Crop Losses Caused by Multispecies Weed Communities Dominated by Wild Oats (*Avena fatua* L.) - A Preliminary Analysis

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Introduction

There are many papers in the literature dealing with crop losses caused by wild oats. Nearly all of these papers deal with losses as determined in experimental plots established with only one weed species present. In the 'natural state', numerous other weed species are present in varying numbers in fields having wild oat infestations. It is important to take into account all species in the weed community when relating yield loss to weed abundance. In this study, multispecies weed communities dominated by wild oats were examined as they influenced crop loss in wheat. The portion of the experiment presented here includes a preliminary analysis of data collected at harvest for the purpose of developing a descriptive model relating measures of weed abundance to wheat loss.

Methods and Materials

Each year from 1988 through 1993, one or two fields in which wild oats was a major weed species were selected for study near Regina, Saskatchewan. Ten to fifteen paired 1-m^2 quadrats were set up in each field and positioned randomly. For each pair, one quadrat was hand-weeded and the other was left untouched. Wheat yield along with the number and shoot dry weight of all weed species and wheat were determined at harvest. The difference in wheat yield between adjacent weeded and nonweeded quadrats was used to estimate wheat yield loss. The relationship between weed abundance of the multispecies weed community and percent yield loss was determined using sigmoidal and/or hyperbolic equations.

Results

Weed Dry Weights at Harvest

Over the six year study, 31 weed species were found in the plots with wild oats accounting for the greatest shoot dry weight of any species (Table 1). Other abundant species included green foxtail, wild mustard, stinkweed, lamb's-quarters, and Russian thistle.

The hyperbolic equation used to relate weed dry weight to % wheat loss was:

$$\% \text{ Wheat Loss} = 0.31Z/(1+0.31Z/152.42)$$

where:

.$Z = 0.80WO + 1.52ST + 1.70LQ + 4.92RT + 0.38OT$;
.WO, ST, LQ, RT, and OT are dry weights of wild oats, stinkweed, lamb's-quarters, Russian thistle, and all other species;
.% Wheat Loss is corrected for differences in wheat density between adjacent quadrats.

This equation accounted for 63% of all variation in the data (Fig.1).

The sigmoidal equation used to relate weed dry weight to % wheat loss was:

$$\% \text{ Wheat Loss} = 57.34-57.34(\exp(-0.0026.Z^2))$$

where:

.$Z = 0.11WO + 0.16ST + 0.26LQ + 0.44RT + 0.0880OT$
.WO, ST, LQ, RT, and OT are dry weights of wildoats, stinkweed, lamb's-quarters,Russian thistle, and all other species, respectively;
.% Wheat Loss is corrected for differences in wheat density between adjacent weeded and nonweeded quadrats.

This equation accounted for 65% of all variation in the data (Fig. 2).

Both hyperbolic and sigmoidal equations accounted for a large proportion of the variation in the data, with the sigmoidal model about 2% more efficient. The sigmoidal model also had the most reasonable upper asymptote, with the maximum yield loss possible estimated to be 57.3%. The hyperbolic model estimated an upper asymptote of 152.4%, an unrealistically large number.

Weed Counts at Harvest

In terms of numbers, wild oats was present in the greatest amount, followed by green foxtail, stinkweed, wild mustard, and Russian thistle, lamb's quarters and barnyard grass (Table 2). Barnyard grass only occurred in 2 of the 11 fields surveyed, however.

The hyperbolic equation used to relate weed counts to % wheat loss was:

$$\% \text{ Wheat Loss} = 0.34Z/(1+0.34Z/103.50) - 0.020WD$$

where:

.$Z = .63WO + 1.86ST + 1.88WM + 4.0WB + 0.09OT$;
.WO, ST, WM, and OT are dry weights of wild oats, stinkweed, wild mustard, wild buckwheat, and all other species;
.% Wheat Loss is corrected for differences in wheat density between adjacent quadrats;

.WD is the wheat density in the weedy quadrat.

This equation accounted for 74% of all variation in the data (Fig. 3).

The sigmoidal model used for the weed count data accounted for only about 64% of the variation in the data, and therefore this equation is not presented.

Discussion

Weed counts accounted for more variation than the model using shoot dry weight data. This may be because a large portion of some species is underground. It has been shown by Martin and Field (1988) and Satorre and Snaydon (1992) that competition between wild oats and wheat occurs to a large extent below ground, and the root system of wild oats is extensive (Pavlychenko and Harrington 1934). Also, root exudates from wild oats have ben shown to inhibit the growth of wheat seedlings (Perez and Ormeno-Nunez 1991).

With dry weight data, the sigmoidal equation was better since it provided a more realistic upper asymptote (57%) and accounted for 2% more variation than did the hyperbolic equation. However, for the count data, the hyperbolic model was more efficient. It still had an unrealisticlaly high upper asymptote (103%), although not as bad as the one determined from the weight data. In other published works, upper maximum yield losses caused by wild oats in wheat have ranged from 52 to 78% at very high densities (Wilson et al. 1990; Martin et al. 1987). Kirkland and Hunter (1991) found that yield losses in spring wheat varied from 40 to 63% with 100 wild oats plants m^{-2}. These values are more compatible with the upper asymptotes provided by sigmoidal distributions determined from data in the current study.

This experiment has shown that it is possible to accurately model wheat losses from multi-species weed communities dominated by wild oats. Included in the experiment were fields with a range of species composition. In spite of variables such as environmental variation from year to year, different seeding equipment, crop variety, and nutrient status of soils, a very high proportion of the variation in the data was accounted for, especially with the equation relating weed counts to wheat yield loss.

References

Kirkland, K.J. and Hunter, J.H. 1991. Competitiveness of Canada prairie spring wheats with wild oat (*Avena fatua* L.). Can. J. Plant Sci. 71:1089-1092.

Martin, R.J., Cullis, B.R., and McNamara, D.W. 1987. Prediction of wheat yield loss due to competition by wild oats (*Avena* spp.). Aust. J. Agr. Res. 38:487-499.

Martin, M.P.L.D. and Field, R.J. 1988. Influence of time of emergence of wild oat on competition with wheat. Weed Res. 28:111-116.

Pavlychenko, T.K. and Harrington, J.B. 1934. Root development of weeds and crops in competition under dryland farming. Sci. Agr. 16:151-160.

Satorre, E.H. and Snaydon, R.W. 1992. A comparison of root and shoot competition between spring cereals and *Avena fatua* L. Weed Res. 32:45-55.

Wilson, B.J., Cousens, R. and Wright, K.J. 1990. The response of spring barley and winter wheat to *Avena fatua* population density. Ann. Appl. Biol. 116:601-609.

Table 1. Weed comunity structure based upon dry weight at harvest

Species	Mean Dry Weight (g/m^2)	Max Dry Wt. in a Single Field (g/m^2)	# Fields Where Species Occurred
Wild Oats	138.215	262.762	13
Green Foxtail	12.116	59.501	13
Wild Mustard	9.141	67.411	9
Stinkweed	5.158	44.695	12
Lamb's-Quarters	1.525	14.238	10
Wild Buckwheat	1.404	4.216	12
Russian Thistle	1.184	8.889	7
Cow Cockle	0.285	3.230	3
Flixweed	0.265	1.558	6
Barnyard grass	0.255	3.110	2
Kochia	0.205	2.347	5
Other Species[z]	0.708	na	1-8

[z] Other species: Red Root Pigweed, Bluebur, Chamomile, Smartweed, White Clover, Cut-leaf Night Shade, Vetch, Prostrate pigweed, Sow Thistle, Rose, Shepherd's Purse, American Dragonhead, Knotweed, Night-flowering Catchfly, Canada Thistle, Tumble Pigweed, Geranium, and Peppergrass.

Table 2. Weed community based upon weed counts at harvest

Species	Mean Dry Weight (g/m^2)	Max Count in a Single Field ($/m^2$)
Wild Oats	210.79	693.40
Green Foxtail	111.20	677.00
Stinkweed	16.35	151.69
Wild Mustard	5.57	30.00
Russian Thistle	4.22	50.92
Lamb's-Quarters	2.96	15.08
Barnyard grass	2.53	31.25
Wild Buckwheat	2.07	7.67
Red Root Pigweed	0.74	8.14
Cow Cockle	0.41	5.00
Knotweed	0.18	2.27
Prostrate pigweed	0.15	1.20
Other Species[z]	0.86	na

[z]Flixweed, Kochia, Bluebur, Vetch, Night-flowering Catchfly, Tumble Pigweed, Smartweed, Shepherd's Purse, Rose, Chamomile, American Dragonhead, Sow Thistle, Geranium, Cut-leaf Nightshade, Canada Thistle, Clover, Peppergrass.

Fig. 1. Hyperbolic Model Relating Shoot Dry Weight to Wheat Yield Loss

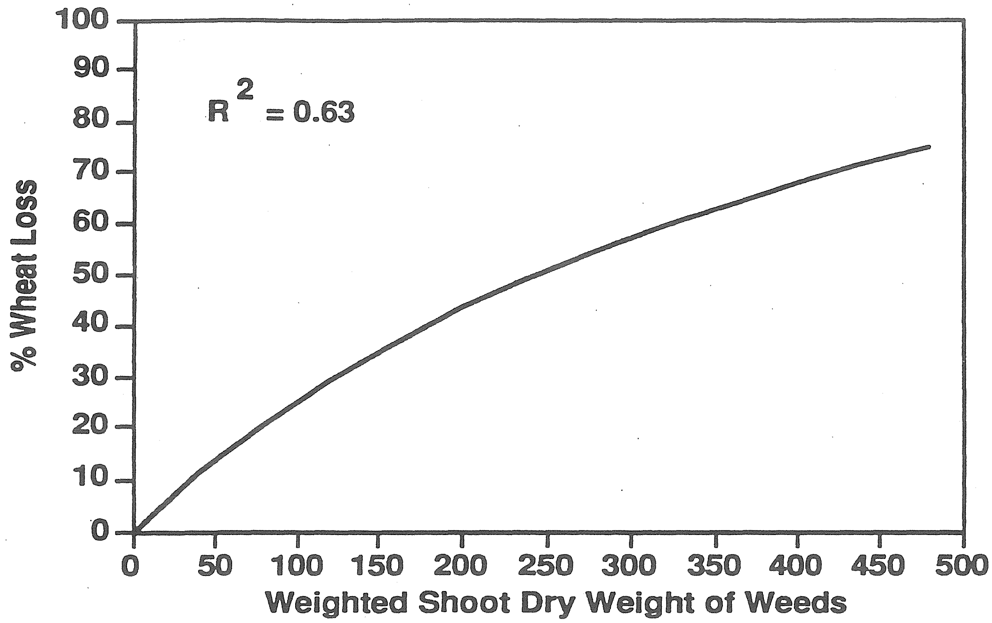


Fig. 2. Sigmoidal Model Relating % Wheat Loss to Weed Dry Weight

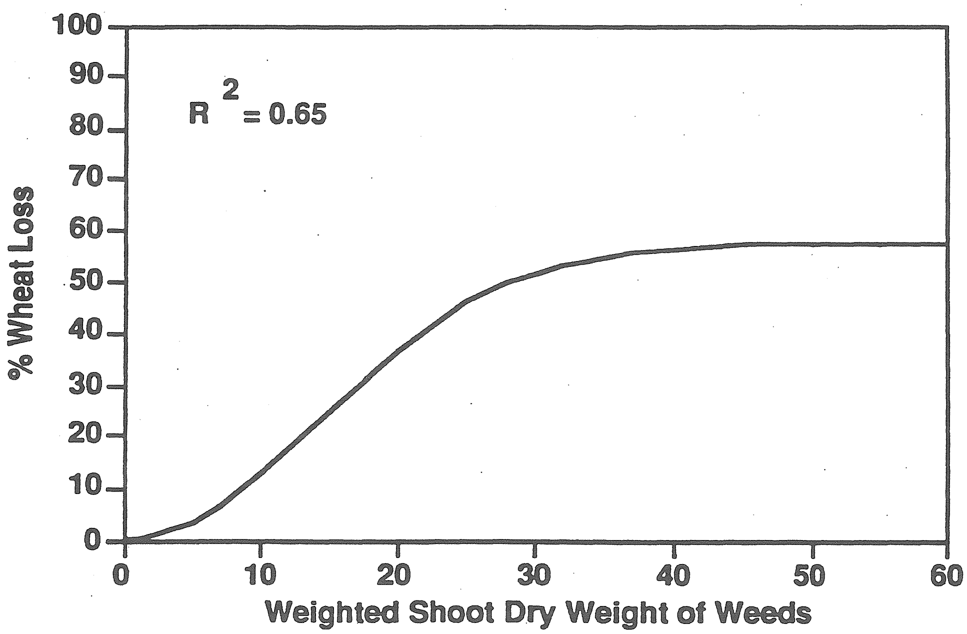
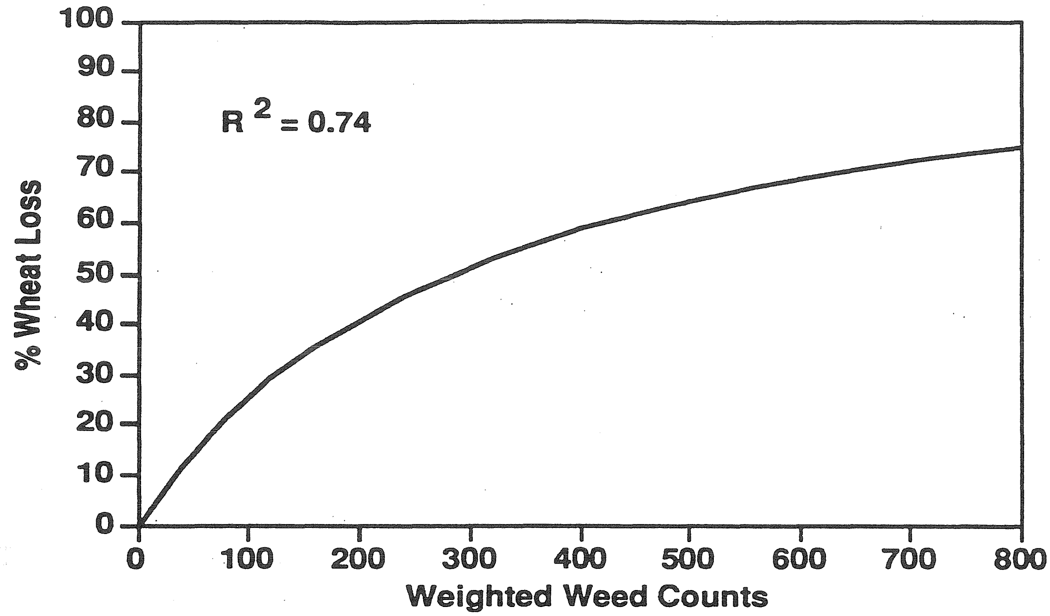


Fig. 3. Hyperbolic Model Relating Weed Counts at Harvest to Wheat Yield Loss



List of Key Words:

Avena fatua L.
competition
wheat
wild oats
model