Cover Crops and Conservation Tillage in Sustainable Vegetable Production

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ABSTRACT

Cover crops have never been as popular as they are today, and the information on cover crops is readily available. There is a cover crop available for every need. However, cover crops in vegetable production are used mainly as green manuring crops. When used for green manuring cover crops are plowed under. Benefits derived from plowed under cover crops are temporary. However, when cover crops are used along with conservation tillage not only is the soil quality improved, but healthy crops are produced which resists insect pests, diseases, and nematodes better. Lewis *et al.* (1997) established why a total system approach is more sustainable for pest, disease, and nematode management and that the "treat-the-symptoms" mentality should be the last line of defense rather than the first. With the integration of cover crops and conservation tillage in vegetable production, it is possible to make pesticide intervention as a last line of defense. In most situations insecticides, fungicides, and nematicides are not needed or used. Weed control strategies are altered. No-till delays harvest of vegetables and thus, strip-tilling is essential to raise vegetables to match harvest with market window.

KEYWORDS

Vegetable, sutainable, total-system tillage, cover crops

INTRODUCTION

Conservation tillage acreage in agronomic crops has rapidly increased in recent years. However, vegetable growers are reluctant to introduce conservation tillage in production systems. Phatak and Reed (1999) outlined the reasons for the lack of increase in vegetable acreage in conservation tillage. Vegetable growers are not willing to take any risks just to save a few dollars by changing tillage alone. It is essential to introduce a total system, which in addition to reduced tillage also reduces use of fertilizers, insecticides, fungicides, nematocides, hebicides and other off-farm inputs. This will make a production system really sustainable. This article discusses some essential components of the total systems approach.

COVER CROPS

Popularity of cover crops has never been as high as it is today and the information on cover crops is readily available (SAN, 1998). There is a cover crop available for every need. However, cover crops in vegetable production are used mainly as green manuring crops. When used as green manuring crops cover crops are chopped by discing a number of times and then residue is buried deep with a moldboard plow. Discing and plowing accelerate oxidization and decomposition of cover crop residues and soil organic matter. Thus, benefits derived from plowed under cover crops are only temporary. This practice of plowing under cover crops fails to bring about a permanent change in soil organic matter or soil physical properties. To make vegetable production sustainable it is essential to make a permanent change in soil organic matter and soil physical properties. Changing tillage from conventional to conservation in combination with cover crops will achieve this objective. Integration of conservation tillage is important to make vegetable production truly sustainable.

TILLAGE

It is essential to have a thorough understanding of tillage for optimum vegetable crop production and to maintain soil productivity for the future. An important function of tillage in vegetable crop production is to provide proper conditions for optimum root and plant growth. Soil conditions that directly regulate plant activities are soil moisture, soil aeration, soil temperature, soil nutrients and soil strength or soil compaction (Blake and Aldrich, 1955; Flocker *et al*., 1959; 1960; Phatak *et al*., 1980a; 1980b). There are some variations in tillage practices used in vegetable production (Emmert, 1937).

Soil tillage in vegetable production can be classified into three forms: primary, secondary and tertiary. Primary and secondary tillage is used as a pre-plant preparation of the seed-bed, while tertiary tillage is performed after planting

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vegetable crops to control weeds and reduce compaction between rows. In vegetable production, primary tillage is performed with a moldboard plow. Secondary tillage is used to prepare a fine seed-bed just before planting. Rotary hoes, sweeps, and other equipment are used in vegetable production for tertiary tillage.

In conventional vegetable production all soil tillage operations described above are essential to maintain a high level of production. However, intensive soil tillage used eroded and degraded soils (Magdoff and van Es, 2000; Wolf, 1999).

SOIL ORGANIC MATTER

Importance and benefits of soil organic matter has been discussed in details by Magdoff and van Es (2000), Wolf (1999), and Snyder and Wolf (2002). Wolf (1999) stated that "no single constituent of the soil is as important as organic matter in changing a pile of decomposed rocks into vibrant, dynamic, living entity. In so doing it affects all three sides of the fertility triangle, affecting air, water, and nutrients in significant ways." These books also gave examples of permanent increases in soil organic matter by changing tillage from conventional to conservation tillage. Readers are advised to read these books to better understand the importance of organic matter in sustainable vegetable production.

CONSERVATION TILLAGE

Lal *et al*. (1990) summarized some of the research done during the seventies and eighties on comparisons of conventional and conservation tillage and suggested that "conservation tillage can be made an integral part of sustainable agricultural systems through practically oriented, multidisciplinary research". Hatfield and Karlen (1994) expressed concerns in the area of nutrient and pest management strategies with these systems with conservation tillage. However, substantial progress in promotion and adaptation of conservation tillage in sustainable agriculture has been made during the last ten to twelve years. In all reality, conservation tillage is an essential component of sustainable agriculture, as it helps to improve soil OM and productivity. Soil health and productivity is important in achieving sustainability in agriculture.

Sumner *et al*. (1986) stated that conservation tillage has not been researched in vegetable production as in agronomic crops. Phatak (1987) suggested that using conservation tillage for vegetables should only be implemented where it has been proven consistently successful. Most research on conservation tillage in vegetable crops has been on individual aspects of vegetable production for example, fertility, weeds, insect pests, diseases, nematodes etc. and not on total system (Abdul Baki *et al.*, 1996; Brunson, 1991; Brunson *et al*., 1997; Bugg *et al*., 1990; 1991; Ghate *et al*., 1991; Hoyt *et al*., 1994; Phatak, 1987; 1992; 1998; Phatak *et al*., 1991; Putnam, 1990; Sumner *et al*., 1986; 1988; 1995). Some research has been done on comparisons of conventional and sustainable vegetable production (Brunson, 1991; Brunson 2002; Brunson *et al*., 1997). Phatak and Reed (1999) discussed the opportunities for conservation tillage in vegetable production and also outlined small plot research and on-farm research conducted since 1985. Overall, most research on conservation tillage on vegetables conducted in recent years has been very encouraging. However, more practically oriented research is needed to integrate conservation tillage in a sustainable vegetable production system.

INTEGRATIVE APPROACH

Phatak (1992) outlined a total systems approach to vegetable production. Lewis *et al*. (1997) further established why a total systems approach is more sustainable for crop production including insect pests, diseases, nematode and weed management, and that "treat-the-symptoms" strategies should be the last line of defense rather than the first line of defense used since the discovery and development of pesticides. Strategies for management of insect pests, diseases, nematodes and weeds in vegetable and agronomic crops by integrating cover crops with conservation tillage have been discussed by Phatak (1998). These strategies were based on research on small plots and on farm research with growers (Phatak and Reed 1999). Since 1985, major vegetables like tomatoes, eggplants, peppers, snap beans, southern peas, lima beans, cucumbers, cantaloupes, squash, and watermelons were produced without insecticides, fungicides, and nematicides. The main observation noted was that these pesticides were not needed to produce these crops. Use of herbicides and fertilizers were substantially reduced. Vegetable growers using these strategies were able to improve their bottom line and increased profits. However, more multi-disciplinary research with approach is needed to make sustainable vegetable production systems practical for all growers.

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