

COVER CROP VARIETY AND SEEDING RATE EFFECTS ON WINTER WEED SEED PRODUCTION

*Nathan S. Boyd and Eric B. Brennan, USDA-ARS, Organic Research Program,
1636 E. Alisal Street, Salinas, CA 93905*

Abstract

Weed management is one of the most critical yield-limiting factors in organic crop production systems. Little is known about the impact of winter cover crops on winter weed population dynamics. The USDA-ARS organic research program in Salinas, California has conducted several trials examining the impact of cover crop management options on weed populations. The research focused on cover crop seeding rate and variety, mixture composition, and rotary hoeing. In a comparison of 1X (industry norm) and 3X seeding rates of rye, mustard and legume-rye cover crops, chickweed seed production was 224 seeds/m² in the 1X legume-rye mix while seed production did not exceed 18 seeds/m² in any of the remaining cover crops. In another experiment, increasing the cereal component or adding mustard to a mix reduced the number of weed seeds produced during the winter. Cover crop mixes with a high plant density that cover the ground quickly after planting are the most effective at reducing weed seed production. In poorly competitive cover crops, the rotary hoe provided an alternative means to control emerging weeds.

Introduction

Most cover crop research in the central coast of California has focused on nitrate leaching and nitrogen cycling. Little is known about cover crop effects on weed management. Preliminary work at the USDA-ARS certified organic site in Salinas indicated that legume-cereal mixes may exacerbate weed problems allowing high weed seed production (Brennan and Smith, 2003). Increasing the seeding rate increases crop competitive ability (Mohler, 2000) and in cash crops reduces weed seed production (Teasdale, 1998). Seeding rate effects on weed suppression in cover crops has received little research attention.

In poorly competitive cover crops, the rotary hoe may be used for weed control after cover crop emergence. It has been used to control weeds effectively in a variety of monocultures, but to our knowledge, has never been evaluated in mixed plantings. Multiple passes with the rotary hoe may help control weeds that germinate and emerge within the cover crop over an extended period of time (Leblanc and Cloutier 2001a).

The objectives of this paper are to report the impact of cover crop seeding rate, mixture, and rotary hoeing on weed biomass and weed seed return.

Materials and Methods

The cover crop variety and seeding rate trial is designed to examine the impact of cover crop variety and planting density (Table 1) on winter weed populations and summer vegetable production. Rye, mustard and a legume-rye cover crop mix were planted at two rates in the fall and measurements of cover crop biomass and ground cover were taken throughout the season. Weed emergence, growth, and seed production were monitored in all cover crops.

Cover crop growth and biomass production as well as weed growth and weed seed production were compared in a variety of existing and novel cover crop mixes. This paper reports the results of 9 of 27 mixes. The rotary hoe trial examined the effect of rotary hoeing on weed populations within a legume-rye cover crop.

Table 1. Seeding rates and estimated plant density for three separate cover crop trials.

Trial	Cover crop mix	Seeding Rate (kg/ha)	Seeding density (plants/m ²)
Cover crop variety and seeding rate trial	Merced Rye1 1X	90	410
	Merced Rye 3X	270	1230
	Mustard2 1X	11	335
	Mustard 3X	33	1005
	Legume-rye3 1X	112	138
	Legume-rye 3X	336	414
Mixes trial	10% oat, 90% legume4	140	173
	40% oat, 60% legume5	140	259
	10% rye, 90% legume4	140	194
	40% rye, 60% legume5	140	346
	Legume4 + 2lbs mustard2	129	216
	Bell beans (<i>Vicia faba</i> L.)	140	32
	Mustard2	11	335
	Cayuse oats (<i>Avena sativa</i>)	112	335
	Rye1	90	410
	Rotary hoe trial	Legume-rye3	255

1 *Secale cereale* ('Merced')

2 61% *Brassica juncea* (L.) Czern. ('Ida Gold'), 39% *Brassica hirta* Moench. ('Pacific Gold') by weight.

3 10% *Secale cereale* L. ('Merced'), 35% *Vicia faba* L., 25% *Pisum sativum* L., 15% *Vicia sativa* L., 15% *Vicia*

benghalensis L. by weight.

4 35% *Vicia faba* L., 25% *Pisum sativum* L., 15% *Vicia sativa* L., 15% *Vicia benghalensis* L. by weight.

5 23% *Vicia faba* L., 17% *Pisum sativum* L., 10% *Vicia sativa* L., 10% *Vicia benghalensis* L. by weight.

6 45% *Vicia villosa* (Lana vetch), 45% *Vicia benghalensis* L. (purple vetch) by weight.

7 30% *Vicia villosa* (Lana vetch), 30% *Vicia benghalensis* L. (purple vetch) by weight.

Cover crop canopy development was estimated by holding a 30 by 30 cm quadrat with 64 cross grids above the cover crop canopy and counting the number of grid crosses above cover crop plants. Weed seed production was estimated by vacuuming the soil surface of 0.5 m² quadrat from each plot. A crust had formed on the soil surface allowing removal of weed seeds and surface debris with minimal soil disturbance. The weed seeds were separated from soil

and organic residue by passing each sample through a 1.7 mm sieve and then floating the seeds in water. All data were analyzed in SAS (Cary, NC) with the PROC GLM procedure and Tukey's or least squares means comparisons. Only the first year of multiple year studies is presented.

Results and Discussion

Cover crop variety and seeding rate trial. Chickweed (*Stellaria media* (L.) Vill.) comprised the majority of the weed biomass. Weed biomass production was significantly affected by cover crop variety and seeding rate throughout the cover cropping period (Figure 1). The legume-rye 1X cover crop achieved 100% ground cover more slowly than any other cover crops and had significantly less biomass production early in the season. Mustard and rye 3X produced the most cover crop biomass early in the season. By early spring (March) there were no significant differences in cover crop biomass production (data not shown). Weed biomass was inversely proportional to early season cover crop biomass. Weed biomass in the legume-rye 1X increased by more than eight fold from November to January when it was 11 times higher than the average weed biomass in all other treatments.

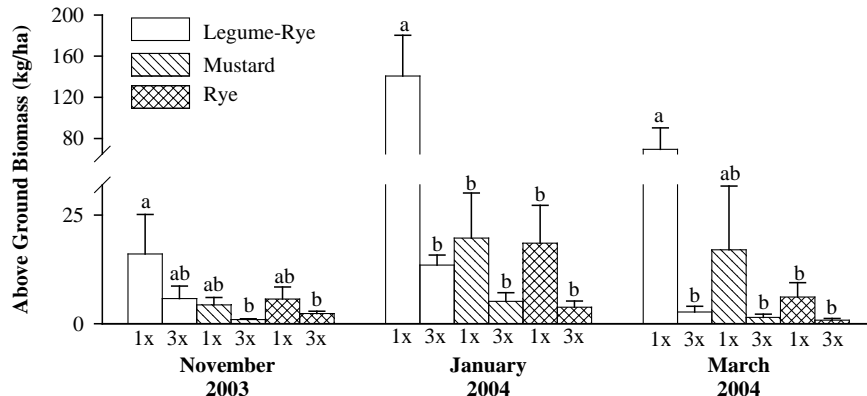


Figure 1. Weed dry biomass production on 3 harvest dates in the cover crop variety and seeding rate trial. Bars are mean \pm SE. Within each date, bars topped with different letters are significantly different at < 0.05 .

Chickweed seed production was also influenced by cover crop variety and seeding rate (Figure 2). The greatest chickweed seed production occurred under the legume-rye 1X (224 seeds/m²) and the least occurred under the legume-rye 3X (3 seeds/m²). Cover crop seeding rate did not influence chickweed seed production in mustard or rye.

Rotary hoe trial. One pass with the rotary hoe in the legume-rye cover crop reduced chickweed and shepherd's purse seedlings by 64 and 91%, respectively. At 36 days after planting (DAP) there were a total of 474 emerged weeds/m² in the no rotary hoe treatment. A single pass with the rotary hoe 14 DAP reduced total weed density by 69% to 148 weeds/m². An additional pass with the rotary hoe did not further reduce weed density. One pass with the rotary hoe reduced seed return by 81% for chickweed and 93% for shepherd's purse (Figure 3).

A second pass with the rotary hoe had no additional affect on weed seed return.

Mixes trial. Ground cover, above ground cover crop and weed biomass and weed seed production were compared for a variety of cover crop mixes. Chickweed was the predominate weed. In single component cover crops the lowest weed seed production occurred in mustard followed by rye (Table 2). Oats and all other legumes examined in this trial were less competitive. Increasing the cereal component of a mix, and consequently its density, decreased

weed seed production (Table 2). Adding mustard to a legume mix reduced weed seed production and survival of the legume component (Table 2). Weed biomass was highly correlated with early season ground cover measurements taken 43 DAP.

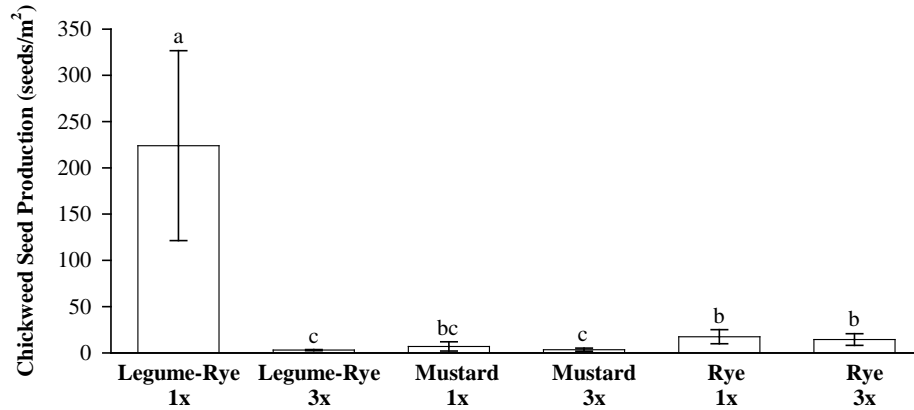


Figure 2. Chickweed seed production by the final cover crop harvest in March, 2004 of the cover crop variety and seeding rate trial. Bars are mean \pm SE. Within each date, bars topped with different letters are significantly different at $P < 0.05$.

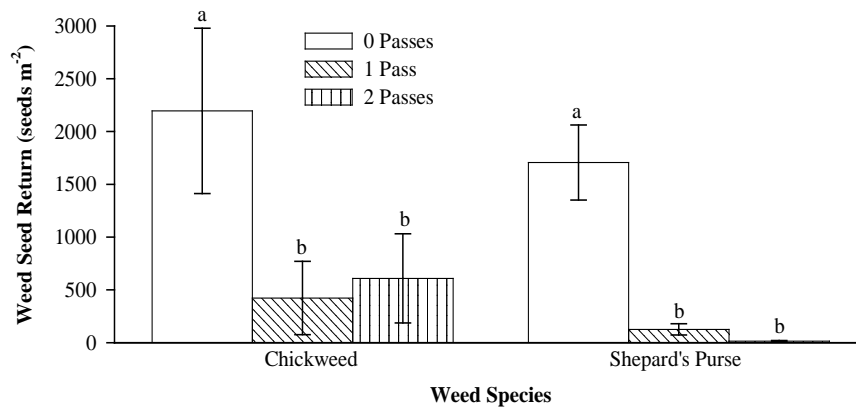


Figure 3. Weed seed return by chickweed and shepherd's purse 134 DAP following 0, 1, or 2 passes with the rotary hoe. Bars within the same weed species with different letters are significantly different at $P < 0.05$.

Table 2. Winter chickweed seed production within various cover crop mixes in the mixes trial.

Cover Crop Mix	Chickweed Seed Production
10% oat, 90% legume ¹	1074 a ²
40% oat, 60% legume	850 ab
10% rye, 90% legume	855 ab
40% rye, 60% legume	435 bc
Legume + 2lbs mustard	90 c
Bell beans	1568
Mustard	46
Cayuse oats	802
Merced Rye	310

¹For further information on the cover crop mix please see table 1.

²Values followed with different letters are significantly different at $P < 0.05$. Single components were not compared statistically.

The differences in weed suppression by the cover crop varieties and seeding rates in these studies is partially explained by differences in canopy development early in the season. As expected, increasing the seeding rate or the cereal component of legume-cereal mixes markedly improved their weed suppressive abilities. However, increasing cover crop seeding rate to improve weed suppression in legume mixes often suppresses both weeds and less competitive components like legumes (Brennan and Boyd, unpublished data). With single component cover crops, increasing the seeding rate may provide 'cheap insurance' against weeds, considering that cover crop seed accounts for a relatively small part (25%) of total cover cropping costs (Klonsky et al., 1994). Alternatively, the rotary hoe may obtain sufficient weed management in poorly competitive cover crops without increasing the seeding rate.

References

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