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USING CULTIVATION AND INTERSEEDED COVER CROPS TO CONTROL WEEDS IN TRANSPLANTED CABBAGE

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Summary: Cultivation and interseeded (undersown) cover crops were evaluated for weed suppression in transplanted cabbage in 1994 and 1995. The 1994 trial compared two types of flex-tine harrows (having round or flat tines), 1 and 2 cultivations, and interseeded lana vetch (*Vicia dasycarpa* L.). Differences between harrows were negligible thus, only the round-tined implement was used in 1995. The 1995 trial compared 1, 2, and 3 cultivations using one flex-tine harrow and 3 cover crops, oats (*Avena sativa* L.), lana vetch, and hairy vetch (*Vicia villosa* L.) interseeded following the final cultivation. Weed control with a single cultivation in 1994 was inadequate with both harrows and yields were equivalent to the weedy check. Yields increased, equalling those of the chemical standard, with 2 cultivations, +/- the interseeded cover crop, but were highest when cultivations were not followed by interseeding, indicating that interspecific competition decreased yields. In 1995, weed suppression was inadequate with all three cover crops when interseeded following 1 or 2 cultivations, but significantly better than the weedy check or a single cultivation. Cultivation 3 times, +/- interseeding provided weed control equivalent to the chemical standard. Incomplete *Chenopodium album* L. control reduced yields in the chemical standard. When cultivated once, weed and cover crop competition reduced cabbage yields, however they were comparable to those of the chemical standard. Yields were equal to or greater than the handweeded control when cabbage was cultivated 2 or 3 times, when interseeded with the vetches at the second cultivation, and when interseeded with all three cover crops at the third cultivation. With the exception of oats interseeded at the second cultivation, differences between cover crops at each interseeding were negligible.

Key words: herbicide reduction; interspecific competition; mechanical weed control; undersowing.

Introduction

There is increasing public concern about the impact of agricultural pesticides on environmental quality and food safety in the United States (U.S.). This concern has led to an interest in reducing herbicide use and there is now a government commitment to having "75% of American farmland under integrated pest management (IPM) by the year 2005" (Browner). Because herbicides constitute 70% of American agricultural pesticide use, it is particularly critical to identify alternative weed management strategies if this goal is to be met.

A major challenge for weed scientists is development of non-chemical control methods that will contribute to a reduction in herbicide use. Cultivation, mulches (organic and synthetic), and cover crops are being evaluated for eventual integration into reduced-herbicide weed management programs. Cultivation research, using new technology, began in Europe in the mid-eighties (Rasmussen 1991; Stiefel & Popay; Vester and Rasmussen), and is being conducted now in the U.S. in several field crops (VanGessel et al.). To date, little work has been repor-

ted in vegetable crops. Vegetable growers have few herbicides registered for their "minor" crops, thus, despite regular use of herbicides in conventional production, most vegetables are routinely cultivated at least once and often several times during a growing season. In these minor crops, cultivation, combined with mulches or cover crops, and judicious use of herbic may provide ides, as-needed, a means of reducing the total quantity of herbicides used.

Legume cover crops, usually chemically regulated, have been used for weed management in reduced tillage systems (Shelby et al.; Wallace and Bellinder) and use of cover crops during the growing season as "living mulches" has also been researched extensively (Akobundu; Costello; Enache and Ilnicki; Hartwig and Hoffman; Nicolsen and Wien). Despite numerous reports of insect pest reductions in vegetable crops grown in living mulches, lack of weed control and interspecific competition have been identified as the major hinderances to wider adoption by growers (Theunissen).

The 1990 Farm Bill, approved by the U.S. Congress, would encourage American growers to adopt practices like interseeding cover crops. This Bill (law) requires growers who recieve federal crop subsidies to have a Soil Conservation Service-approved "whole farm plan" that will provide a minimum of 30% groundcover, year round, on soils classified as highly erodible. Growers who fail to sustain this minimum groundcover risk losing their crop subsidies. A common practice is to plant cover crops after harvest, one month before frost. However, in New York State, frost frequently occurs in early September, preventing the seeding of many cover crops, particularly legumes, in late-season crops like cabbage. Undersowing a cover crop into cabbage would allow adequate cover crop establishment prior to frost.

Time of interseeding is critical if crop/interseed competition is to be minimized. Nicholson and Wien reported that when spring-planted cover crops were seeded prior to planting sweet corn and cabbage, yields were significantly reduced by cover crop competition for water, light, and space. However, when interseeded 4wk after transplanting broccoli, Tessier and Leroux found that yield reductions with interseeded rye, annual ryegrass, and red clover ocurred less often. Cultivation twice, followed by interseeding red clover provided better weed control than cultivation alone and yields were not reduced. Cultivating regularly before cover crop establishment and interseeding 4 to 5 wk after transplanting also has been recommended by Coleman. Müller-Schärer and Potter have suggested that herbicides can be reduced when interseeded cover crops are planted in the second half of the vegetation period in carrots, scorzonera, cauliflower, and red beet.

In crops requiring a long growing season, interseeded cover crops may prove to be too competitive and/or interfere with harvest operations. In these crops, time of cultivation and date of interseeding may be more critical than in rapidly maturing vegetables. Applications of low-dose, selective, postemergence herbicides may minimize competition while maximizing the weed suppression effect of the cover crops. The objective of this research is to develop weed management strategies for transplanted cabbage that integrate the use of cultivation, interseeded legumes or cereal grains, and postemergence herbicides applied on an as-needed basis.

Materials and methods

Studies were conducted in 1994 and 1995 on Howard gravelly loam (Glossoboric Hapludalf, loamy-skeletal, mixed mesic) soils at the H. C. Thompson Vegetable Research Farm, located in Freeville, NY. In 1994, the study compared two flex-tine harrows, an Einbock® having round tines and a Rabe Werk® having flat tines. Both implements were used 14 and 14 + 24 days after transplanting cabbage (DAT) and followed by interseeding lana vetch after the last cultivation. Cultivation alone (14 + 24 DAT), a weedy check, and a chemical standard (metolachlor 1.68 kg ai ha^{-1} + pyridate 0.5 kg ai ha^{-1}) were included for comparison. Metolachlor was applied 48 h after transplanting and pyridate was applied 3 wk after transplanting. A third cultivation, 6 wk after transplanting, was planned but was not performed to prevent crop injury.

Based on results in 1994, one flex-tine harrow (Einbock®) was used in 1995, and cultivation

was done 10, 10 + 20, and 10 + 20 + 30 DAT and lana vetch, hairy vetch, or oats were interseeded following the last cultivation in each treatment. An S-tine, row-crop cultivator was used for the third cultivation. Cultivation checks, without interseeding, for all timings (1, 2, 3 times), as well as a weedy check, a handweeded, and a chemical standard (metolachlor + pyridate) were included.

Four-row plots measured 3 by 9 m and treatments were replicated 4 times. Cabbage var. 'Supergreen', having 2-3 true leaves was mechanically transplanted at 38 cm in-row and 76 cm between rows, on 6/6 and 26/5 in 1994 and 1995, respectively. The studies were handharvested on 17/8 in 1994 and on 3/8 in 1995. Weed control evaluations and yields were taken in both years. Additional data collected in 1995 included cover crop and weed groundcover assessments and biomasses at harvest. All data were subjected to analysis of variance and means were compared using Fisher's Protected LSD.

Results

1994. The two flex-tine harrows damaged cabbage only slightly and the number of heads was not reduced (Table 1). However, weed control, assessed shortly after cultivation, was somewhat better with the Einbock® harrow. This difference was only noticeable when cabbage was cultivated 10 DAT and may be attributable to the closer tine spacing on that harrow than on the Rabe Werk®. A single cultivation provided inadequate weed control and yields were equivalent to the weedy check. Yields increased when cabbage was cultivated twice, both with and without the interseeded lana vetch, but the highest yields occurred when the two cultivations were not followed by interseeding, indicating that interspecific competition had a depressive effect on yield.

1995. Weed suppression was inadequate with all three cover crops when interseeded following 1 or 2 cultivations, but significantly better than the weedy check or a single cultivation (Table 2). Cultivation 3 times, +/- interseeding provided weed control equivalent to the chemical standard. However, common lambsquarters (*Chenopodium album* L.) control was poor with metolachlor and growth stage restrictions prevented pyridate application until it was too large to be successfully controlled. This necessitated handweeding 42 DAT and the competitive effect of this species reduced yields of the chemical standard. Yields of cabbage cultivated once, +/- cover crops were equivalent to the chemical standard and were double those of the weedy check. The combination of weeds and cover crops reduced yields when interseeding following the first cultivation. However, only oats, which produced significantly greater biomass than the vetches, depressed yields when interseeded after the second cultivation. Yields were equal to or greater than the handweeded control when cabbage was cultivated 2 or 3 times, when interseeded with the vetches at the second cultivation, and when interseeded with all three cover crops at the third cultivation. With the exception of oats interseeded at the second cultivation, differences between cover crops at each time of interseeding were negligible.

Discussion and conclusions

These results indicate that cabbage production without herbicides may be feasible with three cultivations, with or without interseeded cover crops. While a single cultivation, regardless of interseeding, was not adequate in terms of weed suppression and yield performance, it is probable that two or three cultivations within 30 DAT will delay interspecific competition (weeds and/or cover crops) long enough to prevent yield reductions. This would enable growers to plant cover crops early enough to get them established before frost. Although three cultivations provided successful weed supression in the 1995, a very dry growing season, in a wet year this might be inadequate, necessitating the use of postemergence, selective herbicides for control of weeds that become problematic following the last cultivation. Additional studies will be needed to determine potential usefulness of interseeded cover crops in integrated weed management.

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Table 1. Effect of harrow type, cultivation timing, and interseeded lana vetch on cabbage yield (1994)

	Harrow Injury (No. plants)	Mid-season Weed Control (%)	Yield	
			Weight No. Heads	(kg x 1000 ha^{-1})
Rabe Werk 1x + lana vetch	1.8	19	29	36.9
Rabe Werk 2x + lana vetch	1.5	61	32	46.9
Rabe Werk 2x	1.3	64	33	50.0
Einbock 1x + lana vetch	1.8	20	31	36.5
Einbock 2x + lana vetch	1.8	54	32	44.1
Einbock 2x	1.5	61	33	47.5
Metolachlor + Pyridate	0	86	30	43.4
Weedycheck	0	0	32	35.9
LSD = 0.05	0.5	12	3.6	7.4

Table 2. Effect of cultivation and interseeding on at-harvest weed biomass and cabbage yield in 1995.

		At-harvest weed biomass (g 0.5m^{-2})	At-harvest cover crop biomass (g 0.5 m^{-2})	Yield (kg x 1000 ha^{-1})
Cultivation	1x	361	0	20.6
	2x	78	0	26.2
	3x	2.4	0	25.5
Cultivation	1x + oats	196	167	22.1
	1x + hairy vetch	148	48	21.9
	1x + lana vetch	159	81	20.3
Cultivation	2x + oats	39	170	23.2
	2x + hairy vetch	33	27	29.0
	2x + lana vetch	82	50	25.6
Cultivation	3x + oats	1.7	32	27.5
	3x + hairy vetch	16	14	33.7
	3x + lana vetch	0.8	18	28.5
Handweeded		0.25	0	27.6
Metolachlor + Pyridate*		2.5	0	22.1
Weedycheck		415	0	11.2
LSD = 0.05		114	37	4.0

*Herbicides supplemented with handweeding 42 DAT.