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Weed populations and pickling cucumber (*Cucumis sativus*) yield under summer and winter cover crop systems

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Abstract

Cucumber growers are increasingly interested in integrating cover crops into their cropping systems. This study was conducted to measure the effect of summer and winter cover crops on weed populations and cucumber yield. The experimental design was a factorial of cover crop and killing method. The cover crops were sorghum sudangrass [*Sorghum bicolor* (L) x *S. sudanense* (P) Stapf.], cereal rye (*Secale cereale* L.), hairy vetch (*Vicia villosa* Roth), and bare ground was used as a control. The cover crops were killed either by discing or with glyphosate application. Cover crop killing method had no effect on weed density, weed species composition, cucumber yield, and soil nutrient composition. Weed density was lower in all cover crop systems compared to bare ground. At 43 days after cover crop kill (DAK) in 2002, weed density was 40, 56, 65, and 372 plants m^{-2} in the sorghum sudangrass, cereal rye, hairy vetch, and bare ground treatments, respectively. Similar results were found at 40 DAK in 2003. Cucumber yield was the highest in sorghum sudangrass and rye systems, and lowest in the hairy vetch system. Sorghum sudangrass and rye showed potential for improvement of cucumber yield. However, fresh residue of rye in early summer may interfere with crop planting. In spite of the high weed suppression, the hairy vetch system was unacceptable because of the low cucumber yield.

Keywords: Cereal rye; Hairy vetch; Integrated crop management; *Secale cereale*; *Sorghum bicolor*; Species richness; Sustainable; *Vicia villosa*

1. Introduction

Pickling cucumber (*Cucumis sativus*) is an important vegetable in the USA, with an average of 48930 ha planted annually (USDA, 2003). Michigan is the largest producer with a total of 14,500 ha valued at over US$ 30 million per year (MDA, 2003). Cucumbers are produced under intensive systems. Crop rotation is limited or non-existent, and some growers produce two crops per year on the same ground. In recent years, however, many vegetable growers have become interested in adopting sustainable practices, such as inclusion of cover crops in their cropping systems. The impetus for the renewed interest in sustainable production practices came from many factors, including pressure from the public to reduce pesticide inputs (Brain et al., 1999; Buys, 1993; Bond et al., 1998; Clark et al., 1999; Liebman and Davis, 2000), growers' interest in soil protection from erosion (Zandstra et al., 1998), and the limited number of herbicides registered for weed control in vegetables in general, and cucumber in particular (Bell et al., 2002; Haar et al., 2002; Zandstra, 2002).

Cucumber production relies on two key herbicides: ethalfluralin and clomazone (Zandstra, 2002). Both herbicides are safe to use on cucumber and are generally applied pre-emergence for grass and broadleaved weed control. If either of the two herbicides were not available, weed management in cucumbers could become a serious challenge. Growers would have to rely mainly on agronomic practices to reduce weed pressure.

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Table 1
Air temperature and rainfall during the growing seasons

Month	Temperature (°C)						Total monthly rainfall (mm)	
	Minimum		Maximum		Average			
	2002	2003	2002	2003	2002	2003	2002	2003
April	3.58	1.6	14.4	14.0	9.0	7.8	55.6	78.5
May	5.3	6.8	17.1	18.4	11.2	12.6	120.9	103.6
June	14.2	11.2	26.7	24.3	20.4	17.8	53.9	37.3
July	16.1	14.6	29.5	27.1	22.8	20.8	95.0	35.8
August	14.91	14.7	27.2	27.8	21.0	21.24	35.5	46.2
September	11.1	9.8	26.1	22.0	18.6	15.9	13.2	65.5
October	2.8	2.8	13.7	14.5	8.2	8.7	31.5	46.7

Increasing crop rotation interval is not a viable economic option for most growers because of lack of good land and the high level of crop specialization of growers. Improving the cropping system with use of cover crops between growing seasons might be more acceptable to those growers than any practice that changed their production system.

Cover crops can reduce soil erosion, water runoff and pollution, and improve soil micro-organisms, structure, tilth, water infiltration, moisture retention, organic carbon and nitrogen (Hall et al., 1984; Teasdale, 1996; Yenish et al., 1996; Sainju and Singh, 1997; Gallandt et al., 1999; Reddy, 2003). Additionally, cover crops can be useful tools for weed suppression in cropping systems (Blackshaw et al., 2001; Boydston and Vaughn, 2002; Ngouajio et al., 2003; Reddy, 2001; Teasdale et al., 2003). Many legume species have been investigated for potential weed suppression (Teasdale and Daughtry, 1993; Reddy, 2003). Hairy vetch (*Vicia villosa* Roth) is a legume cover crop that supplies nitrogen and suppresses weeds in sustainable vegetable cropping systems, but its soil residues do not persist and rapidly degrade. Cereal rye (*Secale cereale* L.) is another commonly used cover crop that reduces density and biomass of several weed species in different crops (Liebl et al., 1992; Mohler and Teasdale, 1993). Rye produces large amounts of biomass and suppresses weed growth by allelopathic effects (Weston, 1996).

Because of the relatively short cycle of pickling cucumbers (40–60 days), it may be possible to use both summer and winter cover crops even under a system with a short growing season. Summer cover crops, such as sorghum sudangrass [*Sorghum bicolor* (L) x *S. sudanense* (P) Stapf.], can produce large biomass in a relatively short time and could therefore be planted after an early harvest of cucumber (Creamer and Baldwin, 2000). Winter hardy cover crops, such as cereal rye and hairy vetch, are usually planted in fall and killed in spring prior to cucumber planting. Both summer and winter cover crops may allow for the improvement of soil fertility, weed management, and cucumber yield. Therefore, this work was conducted to quantify the effects of summer and winter cover crops on weed populations and pickling cucumber yield.

2. Materials and methods

2.1. Experimental site and procedures

Studies were conducted from 2001 to 2003 at the Michigan State University, Horticulture Teaching and Research Center (HTRC) in East Lansing, MI. The soil was a Hillsdale sandy loam (Coarse-loamy, mixed, mesic Typic Hapludalfs) with 1.1% organic matter and 6.9 pH. Monthly precipitation during the study ranged from 13.2 to 120.9 mm (Table 1). The experiment was established on land that had been fallow for over three years.

The experimental design was a factorial arranged in a split-plot design with cover crop type as main plots and killing methods as subplots with four replications. Cover crop treatments consisted of sorghum sudangrass "Cattle Grazer II", cereal rye "VNS", hairy vetch "common", and no cover crop. All treatments were maintained at the same location in consecutive years. Sorghum sudangrass was planted on July 17, 2001 and August 7, 2002 at the rate of 70 kg ha^{-1}. Hairy vetch and cereal rye were planted on September 5, 2001 and September 10, 2002 at 40 and 80 kg ha^{-1}, respectively. The cover crops were broadcast and incorporated slightly into the soil. Sorghum sudangrass was mown twice in 2001 and once in 2002 prior to being killed by frost in October of each year. Hairy vetch and cereal rye are winter hardy and continued to grow in spring of the following year. In spring of every year, all cover crops (or weeds growing in the bare ground and sorghum sudangrass treatments) were killed either chemically with glyphosate application or mechanically by discing. Rye and hairy vetch were killed on May 15, 2002 and May 30, 2003. Two weeks after cover crop kill the entire