

## Crucifer Root Maggots - the Saskatchewan Situation

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The focus of this series of workshop presentations is possible reasons for declining Polish canola seed yields in eastern and northern Saskatchewan. One pest that has significantly reduced seed yields in other regions and which may be present in the area under discussion is crucifer root maggots.

Crucifer root maggots are Anthomyiid flies, the larvae of which feed on cruciferous crops. The most injurious species are the cabbage root maggot, the radish root maggot, and the turnip root maggot. Despite their common names, all three species readily feed on canola. They are slightly smaller than house flies, grey in colour, with black bristles on their bodies, reddish eyes and a darker stripe on the top of their backs.

**Life Cycle:** Root maggots overwinter as small, brown, cigar-shaped pupae 5 to 20 cm deep in the soil near canola roots. Adult flies emerge over a period of several weeks in late spring, feeding on the nectar of flowering plants. They enter canola fields at the late rosette or early bolting stage, often congregating on the tallest plants, searching for mates or feeding on young flowers. In Alberta, about 85% of egg-laying occurs between June 8 and June 20 (Doddall, personal communication). After mating, females deposit creamy white eggs singly or in masses at the base of canola roots. One female can lay from 50 to 200 eggs. Legless maggots emerge in 3 to 10 days, move down along the root into the soil, and feed on root hairs and surface tissues of the root, creating shallow tunnels. Maggots feed for about three weeks and pupate in the soil or within the canola root itself. One or two generations or even a partial third generation can occur in canola growing regions, depending on weather conditions. Generations tend to overlap so that all stages can be found throughout the summer. In warmer latitudes of North America, several generations of crucifer root maggots occur seasonally.

**Damage:** Extensive maggot feeding on canola roots leads to stunted, weakened, yellowing plants, and provides entry points for root diseases. Heavy feeding by maggots can completely sever roots, causing plant to wilt, lodge, and die. Moisture conditions and soil type influence the amount of damage that the maggots can cause. Root maggots flourish in cool, moist conditions.

The extent of root maggot injury to canola across the prairies is largely unknown. In Alberta, Polish canola, *Brassica rapa*, is more susceptible to attack by maggots than is Argentine canola, *B. nupus*, with the mustard *B. juncea* least susceptible. Yield losses from root maggots in Polish canola have been recorded as high as 52%, with 20% yield reductions in Argentine canola (Griffiths 1991). Thus, canola producers in Alberta, where Polish canola comprises 65% of the canola hectareage, annually experience significant economic losses from root maggot infestations. In 1995 canola losses in Alberta from root maggot damage were estimated to be over \$100,000 (P. Thomas, personal communication). Surveys in Saskatchewan in the 1980's found higher root maggot infestation levels in the north central region than in other regions of the province, but the

effects of these infestations was not known. In the past three years there has been growing concern by Saskatchewan canola producers, especially in the area west and south of Prince Albert, about the effects of root maggots on canola yields (J.L. Harris, personal communication).

### **The Study:**

**a) Survey:** A project was initiated in 1995 to determine the extent and degree of root maggot injury to canola, primarily *B. rapa*, across the prairies by means of surveys of commercial canola fields. A preliminary survey was undertaken in the Parkland region of Saskatchewan in 1995, and an extensive survey was undertaken across the Prairies in 1996 wherever canola was grown. Roots were collected in early fall and rated according to their degree of maggot infestation. A 25 root sample from each field was taken; five roots were sampled from five stops in a transect across the field, starting 10 to 25 m from the edge depending on field size. Two fields per rural municipality or county were surveyed. Sampling in 1995 was predominantly in but not restricted to Polish canola fields. In 1996, the majority of fields sampled were Argentine canola, a reflection of the spread of the survey to southern areas. Root samples were taken to the laboratory, where they were washed and examined under a stereoscopic microscope, and the degree of injury rated according to the following scale of Dossdall et al. (1994):

0= no damage

1= small feeding channels on the root comprising less than 10% of the tap root surface area

2= feeding channels comprising 1-25% of the root surface area

3= feeding channels comprising 26-50% of the root surface area, with damage extending beneath the root epidermis

4= feeding channels comprising 51-75% of the root surface area

5= feeding channels comprising 76-100% of the root surface area, or root completely severed by feeding tunnels.

Data collected included sample location, canola species, variety (when known), degree of infestation (percent occurrence per field) and injury (scale 0 to 5).

**b) Variety and Line Testing:** Canola field tests established at AAFC, Saskatoon Research Centre, and satellite sites to assess varietal performance and other characters such as resistance to flea beetles were rated for degree of feeding by root maggots in 1995 and 1996. Ten roots were taken from each of four replicates of cultivars shortly after harvest. Roots were handled and rated as above. Data was subjected to analyses of variance to determine significance of differences in degree of infestation caused by root maggots to different canola species, cultivars, and lines. In 1996, diameters of sampled roots just below the crown were measured with calipers.

**Results: a) Survey 1995** In 1995, 240 fields from 107 rural municipalities in Saskatchewan were sampled for the presence of root maggots; the insect was found in roots of 239 of the fields. Of these, 128 were fields of Polish canola, 103 were Argentine, and 8 were mustard fields. Infestation levels were high. In the majority of fields plant infestation rates were higher than 60%, that is, more than 15 of the 25 randomly selected roots had maggot feeding scars (Figure 1, Table 1). Despite high levels of occurrence of

maggot feeding damage, the degree of injury was light in most of the samples, averaging less than 1.0 (Figure 2, Table 1). However, higher ratings were found in samples from the northern perimeter of the sampled area, especially along the Saskatchewan-Alberta border.

Table 1. Infestation of and degree of injury to canola roots by root maggot collected from canola fields in the Parkland region of Saskatchewan in 1995.

<u>%</u> <u>Roots Infested</u>	<u>&amp;</u> <u>Area Surveyed</u>	<u>Damage Index</u>	<u>&amp;</u> <u>Area Surveyed</u>
0 - 10	0	0.0 - 0.5	14.3
11 - 35	8.0	0.5 - 1.0	61.3
36 - 60	28.6	1.0 - 1.5	22.0
61 - 90	58.9	1.5 - 2.0	1.8
91 - 100	4.4	2.0 - 2.5	0.6

When data was compared by crucifer species, there was little difference in the average degree of damage among them (Table 2).

Table 2. Average degree of injury to canola roots sampled across the Parkland region of Saskatchewan in 1995 and across most of the canola growing areas of the province in 1996.

Canola species	1995		1996	
	No. of Fields	Average Damage Rating	No. of Fields	Average Damage Rating
<i>B. napus</i> (sentine)	102	0.79	310	0.54
<i>B. rapa</i> (Polish)	129	0.80	183	0.79
<i>B. juncea</i> (mustard)	5	0.84	16	0.34
<i>Sinapis alba</i> (mustard)	3	0.87	3	0.57

Survey 1996: In 1996, the survey area was expanded to include 182 Saskatchewan rural municipalities; in total, 512 fields were sampled. Of these, 183 fields were Polish, 310 were Argentine, 16 were *B. juncea* mustard, and 3 were *Sinapis alba* mustard.

The level of root maggot infestation in the southern portion of the survey area was light, in most cases with fewer than 35% of the plants sampled per field having maggot damage. In the northern half of the survey area, maggot infestation was generally lighter in 1996 than in 1995, with most fields having fewer than 60 % of their roots infested. However, there were four areas of the province where almost all roots sampled were maggot infested (Figure 3, Table 3). Damage levels in the southern portion of the survey

area were very light, with infested roots exhibiting one or, at most, two small feeding tunnels, corresponding to damage ratings of 1.0 or lower (Figure 4). Damage levels in the north were similar to or higher than those found in 1995. Canola in the region along the Saskatchewan-Alberta border declined in maggot damage in 1996, but plants in several areas had up to 50% of their root surfaces damaged by root maggots (Figure 4, Table 3).

Table 3. Infestation of and degree of injury to canola roots by root maggot collected from canola fields in Saskatchewan in 1996.

<u>%</u> <u>Roots Infested</u>	<u>%</u> <u>Area Surveyed</u>	<u>Damage Index</u>	<u>%</u> <u>Area Surveyed</u>
0 - 10	8.3	0.0 - 0.5	43.9
11 - 35	29.8	0.5 - 1.0	35.1
36 - 60	36.5	1.0 - 1.5	14.4
61 - 90	24.3	1.5 - 2.0	5.3
91 - 100	1.1	2.0 - 2.5	1.0
		2.5 - 3.0	0.3

Argentine canola had lower average damage levels than Polish canola in 1996 (Table 2), but this may have been a reflection of the extension of the survey into the southern portions of the province, where little Polish canola is grown and where little maggot damage was found. A comparison of damage index classes indicated that the most heavily maggot-damaged canola fields in 1996 were Argentine varieties (Table 4).

Table 4. Degree of root injury (0 to 5 scale) to Polish and Argentine canola by root maggots in Saskatchewan in 1996.

<u>Damage Index</u>	<u>% Area Surveyed</u>	
	<u><i>B. rapa</i></u>	<u><i>B. napus</i></u>
0.0 - 0.5	41.2	48.9
0.5 - 1.0	33.5	34.4
1.0 - 1.5	14.4	10.5
1.5 - 2.0	5.3	5.2
2.0 - 2.5	1.0	0.3
2.5 - 3.0	0.3	0.5
3.0 - 3.5		0.2

**b) Canola variety testing:** In side by side variety trials, Polish canola lines generally suffered more root maggot injury than did Argentine lines. However, none of the varieties or lines tested had high levels of resistance to root maggots. For example, a test of *B. rapa* breeding lines and a mustard control varied statistically in the amount of maggot damage they received, but real differences in the average amount of feeding damage to the roots was not large (Table 5). Data further suggest that under heavy maggot feeding pressure, differences among cultivars and lines decrease.

Table 5. Damage ratings (0 to 5) to roots of *B. Rapa* Polish canola varieties and breeding lines and a mustard control, Saskatoon, 1995.

<u>Canola Line/Variety</u>	<u>Damage rating</u>
Tr4	1.76 a
CompH	1.71 a
Tobin	1.45 ab
Echo	1.36 ab
Tr2	1.36 ab
IMP8618	1.26 b
Cutlass	1.16 b

Damage rating values followed by the same letter are not significantly different,  $P < 0.01$ , LSD

The volume of data generated by this study is extensive, but does it answer the question “Are root maggots the cause of declining Polish canola yields in the Parkland regions of Saskatchewan?”. Root maggots were found in all canola growing areas of the province. Root injury in the two years of the survey was higher in the northern Parkland regions than in the south. However, areas of greatest root damage tended to be localized, rather than across broad areas of the province. Therefore, while root maggots appear to be spreading in distribution and perhaps in damage impact, they are only one of several factors influencing canola yield.

Injury from root maggots tends to be worst in areas of high rainfall, such as central and northern areas of Alberta. Traditionally, Saskatchewan and Manitoba have not seen evidence of significant levels of root maggot infestation in canola. With the cool, wet weather prevalent across much of the prairies in recent years, the impact of root maggots in canola crops outside their traditional areas of pest distribution in Alberta may be increasing.

#### **References:**

Dosdall, L. M., Herbut, M., and Crowle, N.T. 1994. Susceptibilities of species and cultivars of canola and mustard to infestation by root maggot (*Delia* spp.) (Diptera: Anthomyiidae). *The Canadian Entomologist* 126: 25 1-260.

Griffiths, G.C. D. 1991. Economic assessment of cabbage maggot damage in canola. Farming for the Future Technical Report FFF #89-0444, Alberta Agriculture, Edmonton.

Figure 1. Crucifer root maggot infestation levels in Saskatchewan, 1995

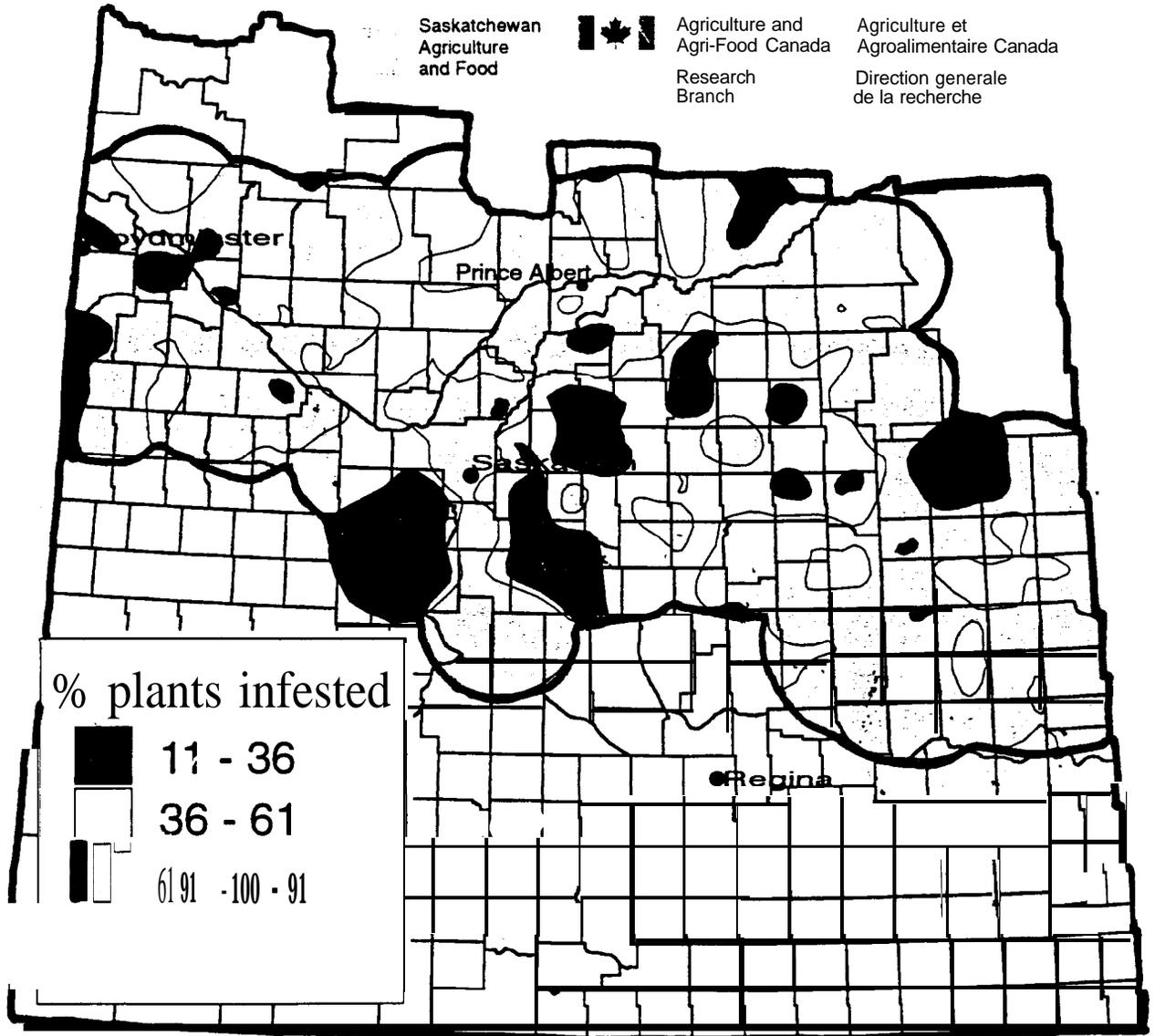
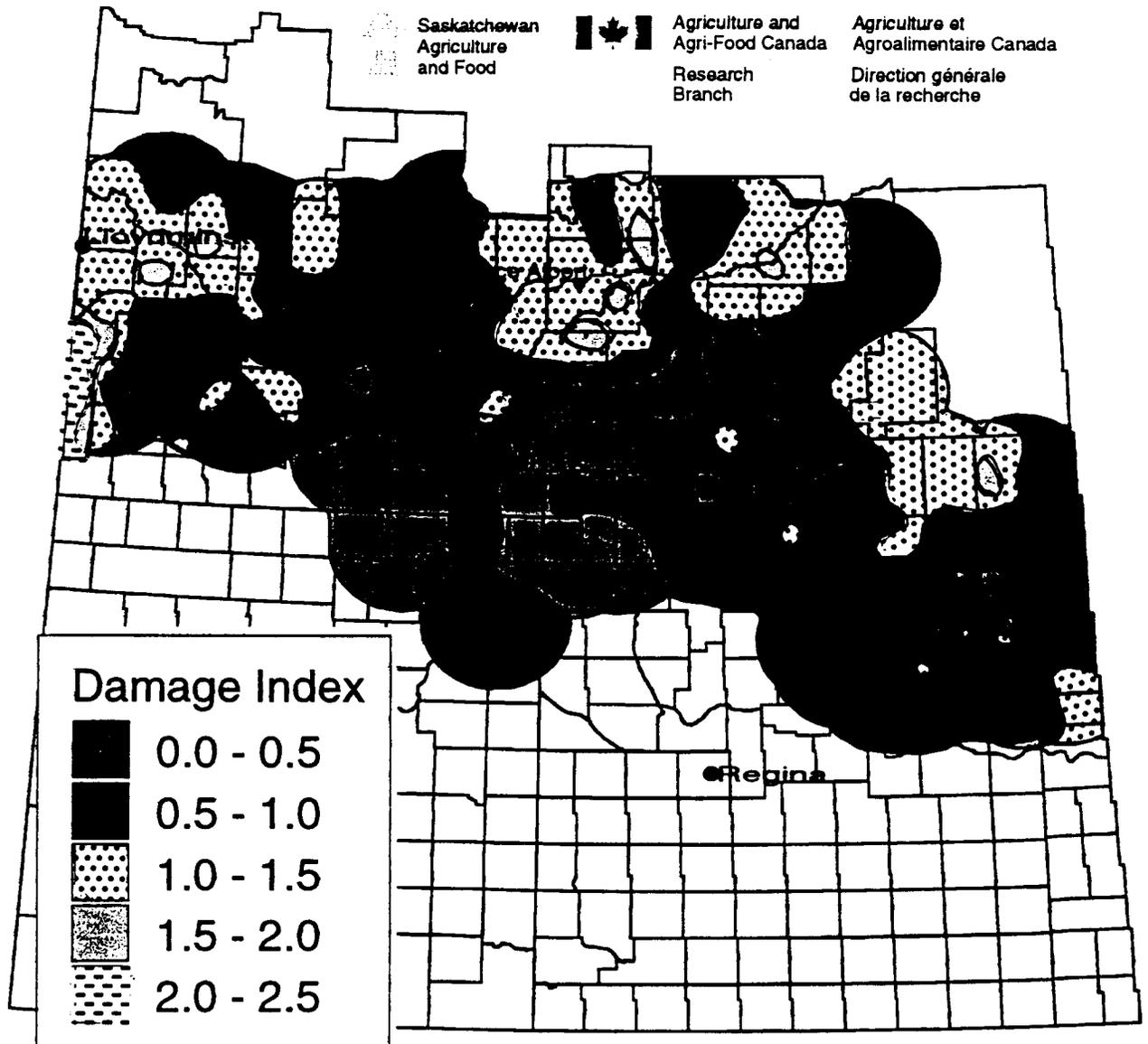


Figure 2. Crucifer root maggot damage levels in Saskatchewan, 1995



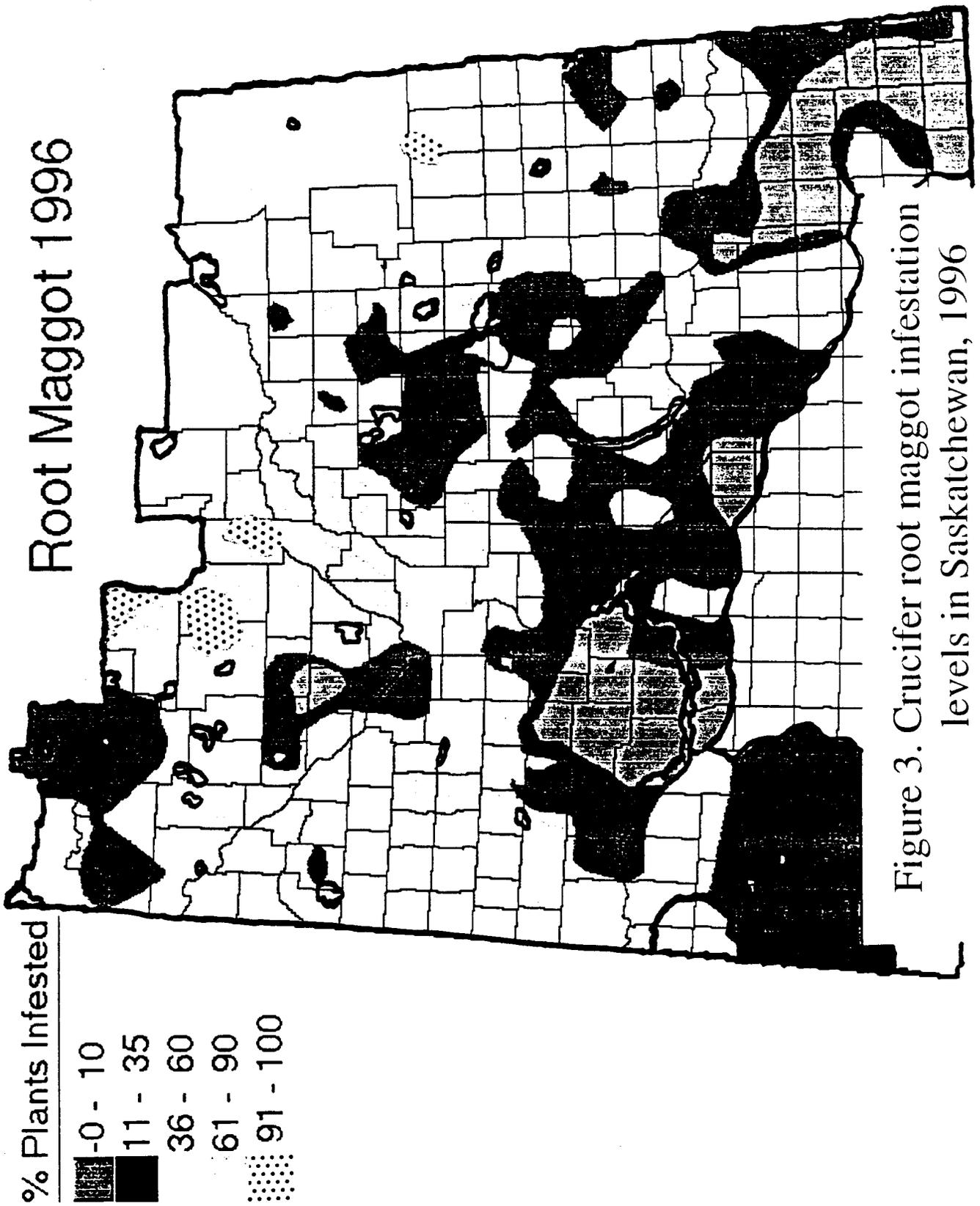


Figure 3. Crucifer root maggot infestation levels in Saskatchewan, 1996

Damage Index

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0

Root Maggot 1996

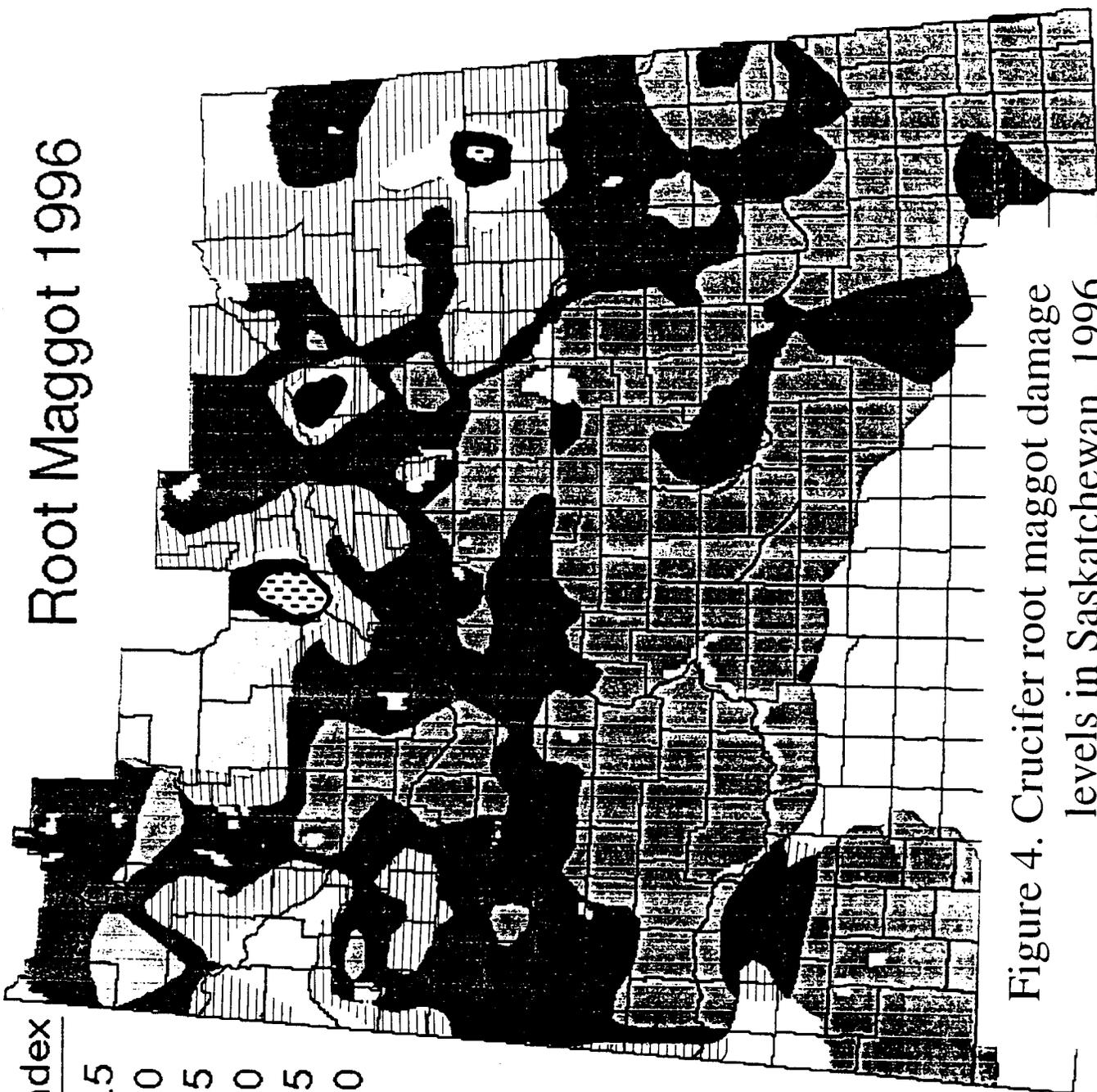


Figure 4. Crucifer root maggot damage levels in Saskatchewan, 1996