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WHAT ARE YOUR WEEDS COSTING YOU?

Final Research Report E2006-02

INTRODUCTION

Organic farmers control weeds, in part, because they reduce crop yield. While the elimination of all weeds may not be practical or desirable, keeping weed densities low can help keep yields high. Certain weeds may be more competitive than others, and their effects can vary between years and at different farms. In organic agriculture, the impact of weeds such as wild radish and lamb's-quarters on crop yields has not been thoroughly studied.

Potatoes are very sensitive to soil moisture conditions, making weed control an important consideration in organic potato production. Barley is a more competitive crop, but yield can still be reduced by weeds[1]. By counting weeds and measuring their biomass, researchers can determine the effect of weed competition on the yield and quality of a harvested crop, the impact of weeds can be determined. This report summarizes research findings of the impact of weeds on the yield, quality, and economic return from two common crops in Atlantic Canada – potato and barley.

Researcher Kate Punnett collects wild radish plants in PEI

WHAT WAS DONE?

We looked at the economic impact of two major weeds (lamb's-quarters and wild radish) on organic farms growing barley and potatoes in PEI (Table 1). At each farm, 30 sample sites were chosen that represented a range of weed densities. For potatoes, samples were collected from 1-m of potato hill row (about 0.3 m^2), and weeds are reported by m^{-1} of hilled row. Barley samples were collected from 0.5 m^2 quadrats; results are reported by m^{-2}. A separate 30 sample sites was identified for each weed to avoid confounding the data.

Table 1. Weeds and Crops Assessed

Crops	Weeds
Barley	Wild radish
Potato (cv. Snowden)	Lamb's-quarters Wild radish
Potato (cv. Goldrush)	Wild radish

In late August, weeds were counted and a sample was collected to determine weed fresh weight (biomass). Stakes were placed into the ground to mark each sampling location. The same site was revisited a few weeks later to collect the yield sample.

Yields were measured and the potatoes were graded using size specifications for round potatoes from the Canadian Agricultural Products Standards Act:

- Total Yield, which is made up of:
  - Canada No. 1 (57-89 mm)
  - Small (38-57 mm)
  - Large (89-114 mm)
  - Cull (<38 mm or >114 mm)

The Large and Cull classes made only a small contribution to total yield and they will not be discussed further.

How we Calculated Yield Losses

We can estimate the impact of weeds by examining crop yield from sites with a variety of weed densities, as shown on Figure 1. Then, statistical analyses can be performed to see if there is a strong relationship between the number of weeds and the resulting yield. Regression lines on the graph show this relationship for potato yield (cv. Snowden) and wild radish.

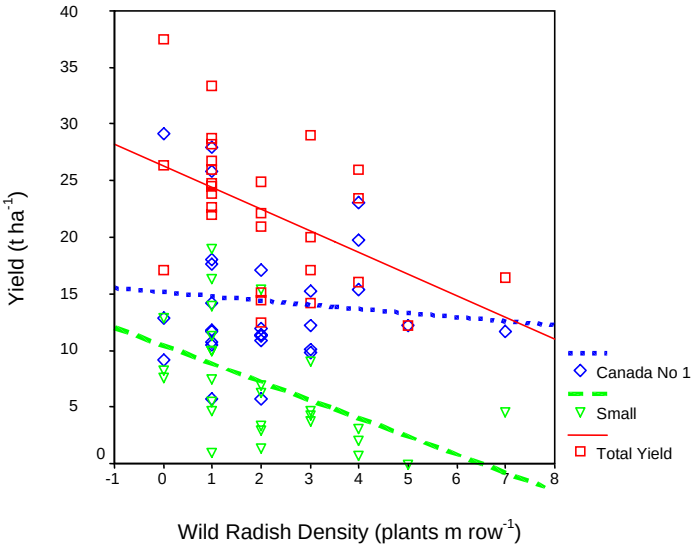

Figure 1. Relationship between potato (cv. Snowden) yield and wild radish density, 2005

Where the line slopes steeply down, this indicates that each additional weed strongly reduces yield (like the Small and Total Classes in Fig. 1). If the line is nearly horizontal, then the weeds have little or no effect on crop yield (like the Canada No.1 class in Fig. 1). We then used regression equations to calculate yield losses from weeds for the different crops. For the above example, the regression equations are as follows:

Total Yield: Y = 26.3 – 1.9WR

Small Yield: Y = 10.4 – 1.6WR

Y represents yield (t ha^{-1}), the first number approximately represents the average yield when no wild radish are present, the second number is the estimated yield reduction per wild radish plant, and WR represents the number of wild radish plants m^{-1} hilled row.

The reduction in economic profits was determined using prices of:

- **$800 per metric tonne for potatoes**
- **$250 per metric tonne for barley**

This may be an overestimate, as the same price was used for all potato classes. Because this was a preliminary study, the results are only an indicator of potential yield impact at the sites studied in 2005. The results cannot be used to predict yield losses in other locations or years.

To convert to hundredweight per acre (cwt ac^{-1}), multiply yield in t ha^{-1} by a factor of 8.318.

What Happened?

Potato (Snowden): Wild radish

The sample graph and calculations from the previous section are made in reference to this site. You can compare the numbers below with the graph and equations to see how losses were determined.

Average weed density = 2 wild radish m^{-1} hilled row
Wild radish = 90% of all weeds by weight

Total:
Yield if no wild radish present = 26.3 t ha^{-1}
Each wild radish m^{-1} hilled row reduces yield by **1.9** t ha^{-1} or **$1,532** ha^{-1}
At the average wild radish density (2 plants m^{-1} row), the yield loss is **3.8** t ha^{-1} or **$3,064** ha^{-1}

Small Class:
Yield if no wild radish present = 10.4 t ha^{-1}
Each wild radish m^{-1} hilled row reduces yield by **1.6** t ha^{-1}
At the average wild radish density (2 plants m^{-1} row), the yield loss is **3.2** t ha^{-1} considering only small potatoes, as opposed to 3.8 t ha^{-1} for total

The small class of potato accounted for 83% of yield losses due to wild radish. If the small potatoes are worth less than $800 per metric tonne, then the economic loss related to wild radish might be lower than calculated for loss of total yield.

Potato (Goldrush): Wild radish

Average weed density = 7.7 wild radish m^{-1} hilled row
Wild radish = 95% of all weeds by weight

Total:
Yield if no wild radish present = 24.3 t ha^{-1}
Each wild radish m^{-1} hilled row reduces yield by **0.52** t ha^{-1} or **$420** ha^{-1}
At the average wild radish density (7.7 plants m^{-1} row), the yield loss is **4.0** t ha^{-1} or **$3,200** ha^{-1}

Canada No.1 Class:
82% of total yield was Canada No. 1 class
Yield if no wild radish present = 19.9 t ha^{-1}
Each wild radish m^{-1} hilled row reduces yield by 0.43 t ha^{-1}
At the average wild radish density (7.7 plants m^{-1} row), the yield loss is 3.3 t ha^{-1}.

Small Class:
Yield if no wild radish present = 4.0 t ha^{-1}
Each wild radish m^{-1} hilled row reduces yield by 0.16 t ha^{-1}
At the average wild radish density (2 plants m^{-1} row), the yield loss is 1.2 t ha^{-1}.

The wild radish plants here were smaller on average (45 g $plant^{-1}$) than at the previous site (328 g $plant^{-1}$).

Organic PEI potatoes with low weed pressure (K. Punnett)

Potato (Snowden): Lamb's-quarters

Average weed density = 2.4 lamb's-quarters m^{-1} hilled row
Lamb's-quarters = 88% of all weeds by weight

Total:
Yield if no lamb's-quarters present = 27.8 t ha^{-1}
Each lamb's-quarters plant m^{-1} hilled row reduces yield by **1.5** t ha^{-1} or **$1,193** ha^{-1}
At the average lamb's-quarters density (2.4 plants m^{-1} row), the yield loss is **3.6** t ha^{-1}; or **$2,863** ha^{-1}

Canada No. 1 Class:
Yield if no lamb's-quarters present = 17.6 t ha^{-1}
Each lamb's-quarters plant m^{-1} row reduces yield by **0.9** t ha^{-1}
At the average lamb's-quarters density (2.4 plants m^{-1} row), the yield loss is 2.2 t ha^{-1}

Small Class:
Yield if no lamb's-quarters present = 9.5 t ha^{-1}
Each lamb's-quarters plant m^{-1} hilled row reduces yield by **0.6** t ha^{-1} (P = 0.12)
At the average lamb's-quarters density (2.4 plants m^{-1} row), the yield loss is 1.4 t ha^{-1}

Barley: Wild radish

Density:
Average weed density = 3.4 wild radish m^{-2}
Average biomass of wild radish = 81 g m^{-2}
Wild radish = 32% of all weeds by weight
Total yield if no wild radish present = 1,280 kg ha^{-1} (1.28 t ha^{-1})
Each wild radish plant m^{-2} reduces total yield by **11** kg ha^{-1} or **$2.75** ha^{-1}
At the average wild radish density (3.4 plants m^{-2}), the yield loss would be **36** kg ha^{-1}; an economic loss of **$9** ha^{-1}

Biomass:
The **biomass** of all weeds (including wild radish) also affected barley yield
Total yield if no weeds present = 1.43 t ha^{-1}
Each additional gram of weed fresh weight will reduce crop yield by **0.68** kg ha^{-1} or **$0.17** ha^{-1}
At an average weed fresh weight of 253 g m^{-2}, the yield loss would be **172** kg ha^{-1}; an economic loss of **$43** ha^{-1}

In the first potato field (Snowden) the average wild radish density was low (2 plants m^{-1} row), as compared with the second field (Goldrush), at 7.7 plants m^{-1} row. Yield reduction caused by the average wild radish density was almost identical: 3.8 t ha^{-1} in the first field and 4.0 t ha^{-1} in the second one. In the field with fewer wild radish plants, each plant grew larger. We monitored both wild radish and lamb's-quarters in the Snowden potato field. Compared with the wild radish discussed above, the lamb's-quarters had a lower impact per plant on yield than wild radish. The average density of lamb's-quarters was similar to that of wild radish, but the average biomass was almost half. The competitiveness of each lamb's-quarters plant appears to be lower than that of wild radish in this potato field.

As barley is a more competitive crop than potato, the weeds were less damaging to crop yield. In all of the examples above, the weeds affected each class of potato differently. For instance, increasing wild radish density mainly reduced the yield of small potatoes in the Snowden field. This may relate to competition for light. A high weed density can block photoassimilates that are transported from the potato leaves down to the tubers for tuber bulking. If the weeds accumulate biomass later in the season, then the classes of potatoes that bulk up later may be adversely affected. In the end, the competitive effect on the crop is a combination of many factors, including the number of weeds present, the size of each weed, time of emergence, and soil and environmental factors[2].

WHAT'S NEXT?

OACC is interested in continuing this research to improve our understanding of weeds in organic systems. Areas of interest include:

1. A survey of weed species and economic losses on organic farms in the Maritimes, including factors such as crop, tillage practices, rotation and soil fertility.

2. A study to develop a system of predicting the economic impact of weeds at a stage when management is feasible (such as the crop's 3-leaf stage).

THE BOTTOM LINE...

At farms in PEI, each additional wild radish plant per m^{-1} hilled row reduced the yield of potatoes by 0.5 – 1.9 t ha^{-1}. Each additional lamb's-quarters plant reduced potato yield by 1.5 t ha^{-1}. Potato farmers may see economic losses of \$3000 ha^{-1} at average levels of weed competition.

In barley, weeds were less detrimental to yield. Each wild radish plant m^{-2} reduced yield by 11 kg ha^{-1} or \$2.75 ha^{-1}.

These findings are site specific and will vary depending on farm conditions.

REFERENCES

[1]Weaver, S.E. and Ivany, J.A. 1998. Economic thresholds for wild radish, wild oat, hemp-nettle and corn spurry in spring barley. Canadian Journal of Plant Science 78: 357-361.

[2] Wallace, J. (ed.) 2001. Organic field crop handbook. 2nd Ed. Canadian Organic Growers, Ottawa ON.

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