Retardation of Germination and Early Growth of Corn Planted No-Till in Sub Clover Cover Crop

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During the past several years interest in using legume cover crops to fix nitrogen and to control winter erosion has grown considerably as has interest in reduced tillage. However, combining the two methods does not always give good results.

Research done in Baton Rouge, Louisiana using sub clover (Trifolium subterraneum) as a cover crop for corn (Zea mays), has resulted in unacceptably poor stands in the past three years, 1982–1985. The corn was planted on the same experimental area, a silty clay loam soil (Commerce/Mhoon series).

In 1983, cover crops of Tibbie Crimson Clover (T. incarnatum), Mt. Barker Sub clover, Nova II Vetch (Vicia sativa), Coker 762 Wheat (Triticum cestivum) and fallow were used. On March 14, Funk's hybrid G–4611 corn was planted on 0.72 in rows using a Moore no–till grain drill. Herbicide (0.56 kg ai/ha Paraquat and 3.36 kg ai/ha atrazine were sprayed at planting. The mean stand count reported as plants/ha for the various covers were 29,340 fallow, 12.325 wheat, 4,910 crimson, 2,100 sub, and 1,785 vetch. The cause of the poor and varying stand was not determined. Birds, insects and allelopathy were suspected. The corn was replanted (April 21) 38 days after the initial application of herbicide, and except in the previously unsprayed plots an adequate stand was achieved.

The experiment was modified for 1984. The corn was planted with a four row planter at a 0.76 m row spacing. The planter consisted of ripple colters mounted on a toolbar ahead of John Deere 77 planting units. The only cover crop was sub clover. One strip in each replication was subsoiled and disked, and one was left fallow and not tilled. One set of clover plots received the broadcast and strip spray 3 weeks prior to planting. The intention of the early spray treatment was to reduce or eliminate any allelopathic effect that may result from planting directly into clover sprayed at planting time. Early spraying was also intended to reduce the danger of plant feeding insects moving from the dying clover plants to the newly emerging corn.

The emergence of the corn in the sub clover plots was somewhat slower and less uniform then in the tilled and the fallow plots, and the early growth appeared to be retarded. It was suspected that shading of the soil by the clovers was reducing the soil temperature and was thereby retarding the growth. Soil temperatures were taken at the depth at which the seeds were located. There was a significant difference in soil temperature between the different treatments (See Table 1). However, this temperature difference may not have been the cause of tlie reduced stands. In the areas of the heaviest vegetation, the press wheels did not close the slit produced by the disk openers and the seed could be seen laying in the bottom of or wedged between the walls of the open slit. In other cases, seeds that failed to germinate were found between layers of vegetation and were not in contact with the soil. Little rainfall after planting and the corn seedings in the clover areas appeared severely stressed.

In 1985, Funk's G4765 corn was planted April 4, on the same area used in 1983 and 1984. Plot size was 7.62 m x 3.05 m. One week before planting the entire area had been sprayed with Roundup at a rate of 4 l/ha. The planter consisted of 4 John Deere 77 units with dual disk openers mounted at a 0.76 m row spacing on a set of toolbars designed by the Agricultural Engineering Department at Louisiana State University. This arrangement allowed various tools such as colters, cultivator sweeps and disks to be mounted ahead of the planter units. Using this one pass planter, the seeds were planted into 3 types of seed beds: conventionally tilled, consisting of subsoiling, disking and disking again just before planting; no till, consisting of scattered vegetation of weeds and bare ground; and sub clover. Most of the weeds and clovers were dying but not yet dead as a result of the herbicide application. Vegetation samples taken March 28 gave mean dry matter yields of 1379 kg/ha on the fallow plots and 3112 on the sub clover plots.

Four combinations of tools were used on the toolbar ahead of the planters in an effort to improve the stand. These consisted of (1) ripple colters ahead of John Deere 77 planter units; (2) same as 1 but with a 15 cm sweep between the colter and planter unit with the sweep set to run about 2.5 cm deep; (3) the same as 2 but with disks on either side of the area worked by the sweep to push the soil back; (4) the same as 3 but without the sweep closing somewhat the slit opened by the colter to provide better contact of the seed with the soil.

In an attempt to see if different soil temperatures were an important cause of retarded germination soil temperature probes were placed in selected plots in two of the reps to detect if there was a difference in soil temperature under the different treatments. They were connected to Dataloggers and were automatically read and recorded at hourly intervals. Maximum and minimum soil temperatures in tilled and no-till clover plots are reported in Table 2. During the first week after planting, the clover areas had maximum temperatures 5–6°C cooler than tilled plots and minimum temperatures one or two degrees warmer. No–till fallow plots had similar soil temperature to tilled plots. All temperatures became similar following 7 cm of rain which fell on days 12 and 13 often planting.

Soil cores were taken at planting time to determine water content on the different plots. The data are presented in Table 3. It does not appear that soil moisture or bulk density would limit germination or emergence although the lower moisture at the over 7.6 cm depth may have slowed growth in the clover plots.

Table 1. 1984 Corn plant population and soil temperature.

Treatment	1000 plants/ha Stand	C° Temperature
Rand early	36	25.8
Band late	49	22.4
Disc	50	29.8
No till	49	29.0
Broadcast early	35	23.8
Broadcast late	33	21.8

Note: A general linear models procedure did not show significant differences in the stand. However, temperatures varied significantly, with an F value of .0003.

Table 2. 1985 Daily maximum and minimum temperatures in tilled plots and no till and clover plots recorded by datalogger at 2 cm below soil surface.

Temperatures		Days After Planting														
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Maximum	tilled		30	27	30	34	28	29	30	30	22	29	30	27	32	32
	no-till		31	26	29	31	28	28	28	30	21	28	28	28	32	31
	clover		25	22	24	28	22	24	26	28	20	27	28	27	31	31
Minimum	tilled		18	11	15	14	12	12	15	18	15	16	14	16	16	17
	no-till	12	18	12	16	14	12	12	16	19	16	18	15	16	16	17
	clover		18	14	16	14	12	13	15	19	16	17	15	16	16	17

Note: Temperature data from soil probes 2 cm below soil surface recorded by datalogger.

Table 3. Bulk density and soil moisture taken at time of planting corn, 1985.

	Bulk Density (g cm^{-3})		Volumetric Soil Moisture	
	0 - 7.6 cm	7.6 - 15.2 cm	0 - 7.6 cm	7.6 - 15.2 cm
Tilled	1.09	1.48	.27	.39
No-till	1.31	1.52	.31	.35
Clover	1.22	1.48	.31	.29

Twelve days after planting, germination was measured by searching for corn seeds in a 0.5 m long area in the center of the second row of each plot. The number of seeds found was recorded, as was the depth of the bottom of each seed below the soil surface and the height of the plant from the seed to the highest point of the plant. (The leaves were not lifted to an upright position for this measurement.) In addition to this, the number of plants in each of the two center rows of the four row plots was counted. In Table 4 mean data are presented regarding mean depth of seed placement, plant height and stand counts made 12 days after planting. None of the planter arrangements was successful in producing a stand of corn.

Table 4. 1985 Mean planting depth, plant height, and stand of corn 12 days after planting.

Mean of 16 Plots/Treatment	cm Seed depth	Plant Height	Plants per ha	Plants per acre
Conventional till	2.9	18	58210	23567
No-till fallow	2.1	15	54604	22107
No-till sub clover	1.0	3	11942	4835

Note: Stand data is derived from the mean of all plants in 2 center rows of 7.5 m long plots; 16 plots per treatment. Seed depth and plant height are from .5 m long area in the same plots.

Data on plant height was grouped into classes of 0, <15m and >15cms. Data on depth of seed placement was grouped into two classes, < 1 cm or > 1 cm. Table 4 presents the distribution of these classes as influenced by cover treatments. In the conventionally tilled plots, only one of the 43 seeds in the measured area was at less than one cm; two seeds failed to grow; and 35 of the plants were over 15 cm tall. In the no-till fallow plots, 7 seeds were at less than one cm. Of the 43 seeds in the measured areas, 4 failed to grow and 25 grew to more than 15 cm. In the no-till sub clover, 22 seeds located were at less than 1 cm, and only half of the 22 grew. Of the 13 seeds that were deeper than 1 cm, only 1 grew. Only 1 of the plants grew more than 15 cm. It appears that if the planter had been adjusted to more effectively plant through the 3 ton per ha dry matter of clover tops, the stand would have been even worse than 11,900 plants per ha.

Table 5. 1985 Frequency distribution of plant height and seeding depth classifications.

	Height of Plant			Depth of Seed	Total
	0	<15 cm	>15 cm	cm in soil	Seeds
Conventional till	0	0	1	<1	
	2	6	34	>1	43
No till fallow	3	3	1	<1	
	1	10	25	>1	43
No till clover	11	10	1	<1	
	12	1	0	>1	35

Observations were made in 1982 and 1983 that johnsongrass was inhibited early in the season where sub clover residues remained. These observations and difficulties in obtaining a stand of corn prompted a laboratory trial in which germination tests were conducted in the lab placing seeds in petri dishes on filter paper saturated with water in which sub clover had been soaked. In one study, the sub clover leachate did not appear to prevent germination or root growth rate. In a second trial root elongation rates were severely reduced by watering with extracts (Table 6). The depression could be due to substances present in the clover, or to microbial degredation products.

Table 6. Root elongation of corn seedlings as influenced by sub clover leachates.

Source of sub clover leachates	Mean Length (mm) of shoot at 4 days	Mean Length (mi) of shoot at 7 days	Mean growth mm per day; Day 4-7
Fresh tops	12.9	19.7	2.3
Dried tops	10.7	25.8	5.0
Distilled water	21.8	69.4	15.9
Fresh roots	17.6	46.0	9.5

In the field, lack of stand establishment may be due to a combination of many factors. The slowing of growth by clover leachates may combine with any retardation in germination due to the lower soil temperatures and with problems in seed placement due to vegetation to reduce stand and growth rate. This slowed growth would make the seedlings more susceptible to bird, insect, and pathogen damage. Deep placement, by delaying establishment and increasing coleoptile length increases exposure of seedings to a hostile environment under heavy residue.

Summary

Minimum tillage appears to be very promising. Adequate seed placement in the soil can be achieved in most cases. However, there is definitely a problem in getting adequate germination and good early growth when corn is planted into untilled sub clover sod. Germination and early growth of the Johnsongrass weeds was also very much retarded indicating that planting no-till in sub clover may be beneficial in weed control in the absence of herbicide application. There appears to be a need for more basic research into possible alleopathic interactions between various cover crops and crops and weeds when used in no till planting.