UTILIZATION OF MULCHES INCREASE YIELD AND IMPROVE WEED CONTROL IN NO-TILL ORGANIC BROCCOLI

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ABSTRACT

Weeds are a major limiting factor in organic vegetable production systems. The objective of this study was to determine the effects of mulch, cover crop, and tillage on weed control and yield of organic broccoli. The trial was conducted during 2005 and 2006. The experiment was a split plot with four replications, where tillage (conventional or no-till) was the main plot, cover crop [pearl millet (*Pennisetum glaucum*), cowpea (*Vigna unguiculata*), or soy bean (*Glycine max*)] was the subplot, and mulch (black plastic film, wheat straw, and unmulched) was the sub-sub plot. The cover crops were sown in the summer of 2005 and the broccoli plants were grown in the spring of 2006. Weed control over the season was 82% and 74% for the conventional tillage and no-till, respectively. Among cover crops, pearl millet provided the highest weed control and cowpea the lowest. Wheat straw and plastic film mulch both had higher levels of weed control compared to unmulched soil. Broccoli top biomass was higher in conventional tillage than in no-till, it was not affected by cover crop, and it was highest in plastic mulch and lowest in bare soil. Total marketable yield was not affected by tillage or cover crop. Broccoli yields were lowest in unmulched soil. Weed control was the main factor that explained the increased yields of plants grown on mulches.

Key words: weed control, sustainable agriculture, mulches, no-till, organic agriculture

INTRODUCTION

Weeds are a major limiting factor in the production of organic vegetables, as shown by a survey of organic growers in the U.S.A. (Waltz, 1999). Weeds compete with the crop for water, light, and mineral nutrients and thus they may significantly reduce the growth and yield of the crops. This detrimental effect of the weeds on the crop is particularly considerable when weeds are not controlled on time. The methods of organic weed control include mechanical control, manual control, chemical control, and cultural control by utilizing mulches, which involve the use of organic mulches, cover crops, or plastic film mulches (Abdul-Baki and Teasdale, 1993; Lamont, 1994; Ngouajio, 2005; Phatak and Diaz-Perez, 2007; Snapp et al., 2005).

Small scale growers often use manual control and mechanical control to manage weeds, while larger growers utilize a diversity of weed control strategies. In industrialized countries, like the U.S., there is a tendency to more utilization of mechanical, cultural and chemical weed control methods because manual control is expensive due to the high labor costs, in addition to the increasing difficulty in finding farm workers.

Cover crops provide ample benefits, such as, erosion reduction, improvement of soil structure, increased soil organic matter, and reduction in the pressure by insect pests and plant pathogens (Díaz-Pérez et al., 2008; Phatak and Díaz-Pérez, 2007; Snapp et al., 2005). Cover crops in combination with reduced tillage, and the utilization of appropriate cultivars and planting dates can result in reduced incidences of insects, pathogens, nematodes, and weeds (Phatak and Díaz-Pérez, 2007).

There are relatively few studies on the effects of cover crops in combination with conservation tillage in organic vegetable production (Abdul-Baki et al., 1996; Morse, 1999; Teasdale et al., 1991). The objective of this study was to determine the effects of integrating the utilization of mulching, cover crops, and tillage on weed control and yield of organic broccoli.

MATERIALS AND METHODS

The study was conducted at the Horticulture Farm, Tifton Campus, University of Georgia, during 2005 and 2006. The experimental design was a split plot with four replications, where the main plot was tillage (conventional and no-till), the sub-plot was the cover crop [pearl millet (*Pennisetum glaucum*), cowpea (*Vigna unguiculata*), or soy bean (*Glycine max*)], and the sub-sub-plot was mulching (wheat straw, black plastic mulch, or unmulched). Wheat straw mulch was applied using one bail per 20-ft long bed section (6.2 ton/acre).

The cover crops were sown on July 2005 and were allowed to develop until they were destroyed by a frost in November of 2005. In 2006, two weeks prior to planting the broccoli to the field on 8 Mar., the residues of the cover crops were mowed with a flail mower.

The soil of the experimental site was fertilized with a total of 6.7 t/ha (5,982 lb/acre) of organic fertilizer (4N: $2P_2O_5$: $3K_2O$; MicroSTART 60, Perdue AgriRecycle, LLC, Delamarva, Delaware, EE.UU.) one week prior to transplanting the broccoli. Broccoli transplants ('Packman') were produced organically utilizing a substrate based on peat moss and was fertilized (1 part of organic fertilizer and 9 parts of substrate) with the MicroSTART 60 organic fertilizer.

Broccoli ('Packman') plants were planted at a 30-cm (12-inch) distance between plants within the rows, having two rows of plants per bed. Plot length was 20 ft. The distance from the center to the center of the beds was 180 cm (6-ft). The broccoli crop was drip-irrigated, with the drip tape being midway between the two rows of each bed. Due to the low incidences of insect pests and diseases, no insecticides or fungicides were applied. Broccoli plants were harvested several times from 29 Apr. to 23 May. 2006

The level of weed control obtained by the different treatments was determined visually, where 0% control represented total soil surface being covered by weeds, and 100% control was when total soil surface was weed free.

RESULTS AND DISCUSSION

Weed control

The percentages of weed control were 82% and 74% under conventional tillage and no-till, respectively. During the first weeks after transplanting the broccoli, the residue from the cover crops provided partial weed control. As the season progressed, the cover crop residues were gradually broken down and, consequently, the ability of the cover crop residues to control weeds was reduced. Among the cover crops, pearl millet provided the highest weed control (85%), followed by soy bean (76%), while cowpea (72%) provided the lowest weed control. At the end of the broccoli season, the amount of cover crop residue (dry weight) present on the soil surface was 3.6 ton/acre (pearl millet), 1.4 ton/acre (cowpea), and 0.7 ton/acre (soybean). The residue from pearl millet was the most persistent in the field, probably because grasses generally have a lower C/N ratio than legumes, and low C/N ratios result in reduced microbial activities in the soil. Among mulching treatments, wheat straw mulch and black plastic mulch provided higher percentages of weed control (94% and 89%, respectively) compared to unmulched soil (51%). The difference in weed control between wheat straw mulch and black plastic mulch was not significant.

Insect pests

The populations of insect pests were low, although there was an increment in the number of larvae of diamondback moth (*Plutella xylostella*) at the end of the broccoli growing season. There were no differences in the number of diamondback moth larvae among treatments.

Broccoli crop biomass

The aerial biomass of broccoli plants was higher under conventional tillage [127 g/plant (0.28 lb/plant)] than under no-till [111 g/plant (0.24 lb/plant)], and it was not affected by the type of cover crop used prior to planting the broccoli. Aerial biomass was highest in broccoli plants on black plastic mulch [130 g/plant (0.29 lb/plant)], followed by wheat straw mulch [120 g/plant (0.26 lb/plant)], and lowest in plants on unmulched soil [107 g/plant (0.24 lb/plant)]. This reduction in top growth was due, at least partially to the increased weed pressure in unmulched soil.

Yield

Marketable broccoli yield was unaffected by tillage and cover crop treatments, although it was affected by mulching. Broccoli yields were lowest in unmulched soils [3,123 kg/ha (2,788 lb/acre)], followed by soils covered with black plastic mulch [4,036 kg/ha (3,604 lb/acre)] and wheat straw mulch [4,684 kg/ha (4,182 lb/acre)]. The yield increase in plants on mulches was attributed to the increased levels of weed control obtained by the use of mulches.

CONCLUSIONS

- The level of weed control was the most important factor determining broccoli yield.
- Under no-till, the residue from the cover crop that preceded broccoli provided only a partial weed control.
- Utilization of either wheat straw mulch or plastic film mulch resulted in reduced weed populations both, in conventional tillage and in no-till systems.

- Weed control in no-till and reduced-till vegetable production systems may be improved by the use of either organic or inorganic mulches.

LITERATURE CITED

Abdul-Baki, A.A., and J.R. Teasdale. 1993. A no-tillage tomato production system using hairy vetch and subterranean clover mulches. HortScience 28:106-108.

Abdul-Baki, A.A., J.R. Teasdale, R. Korcak, D.J. Chitwood, and R.N. Huettel. 1996. Fresh-market tomato production in a low-input alternative system using cover-crop mulch. HortScience 31:65-69.

Díaz-Pérez, J.C., J. Silvoy, S.C. Phatak, J. Ruberson, and R. Morse. 2008. Effect of Winter Cover Crops and No-Till on the Yield of Organically-Grown Bell Pepper (Capsicum annum L.). Acta Horticulturae 767:243-247.

Lamont, W.J. 1994. Opportunities for plasticulture in organic farming systems. Proc.25 Amer.Soc.for Plasticulture 25:34-35.

Morse, R.D. 1999. No-till vegetable production -- Its time is now. HortTechnology 9:373-379.

Ngouajio, M. 2005. Historical perspective on weed control and pest management in horticultural crops 23. HortTechnology 15:508-510.

Phatak, S.C., and Díaz-Pérez, J.C. 2007. Managing pests with cover crops, p. 25-33, *In* A. Clark, ed. Managing Cover Crops Profitably, Third ed. Sustainable Agriculture Network, Beltsville.

Snapp, S.S., S.M. Swinton, R. Labarta, D. Mutch, J.R. Black, R. Leep, J. Nyiraneza, and K. O'Neil. 2005. Evaluating cover crops for benefits, costs and performance within cropping system niches. Agronomy Journal 97:322-332.

Teasdale, J.R., C.E. Beste, and W.E. Potts. 1991. Response of weeds to tillage and cover crop residues. . Weed Sci. 39:195-199.

Waltz, E. 1999. Third biennial national organic farmers' survey. Organic Farming Research Foundation:19-47.