FACTORS IN FUMIGATION FAILURE

By

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Ladies and Gentlemen today I would like to be able to stand here and tell you all the factors that are related to fumigation failures, whether it be for nematodes, verticillium wilt or for the control of Canada thistle.

I was in hopes that by sending out questionnaires asking for information relative to the various practices used in fumigating that we would be able to detect a pattern that might show why some people had failures. In order for this to work, you have to get the questionnaires back and I received less than 10% back of the number sent out.

In checking out the various fields that I did hear of failure in relation to the control of nematodes, I found that one of the most common things that appeared in the practices used was that the crop that was being followed was potatoes. In a few other cases that we have heard of, failures in controlling nematodes, the preceding crops that were involved were either alfalfa or clover. So at this point I would like to go over some of the factors as I know them that are necessary in order for fumigation to be successful.

In order for fumigation to be successful it must be remembered that fumigation is a program and not just a treatment.

NON - HOST CROPS

First it is necessary to lower the numbers of nematodes or in the case of verticillium wilt, the number of propugules to the lowest population possible. This is done by raising crops that are not hosts to the organism for two or three years. Along with the non-host crop one must also maintain good weed control as weeds may also be a host either to nematodes or verticillium wilt. The purpose for this is to lower the number of nematodes in the soil to the lowest possible number, remembering that control is usually expressed in percent - Good control is usually never better than 95% and an average of 90% control is more usual. Knowing that the average female root knot nematode will produce from 300 to 500 eggs and that a life cycle of a nematode under ideal conditions can be from 20 to 30 days it is easy to see what can develop from 10% of a large population of nematodes to begin with. During a summer several generations can be produced and a few thousand per square foot can become several million per square foot. So our number one rule is to reduce the number of nematodes before fumigating to the lowest possible number.

CROP RESIDUES

I think that the next thing that a person must do in order to insure good results from fumigation is to have all crop residues broken down as much as possible. There are two very good reasons for this; the first being that any undecomposed roots containing nematodes or their eggs protect them from the fumigants. Very few fumigants are able to penetrate plant tissue very far. Hence the reason for failures where fumigation has been done after potatoes, sugar beets, alfalfa or clover, -- unless ample time has been allowed for the breakdown of the roots. The second reason for this is that undecomposed organic matter adsorbs fumigants and there by reducing the concentration of fumigant that goes through the soil pores killing nematodes. So what has to be done to remedy this situation is first to plant a crop that has little crop residue the year preceding fumigation. Then immediately after the harvest of that crop, work the crop residue into the soil with some nitrogen and then keep the soil moist to promote decomposition. An occasional working of the soil will also hasten decomposition. By having crop residues well decomposed before fumigating also prevents straws or stems from acting as an escape chimney for the fumigant when it breaks down into a gas.

TILTH

Still another factor that plays an important role in fumigation is tilth. Good tilth is a must in order for the fumigant to penetrate all parts of the soil evenly. A packed soil means less air spaces in the soil for the gas to enter thereby reducing the concentration below the level to kill the nematodes. So in order to insure good even movement throughout the soil profile be sure that the soil has been loosened at least 12 to 14 inches deep and that the soil is worked two to three weeks ahead of fumigating. As I go on with these various points, I hope that you are beginning to see that fumigation requires some advanced planning if you are to insure success.

MOISTURE

There probably is no scientific method for determining the exact amount of moisture that is best for fumigation but the best basis for determining moisture at this time is the ball method. This is by grabbing a handful of soil and clenching the hand into a tight fist. If the soil holds a ball shape when the hand is released without being soggy then the soil moisture is considered to be adequate. A soil that is too dry allows the fumigant to diffuse through the soil pores too rapidly thereby reducing the concentration below the lethal point; while a soil that is too moist fills the soil pores thereby restricting the movement of the fumigant which again lowers the concentration of fumigant. A wet soil also retains the fumigant for a prolonged period increasing the possibility of injury to the crop when planted. If the soil near the surface is dry, this will allow for rapid diffusion of the gas through the large pores and result in poor control at the surface level. Packing after fumigation will help to alleviate this problem.

TEMPERATURE

Temperature is another very important factor in relation to the results obtained from fumigation. I have heard of temperatures being recommended all the way from 30^{o} to 80^{o}. We know that different materials react differently at different temperatures. The temperatures that I would like to recommend are those that were quoted by Dr. O. J. Dickerson from Kansas State University, at the nematode workshop held in Pasco this past December. Quote: "Soil temperatures at the depth of injection or placement should be between 50 and 80^{o} F. for fumigants containing chloropicrin, 60 and 85^{o}F. for chloropicrin alone, 50 and 95^{o}F. for bromide-containing fumigants alone, and 40 and 80^{o}F. for dichloropropene fumigants alone. These are minimum and maximum temperatures and the best kill will be midway between them. Poor results can often be traced to fumigants being placed in cool, wet, fine-textured soils." End of Quote - Most of the fumigants used in this area are thosecontaining dichloropropene or those for verticillium wilt which contains chloropecrin. So what I am suggesting is that the soil temperature should be at least 40^{o}F. for nematodes and above 50^{o}F. for the control of verticillium wilt.

PLACEMENT

There are three common methods of placement being used here in the Columbia Basin. They are the plow-sole method, the broad cast method where the material is shanked in and the shanks are about 12 inches apart and then there is the row placement method where either the fumigant is shanked into the row with a single shank or with two shanks one on either side of the row and no more than 12 inches apart. At this time I feel that there probably is little differences between methods as long as the material is put in somewhere between 8 to 12 inches deep. In regards to deep placement which is being used in other areas, Dr. Faulkner has indicated to me that we don't have enough evidence as yet to indicate that we can recommend this practice.

Other practices that must also be included in a successful fumigation program is the sealing or packing of the soil after application to reduce the rate of escape; the exposure time should be at least 10 to 14 days and even longer in cool wet soils. Last but not least, an aeration time should be allowed. This means that the soil should be tilled so that all fumigant can escape before planting. All of what I have been discussing leads up to a planned program. So if you are a potato grower and plan to continue growing potatoes, I cannot emphasize enough the necessity of developing a rotation and a planned program that will allow you to carry on a fumigation program by the numbers.

Now I would like to switch horses a little and discuss what we have seen in the role of fumigation for the control of Canada thistle. In looking at some seventy questionnaires that were returned I see anywhere from 0% control to 100% control reported. There did not seem to be any one material, rate or method of application that gave consistant good or bad results. So from what I have seen at this time I don't feel that anyone can guarantee you that you can control Canada thistle by fumigating, using the materials that are commonly being used in the Basin today. If you do fumigate and get Canada thistle control, then you have received a plus value. But if you don't have nematodes and you are fumigating on the strength of controlling Canada thistle and other weeds, I think you will be better off to just fumigate the areas containing the thistles and let the rest of the field go. With this method if you don't get control you won't have a total loss. As far as annual weed control is concerned with the materials presently being used, there is very little or no indication of annual weed control.

So in summary, I would suggest that you consider the following points: 1 - Determine which fields that you farm contain nematodes. 2 - Develop a rotation that will allow you to reduce the nematode populations between potato crops. 3 - Choose crops preceding the year for potatoes that will leave little crop residue. 4 - Plan to work the crop residue into the soil as soon after harvest as possible and plan to carry on cultural programs that will hasten the decomposition of the residue. 5 - Follow the recommended procedures and requirements for good fumigation. Apply the proper amount for your soil type. 6 - Don't fumigate just on the basis of an increased yield and better quality unless you can afford to lose $40 to $100 because no one can guarantee that you will get a better yield and quality. 7 - And last but not least don't fumigate just to control Canada thistle. If you have to fumigate for nematodes or verticillium wilt and you do control the thistle then you have a plus factor, but few people can afford the cost of fumigating just for the practice.