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04-11-01

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BACK-TO-BACK ALFALFA WITH METAM SODIUM

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Key words: Vapam, metam sodium, fumigation, alfalfa, root-knot nematode, forage yield, autotoxicity, allelopathy

INTRODUCTION

Alfalfa producers sometimes desire to replace a failing stand of alfalfa with a new seedling stand in order to have an uninterrupted supply of forage. These attempts are sometimes successful, but most are failures. Re-establishment failures are usually attributed to autotoxicity and extreme pest pressure. This paper deals with an attempt to circumvent the effects of autotoxicity and pest pressure with application of Vapam. AMVAC Chemical and DM Ranches provided cooperation and support for this project.

Autotoxicity. Autotoxicity is defined in the context of allelopathy. Allelopathy results when the growth of the second crop of a two-crop sequence is inhibited. This inhibition of growth may include poor germination, slow early development and long-term yield depression. Autotoxicity is allelopathy of one crop to itself. The agents responsible for the allelopathic effects are believed to be chemicals (allelochemics) leaching form the plant leaves, stems and roots. They are thought to be secondary metabolites such as alkaloids, phenolics, flavonoids, terpenoids and glucosinolates. In alfalfa suspect autotoxic chemicals include medicarpin and sativan. Laboratory experiments have repeatedly demonstrated deleterious effects of alfalfa extracts on germination of alfalfa seed.

Dr. Milo Tessar at Michigan State University studied Autotoxicity in the early 1970's. He developed protocols for successful alfalfa-to-alfalfa rotations for the Michigan environment. In short, he found that late summer application of glyphosate followed by plowing and waiting for 21 days before replanting resulted in successful establishment. Other Midwest researchers found considerable autotoxicity even in spring seedings following fall plow-down of old crop. C. J. Nelson, (University of Missouri) conducted a three-year study of autotoxicity and recommends at least a 12-month waiting period between alfalfa crops. He observed reduced germination due to a slowing and killing of the primary root within the germinating seed. More significantly, Nelson found that alfalfa does not outgrow the initial autotoxic effects. Other research has found that autotoxicity reduces Rhizobia nodulation.

According to Nelson, "Alfalfa appears to have a 'memory' of response to the autotoxins that is termed autoconditioning. Even if a producer reseeds and appears to have successfully established a stand following a three-to-six month alfalfa-free interval, autoconditioning will lower the productivity of the stand over an extended period because of the initial damage. These losses can't be visually assessed, and the potential economic losses go well beyond seeding failure. Over the long-term, yields can be 8% to 29% lower where the stand is impacted by autotoxicity."

Pest pressure. During the life of an alfalfa stand, populations of pests such as insects and disease organisms build up. These include bacterial, fungal and viral pathogens, plant parasitic nematodes and insects. Crop rotations to non-host crops can lower the levels of inocula in soils.

The purpose of this field trial was to investigate the potential benefits of fumigation in establishing alfalfa following alfalfa. Anecdotal evidence suggested that reduced weed pressure and better stand establishment resulted from Vapam fumigation when used to kill the existing alfalfa stand before replanting.

MATERIALS AND METHODS

A 22-acre field near Othello, WA irrigated with a center pivot system was chosen as the experimental field with the cooperation of Darin Michel and AMVAC Chemical. The existing stand of alfalfa was 4 years old. The soil type is very sandy. The field was sampled for nematodes to establish a background population. The circle was divided in half for the two tillage treatments. Primary tillage consisted of half the field being plowed and the other half disked. Vapam at 12 gal/ac was applied through the water immediately after plowing by AMVAC personnel. Vapam treatments were designated to the second half of each span (tower) by tying up the drops (sprinkler rotators) in the first half of the span. This resulted in a pattern of non-fumigated sections followed by fumigated sections over the length of the circle. The seedbed was prepared using a finishing disk. Nine days after fumigation WL 325 alfalfa was planted with an air seeder at 20 lb/ac. Seed was incorporated with a drag harrow.

Data recorded in the fall included seedling emergence, surviving nematode populations and weed populations. Forage yield of first cutting was taken in May 2004. The grower recorded the total harvest of each cutting. In September 2004, plants were dug and evaluated for nematode infection and internal root disease. A diagram of the plot plan is attached as an appendix.

RESULTS AND DISCUSSION

Seedling emergence. Fumigation with Vapam did not influence seedling establishment (Table 1). However, seedling stands were better in the disked ground than in the plowed ground. The softness of the soil in the plowed half was noticeable when walking over the field while taking stand notes. It is my determination that the softness or fluffiness of the plowed ground was detrimental to seedling establishment.

Table 1. The effect of tillage and fumigation treatments on seedling establishment.

		TILLAGE		
		Plow	Disk	Avg.
		Plants/ft^2	Plants/ft^2	Plants/ft^2%
Fumigation	Metam	49	73	61
	Check	62	68	65
	Avg.	55	70*	

* indicates a significant difference between tillage treatments averaged over fumigation treatments.

Nematode populations. Nematode counts prior to fumigation indicated a multitude of free-living and plant parasitic nematodes. Table 2 shows nematode counts before and after fumigation. Post-fumigation sampling occurred in October after tillage treatments and several irrigations. Free-living nematode populations remained about the same. Plant parasitic nematode populations decreased at the post-fumigation sampling. However, the absence of plant parasitic nematodes in the check plots would indicate that other factors, such as soil temperature influenced nematode populations rather than any treatment effect. This effect was temporary as plant infection with root-knot nematode was severe when plants were dug in the fall of 2004 (See Table 3). Root-knot nematode populations increased during the summer of 2004 as evidenced by the high infection rate of alfalfa roots in both Vapam-treated and non-fumigated soil. There were no significant differences in nematode infection as a result of tillage or fumigation treatments.

Table 2. The effect of tillage and fumigation on nematode populations.

Tillage treatment	Fumiga-tion. Treatment	Free-living Nemas/100 cm^3		Root-knot Nemas/100 cm^3		Lesion Nemas/100 cm^3		Ring/stubby root Nemas/100 cm^3	
		Pre*	Post	Pre	Post	Pre	Post	Pre	Post
Plowed	Vapam	661	477	248	0	118	0	257	0
Plowed	Check		360		0		0		13
Disked	Vapam		767		0		0		63
Disked	Check		560		15		3		0

*Pre-fumigation sample number = 16, post fumigation sample number = 12

Table 3. Root-knot nematode infection (%) on year-old alfalfa in Vapam-treated and non-fumigated soil.

		TILLAGE		
		Plow	Disk	Avg.
		% Infection	% Infection	% Infection
Fumigation	Metam	83	89	86
	Check	85	91	88
	Avg.	84	90	

Weed suppression. In September 2003, weed populations were recorded in all plots. Predominant weed species included pigweed, lambsquarters, barnyardgrass, flixweed and tumble mustard. Both Vapam fumigation and tillage treatments resulted in significant effects. Plowing was effective in burying some weed seeds, particularly those of barnyardgrass. Weeds in the disked half of the circle were 1.5 times as numerous as in the plowed half. Fumigation reduced the incidence of broadleaf weeds but not barnyardgrass (Table 4). In the spring, Vapam fumigated areas in the plowed half of the circle were visibly freer of weeds than in the non-fumigated areas. The same was not observed in the disked half.

Table 4. The effects of tillage and fumigation treatments on weed emergence.

		Tillage			
		Plow		Disk	
Fumigation		Broad-leaves #/ft^2	Barnyard grass #/ft^2	Broad-leaves #/ft^2	Barnyard grass #/ft^2
	Vapam	1.3	2.9	3.0	10.8
	Non-fumigated	13.2*	4.1	5.5	6.0
	Avg.	7.1*	3.5	4.3	8.4†

* indicates significant differences in reaction to fumigation effects (P.05) for broadleaves and “all weeds” within the Plow treatment.
† indicates significant differences in reaction to tillage effects for barnyard grass averaged over fumigation treatments

Forage yield. Forage yield was determined for the first cutting in 2004. Sub-samples of each 4 X 15 foot plot were harvested with a flail chopper and weighed fresh. Samples of each plot were taken for dry weight determinations. Because weeds were present in almost every plot, dry weight samples were separated into weeds and crop. Yield data represent alfalfa dry matter (weeds removed). Table 5 shows that forage yields were not affected by either tillage or fumigation treatments. The producer also kept records of the other three cuttings. Total dry matter yield for the 22-acre field was 76 tons, or 3.5 t/ac. According to grower records, the plowed half of the field produced 63% of the total dry matter of the field in the fourth cutting. This level of production is less than half of what is normal for first-full-year alfalfa production in this environment.

Table 5. The effect of tillage and fumigation treatments on first harvest dry matter.

		TILLAGE	
		Plow	Disk
Fumigation		T DM/ac	T DM/ac
	Vapam	2.1	1.7
	Check	2.1	1.7

Root disease. In September 2004, 15 to 20 plants pre plot were dug, roots cross-sectioned and evaluated for presence of root health. Root tissues with signs of disease typical of Verticillium wilt (*Verticillium albo atrum*), and/or Fusarium wilt (*Fusarium oxysporum)* were scored. Table 6 shows that Vapam had no effects on root disease incidence. However, plants in the disked half of the field showed a statistically significant 32% disease, almost twice the incidence of root disease in the plowed half at 18%.

Table 6. The effects of tillage and fumigation treatments on root disease in alfalfa.

		TILLAGE		
		Plow	Disk	Avg.
		% Diseased	% Diseased	% Diseased
Fumigation	Vapam	18	35	27
	Check	18	29	24
	Avg.	18	32*	

* indicates a significant difference between tillage affects averaged over fumigation treatments.

Summary. This experiment was designed to test the effectiveness of using Vapam to aid in the establishment of alfalfa following alfalfa. The results indicated that Vapam at 12 gal/ac was effective in reducing weed emergence, particularly in combination with plowing. Vapam had no effect on the infection of plants with parasitic root-knot nematodes. This is not unexpected as the labeled rate for Vapam is 50 – 100 gal/ac. The 50-100 gal/ac rate would prove too costly as a pre-plant treatment for alfalfa production. Vapam also did not affect alfalfa seedling emergence or forage yield of the first harvest. Plowing was beneficial in burying some weeds, particularly barnyardgrass. Plants in the disked half of the field had greater infection with internal root pathogens and produced less forage in the fourth harvest. The increased level of disease was most likely due to the association with old alfalfa roots in the upper levels of soil, whereas in the plowed ground, old plants were buried deeper in the soil profile.

Although no measurement of autotoxicity was made, it is likely that autotoxicity resulted in the depressed forage yield and negated any benefit of Vapam in the establishment and productivity of this alfalfa.

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APPENDIX