Principles of Crop Rotation Oilseeds and Pulses

David Kaminski
Plant Disease Specialist
Saskatchewan Agriculture and Food
February 23, 1996

Introduction

Two years ago at a similar conference in Saskatoon, I spoke on "Oilseed Diseases and Crop Rotations." Peter Entz, Karen Bailey and Robin Morrall also spoke on disease management through crop rotation. This year, Karen, Robin, Lorne Duczek and I have been asked to re-examine this issue. We have elected to do so by considering first cereal crops and then broadleaf crops, not because we were afraid of the complexity of discussing all crops together, but because there are some basic differences in the crop intervals necessary for reduction of inoculum.

Of all the residue-borne diseases of broadleaf crops, blackleg on canola takes the longest to break down. The woody portion at the base of the canola stem is highly resistant to decay and likely to be found six or more years after the crop was last grown. Allan Petrie's work has shown clearly that the sexual stage of the blackleg fungus can persist on such residue and produce viable spores for as long as seven years. Fortunately, spore production is substantially reduced after four years or rotation might be of no use in managing blackleg.

The residues of pulses, particularly field pea and lentil, break down more quickly than canola stubble but are still likely to persist and support fungal pathogens longer than cereal crop residues do. Thus, the long standing recommendations for crop rotation intervals are more stringent for broadleaf crops than for cereals.

cautions

The idea of crop rotation as a disease management tool is almost intuitive. It's not difficult to sell it as a concept. This is the way Robin Morrall explained it in "The role of crop rotations in disease control" (1990): "By practising rotation we **hope** that *before the same crop is grown again infectious plant residues will have decomposed and that spores and other resting structures of pathogens will have lost viability.*"

At the same time it's easy to oversell crop rotation as a disease management tactic. As many have pointed out, crop rotation is not a panacea and it is probably worth reminding you of the cases where it is of no use and those where it's usefulness is seriously limited.

1. The pathogen is primarily or entirely seed-borne. Among broadleaf crops grown here, there are precious few examples - pea seed-borne mosaic virus (PSbMV) is not a common problem on the prairies.

2. The disease is spread a very long distance by air-borne spores. One example is cereal rust diseases.

3. The disease is vectored by insects that are, like spores, transported long distances on air currents. An example, albeit a minor disease, is aster yellows in canola, vectored by leafhoppers.

4. The pathogen has a very wide range of host plants. Sclerotinia sclerotiorum is a fungus that attacks more than 400 species, including most of the annual broadleaf crops grown in Saskatchewan.

5. The pathogen is capable of saprophytic existence in the soil apart from its host. An excellent example of late has been Botrytis gray mold on lentil.

6. The pathogen has long-lived resting spores. One example is flax wilt. Fortunately this disease is limited in importance by adequate resistance in most cultivars.

Before we give up in desperation over these limitations, let me underscore the positive benefit from the reduction of residue-borne disease through careful crop rotation. At a meeting to discuss integrated pest management, under a wide range of reliance on tillage and chemical pesticides, an organic farmer had this to say: "As an organic *producer, I* am forced to be more cognizant of the *effects of crop rotation. Unless I use tillage my biggest problem is weed management. Disease, on the other hand, is really almost never a problem*"

Challenge #1 - The Trend Toward More Broadleaf Crops

Is there an ideal crop rotation? It's a question I posed to a prominent seed grower a few weeks ago. His response: "No, we have not come up *with an ideal rotation for our operation but, with prices for different crops being a little more in line with each other, maybe it's time to start looking at more agronomically sound rotation.*"

To illustrate how the need for a set of "principles of crop rotation", specifically considering disease management, has grown recently, I want to compare the relative importance of cereals, oilseeds and pulses as reflected in the production area devoted to those crops in 1993 and 1995 (Table 1). As you can see, dramatic changes are in progress, reflected in a reduction in total cereal acres and increases in both oilseed and pulse acreage. The major shifts have been in flax, field pea and canola. Another trend not immediately evident in the table but consistent with the last eight years and is the reduction in summerfallow acreage. In short, there are more acres in crop with an increasing proportion of broadleaf crops. Furthermore, these numbers are provincial averages. In some crop districts in the last two seasons, canola has made up more than 30% of seeded acres.

Table 1. Comparison of **Harvested Acres** of Annual Crops in Saskatchewan, 1995 vs. 1993.

Crops	1995		1993	
	'000 ac	%	'000 ac	%
Cereals	21625	68 (-7)	22 920	75
Wheat	16 125	(50)	17 895	(59)
Barley	4 100	(13)	3 700	(12)
Other	1 400	(4)	1 325	(4)
Oilseeds	**7 350**	**23 (+6)**	**5 230**	17
Canola	6 100	(19)	4 580	**(15)**
Flax	1 250	(4)	650	(2)
Pulses	**2 020**	**6 (+1)**	**1425**	**5**
Field Pea	1 300	(4)	725	(2)
Lentil	720	(2)	700	(2)
Total	31 950		30 380	

Source: Statistics Canada, as printed in Saskatchewan Agriculture and Food's StatFacts "November Estimate of 1995 Crop Production."

I now want to quickly review those diseases of oilseeds and pulses for which crop rotation is most effective or worth consideration.

Specific Diseases (slides - discussion)

CANOLA

blackleg, Leptosphaeria Maculans*, **
sclerotinia stem rot, S. *sclerotiorum**

FLAX

pasmo, *Septoria linicola*

FIELD PEA

mycosphaerella blight, M. *pinodes**

LENTIL

ascochyta blight, *Ascochyta fabae* f.sp. *lentis***

* the occurrence, in nature, of the sexual stages of these fungi facilitates airborne dissemination of ascospores, which can undermine the effectiveness of crop rotation as a control measure.

** seed-borne infection is important in ascochyta on lentil and blackleg on canola

Challenge #2 - "Fitting It All In"

'Iwo weeks ago, I was speaking at a meeting sponsored by the Sask. Pulse Crop Development Board in Moose Jaw. When I presented my list of control options for ascochyta on lentil, a long-time grower spoke up to challenge the statement that a two year break was sufficient for reduction of residue borne inoculum. He said *"Al Slinkard used to say one in four years for lentils. We found we got into trouble with disease whenever we tried to shorten that."* My only response at the time was that immediate proximity to fields which carried infected stubble was a complicating factor that must also be addressed through rotation. However, it was only afterward that I really tried to come to grips with how this works. Finally, I came up with a visual means of depicting the increased risk associated with moving from a one in four rotation to a one in three (Figure 2).

Some of the assumptions we will use include:

1. For the four year rotation, we will use 50% cereals and 50% broadleaf crops. For the three year rotation, we will use 67% cereals and 33% broadleaf crops.

2. We will, for now, consider the large block to be grown in isolation and not be concerned with those crops that surround it.

3. Our primary objective in the exercise is to minimize the frequency of planting lentils adjacent to lentil stubble.

Flying over Saskatchewan, you will see a patchwork of fields and no two are exactly alike. On the other hand, there are some areas where sections or quarters are split up in fairly regular fashion and there are not that many ways to divide a square piece of land. Most choose either more squares or strips of varying widths. Here are four basic field divisions in which we might consider the proximity effects of three and four year rotations (Figure 1).

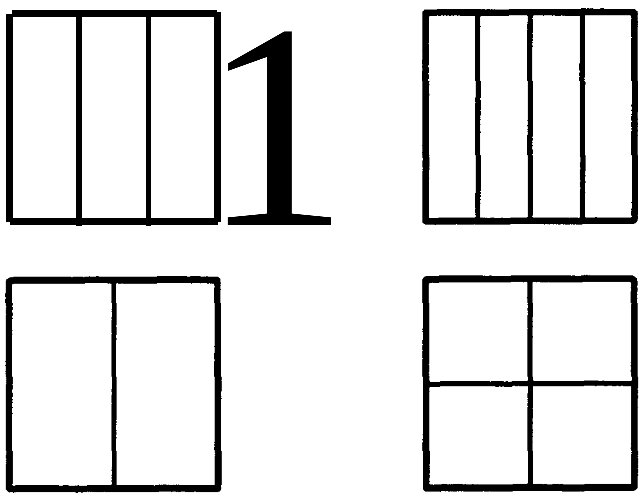

Figure 1 - Examples of field divisions of a section or quarter of land.

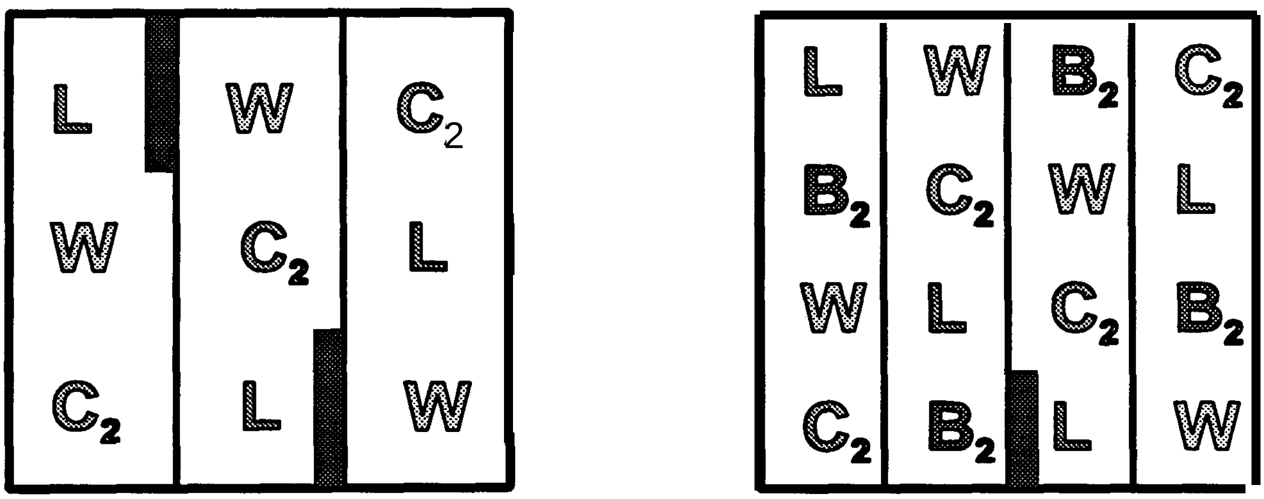

Figure 2 - Comparison of a three-year rotation and a four-year rotation to show the effect on proximity of one crop to stubble of that same crop. Columns represent field divisions and rows represent years.

L = lentil B_2 = second broadleaf (flax, canola, field pea, mustard, etc.)
W = wheat C_2 = second cereal (barley, oats, rye, [canaryseed], etc.)
Bars represent instances of planting adjacent stubble of same crop.

In the final analysis, in this model, we can see that by moving from a four year to a three year rotation we have increased the frequency of planting lentil adjacent to lentil stubble by more than 40%, thereby jeopardizing the benefits of not planting lentil on the same piece of ground more than once in three years.

Challenge #3 - Research Towards Accurate Assessment of Disease Risk from Crop Residues

Two **years** ago, I said: *"Growers and agrologists alike have challenged me that the 'standard' rotational recommendation, particularly for canola is 'just not good enough' today. They want to know the probability of a crop loss or crop failure should they grow canola two or three years after the last crop. Unfortunately, for most diseases, we do* ***not have in hand the predictive*** **tools to calculate that probability."**

That statement holds true today although research is underway to address this deficiency. If we had diagnostic tests that could confidently determine whether or not crop residues are carrying viable inoculum of a particular disease, we could use that information to decide whether it is OK to plant the host crop. Work is underway in this area, based on molecular biology techniques. Although the commercialization of such procedures may not be realized in the immediate future, it is conceivable that it could.

For one disease, stem rot in canola (where rotation bears consideration but is no guarantee of success in disease management) we have a commercially available procedure to determine the risk of infection when the crop is in bloom, prior to the onset of disease. This facilitates the judicious use of fungicides which are, in this case, an available alternative.

Conclusion

Crop rotation can be effective as **one of the tools** used to minimize the impact of certain diseases on oilseed and pulse crops. So-called "rules of thumb" are a good place to start in planning a rotation, but it is important to know how both crop sequence and proximity to previously infected residues of the particular crop come into play. To know rather than to **hope** that "infectious plant residues have decomposed and that spores and other resting structures of pathogens will have lost viability" would be a notable improvement in the use of crop rotation as a disease management tool.

Finally, if growers are able to implement a "set rotation" rather than making cropping decisions based on immediate objectives, they will find that personal experience is perhaps the only way to refine or optimize a "good rotation" for their particular location, soil type and other management practices.