Effects of Conservation Tillage and Cover Crops am Vegetable Crop Yields in Southwestern Mississippi on a Memphis Silt Loam Soil

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Abstract: This field research was initiated in year 1989 on highly erodible Memphis Silt Loam Soil. To determine the effect of minimum tillage on the yields of sweet corn (Zea mays L.), snap beans (Phaseolus vulgaris L.). and cowpeas (Vigna unguiculata L.), and the physical penetrability of the topsoil due to wheat, clover, and vetch treatments followed by the main crops as affected with time. arandomized complete block design with four replications was used. The control treatment received conventional tillage and the rest of the treatments with wheat, clover and vetch received minimum tillage. merely to seed the crops. The entire area received herbicides uniformly and the recommended dose of fertilizers along with the side dressings were used before planting the main crops like sweet corn, snap beans, or cowpeas. The average ground residue cover percent determined by camline on March 1992, showed that clover and vetch were significantly superior to wheat, and wheat was found significantly superior to the control ($P<0.05$). The subsequent statistical analyses were also performed at *0.05* level of probabilities. Sweet corn in 1992 had non-significant yield differences due to treatments: which also was found to be true in case of cowpeas in years 1992 and 1993. However, the multiple harvested total yields of snap beans showed significantly higher yield (1863 lbs/acre) due to vetch treatment as compared to the control (411 lbs/acre). Therefore, snap beans responded better than sweet corn and cowpeas with minimum tillage when planted after vetch. Also, the penetrometer readings taken in December 1994 did indicate significant lowest resistance due to control treatment as compared to the other treatments (wheat, clover and vetch).

lntroduction

Memphis Silt Loam Soil (Typic Hapludalf, fine-silty, mixed, thermic) is fertile but highly erodible (Vanderford, 1962) which is extended in the western part of Mississippi from north to south (Soil map of Mississippi). This soil contains on the average 65% silt, 28% clay, 6% sand, and has close to 1% organic matter. (Panicker and Tiwari, 1991).

Organic matter residues such as green manures that decompose rapidly, improve soil structure more quickly than the materials such as barley, rice, and wheat. However, the slowly decomposing materials also have the immediate effect of protecting soil surfaces from the impact of rain drops before they decompose. Organic matter when decomposing produces polysaccharides and polyuronides which stabilize soil for better infiltration of soil moisture (Boyle et al., 1989). Crop residues contain appreciable plant nutrients, which contribute to the maintenance of soil productivity when not removed (Holland and Coleman, 1987).

The objectives of this field trial were: (I) To determine the effect of minimum tillage on the subsequent yields of horticultural crops (sweet corn, cowpeas, and snap beans) planted after the yearly treatments of wheat, clover, vetch and control as well as (2) The physical penetrability of the top soil due to these treatments followed by the main crops as affected with time. Continuous minimum as well as no tillage for 28 years had no deleterious effects on soil physical properties (Mahboubi et al., 1993). However, the use of no-till in Iowa, Central Illinois, and Minnesota; as well as on poorly drained soil in Indiana and Ohio, has led to some soil compaction problems (Karlen, 1990).

Hoyt (1983) indicated that providing winter cover by legume crops have two advantages. Firstly, they increase nitrogen and secondly, they provide coverage. Whereas grasses only provide the winter cover. In case of tomatoes and broccoli, Hoyt, 1984, explained that the yield have shown to increase with vetch and crimson clover. Also, the timing of planting as well as herbicide application with intervals before planting the main crop, may be the key factors in sustaining higher crop yields (Hoyt , 1989).

Conservation tillage may reduce crop yields, which may arise from intensive management, based on varying equipment, and long spectrum of weeds, insects, and disease problems combined with allopathic effects and decreased nutrients' availabilities (Unger and McCalla, 1980). On the other hand conservation tillage systems enable seed to be planted earlier and faster, the benefits of which help offset the disadvantages of colder soil in the spring (Carter and Kunelius, 1990).

Thus, no-till and minimum tillage systems are more energy efficient than conventional tillage systems. Conservation tillage systems require less total energy to achieve approximately the same crop production levels as conventional tillage systems. No-till and minimum tillage reduce organic C losses from soil and reduce emission by using less fossil fuel (Frye, 1984).

Materials and Methods

A long term randomized complete block esperiment was set in year 1989 with four blocks. Each block (25'x36') received four treatments: crimson clover (Trifolium incamatum L. var. Dixie), vetch (Vicia Villosa L. var. Hairy), wheat (Triticum aestivum L. var. Mixed) and control. The experimental unit for each randomized treatment consisted of three rows (25'x9'). These treatments were initiated in fall of every year; however the control treatment received conventional tillage by using a rotary tiller to till the land 7 times and a middle buster one time. The other treatments received minimum tillage by using a mantis tiller cultivator. It cuts 10" down into the soils, churning up sod and weeds, incorporating compost and soil amendments. Sweet corn (variety Merit), was planted in April 1992 and 1993, in rows 3' apart with plant to plant distance of one foot. Cowpeas (variety Mississippi Silver) were planted in September 1992 and 1993, by using the planter with 6" spacing from plant to plant. The yield was harvested in the end of October. Snap beans (variety Provider) were hand seeded in the end of April 1994. The row to row and plant to plant distances were 3' and 6" respectively for cowpeas and snap beans.

Herbicides (Gramoxone and Bladex, 1.1 8 L/HA of each) were mixed with water and used uniformly to kill the cover crops and the weeds before planting the main crops. All the main crops (sweet corn, cowpeas, and snap beans) were sprayed twice with spectracide and captan by mixing them with water at the rate of I.573 L/HA against diseases and insect attack. Fertilizer (13:13:13) was used uniformly for each crop at the rate of 145.2 Ibs/A.

The soil area of the four treatments were then tested for resistance against penetration to reveal the intensity of soil compaction by penetrometer. Also, residue meters (camline) were used to determined the ground residue cover. The matured crops were then harvested and the yields were recorded for statistical analysis based on analysis of variance followed by Duncan Multiple Range Test.

Results and Discussions

Ground residue cover with clover and vetch were found to be significantly superior to wheat and to the conventional tillage at 0.05 probability level; which has been indicated by the previous researchers (Hoyt 1983, 1984, and 1989; Boyle et al., 1989). Conventional tillage had significantly the least residue coverage as compared to the other treatments (Table I). The common weed infestations were found to be higher in the clover and vetch treatments than the wheat and control treatments as measured on scale of 0 to 10 (Table 2). The final sweet corn yields as affected by control treatment was minimum as compared to other treatments and found to be non-significant (Table 3). However, this result needs to be ignored due to the invasion of raccoons at the harvest time. With no such invasion, the yield of cowpeas as affected by control, clover, vetch, and wheat were found to be non-significant in both the years (1992 and 1993). However, there is a remarkable trend of comparative higher yield due to wheat, vetch, and clover as compared to control in year 1993 when compared to year 1992 (Table 4). This trend of the increase over the control seemed to be very clear in case of snapbeans in year 1994. The vetch treatment was found to be superior to all the treatments; and the control and wheat treatments were found to be inferior to clover treatment at 0.05 probability level (Table 5). These yield results seem to be somewhat consistent with the findings of Hoyt in year 1989 where he experimented on tomatoes and broccoli. The soil resistance to penetration after five years did indicate lowest resistance value in the control treatment as compared to other treatments including vetch, clover, and wheat (Table 6). Such compaction has been found in no till plot in the poorly drained soil (Karlen 1990); which is just the reverse in case of this moderately well drained soil where the moisture permeates freely and in due coarse causes compaction if not cultivated.

Conclusion

There is clear indication to show that the response of well drained soil to minimum tillage is different than the poorly drained soils. In addition, the analyzed data from this research shows that snap beans responded better than sweet corn and cowpeas with minimum tillage when planted after vetch as a legume crop compared to conventional tillage with no vegetation raised before planting the main crop. However, the ground residue cover percent as well as the resistance to penetration in top soil seem to be directly related (Tables 1 & 6. Soil compaction measured by penetrometer within 6" depth in the conventional tilled treatment indicated significantly easy penetration with lesser resistance as compared to all other minimum tilled treatments with clover, vetch, and wheat covers. Additional ongoing research data on a continuing basis may seem to be essential for exploring the long term effects of minimum tillage on this moderately well drained Memphis Silt Loam Soil.

Table 1. Ground residue cover percent measured by the camline as affected by the treatments recorded on March 1992.

Treatments	Average Ground Residue Cover
	%
Control	60 c*
Clover	98 a
Vetch	95 a
Wheat	80 b

*Means followed by the same letter are not significantly different at 0.05 probability level using the New Duncan Multiple Range Test.

Table 2. Average infestation of common weeds as quantified on the scale of (0-lo)** recorded on March 1993.

Treatment	Common Weeds Infestation on Scale (0-10)
Control	3 a*
Clover	6 a
Vetch	6 a
Wheat	3 a

**(0) Value indicates less than 10% of weeds and (10) indicates more than 90% infestation of weeds.

*Means followed by the same letter are not significantly different at 0.05 probability level using the New Duncan Multiple Range Test.

Table 3. Average total yield of sweet corn in year 1992 as affected by treatments.

Treatment	Yield
	(I bs/Acre)
Control	1452 a*
Clover	2166 a
Vetch	1538 a
Wheat	1568 a

*Means followed by the same letter are not significantly different at 0.05 probability level using the New Duncan Multiple Range Test.

Table 4. Average total yield of cowpeas in 1992 and 1993 as affected by the treatments.

Treatment	Yearly Yields	
	I992	1993
	lbs/acre	
Control	3399 **a***	3242 a*
Clover	2431 a	4598 a
Vetch	3339 **a**	4065 a
Wheat	3695 a	4344 a

'Means followed by the same letter are not significantly different at 0.05 probability level using the New Duncan Multiple Range Test.

Table 5. Average total yields of snap beans in year 1994 as affected by the treatments.

Treatment	Yields
	(Ibs/Acre)
Control	411 b*
Clover	968 ab
Vetch	1863 a
Wheat	949 ab

*Means followed by the same letter are not significantly different at 0.05 probability level using the New Duncan Multiple Range Test.

Table 6. Average resistance up to 15 cm depth measured by penetrometer in December 1994 as affected by treatments.

Treatment	Average Resistance Based on Five Readings with Four Replications
	Pounds Pressure 10.75 inch
Control	63 b*
Clover	162 a
Vetch	181a
Wheat	192 a

*Means followed by the same letter are not significantly different at the 0.05 probability level using the New Duncan Multiple Range Test.

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