Skip-row Planting: a Strategy for Stabilizing Dryland Corn/sorghum Yields

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INTRODUCTION: The Central Great Plains Region (CGPR) is a net importer of feed grains. This market provides an incentive to develop stable dryland corn and sorghum yields. The lack of adequate moisture during silking/pollen shed is a major limitation to dryland feed-grain production in the region. In this manuscript, we investigate strategies to circumvent the water limitation during silking/pollen shed using the skip-row technique.

The idea behind "skip-row" is: water stored in the soil of the "skipped-row area" serves as a reserve for drought or high water demand periods later in the season. Because of the distance between the skip-row center and the planted row of corn or sorghum, the soil water in the skip-row is not positionally as available to the young plants until they are at the reproductive stage of development (silking/pollen shed, the critical stage for yield determination for these crops). A second facet of this technique is that the same plant population in a conventional planting, is twice as dense "in the row" in the skip-row planting. For example, a 12,000 plant per acre planting in the skip-row method would have a plant density in the row that would be the same as a 24,000 plants per acre planting in a conventional planting. This "high population" in the row makes up for no plants in the skip-row. Three alternative planting schemes are currently being investigated in the region. These are plant 2 rows, skip 2 rows (P2S2); plant 1, skip 1 (P1S1); plant 2, skip 1 (P2S1). In this manuscript, we summarize the last two years of data collected at Akron and include data collected in Kansas and Nebraska.

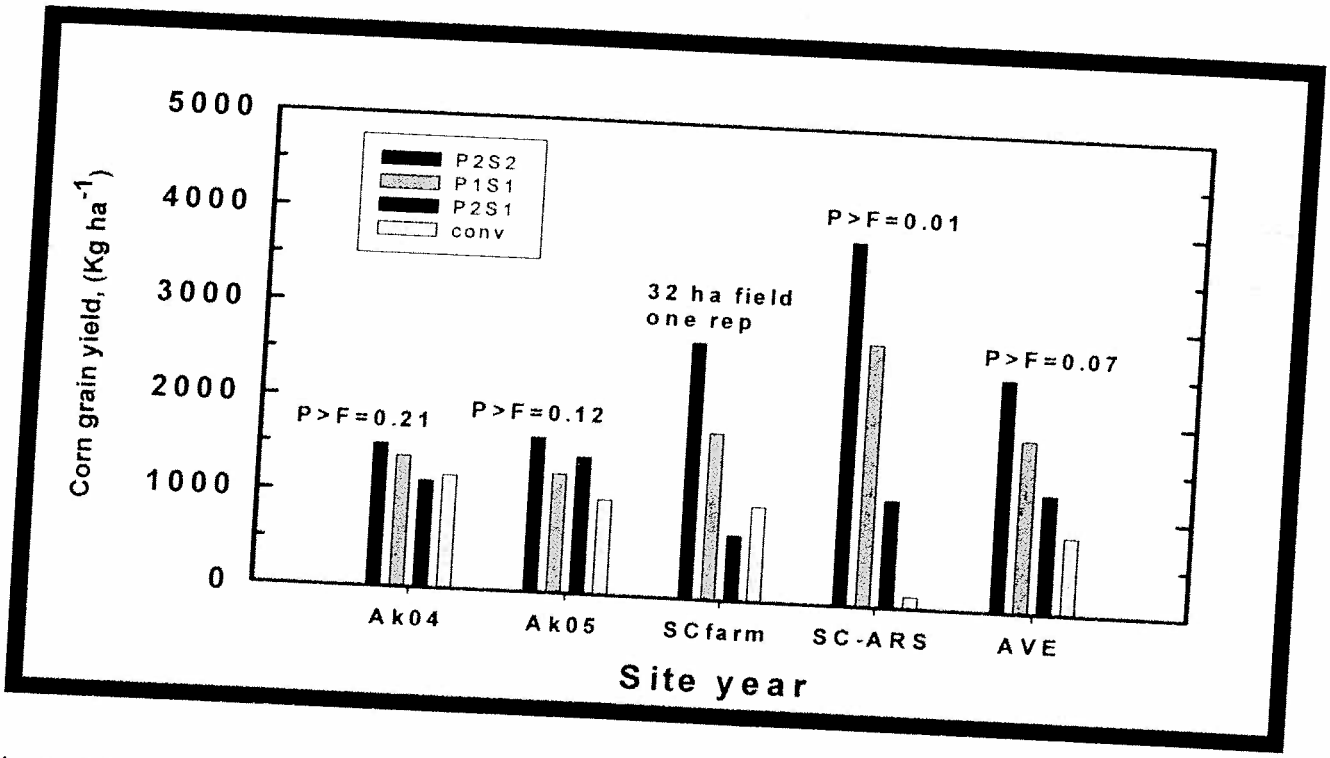

Figure 1. Corn Grain yields as affected by planting arrangement. At Scott City P2S2 and P1S1 had significantly greater yields than conventional and P2S1 planting (P value of 0.001).

METHODS: We investigated 4 planting schemes (replicated four times). The treatments were:

P2S2, P1S1, P2S1 and conventional 30-inch rows. All plots at Akron were seeded with a roundup ready hybrid (LAZER L45-F3) into barley stubble in 2004 and wheat stubble in 2005, using a John Deere maximerge air seeder (May 25, 2004, May 20 2005). All planting schemes were seeded at two plant populations of 12,000 and 16,000 plants per acre in 2004. In 2005 another population of 8,000 plants per acre was seeded final populations were 7200 (8K), 11500 (12K) and 13400 (16K). Roundup was sprayed again at V-8 stage of development for weed control. The site was sprayed with ½ lb a.i Atrazine and glyphosate just prior to planting. Plots were fertilized with 70lbs of N top dressed 2 inches to the side of the seed opener using UAN (32-0-0) and 20 lbs of P (P_2O_5) as ammonium polyphosphate,(10-34-0) was applied with the seed at planting. Plots were harvested in November both years. In addition to the replicated study in 2005 three bulk fields on the station were split in half with one half planted in the P2S2 arrangement at 12,000 plants per acre and the other half planted at the same population in conventional 30 inch rows. Grain sorghum was seeded at 20,000 and 40,000 plants per acre using P2S2, P1S1 and compared with conventionally planted grain sorghum on 30-inch centers. A fourth experiment was established on the Steve Schmitt farm near Scott City Kansas. At the Steve Schmitt site DKc58-80 was planted May 13th. All 4 planting configurations were included at a single population of 17,500 plants per acre and the plantings were replicated 4 times.

Table 1. Dryland corn yields in 2004 and 2005 as affected by skip row planting arrangement.

	Grain Yield (bushels/acre)				
Planting scheme	2004 Akron	2005 Akron	Scott City KS farmer field	Scott City Kansas-ARS replicated plots	4 site year average
Plant 2 skip 2	24	21	43	61	39
Plant 1 skip 1	22	29	28	44	29
Plant 2 skip 1	18	23	11	18	20
conventional	19	16	16	2	13
P>F	0.21	0.12	---	0.01	0.07

P>F is a statistic used to determine if treatments means are significantly different. If the P>F is small (less than 0.1) then we have more confidence that one ore more of the treatment means are statistically different from each other. When P>F values are less than 0.05 we can be confident that true treatment differences exist and the differences are due to treatment effects and not due to chance alone. In this table the only truly significant data are the data collected at Scott City Kansas. The farmer harvested field at Scott City KS represents a whole field yield and was not replicated data.

Table 2 dryland corn yields in bulk fields planted in the P2S2 arrangement as compared to conventionally planted corn at the Akron field station. This is an average of three replications (3 fields).

Treatment	Bushels/acre
P2S2	41
Conventional	19
P>F	0.13

RESULTS: There exist a trend for greater yields with the alternative planting arrangements at Akron but the effect is not statistically significant at a probability level of 5% (Table 1). Only at

Scott City Kansas do we have a highly significant affect due to planting arrangement. At Scott City, the alternative planting arrangements produced significantly greater yields than conventionally planted corn. At Akron, population did not significantly affect corn yields. Because population did not influence yield we averaged across population to evaluate planting architecture effects. In the split field comparisons, the P2S2 planted corn had higher yields in each field. The increase ranged from 8 to 27 bushels in favor of the P2S2 corn over the conventionally planted corn (Table 2). Bob Klein, Alex Pavlista and Dr. Alan Schlegal conducted similar experiments, at Trenton, Ogalala, and ScottsBluf, Nebraska and at Tribune Kansas in 2005. In those studies, the skip-row corn in the P2S2 and P1S1 arrangements were 10-12 bushels better than the conventionally planted corn. Yields were between 64 and 74 bushels (averaged across 4 replications) for the skip row corn and about 53 bushel for the conventional corn at Trenton and at Ogalala. At Tribune and at Scottsbluf yields were between 80 and 92 bushels with no trend for an advantage or disadvantage with planting arrangement. With Grain sorghum both P2S2 and P1S1 had significantly greater yields than the conventionally planted grain sorghum at either population of 20,000 or 40,000 plants/acre (Table 4).

Table 3. Skip row corn at Trenton, Ogalala and Scottsbluf, Nebraska (Bob Klien, Alex Pavlista, Drew Lyon: University of Nebraska), and at Tribune, Kansas (Dr Alan Schlegal Kansas State University at Tribune) in 2005. Yields are the average of four replications.

Treatment	Trenton	Ogalala	Tribune	Scottsbluf
	bushels/acre			
P2S2	74	64	81	87
P1S1	66	65	84	92
P2S1	63	46	80	82
Conventional	53	52	85	86
P>F	0.001	0.001	0.73	0.17

Table 4. Skip row Grain sorghum at Akron Colorado in 2005. Yields are an average of 4 replications.

Treatment	Bushels /acre
P2S2	53
P1S1	57
Conventional	19
P>F	0.0001

SUMMARY: There exists a trend for the alternative planting arrangements to yield higher than conventionally planted corn and sorghum. In a preliminary analysis, it seems as though the alternative planting arrangements are showing an advantage if you are in the 40-75 bushel yield range, but do not show a disadvantage or an advantage if yields potentials are greater than this up to at least 90 bushels (Table 3). An analysis of these data would suggest, that the alternative planting arrangements show potential for greater yields in dryer areas and/or in dry years where yields are less than 75 bushel.

Low yield due to extreme drought may be overshadowing advantages or disadvantages of planting arrangements at some locations (particularly at Akron with corn). Because of this, we need to repeat the research a few more years to sort out if dryland corn and sorghum will consistently perform better when planted skip-row. In 2006, we will take detailed measurements of soil water depletion to further evaluate the system. We have added an additional population of 8,000 plants per acre and are using the system on our bulk acres at the 12,000 plants per acre planting rate. There is some concern regarding the "plant two, skip two arrangement" in that you have 90 inches of space

for weeds to grow and for the wind to blow after the corn is done. However that has not been a problem in our plots at Akron or at Scott City Kansas. The best methods for fertilizer placement and weed control in skip-row are still being researched. We also question what should be the optimal distance to skip between the paired rows. What is "magic" about a 90 inch gap? This summer (2006) we have experiments for skip-row corn, sunflowers, and sorghum. In these studies we hope to learn about the benefits and pitfalls from these alternative planting methods.

When it does work, Why does it work? We suspect that it has to do with the timing of water availability to the crop. You don't have more water in a skip-row field at planting time than in a conventionally planted field. All you have changed with the skip-row technique is the timing of water use. The small plants in the planted rows, in the skip-row field, will use all of the water that is in the immediate vicinity of where they are growing, but are not "big enough" (don't have the roots development yet) to get to the water in the skip area when they are small. However, as they approach maturity, the plants are large enough to get to the reserve of water in the middles of the skip-row area. The key point here is the critical moisture demand period for corn development is during silking and pollination. Because these crops are sensitive to drought during flowering the water reserve in the skip-row area tends to counteract the drought that commonly occurs during flowering in the CGPR. In a conventional planting, where the plants are more evenly distributed in the field, soil water is used as the plants grow and is depleted earlier in the season (corn plants just don't plan for the future very well). The skip-row method ensures that some water will still be left in the soil profile for the crop during that critical period at pollination. That extra water reserve then can result in better corn yields with the skip-row technique at yield potentials common for the dryer portions of the CGPR.