

MULTIPLE CROPPING - VALUE OF MULCH

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INTRODUCTION

Multicropping (growing two or more crops per year on the same land area) has greatest advantage in the tropics and sub-tropics where 12 month growing seasons are not unusual. Since Florida and much of the southeastern U.S. lies in or close to this region, properly managed multicropping systems could result in increased food production by taking advantage of the long growing season. Farmers in Taiwan, for example, successfully use multicropping and routinely grow as many as 5 or more crops per year on the same land. This success by the Taiwan farmers is due in part to the utilization of a year-round favorable growing season and to the use of new technology, including short season crop varieties, ingenious systems for overlapping planting and harvest dates, and proper use of fertilizer and pesticides.

The acreage under multicropping has increased rapidly during recent years in the U.S., the largest agronomic multicropping system being small grain succeeded by soybeans. Climatic conditions in the southeast are such that multicropping should be exploited to the utmost to help meet the demand for agricultural products. Food and fiber production must increase to satisfy the needs of a rapidly growing population in the southeast and to help meet the needs created from national and world competition. Producers in the southeast must make better utilization of their farmland on a year-round production basis to offset increased cost and inflation from land prices, taxes, labor, machinery, interest, irrigation systems and other forms of overhead.

Many multicropping farmers are increasing their chances for success by utilizing no-tillage (the opening of a slot in the soil only sufficiently deep and wide to properly deposit and cover the seed) or no-tillage plus subsoiling, to plant one or more crops in their multicropping system. Multicropping no-tillage farming requires a high level of management that most producers have not experienced. No-tillage has numerous advantages over conventional tillage planting management. No-tillage reduces erosion (18). No-tillage conserves soil moisture when plantings are into a chemically controlled mulch crop and indications are that a more vigorous root system develops to aid in withstanding drought stress (11). No-tillage results in timely planting of crops in succession without delays experienced in conventional seedbed preparation (13). No-tillage reduces the number of farming operations, thus in many cases reducing production cost and conservation of fuel (22). No-tillage results in greater or equal yield of crops (10, 12, 19). No-tillage reduces problems with Lesser Corn Stalk Borer, one of the most dreaded insects in the southeast (2,3). No-tillage in

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conjunction with a good mulch crop can reduce weed problems when compared equally with conventional tillage (12). No-tillage farming has disadvantages as well as the previously mentioned advantages. The disadvantages can be summed up in the fact that this type of farming requires an innovative, highly skilled, and informed farmer who, to be successful, wants to make it work.

Many producers are utilizing no-tillage planters to grow crops in crop residues, mulch crops or sod crops in succession multicropping systems. Because of new no-tillage and no-tillage plus subsoiling equipment and chemical weed control, producers can utilize crop residues, mulch crops and sods to great advantage as mulch for succeeding crops instead of burning or otherwise destroying them as in past management. Mulch materials include anything left on or applied to the soil surface around plants or in which crops are planted into to conserve moisture, moderate soil temperature, control weeds, prevent erosion and to increase crop or plant production capacity. The mulch material may be organic, such as compost, bark, leaves, grass clippings, crop residues, dormant or killed sods, and killed winter cover crops such as small grains and legumes; or it may be inert, such as sand, gravel, pebbles, tinfoil or polyethylene film.

Probably the most important factor to farmers is the fact that properly utilized mulch can result in significant increases in yield of crops (11, 14, 23, 24). The major contributing factors to yield response from use of a mulch is a result of the conservation of soil water (6, 11, 14, 20, 23, 24), from reduced water runoff (1, 4, 14, 16, 24) and increased water infiltration (9, 15, 16). Mulch material prevents loss of water from the soil by evaporation. Soil moisture moves by capillary action to the surface and evaporates if not covered by a mulch. Mulching will prevent crusting of the soil surface, thus improving absorption and percolation of water into the soil and at the same time, eliminating erosion. Soil itself, fertilizers and other chemicals applied to the soil are major contributing sources to agricultural pollution. Losses of soil and chemicals by both water and wind erosion can be reduced to near zero by utilizing mulches in crop production (1, 4, 9, 15, 16, 23). Maintenance of a more uniform soil temperature can be obtained by using mulches in crop production (6, 20, 23). The mulch acts as an insulator that keeps the soil warm during cool periods and cool under intense sunlight. Organic mulches can improve soil structure and tilth. As the mulch decays, the material works down into the topsoil. Decaying mulch can serve as a source of increased cation exchange sites to hold more plant nutrients as well as the addition of nutrients to the soil. Mulch from legumes can furnish substantial quantities of nitrogen (N) and other nutrients to the succeeding crop (17). Good mulches have 'controlled or reduced weeds (5, 12, 21), increased plant nutrient the need for tillage operations and thereby reduced soil compaction (7), increased soil aggregation, organic matter and soil N (4), and improved crop stands and reduced production costs (5).

When no-tillage and mulch management are properly incorporated in various multiple cropping systems, advantages of each can assist modern day farmers to be better producers of food and fiber. The objective of this paper is to discuss some examples of mulch management associated with multiple cropping. It will be impossible to cover all aspects of the subject or to cite every research reference on the subject.

SMALL GRAIN RESIDUE FOR A MULCH

Small grain followed by soybeans is the agronomic multicropping system most widely grown in the southeast U.S., and probably in the world. About half of small grain plants is crop residue that can be used for a mulch in no-tillage planting of summer annuals. Wheat straw residue averages about 90, 0.67, 0.07, 0.97, and 0.17% dry matter, N, phosphorus (P), potassium (K) and calcium (Ca), respectively (8). A 40 bu/A wheat crop will leave a residue of about 4,080 lb/A containing about 27, 6 and 47 lb/A of N, P_2O and K_2O , respectively. Soil erosion can be reduced to a minimum with about 1,700 lb/A of wheat residue on a sandy or sandy loam soil and about 750 lb/A is needed on a clay loam (8).

Interrill erosion can be reduced by 40% with 450 lb/A wheat straw and about 80% by 1,800 lb/A as compared to no mulch (15). Erosion was near zero at higher mulch rates. Water runoff was slightly reduced at the 1,800 lb/A rate. Another study found that 2,000 lb/A of wheat straw decreased soil loss to only 18% but that 4,000 lb/A reduced erosion to less than 5% of the control (16). Runoff velocity reduction by the mulch was the major contributing factor to reduce erosion.

Summary of 3 to 4 years and 4 locations in Georgia of wheat-soybean double cropping yield is found in Tables 1 and 2. Note that system 4, no-tillage of soybeans into wheat straw, is the system in which mulch is utilized. Soybean yield for treatment 4 is equal to soybeans in all other systems including monocropped full season soybeans, treatment 3.

Table 2 shows fertility response of wheat soybean double cropping at the same soil site for 3 years. Effective use of preemergence and post-emergence herbicides, narrow rows, timeliness of harvesting of wheat and planting of soybeans into the wheat straw has essential to obtain these yields.

WINTER ANNUAL CROPS FOR A MULCH

These multicropping systems include growing of wheat, rye, oats, barley, ryegrass, vetch, lupin and clovers that are chemically killed and converted to a mulch crop at or before planting of the succeeding crop. In some instances a small grain and legume mixture is grown as the mulch crop. No-tillage corn planted into Harry vetch and crimson clover mixtures produced grain yields comparable to those obtained by the application of 100 lb/A N in a University of Delaware study (17). Approximately one-third of the total N from mulch covers was released to the corn in a single season, with about 90% of this derived from cover crop top growth. Mulch covers were less reflective than the bare soil surface, resulting in mulch surface temperatures up to 10 C higher than those with unprotected soil surfaces. Temperatures immediately below the mulch covers were more than 10 C lower than those of the surface of unprotected soil.

Ten years of research at Clemson University has shown that vetch and rye mulch averaged 3.11 inches less water runoff per year, 2.38 tons/A less soil erosion loss per year and that yield was equal or greater than

plowed unmulched corn (4). This study showed that the degree of soil aggregation increased after 10 years in mulched treatments but was reduced significantly in the plowed check treatment. Mulched treatment of vetch and rye increased soil organic matter from 1.5 to 2.6%, and soil N from 0.047 to 0.069% after 10 years of continuous corn, while the plowed check remained at 1.2% organic matter and 0.036% N.

In a Georgia study, no-tillage of corn and soybeans showed that using the rye crop for a mulch as opposed to removal for hay resulted in 52 bu/A more corn and 13 bu/A more soybeans (11). This was a 46% increase for corn and 30% increase for soybeans. Conservation and better utilization of moisture was the major attributing factor to better yield from the rye mulch corn and soybeans. Similar studies in Florida of no-tillage plus subsoiling into rye mulch versus conventional tillage resulted in significantly greater soybean and grain sorghum yields, taller plants, greater crop populations and fewer weeds (12).

Tables 3-5 give yield data from the University of Florida on growth of crops planted in winter annuals grown for a mulch. These data illustrate many of the benefits of no-tillage and a mulch as discussed in the introduction. No-tillage plus subsoiling resulted in higher yield than regular no-tillage for corn, grain sorghum and sunflowers (Table 3). In a similar study corn yield was 133 bu/A from no-tillage plus subsoil in rye for mulch and 114 bu/A for conventional tillage plus subsoil.

Harry vetch provided almost all the N required for corn and grain sorghum (Table 4), and no-tillage of these crops into the vetch gave higher yield than conventional tillage. Data in Table 5 illustrates the difference in N requirements of grain sorghum depending on the mulch or green manure crop preceeding the grain sorghum.

SOD CROPS FOR A MULCH

Sod crops of perennial grasses, such as orchardgrass, bluegrass, fescue, bermudagrass and bahiagrass have been used as mulch crops for no-tillage corn more than any other summer annual. More problems have been encountered from the warm season sod crops than cool season. In general corn production has been good in these sod crops if the sod is killed effectively with herbicides so that the sod crop does not compete with corn for water and fertilizer. Properly managed sods can be beneficial as a mulch for growing no-tillage corn.

A Virginia study (14) showed that mulched treatments, whether of undisturbed killed orchardgrass sod on no-tillage plots or of wheat straw on conventional plots, gave the lowest values for water runoff and highest values for soil water content and yield of corn. Soil water conserved by the mulches increased corn yield by 39 bu/A. Another Virginia study produced an average of 103 bu/A corn on no-tillage in orchardgrass versus 80 bu/A from conventional tillage (23). The higher yield with 23 bu/A more corn from no-tillage versus conventional was attributed to less water runoff, less evaporation, and negligible erosion. This resulted in more efficient use of water for crop production. Kentucky researchers have shown that killed bluegrass sods have higher soil water content and lower soil temperatures

in no-tillage corn studies (6). In an Ohio study, tall fescue killed and used for a mulch in no-tillage corn management produced 3 times as great a yield effect for corn as conventional tillage treatments (24).

In a Georgia study, the author found that no-tillage of corn in a field of about 50% fescue and 50% bermudagrass averaged 10 bu/A less than conventional tillage treatments. Conventional tillage corn ranged from 128 to 154 bu/A with an average of 143 bu/A and no-tillage into the sod ranged from 121 to 138 bu/A with an average of 133 bu/A. Incomplete control of the bermudagrass resulted in competition of the sod with the no-tillage corn.

Grain sorghum tended to yield about the same for no-tillage versus conventional tillage in a bahiagrass sod (Table 5). Bahiagrass was effectively controlled by preapplication of Roundup and post direct application of Paraquat in this study.

SUMMARY

Crop residues, mulch crops, and sod crops can be utilized in numerous multiple cropping systems. Effective management of mulches requires knowledge of how to farm by the no-tillage method and how to effectively utilize contact herbicides such as Paraquat and Roundup to kill and/or convert crop residues, mulch crops and sod crops into a mulch. Properly managed mulches in multicropping no-tillage farming are valuable because of reduced erosion and pollution, moisture conservation, lower soil temperatures in warm weather, higher soil temperatures in cold weather, being a source of soil organic matter and plant nutrients, reduced weed growth, reduced Lesser Corn Stalk Borer infestation, improved chemical and physical soil properties, improvement in timeliness for planting of crops, fewer tillage operations, and improved crop yield.

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TABLE 1. AVERAGE OF THREE OR FOUR YEARS AND THREE LOCATIONS (CALHOUN, GRIFFIN AND PLAINS, GA.) OF DOUBLE CROP WHEAT-SOYBEANS.

System	SOYBEANS		AVERAGE YIELD	
	Following	Planted	Tillage	
			Wheat	Soybeans
			ton DM/A	bu/A
1. Wheat forage		early	no	3.0
2. Wheat forage		early	yes	3.0
3. No-crop		early	yes	-
4. Wheat grain		late	no	45.0
5. Wheat grain		late	yes	45.0

TABLE 2. THREE YEAR AVERAGE YIELD OF WHEAT-SOYBEAN MULTICROPPING FROM FERTILIZATION ON A CECIL SCL AT GRIFFIN, GA.

Treatment	Tillage		Annual Fertility		Yield		
	Wheat	Soybeans	Wheat	Soybeans	Wheat	Soybeans	Total
			N-P-K			bu/A	
1	yes	no	0-0-0	0-0-0	15 d	16 d	31 d
2	yes	no	67-0-0	0-0-0	39 c	29 c	68 c
3	yes	no	67-65-125	0-0-0	43 a	36 b	79 b
4	yes	no	67-130-250	0-0-0	50 a	39 a	89 a

TABLE 3. CORN, GRAIN SORGHUM, AND SUNFLOWERS PLANTED NO-TILLAGE INTO RYE FOR A MULCH IN 1978 AT WILLISTON, FLORIDA.

Crop	Variety	No-Tillage	No-Tillage plus subsoil	Difference	% Increase
Corn	Funks G4507	89 bu/A	100 bu/A	11 bu/A	12
Sorghum	Grower ML135	46 bu/A	72 bu/A	26 bu/A	57
Sorghum	Dekalb BR54	27 bu/A	69 bu/A	42 bu/A	156
Sunflower	Sungrow 380*	358 #/A	914 #/A	556 #/A	156

* Sunflower data was in cooperation with Or. Brian A. Bailey.

TABLE 4. GRAIN AND FORAGE YIELD FOLLOWING HARRY VETCH KILLED FOR A MULCH (M) OR USED AS A GREEN MANURE (GM). AVERAGE OF 1977 and 1978 AT THE UNIVERSITY OF FLORIDA.

Tillage	----- Nitrogen #/A -----			
	0	75	150	average
	Dekalb BR54 Grain Sorghum bu/A			
no (M)	62	71	72	68
yes (GM)	49	53	57	53
X	56	62	65	
	Dekalb BR54 Grain Sorghum ton dry matter/A			
no (M)	4.45	4.97	4.97	4.80
yes (GM)	3.52	3.86	4.03	3.80
X	3.99	4.42	4.50	
	Dekalb XL75A Corn ton dry matter/A			
no (M)	3.65	3.85	4.05	3.85
yes (GM)	2.53	2.65	2.63	2.60
X	3.09	3.25	3.34	

TABLE 5. YIELD OF DEKALB BR54 GRAIN SORGHUM PLANTED INTO VARIOUS CROPS THAT ARE USED FOR A MULCH (NO-TILLAGE PLUS SUBSOIL) OR GREEN MANURE IN 1978 AT THE UNIVERSITY OF FLORIDA. (MULCH, M. GREEN MANURE, GM.)

Tillage	----- Nitrogen #/A -----					\bar{X}
	0	25	50	100	200	
	----- bu/A -----					
	cover crop--Pensicold bahiagrass					
no (M)	18	32	53	59	73	47
yes (GM)	19	32	66	67	67	50
X	19	32	60	63	70	
	cover crop--Wrens Abruzzi Rye					
no (M)	18	46	70	83	85	60
yes (GM)	20	46	57	81	74	56
X	19	46	64	82	80	
	cover crop--Frost Lupin					
no (M)	42	62	72	72	70	64
yes (GM)	65	77	86	70	69	73
X	54	70	79	71	70	
	cover crop--none, winter fallow					
no	18	50	65	79	86	60
yes	35	58	68	86	86	67
X	27	54	67	83	86	