EVALUATION OF THE ADAPTATION OF ULTRA-SHORT SEASON CORN FOR THE MID-SOUTH

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Abstract. Soils in the South are thin and low in organic matter. Summer crops suffer from drought in the summer after stored soil water is depleted. Summer crops that grew and matured prior to the depletion of the stored soil water could avoid this drought stress. They could also provide a high residue grass crop for rotation if they were corn or grain sorghum. Some ultra-short season corns have been developed commercially for the extreme northern corn belt. Experiments to investigate cultural practices and growth habits of ultra-short season corn were conducted in Arkansas and Louisiana. Results indicate that plant population needs to be higher than that used in full-season corns. Planting early on narrow rows results in some inherent problems with fertility; especially post planting N. Plant maturity measurements indicate that ultra-short season corn can mature early enough for drought avoidance while producing an acceptable yield. However, other characteristics such as disease tolerance, shuck cover, etc. may not be suitable for production in the region. Continued selection and production practice evaluation are needed before this can be a recommended practice.

INTRODUCTION

The Southeastern United States has a humid climate receiving in excess of 40 in. of rainfall annually (Bruce et al., 1980). This would be an abundant supply, except most of it comes during the winter months. Many of the soils in the region are shallow and have low water storage capacity (Buol, 1973). There are about 15,000,000 acres that fit this category. Crops grown in the region usually possess some degree of drought tolerance. The management or cropping system used is an integral component of producing a profitable crop.

One relatively recent innovation in the region has been early soybean production systems (ESPS) (Heatherley, 1999). In certain areas and on certain soil types this has been very successful. For other areas and soil types, it has been less than successful. The reason for its success or failure for dryland production appears to be a combination of climate and stored extractable soil water. If the combination of these two factors is sufficient to avoid the major soil droughts by maturing early, then the system is very successful; otherwise, it can be a drastic failure. Since a large part of the region consists of soils with lower water storage capacity (3 to 4 inches), growing the ESPS soybeans on them can be a risk.

Looking at alternative crops with similar drought avoidance strategies brings to mind cool season crops such as the cereal crops of wheat, oats, barley, and rye, or an oilseed, such as rapeseed. These do well in avoiding droughts but have other problems associated with them such as disease susceptibility, lack of winter hardiness, the lack of a ready market, or the lack of economically sustainable production. These crops do avoid droughts in the region well. Examining other warm season grain crops suggests corn or grain sorghum. These crops have traditionally been grown as full-season crops. In the case of dryland corn this has meant planting at low populations to conserve soil moisture for critical growth stages. Grain sorghum is much more drought tolerant than corn and is preferred for dryland production in many cases. However, the yield of both crops is drastically reduced under drought conditions.

The current dryland cotton and soybean crops do not return sufficient residues to the soil surface to prevent erosion or to provide a source of carbon for the rapid building of organic matter. A high residue crop with stover having a high C:N ratio would fill a much needed niche here (Denton et al., 1995; Langdale et al., 1995a; Langdale et al., 1995b; and Keisling et al.,1995).

Ultra-short season cultivars (i.e. those having maturity dates of 75 to 90 days) have been developed for corn and grain sorghum. The corn was developed for the extreme northern corn belt, but cultivars that would mature at approximately the same time as winter wheat could make an attractive alternative crop for the southern region of the United States. Winter wheat could mature from the first week in May to the first week in July depending on the location, variety, and year. These crops have a ready market in the region, may avoid droughts almost as well as cool season crops, provide a much needed high residue producing monocot for crop rotation, and if yields are high enough can be economically sustainable. Thus, it appears that there exists good potential for their adaptation.

Experiments were done in Arkansas in 1998 and in Louisiana in 1994 and 1995 to assess the current potential of ultra-short season corn for the region and to observe its growth characteristics.

MATERIALS AND METHODS

Arkansas

Several cultivars were obtained to test in a population by N fertility test. The experimental design was a stripped-stripped-split plot with two replications. Main plots for one set of strips were varieties with sub-plots being populations of 40,000, 50,000, and 60,000 plants per acre. Stripped across the test perpendicular to the varieties were N rates of 175,250, and 325 lbs. N per acre. This test was conducted as a dryland test at Keiser, AR, on a sandy, silty clay and at Pine Tree, AR, on a Calloway silt loam. Another test at Pine Tree was irrigated. Cultivars used in the tests at both locations were 'Cargill 1877' and 'Cargill 2427'. The tests were planted the first time on April 6 at Keiser and April 7 at Pine Tree. The tests were replanted on May 5 at both locations. Treatments remained the same at Keiser. However, 'Cargill 2427' and 'Cargill 1877' were replanted in the irrigated trial at Pine Tree, and the populations were 40,000 and 60,000 plants per acre. The dryland test at Pine Tree was planted only with 'Cargill 2427' at 40,000 and 60,000 plants per acre. Weed control measures were according to recommended guidelines for pre-emergence herbicides. A multi-population, dryland grain sorghum test was planted on May 5 in conjunction with the dryland ultra-short season corn test at Pine Tree for comparison. Planting equipment, weed control, and fertilizer applications for the grain sorghum were the same as those for corn. In addition, a small cultivar test was conducted at Keiser to observe the growth of other commercially available ultra-short season corn cultivars.

The test at Keiser was planted each time with a John Deere drill with 7.5-in. row spacing. Plot size was 10-ft wide by 60-ft long. The first planting at Pine Tree was done with a Marliss drill on 7.5-in. row spacing, and the plot size was 10-ft wide by 60-ft long. The replanting was done with a John Deere drill on 7.5-in. row spacing, and the plot size was 15-ft by 60-ft.

Prior to the first planting, fertilizer, 50-80-80 (N-P_2O_5-K_2O) per acre, was applied over the test areas with a ground driven spreader. The N strip treatments were applied at Keiser on May 29 when corn was at the 6-leaf stage and at Pine Tree on June 8 when corn was in the 8-leaf stage with a tractor mounted, PTO-driven spreader.

Louisiana

Field experiments were conducted in 1994 and 1995 on a Sharkey clay (very fine, montmorillonitic, nonacid, thermic Vertic Haplaquepts) at the LSU Agricultural Center's Northeast Research Station near St. Joseph, LA, to evaluate hybrid maturity at two planting dates. Nine hybrids were evaluated. Very-early and early maturing hybrids included 'Dekalb 372' (88 day maturity), 'Pioneer brand 3751' (97 day maturity), 'DPL 4393' (100 day maturity), 'AgraTech 575' (103 day maturity), 'Pioneer brand 3563' (103 day maturity), and 'Asgrow RX623' (105 day maturity). Three standard medium to late maturing hybrids, 'DynaGro 5510' (112 day maturity), 'DPL G-4666' (116 day maturity), and 'Pioneer brand 3165' (123 day maturity) were also evaluated. Planting dates were March 7 and April 15, 1994 and March 13 and April 17, 1995. Seeding rates were about 28,000 seed/A. Tests were not irrigated. All recommended cultural practices were followed (Mascagni and Burns, 1995).

Silking dates were recorded as the date when approximately 50% of the plants were silking. Hybrids were regarded as physiologically mature when about 75% of kernels in the middle portion of the ear had developed a black layer. Date of 20% grain moisture was determined by monitoring grain moisture dry-down. Grain yield was collected from two rows. Plots were harvested when grain moisture reached approximately 18% and yields were adjusted to 15.5% grain moisture.

The experimental design was a randomized complete block with a split plot arrangement of treatments. Planting dates were main plots and hybrids split plots. Four replications were used. Plots were four rows (40-in.) wide in 1994 and two rows (40-in.) wide in 1995. Analyses of variance were conducted using the GLM procedure of SAS (SAS, 1985).

RESULTS

Louisiana

Yields generally increased as hybrid maturity increased (Table 1). Highest yields occurred for the mid-April planting in 1994 and mid-March planting in 1995. The recommended planting window for north Louisiana is from March 10 to April 10. Across planting dates, 'Pioneer brand 3563' (103 day maturity) and 'Asgrow RX623' (105 day maturity) were competitive in yield performance with the standard, later-maturing hybrids, 'DynaGro 5510', 'DPL G-4666', and 'Pioneer brand 3165'.

As expected, dates to mid-silk, physiological maturity, and 20% grain moisture increased as maturity increased (Tables 2 and 3). Relative differences in maturity among hybrids were similar between planting dates each year. 'Pioneer brand 3563' reached 20% grain moisture 15 and 16 days earlier than 'Pioneer brand 3165' at the mid-

March and mid-April, 1994 planting dates, respectively. In 1995, the relative differences were 14 and 13 days for the same hybrids and similar planting dates.

The data indicates that hybrids with approximately 105 day maturity may compete with the standard, later-maturing hybrids. The earliest hybrids currently recommended in Louisiana mature in about 110 days. Other advantages for the early hybrids include early harvest, higher prices, less conflict with other cropping systems, and less risk from late summer storms. However, there are some potential problems with early hybrids. The early hybrids evaluated in this test were developed for the upper cornbelt. In that region, early-maturing hybrids are required because of the short growing season. One of the traits that enhance early harvest and quick grain drydown is loose or open husks. In the lower South, this trait may be detrimental to grain quality. Usually, as husk cover decreases, insect damage and, in some years, aflatoxin accumulation increases.

Arkansas

Potential evapotranspiration was estimated (Anon., 1985; Duchon, 1986; Cahoon et al., 1990; and Smajstrla et al., 1984) for a corn maturing on June 25 (Fig. 1). The stored soil water plus the incidental rainfall is sufficient to meet these needs on most years. Thus, we have a climatic as well as soil niche for these short season cultivars. If they matured around the time that wheat currently is harvested, they would avoid most droughts that occur in the region.

Corn is normally planted on a 38 in. bed in Arkansas. Since most crop land has slopes of less than 1%, planting on beds is done primarily to provide micro relief for surface drainage but it also provides a slightly faster soil warming. When we began to plant corn with a drill on a flat seedbed, the fact that bedded planting also controls traffic patterns became immediately obvious. The area of soil compacted by the trips used in land preparation, planting, fertilizer application, and pesticide applications is shown graphically in Fig. 2. These zones of high traffic were very easily identified in subsequent plant growth and survival. The corn growing in a wheel track was severely stunted while nearby plants (as close as 6 in.) in a non-compacted area grew normally. At the 4 to 6 leaf stage, the "normal" corn was two to four times taller. If the wheel track had depressions or natural depressions occurred where water stood more than two days following a rain, the stand tended to be lost and surviving plants were very yellow, indicating N deficiency.

During the late winter and early spring, the soil can be very moist and, as a result, easily compacted. Trying to prepare a seedbed and plant early on a flat seedbed resulted in areas of compaction. There are almost always periods of wet weather in late March, April, and early May that will cause standing water for several days in soil surface depressions. We feel that we need to address this situation by going to a stale seedbed that has corrugations every 38 in. for drainage. These corrugations will also serve to provide guidance for controlling the traffic patterns.

In applying nitrogen fertilizer, previous experience has shown that we get no damage to seedlings if the preplant N rate is kept at 50 lbs. or less per acre. This translates into 150 to 250 lbs. per acre that needs to be applied post-emergence, usually near the 6 to 8 leaf growth stage. Having aerially applied dry urea on corn near silking at a rate of 30 lbs. of N per acre with no problem, we anticipated no problems with broadcasting N over the top of the crop. However, the rates of N that were used in the post-emergence applications in all tests resulted in 100% leaf burn in both corn and grain sorghum, and there was some severe stalk burn where leaf collars were wrapped around the stalk.

Under dryland conditions at Pine Tree on the layered Calloway soil, the stored soil water was exhausted by early July, and all the leaves on the plants turned brown within 5 days. The grain sorghum planted next to the corn survived and produced a yield. With the loss of the crop canopy in early July and the presence of abundant N, weeds grew profusely. There were heavy infestations of morningglory, cocklebur, pigweed, and grasses. These weeds may necessitate a pre-harvest application of a desiccant.

Even though mistakes and production problems were encountered, 'Cargill 2427' at 60,000 plants per acre and fertilized with 300 lbs. of N per acre produced 102 bushels per acre yield in the irrigated test at Pine Tree. Plant populations differed with varieties in their influence on yield (Table 4). The corn tests at Keiser and the dryland test at Pine Tree were not harvested for grain yield.

In an effort to avoid some of the problems encountered with drainage, fertilizer leaf burn, and traffic, future research will include a planting and fertilization scheme as shown in Fig. 3. For producers, this planting scheme is usually accomplished with an 8-row, 38 in. toolbar that is configured with three 19 in. rows under the tractor, two 38 in. wheel track middles, and five 19 in. rows on the outside of the wheel tracks.

CONCLUSIONS

There appears to be a niche in the South for ultra-short season corn. The development of suitable varieties could result in consistent desirable yields, and a chance to miss some weather related problems concerning quality, such as aflatoxin. An earlier harvest could mean better grain prices, and may present the possibility of double-cropping with soybeans. However, more research is needed regarding production systems in relation to these cultivars.

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Table 1. Influence of Planting Date on Yield Performance of 12 Hybrids on Sharkey Clay at St. Joseph, La, 1994 and 1995.

Hybrid	1994		1995	
	March 7	April 15	March 13	April 17
		bu/A		
Dekalb 372 (88)[1]	99	134	71	66
Pioneer 3751 (97)	129	185	109	76
DPL 4393 (100)	151	161	92	83
Agra Tech 575 (103)	94	123	94	82
Pioneed 3563 (103)	155	180	118	122
Asgrow RX623(105)	156	172	111	95
Dyna Gro 5510 (110)	153	192	125	104
DPL G-4666 (115)	160	170	121	90
Pioneer 3165 (123)	144	161	129	79
LSD (0.05) :				
Planting date (PD)	11		5	
Hybrid (H)	14		12	
PD X H	NS		17	

[1]Maturity as defined by the seed company.

Table 2. Influence of Planting Date on Date of Mid-silk, Physiological Maturity[1], and 20% Grain Moisture for 12 Hybrids on Sharkey Clay at St. Joseph in 1994.

Planting Date	Hybrid	Mild-Silk	Physiological Maturity	20% Grain Moisture
March 7	Dekalb 372	May 13	June 29	July 6
	Pioneer 3751	May 14	June 30	July 14
	DPL 4393	May 16	July 2	July16
	AgraTech 575	May 20	July 7	July 15
	Pioneer 3563	May 18	June 29	July 16
	Asgrow RX623	May 18	July 1	July 18
	DynaGro 5510	May19	July 9	July24
	DPL G-4666	May 23	July 10	June 27
	Pioneer 3165	May 25	July 11	July 31
April 15	Dekalb 372	June 3	July 19	July 27
	Pioneer 3751	June 5	July 21	August 1
	DPL 4393	June 10	July 24	August 6
	AgraTech 575	June 10	July 24	August 2
	Pioneer 3563	June 10	July 18	August 4
	Asgrow RX623	June 9	July 23	August 6
	DynaGro 5510	June 10	July 28	August 14
	DPL G-4666	June 13	July 31	August 17

	Pioneer 3165	June 15	August 1	August 20

[1]Hanway, 1971.

Table 3. Influence of Planting Date on Date of Mid-silk, Physiological Maturity, and 20% Grain Moisture for 12 Hybrids on Sharkey Clay at St. Joseph in 1995.

Planting Date	Hybrid	Milk-Silk	Physiological Maturity	20% Grain moisture
March 13	Dekalb 372	May 20	July 8	July 21
	Pioneer 3751	May 16	July 4	July 16
	DPL 4393	May 18	July 4	July 16
	AgraTech 575	May 22	July 9	July 18
	Pioneer 3563	May 19	July 2	July 16
	Asgrow RX623	May 19	July 5	July 16
	DynaGro 5510	May 20	July 8	July 21
	DPL G-4666	May 24	July 13	June 23
	Pioneer 3165	May 26	July 17	July 30
April 17	Dekalb 372	June 5	July 22	August 1
	Pioneer 3751	June 6	July 24	August 2
	DPL 4393	June 10	July 25	August 7
	AgraTech 575	June 12	July 26	August 6
	Pioneer 3563	June 11	July 24	August 6
	Asgrow RX623	June 11	July 25	August 5
	DynaGro 5510	June 12	July 31	August 13
	DPL G-4666	June 16	August 1	August 15
	Pioneer 3165	June 17	August 5	August 19

Table 4. Corn Yield as Influenced by Plant Population and Cultivar at Pine Tree. 1998.

Cultivar	Plant population	Yield
	(000's/acre)	(bu/acre)
Cargill 1877	40	65
	60	43
Cargill 2427	40	69
	60	93

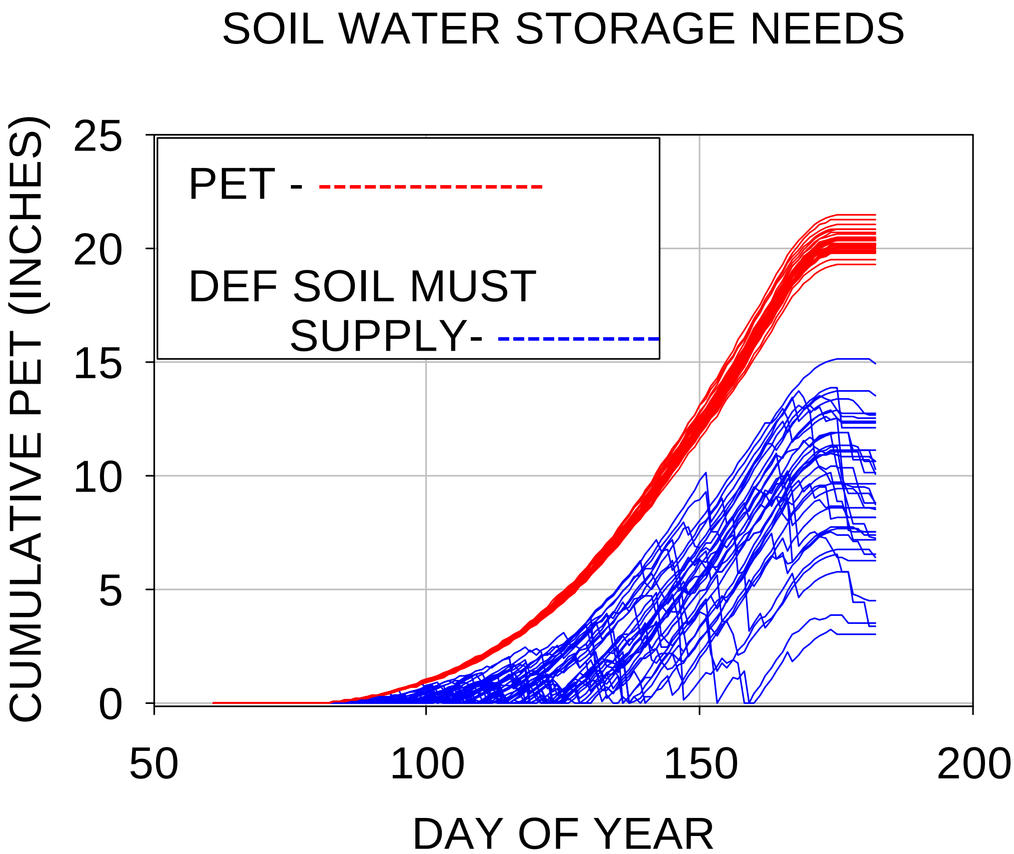

Fig. 1. Assessment of annual portion of evaporation that must be supplied by stored soil water to meet evapotranspiration demands, where PET refers to potential evaporation transpiration and DEF refers to moisture deficit that must be supplied by soil to meet PET.

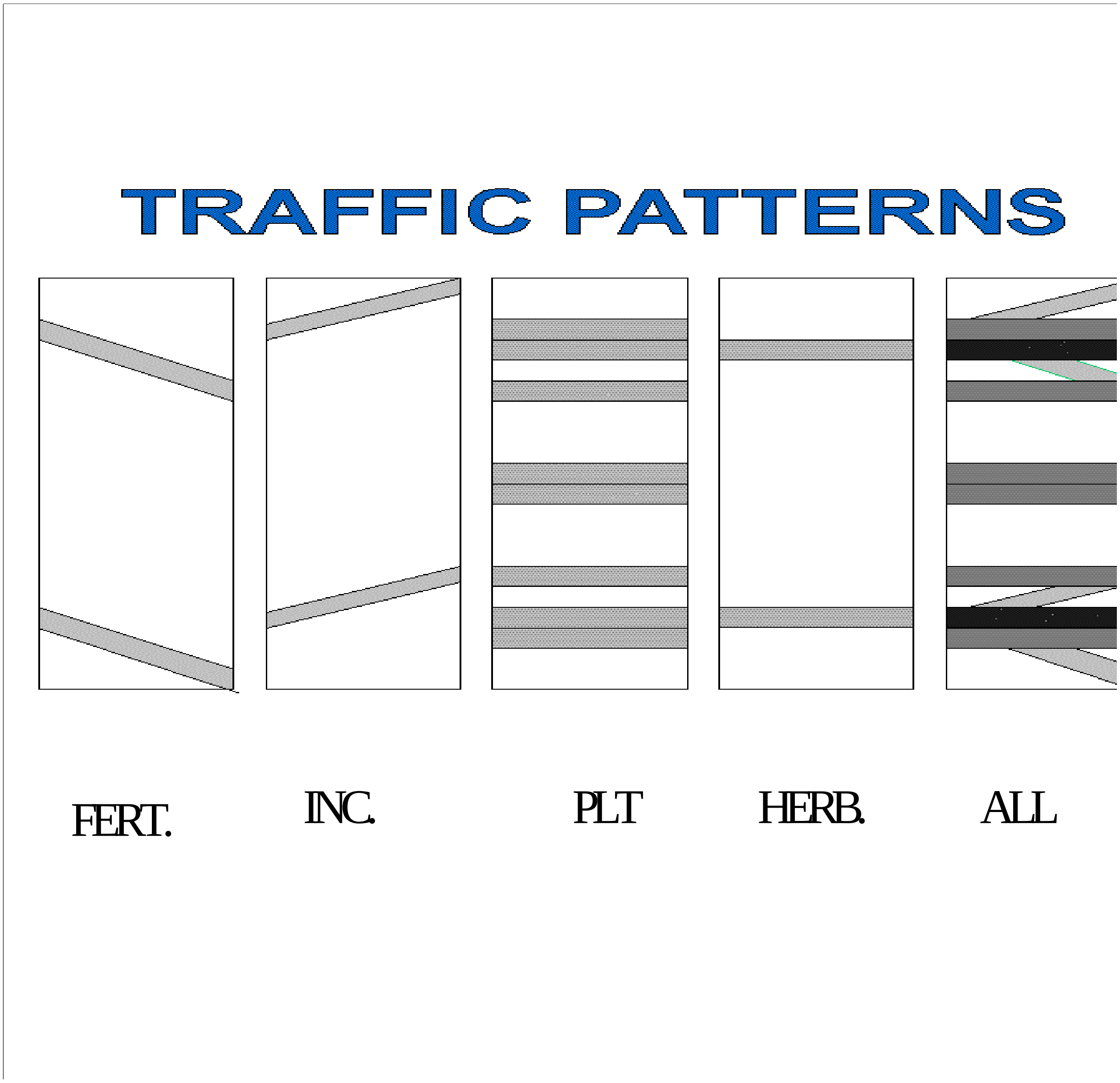

Fig. 2. Traffic patterns for 1998 at Keiser, AR.

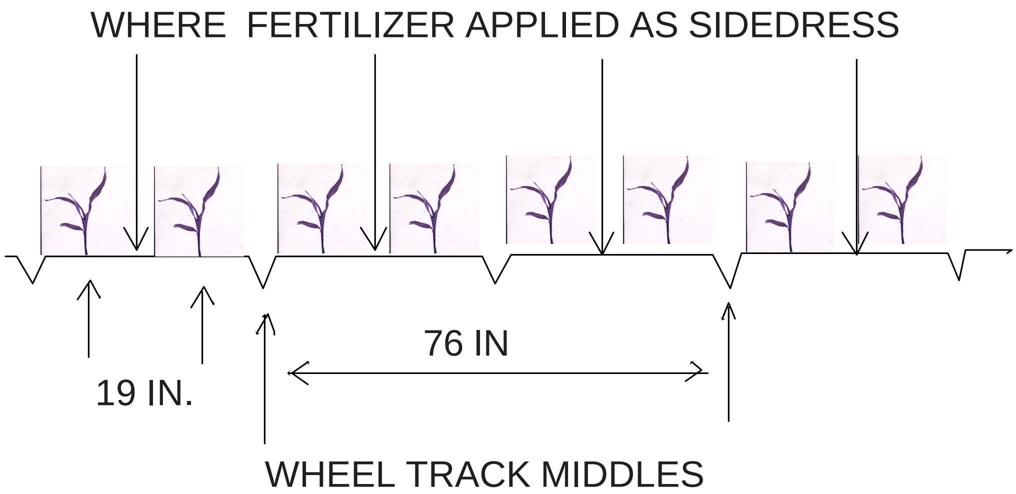

Fig. 3. Proposed seedbed preparation and planting pattern plan to alleviate surface drainage, soil compaction, and fertilizer burn problems.