Effect of No-Tillage and Rye Mulch on Occurrence of Weeds and Aphids and on Yields of Cabbage, Carrot and Red Beet

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Abstract

In 1999 cucumber, lettuce and snap bean were grown on experimental field for the first time using no-tillage method and rye as cover crop and in the year 2000 cabbage, carrot and red beet were grown on the same field using the same cultivation method. Rye was sown in the middle of September and at the beginning of May it was desiccated with glyphosate. Two weeks later seeds of carrot (*Daucus carota*) and of red beet (*Beta vulgaris*) and transplants of cabbage (*Brassica oleracea* var. *capitata* f. *alba*) were planted into no-tilled field covered with rye mulch and on field cultivated conventionally. Three weeks after planting number and fresh weight of weeds grown in no-tilled plots were reduced by 99% in comparison to those in conventional tillage treatment. Four weeks later the differences in weed infestation between compared treatments were considerably smaller but still significant. At the beginning of July about 10% of carrot plants cultivated conventionally and 5% under no-tillage cultivation were invaded by *Semiaphis dauci*. Similarly cabbage plants were less invaded by *Brevicoryne brassicae* on no-tilled then on conventionally tilled plots. Method of cultivation did not influence significantly total and marketable yield of vegetables however on no-tilled plots cabbage grew slower and was harvested three weeks later.

INTRODUCTION

No-tillage cultivation with an autumn seeded cover crop killed in the spring offers several advantages: protection from soil erosion, from nutrients leaching and to some extend also from weeds and pests (Hoyt et al., 1994; Masiunas, 1998; Sainju and Singh, 1997). Rye is a valuable winter-hard cover crop efficient at reducing weed infestation (Barnes and Putnam, 1983; Smeda and Weller, 1996) and well adopted to Poland's natural conditions. In the studies carried out at the University of Agriculture in Lublin, the growth and yield of several vegetable plants under first year of no-tillage cultivation and rye as cover crop were similar to those under conventional tillage (Borowy and Jelonkiewicz, 1999). The aim of this work was to determine weed infestation and yield in three vegetable crops under second year of no-tillage cultivation using rye as cover crop.

MATERIAL AND METHODS

The experiment was carried out at Felin Experimental Farm on loess-like soil containing 1.6% of organic matter. In 1999 cucumber, lettuce and snap bean were grown on an experimental field using no-tillage method and rye as cover crop for the first time. In the year 2000 cabbage (*Brassica oleracea* var. *capitata* f. *alba*) 'Sława z Enkhuizen', carrot (*Daucus carota*) 'Nantejska' and red beet (*Beta vulgaris*) 'Chrobry' were grown on this field using the same cultivation method. Beginning of September half of the field was ploughed 20 cm deep, fertilized with 22 kg P ha^{-1} superphosphate and 50 kg K ha^{-1} potassium salt and tilled with cultivator. Three weeks later, rye (*Secale cereale*) 'Dańkowskie' was seeded at 140 kg ha^{-1}. On March 20 of the following year rye was top-dressed with ammonium nitrate 50 kg N ha^{-1} and on May 7 it was sprayed with glyphosate at 1440 g a.i. ha^{-1} plus adjuvant. At that time the rye plants reached 105 cm height and fresh weight of their aerial parts and roots was 4.0 and 1.1 kg m^{-2} respectively.

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After two weeks seeds of carrot at 6 kg ha^{-1} and of red beet at 12 kg ha^{-1} and also 4 weeks old transplants of cabbage were planted on the half of the field covered with rye mulch and also on second half of the field which had been tilled conventionally: fertilized with the same quantities of mineral fertilizers and ploughed 20 cm deep in November and then tilled with rotary cultivator one day before planting. Each vegetable species was planted in 4 succeeding 6-m-long rows, with interrow distances of 0.75 m and cabbage transplants were planted with 0.5 m within-row distance. One row was considered as one replicate. All vegetables were top-dressed with calcium nitrate 50 kg N ha^{-1} 4 weeks after planting and carrot and red beet were top-dressed additionally with the same quantity of nitrogen 7 weeks later. Weeds were counted by species in four 0.25 m x 0.4 m frames placed randomly in each interrow space within no-tilled and conventionally cultivated plots 3 and 7 weeks after planting and then the plots were weeded by hand. During vegetation period occurrence of aphids on vegetable plants was observed. Carrots and red beets were harvested on September 15. Conventionally cultivated cabbage was harvested on August 3 but under no-tillage it grew slower and was harvested on August 28. Number of weeds as well as total and marketable yields of vegetables were studied by analysis of variance and significance of differences was determined using Tukey's test at 0.05 probability level.

RESULTS AND DISCUSSION

The spring was very dry and warm and rye plants absorbed the rest of water residues making soil hard and difficult for seeding and planting of vegetables. At the time of planting no-tilled plots were covered completely with 4 cm thick layer of rye mulch which decomposed slowly: it covered about 80% of soil surface in the middle of the vegetation period and about 30% at harvest time. Three weeks after planting the number of weeds grown on 1 m^2 in no-tilled and conventionally cultivated plots was 3 and 371 and four weeks after first weeding it was 45 and 72, respectively, with the differences being significant. 23 weed species occurred in the experiment and following species dominated at the first weed count: *Capsella bursa-pastoris* (30% of total weed density), *Poa annua* (23%), *Chenopodium album* (12%), *Amaranthus retroflexus* (7%), *Echinochloa crus-galli* (7%) and *Lamium amplexicaule* (4%). On plots covered with rye mulch number of these weed species was reduced by 96-100% (Table 1). At the second weed count following weed species dominated under conventional cultivation: *Amaranthus retroflexus* (28%), *Capsella bursa-pastoris* (13%), *Matricaria chamomilla* (11%), *Echinochloa crus-galli* (8%) and *Veronica persica* (8%). On plots covered with partially decomposed mulch, the number of these species was reduced (except of *Echinochloa crus-galli)* by 85, 67, 100 and 83% respectively, however the number of sporadically occurring *Stellaria media* and seedlings of *Taraxacum officinale* was higher (Table 1). At harvest time the number of *Taraxacum officinale* seedlings growing on no-tilled plots made 30% of total weed population in comparison to 2% under conventional cultivation.

Obtained results confirm the opinion of Masiunas (1988), that weed species respond differently to cover crop mulches and that population of weeds having wind blown seed, such as *Taraxacum officinale*, are increased in mulch systems. They confirm also the results obtained earlier by Borowy and Jelonkiewicz (1999). The method of cultivation did not influence significantly the yields of cabbage, carrot and red beet (Table 2). However, cabbage cultivated conventionally attained harvest maturity 3 weeks earlier in comparison to no-tillage cultivation. In a previous experiment by Borowy and Jelonkiewicz (1999) cabbage was harvested at the same time in both treatments and yield obtained under no-tillage cultivation was lower.

First weeks after planting of vegetables were extremely dry and hot and therefore favourable to development of aphids. In July, 10% of carrot plants cultivated conventionally and 5% under no-tillage cultivation were invaded by *Semiaphis dauci*. Similarly cabbage plants were less invaded by *Brevicoryne brassicae* on no-tilled then on conventionally tilled plots, however these differences were smaller. This is in line with

the results of another experiment by Borowy and Jelonkiewicz (2000) and with Masiunas' (1998) description of beneficial effect of mulches formed from cover crops on different pests.

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Tables

Table 1. Weed infestation (plants m^{-2}) on no-tilled and conventionally tilled plots assessed 3 and 7 weeks after planting of vegetables.

Weed species	3 weeks		7 weeks	
	Convent.	No-till.	Convent.	No-till.
Amaranthus retroflexus L.	25	1	20	3
Capsella bursa-pastoris (L.) Med.	112	0	9	3
Chenopodium album L.	46	0	4	1
Chenopodium glaucum L.	7	0	2	1
Cirsium arvense (L.) Scop.	6	0	1	0
Convolvulus arvensis L.	5	0	0	0
Echinochloa crus-galli (L.) P.B.	25	0	6	7
Galinsoga parviflora Cav.	8	0	1	1
Galinsoga quadriradiata Ruiz et Pav.	1	0	2	1
Geranium pusillum L.	3	1	1	1
Gnaphalium uliginosum L.	9	0	1	1
Lamium amplexicaule L.	13	0	1	1
Matricaria chamomilla L.	2	0	8	0
Plantago major L.	1	0	2	1
Poa annua L.	85	0	2	1
Polygonum aviculare L.	1	0	0	0
Polygonum persicaria L.	9	0	1	1
Senecio vulgaris L.	1	0	1	1
Stellaria media Vill	9	0	1	7
Taraxacum officinale Web.	1	0	1	11
Thlaspi arvense L.	1	0	1	1
Urtica urens L.	1	0	1	1
Veronica persica Poir.	0	1	6	1
Total number of weeds	371	3	72	45
Weight of weeds (g)	121.9	1.5	972.1	105.3
Number of weeds ($LSD_{0,05}$)	24		14	
Weight of weeds ($LSD_{0,05}$)	11.9		216.5	

Table 2. Total and marketable yields of vegetables (kg/a).

Method of cultivation	Cabbage		Carrot		Red beet	
	Total	Marketable	Total	Marketable	Total	Marketable
Conventional	790.4	496.9	191.7	180.6	249.4	233.7
No-tillage	768.0	530.4	219.4	203.6	184.2	166.8
$LSD_{0,05}$	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.