achievement would certainly change the situation in Wisconsin and elsewhere. Also, it has been recognized for many years that high levels of nitrogen in the soil increase the probability of lodging. Consequently, rates of nitrogen must be carefully controlled to avoid this hazard.

Lodging brings out three main problems: a) A detrimental smothering effect on the new alfalfa seeding before the grain crop is removed, b) a significant grain loss due to shattering at harvest, and c) a volunteering oat growth that may be as detrimental to the new seeding as is lodging since it occurs in the fall months, the critical management period for the legume plants.

Since there is no practical substitute for oats as a nurse crop to alfalfa seedings and since there is so much interest in the grain and straw, lodging will continue to be a problem for some time. Of course, if one is not interested in the grain, this lodging difficulty could be generally avoided by removing the oat crop early for hay, silage or pasture.

As to the loss of grain by shattering, proper adjustment of the combine by a skillful operator would probably reduce the problem, thus avoiding excessive growth of volunteering oats during the fall months. However, since lodging is a regular occurrence, grain shattering and the consequent volunteering oats will have to be accepted as problems that must be studied.

Volunteering oats is unquestionably detrimental to alfalfa. It reduces the legume stand and interferes in the process of carbohydrate accumulation in the roots of the legume. High levels of food reserve are necessary for better survival from the hazards of the winter and for initiation of a healthy growth in the next spring. To eliminate the volunteering oats without interfering with the legume getting ready for winter appears to be difficult. Volunteering oats should be prevented or eliminated as soon as possible so that the legume can grow through the fall without the "choking" effect of the oat plants resulting in competition for light, moisture and soil nutrients.

Carbohydrate reserve accumulation in the legume roots in the fall months plays a very important role in the management of alfalfa during this critical period. Therefore, volunteering oats control methods

should be based upon a recognition of the importance of this organic food accumulations in the roots and crowns of the legume. Clipping during September and up to mid-October is out of the question as this is unfavorable for the proper fall management of alfalfa. At this time defoliation of the legume will force the plant to use some of reserve already accumulated for new top growth and there may not be time enough to replenish it.

Removal of the oat growth from the windrows in the late fall (Fig. 5) will provide some feed for the livestock. This operation, however, removes too much stubble necessary to catch snow during the winter and the detrimental effect of the oats on the legume will already have been accomplished.

The use of pre-emergence herbicides on the oats that would cause little or no injury to the legume and still inhibit germination of the shattered seeds appears to be the most reasonable approach to the solution of the problem. The Triazines (Simazine and Atrazine) and new herbicides like Sinbar are chemicals that show some promise. Also post-emergence herbicides like dalapon when properly applied may help to reduce the volunteering oats.

With the rapid progress of the herbicide industry and with the amount of research being done in this area it is hoped that in the near future, effective chemicals will be available for this purpose.

It is suggested here that further experiments be done in an attempt to better evaluate some possible management techniques for the control of volunteering oats in new seedings. Effective control must take into consideration the trend of total available carbohydrates in roots and crowns of the legume and the importance of these reserves.

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