Tillage and Cropping Sequence Effects on Yields and Nitrogen Use Efficiency

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Conservation tillage practices have rapidly been adopted over the past decade, especially in the southeastern and midwestern United States. Because of cost effectiveness, improved moisture storage, etc., certain conservation tillage practices may be adaptable to portions of the southwestern United States. Fertilizer requirements for conservation tillage may be different from conventional practices, particularly in drier regions. The objectives of the reported study were to determine the effects of several cropping sequences of grain sorghum, wheat, and soybeans and conventional and no-ti11 practices on crop yields and N use efficiency.

Materials and Methods

Several cropping sequences receiving varying N rates were established on a Ships clay - Norwood silt loam intergrade in Burleson county in 1983 (Table 1). The statistical design was a split plot within randomized complete blocks (4 replicates) with sequence serving as the main plot and tillage-fertilizer combinations constituting split plots. The study was organized so that each crop in each sequence was represented every year. Wheat-soybeans were doublecropped while the sorghum-wheat-soybeans sequence represented 3 crops produced every 2 years. Cultivars used were NK Pro 812 wheat, Funks G522DR sorghum, and Ransom soybeans. Wheat was planted in early December following the soybean harvest, while sorghum was planted in late March and soybeans in late May or early June subsequent to wheat harvest. No-till treatments were planted with a no-till drill, while conventional treatments were planted with a standard row planter. Herbicides used were propazine on sorghum and alachlor on soybeans. Paraquat was added along with the above herbicides for burn-down on no-till plots. Wheat received no herbicide. Nitrogen treatments for wheat were split into 2 topdress treatments and were applied in mid-December and mid-February. Nitrogen as NH_4NO_3 was knifed into beds of conventional sorghum in late February, while N treatments for no-till sorghum were surface broadcast following sorghum emergence in April. Each plot was 12.2 x 4 in. Row spacing for sorghum and soybeans was 1 m, while wheat was planted on 18 cm centers. Yield samples for corn and sorghum were cut from 3 m of the middle 2 rows of each plot, while a 12.2 x 1 m swath from the center of each plot was used to estimate wheat yields. Grain samples from each plot were ground, dried, and digested for total Kjeldahl N. Results from 1984 will be presented, as appropriate tillage treatments had been established for one full year prior to the 1984 cropping year. Results were statistically analyzed by analysis of variance and reyression techniques.

Results and Discussion

Cropping sequence influenced the yields of all crops in 1984, while tillage effects varied with the specific crop and cropping sequence. Hard red winter wheat production was affected by cropping sequence, with continuous wheat producing the most grain, followed by the wheat-soybean doublecrop and the sorghum-wheat-soybean doublecrop (Table 2 and 3). Wheat yields from the sorghum-wheat-soybean sequence were analyzed separately from the other sequences since wheat in this sequence relied only on residual nitrogen applied to sorghum. Residual nitrogen following sorghum was generally not sufficient for optimal wheat yields and N rates corresponding to the other wheat sequences were applied to wheat in this sequence in 1985. The winter of 1983 and spring of 1984 were unusually dry. Monocrop wheat produced the highest yields probably because of greater available soil water as compared with doublecrop treatments. Tillage treatment did not significantly influence wheat yields with continuous wheat or the wheat-soybeans doublecrop,. but no-till did increase wheat yields in the sorghum-wheat-soybeans rotation. Soybeans normally are not harvested in this location until late November. Since the winter and spring were unusually dry, little difference in soil moisture storage would be expected between tillage treatment in the wheat-soybeans doublecrop. Sorghum is harvested by mid-July and presents a greater potential for differences in soil water storage from early fall rains that might be attributed to varying methods of residue management.

Cropping sequence influenced grain sorghum yields in 1984, with continuous sorghum producing significantly more grain than the sorghum-wheat-soybean rotation (Table 4). Conventional tillage sorghum outperformed no-ti11 sorghum when averaged across cropping sequences. Nitrogen treatments were topdressed on no-ti11 sorghum, while N was subsurface knifed in conventional tillage plots. No rainfall was received for six weeks after topdressing the no-till plots, resulting in poorer early season growth and nitrogen uptake and demonstrates that surface applying N for no-ti11 warm season crops may not be practical under drier climatic conditions.

A significant cropping sequence x tillage interaction was noted for soybeans. Therefore, tillage means were compared within cropping sequence (Table 51. The wheat-soybean doublecrop produced the greatest mean yield, followed by continuous soybeans and the sorghum-wheat-soybean rotation. No-till increased yields, though not statistically, in the first two cropping sequences and significantly improved yields in the sorghum-wheat-soybean rotation. It was noted that both wheat and soybeans following sorghum have decreased yields as compared to other cropping sequences.

Applied N increased grain yields of both wheat and sorghum. Continuous wheat responsed to applied N more than wheat in the wheat-soybean doublecrop, presumably due to differences in available soil water (Fig. 1). Nitrogen applied to no-ti11 wheat was also more effective in improving grain yield as compared to conventional tillage plots (Fig. 2). Conventional tillage sorghum utilized applied N more effectively than no-ti11 sorghum in 1984 (Fig. 31. Some of the difference was attributed to topdressing versus knifing the added N, as previously discussed. Conventional tillage sorghum produced greater yields than no-till, even with no applied N, implying that nutrient cycling may be significantly slower under no-till conditions. Applied N was a more important determinant of grain yield in continuous as compared to rotational sorghum (Fig. 4), implying greater soil water available to the monocrop or greater depletion of other nutrients by the doublecrop rotation.

Conclusions

1) Cropping sequence influenced the yields of all crops studied.
2) The effect of tillage on crop yields varied with crop and cropping sequence.
3) Cropping sequence and tillage also altered crop response to applied N.

Table 1. Cropping sequences and nitrogen fertilization rates.

Crop Sequence	N Applied to:	N Rate, kg ha $^{-1}$
Continuous Wheat	Wheat	0, 34, 68, 102
Wheat-Soybeans	Wheat	0, 34, 68, 102
Continuous Soybeans	-----	-----
Sorghum-Wheat-Soybeans	Sorghum	0, 45, 90, 135
Continuous Sorghum	Sorghum	0, 45, 90, 135

Table 2. Cropping sequences and tillage effects on wheat grain yields, 1984.

Treatment	Grain yield
	kg ha $^{-1}$
Sequence	
Continuous wheat	3688 a †
Wheat-soybean doublecrop	2610 b
Tillage	
No-till	3244 a
Conventional till	3054 a

† Values within a treatment parameter followed by the same letter are not different by LSD (0.05)

Table 3. Tillage effects on wheat grain yields in sorghum-wheat-soybeans cropping sequence, 1984.

Tillage Treatment	Grain yield
	kg ha $^{-1}$
No-till	2531 a †
Conventional till	1691 b

† Values followed by the same letter are not different by LSD (0.05).

Table 4. Cropping sequence and tillage effects on grain sorghum yield, 1984.

Treatment	Grain yield
	kg ha $^{-1}$
Sequence	
Continuous sorghum	5087 a †
Sorghum-wheat-soybeans	4512 b
Tillage	
Conventional till	5044 a
No-till	4555 b

† Values within a treatment parameter followed by the same letter are not different by LSD (0.05).

Table 5. Crop sequence x tillage interaction on soybean yields, 1984.

Sequence	Tillage	Grain yield
		kg ha $^{-1}$
Wheat-soybeans	Conventional	3722 a †
	No-till	3493 a
Continuous soybeans	No-till	3501 a
	Conventional	3388 a
Sorghum-wheat-soybeans	No-till	3434 a
	Conventional	2844 b

† Values within a crop sequence followed by the same letter are not different by LSD (0.05).

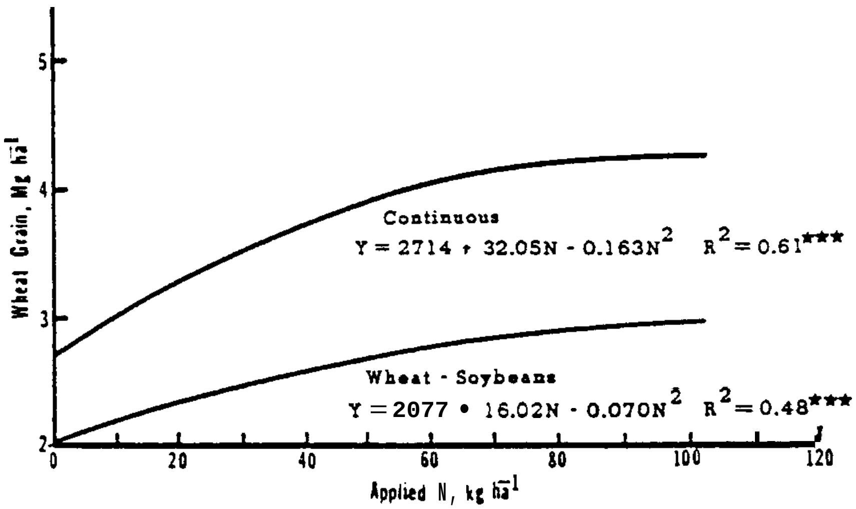

Figure 1. Applied N effect on wheat yields in monocrop and doublecrop sequences.

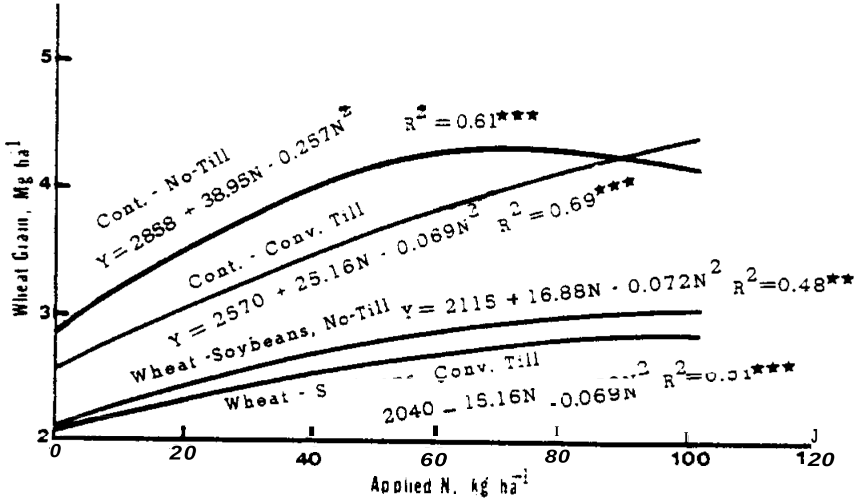

Figure 2. Wheat response to applied N as modified by crop sequence and tillage.

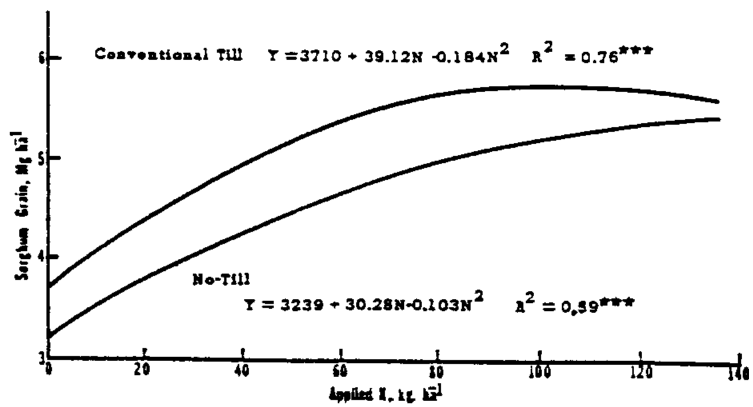

Figure 3. Tillage effect on the response of sorghum to applied N.

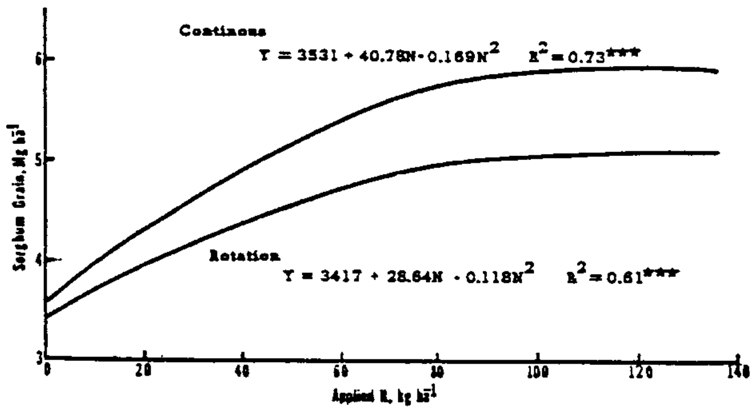

Figure 4. Effect of crop sequence on the response of sorghum to applied N.