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Starter Fertilizer, Additives, and Growth Regulators in Cotton Production: An Economic Analysis

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INTERPRETIVE SUMMARY

Producers and researchers are evaluating plant growth regulators and starter fertilizers applied in-furrow to determine whether they improve cotton yields. Existing research on these products for cotton is limited and often conflicting. In addition, no economic analysis exists for this area. The present research was conducted to evaluate the profitability of selected rates of Asset RTU (ready to use) applied in-furrow, compared with those of PGR-IV, a low rate of ammonium polyphosphate (11-37-0), and Asset for cotton that is produced in disk-till and no-till production systems.

For cotton produced on highly erosive soils, conservation tillage production systems are recommended. The soil environment is affected by the residues and/or winter cover normally used for erosion control, which leads to restricted water evaporation and a reduction in soil temperatures. These conditions can cause a reduction in seed germination, plant vigor, root growth, and yields, and may increase pathogen activity. Two commercial products reported to improve root growth and ultimately increase yields, PGR-IV and Asset RTU, were evaluated for cotton produced in disk-till and no-till systems.

Research was conducted in 1996 and 1997 on a Loring silt loam at the Milan Experiment Station, Tennessee. The in-furrow treatments were (i) ammonium polyphosphate (11-37-0) applied at 32 oz acre^{-1}; (ii) 11-37-0 and Asset (Helena Chemical Company, Memphis, TN) co-applied at 32 and 2 oz acre^{-1}, respectively; Asset RTU (Helena Chemical) applied at (iii) 16, (iv) 24, and (v) 32 oz acre^{-1}; (vi) PGR-IV (Micro Flo Co., Memphis, TN) applied at 1 oz acre^{-1} in-furrow at planting followed by a foliar application of 4 oz acre^{-1} at pinhead square and repeated in 7 d; (vii) an untreated check. For treatments (i) and (ii), rates of 11-37-0 and Asset were selected to simulate those of Asset RTU. All treatments were applied to disk-till and no-till cotton, and each tillage system was treated as a separate experiment.

Cotton cultivars Deltapine 50 and Deltapine 5409 were planted by mid-May of 1996 and 1997, respectively. Plots were 30 ft long by four 40-in rows.

Yield means, net-revenue means, and break-even cotton lint prices were calculated for the data collected. The application of Asset RTU at 32 oz acre^{-1} in-furrow at planting in the disk-till system earned higher yield and net-revenue means than other treatments; however, this treatment was not significantly different from Asset RTU applied at 24 oz acre^{-1}. For the no-till system, Asset RTU applied at 32 and 24 oz acre^{-1} and 11-37-0 produced similar yield means that were both greater than those of PGR-IV and the check.

Regardless of the tillage system, all but one of the break-even cotton lint prices for comparisons between any two treatments were more than two standard deviations from the mean cotton lint price of \$0.63 lb^{-1}. This variability suggests that a producer's decision about which material to apply is little affected by fluctuations in the cotton lint price. Furthermore, break-even cost differences between any two treatments were many times greater than budgeted cost differences, which suggests that economically based decisions among the treatments evaluated in this research are not likely to be affected by reasonably expected future cost changes.

The PGR-IV treatment would not likely be economically preferred by producers for either tillage system due to high material costs without

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adequate increases in yields and net-revenues. Break-even cotton lint prices more than two standard deviations from the mean price and large break-even cost differences with other treatments suggest that PGR-IV likely will not become an economically viable choice for cotton producers. These results will help cotton producers make decisions about starter fertilizers, fertilizer additives, and plant growth regulators for their tillage systems.

ABSTRACT

Data from field research conducted in 1996 and 1997 on a Loring silt loam (fine-silty, mixed, active, thermic, Oxyaquic Fragiudalf) were used for economic evaluation of plant growth regulators and fertilizer additives in cotton (*Gossypium hirsutum* L.) production. Disk-till and no-till treatments applied in-furrow at planting included ammonium polyphosphate (11-16-0) applied at 2.33 L ha^{-1}; 11-16-0 + Asset applied at 2.33 and 0.15 L ha^{-1}, respectively; Asset RTU applied at 1.17, 1.75, and 2.33 L ha^{-1}; PGR-IV applied at 0.07 L ha^{-1} followed by two foliar applications of 0.29 L ha^{-1} each; and a check. For the disk-till system, Asset RTU applied at 2.33 L ha^{-1} produced higher yield and net-revenue means than did all other treatments except Asset RTU applied at 1.75 L ha^{-1}. Asset RTU applied at 2.33 L ha^{-1} produced higher yield and net-revenue means than PGR-IV and the check for the no-till system. The PGR-IV treatment would not be economically preferred by producers for either tillage system due to higher material costs without adequate increases in yields and net-revenues. All but one of the break-even cotton lint prices for comparisons between treatments were more than two standard deviations from the mean cotton lint price of $1.38 kg^{-1}, which suggests that a producer's decision about which material to apply is not sensitive to fluctuations in cotton lint price. Furthermore, break-even cost differences between any two treatments were many times greater than budgeted cost differences, suggesting that economic choices among the treatments are not sensitive to reasonably expected future cost changes. These results will help cotton producers make decisions about starter fertilizers, fertilizer additives, and plant growth regulators for their tillage systems.

Producers and researchers are evaluating plant growth regulators and starter fertilizers applied in-furrow to determine whether they improve cotton yields. Relatively little multiyear research that evaluates in-furrow applications of plant growth regulators has been published. Published data indicate considerable variation in the effect of plant growth regulators on yields (Howard et al., 2001). Oosterhuis and Guo (1994) have suggested the need for additional research before they could recommend the widespread application of commercial plant growth regulator materials.

Bradley (1995) recommends conservation tillage systems for cotton produced on highly erosive soils. Crop residues and winter covers used to control erosion affect the soil environment by restricting water evaporation and reducing soil temperatures. These conditions affect seed germination, stand establishment, and plant vigor, and they provide favorable environmental conditions for increased pathogen activity (Chambers, 1995). In certain years yields have been reduced, possibly from the restricted root growth that is attributed to the growing conditions associated with conservation production systems (Bradley, 1995). Early-season plant development may be enhanced through the use of plant growth regulators and starter fertilizers to improve root growth and plant vigor, although research that has evaluated in-furrow applications of plant growth regulators and starter fertilizers for cotton has produced conflicting yield results (Howard et al., 2001). Two products reported to improve root growth are PGR-IV (Oosterhuis and Zhao, 1993) and Asset RTU (J.M. Thomas, Helena Chemical, personal communication, 2000). Basset (1999) reported that the application of 2.33 L ha^{-1} of Asset RTU in-furrow improved germination and emergence in one of two years but concluded that yields were not enhanced by the Asset RTU treatments.

Information is needed about the profitability of in-furrow fertilizer additives and/or plant growth regulators on cotton. The objective of this research was to evaluate net-revenues and break-even cotton lint prices to determine the profitability of in-furrow application of 11-16-0, Asset, Asset RTU (Helena Chemical Co., Memphis, TN), and PGR-IV (Micro-Flo, Memphis, TN) to cotton production in disk-till and no-till systems.

Asset is a proprietary fertilizer additive that contains 2% water soluble Mg, which is derived from magnesium ammonium carboxylate (Helena Chemical, 1997a). Asset RTU is a pre-mixed 6-20-5 plant nutrient solution that also contains

0.02% B, 0.05% Cu, 0.1% chelated Fe, 0.05% chelated Mn, 0.0005% Mo, and 0.05% chelated Zn (Helena Chemical, 1997b). PGR-IV is a solution that contains 0.0028% indolebutyric acid and 0.003% gibberellic acid (Micro Flo, 1997).

MATERIALS AND METHODS

Research was conducted in 1996 and 1997 on a Loring silt loam (fine-silty, mixed, active, thermic, Oxyaquic Fragiudalf) at the Milan Experiment Station, Tennessee. Individual plots were 9.1 m long by four 1.02-m rows. Mehlich-I extractable P and K were high at 70 and 230 kg ha^{-1}, respectively (Extension Plant and Soil Science, 2000). The experimental design was a randomized complete block with five replications. The in-furrow treatments were (i) ammonium polyphosphate (11-16-0) applied at 2.33 L ha^{-1}; (ii) 11-16-0 and Asset[1] co-applied at 2.33 L ha^{-1} and 0.15 L ha^{-1}, respectively; Asset RTU applied at (iii) 1.17, (iv) 1.75, and (v) 2.33 L ha^{-1}; (vi) PGR-IV applied at 0.07 L ha^{-1} at planting followed with a foliar application of 0.29 L ha^{-1} at pinhead square and repeated in 7 d; and (vii) an untreated check (Howard et al., 2001). For treatments (i) and (ii), rates of 11-16-0 and Asset were selected to approximately simulate Asset RTU. All treatments were applied to disk-till and no-till cotton, and each tillage system was treated as a separate experiment. Fertilizer was applied to the tilled system immediately before planting, then the plot was disked twice to a depth of 10 cm. Fertilizer was also applied to no-till plots before planting. All plots were uniformly fertilized annually with 80, 20, and 56 kg ha^{-1} of N, P, and K, respectively (Howard et al., 2001). Broadcast fertilizer material included ammonium nitrate, triple superphosphate, and potassium chloride.

Deltapine 50 and Deltapine 5409 were planted in 1996 and 1997, respectively. They were planted the last week of April, but in 1997 the plots were replanted 13 May and treatments were reapplied. Before planting, winter vegetation was killed with a tank mix of burn-down chemicals; weeds were controlled as needed (Howard et al., 2001). Additional recommended practices (insecticides, defoliants, etc.) were used for production each year (Shelby, 1996).

Partial budgeting was used to estimate net-revenue differences among the six treatments because it provided a method for calculating the expected change in net revenue through the consideration of only those revenue and cost items that changed from treatment to treatment (Boehlje and Eidman, 1984).

Expected gross revenue differences were calculated by multiplying the average Tennessee cotton lint price of \$1.38 Kg^{-1} that farmers received 1995 through 1999 (Tennessee Department of Agriculture, 2000) by the differences in 2-yr yield means (1996 and 1997) between treatments. Material costs were calculated by multiplying the quantities of 11-16-0, Asset, Asset RTU, and PGR-IV by their respective prices. The price of 11-16-0 in autumn 2000 was \$0.38 L^{-1}, according to the Tennessee Farmers Cooperative (J. Duke, personal communication, 2000). Helena Chemical Company (M. Powell, personal communication, 2000) provided concurrent prices for the fertilizer additives and PGR-IV: Asset was \$18.49 L^{-1}; Asset RTU was \$24.95 L^{-1}; and PGR-IV was \$50.72 L^{-1}.

Most Tennessee farmers use an 8-row cotton planter that is equipped with a liquid stacked-fold sprayer (M.A. Newman, personal communication, 2000). Use of this planter allows other in-furrow materials to be applied at planting, so the treatments evaluated in this paper were applied in-furrow with little or no additional machinery or labor costs compared to the check.

A self-propelled sprayer with an 18-m boom was assumed to have made foliar applications of PGR-IV in 2.7 min ha^{-1}. The sprayer's purchase price was assumed to be \$105,000 - its useful life, 15 yr. Additional costs included the variable costs of fuel, oil, filters, and repairs, as well as the fixed costs of depreciation, interest, insurance, and storage. A wage rate of \$6.75 h^{-1} was assumed in calculating labor costs, and hours of labor were assumed to be 1.25 times machine hours or 3.4 min ha^{-1}. This method of allocating machinery costs implicitly assumed the sprayer was fully employed on the farm, but not necessarily in cotton production (Gerloff, 2000; Roberts et al., 2000).

Sensitivity analysis was performed by calculating break-even cotton lint prices and break-even cost differences between treatments. Break-even prices were calculated that made gross revenue differences between treatments equal to

[1] The use of trade names in this publication is for clarity and does not imply approval of the product to the exclusion of others that may be of similar suitable composition, nor does it guarantee or warrant the standard of the product.

cost differences (i.e., no difference in net-revenue between treatments). They were calculated by solving $PY = C$ for P, where P was the break-even cotton lint price (\$ kg^{-1}), Y was the experimental 2-yr yield mean difference between two treatments (kg ha^{-1}), and C was the budgeted cost difference between the two treatments (Roberts et al., 2000). Break-even cotton lint prices were compared with the standard deviation (\$0.25 kg^{-1}) in lint prices from 1995 through 1999. Break-even prices estimated to exceed two standard deviations (\$0.88 to \$1.88 kg^{-1}) from the mean lint price were considered unlikely to occur in the near future. For a normal distribution, the probability that the price will be more than two standard deviations from its mean is 4.56% (Kmenta, 1986). From the above formula, break-even cost differences (C) equal net-revenue differences between treatments (PY).

The statistical analyses of lint yields and net revenues were conducted using the mixed-model procedure of the Statistical Analysis System (SAS Institute, 1997). The mixed-model procedure provides Type III F statistical values, but does not provide mean square values nor the error terms for normal mean separation. Consequently, mean separation was evaluated at a probability level of $\alpha = 0.05$ through a series of protected pair-wise contrasts among all treatments (Saxton, 1998).

RESULTS AND DISCUSSION

Budgeted costs of material and foliar application and the total cost of material and application for each treatment are presented in Table 1. As a practical matter, the in-furrow treatments would likely be co-applied with other in-furrow materials at planting, so differences in in-furrow application costs among the treatments and the check would be zero. The least expensive treatment was 11-16-0, which had a material cost of only \$0.89 ha^{-1} more than the untreated check. The material cost of 11-16-0 + Asset was budgeted at \$3.66 ha^{-1}, or \$2.77 ha^{-1} more than 11-16-0 alone. The budgeted cost of Asset RTU gradually increased as the amount applied increased. Asset RTU applied at 1.17 L ha^{-1} was estimated to cost \$7.71 ha^{-1}. Asset RTU applied at 1.75 L ha^{-1} had a cost of \$11.53 ha^{-1}, whereas the cost of Asset RTU applied at 2.33 L ha^{-1} was estimated at \$15.35 ha^{-1}. The material cost of one in-furrow and two foliar applications of PGR-IV was estimated to be \$32.97 ha^{-1}. The application cost of two foliar applications was calculated to be \$19.36 ha^{-1}, which was the sum of machinery variable (\$4.96 ha^{-1}), fixed (\$13.14 ha^{-1}), and labor (\$1.25 ha^{-1}) costs. PGR-IV was clearly the most expensive treatment and cost \$52.32 ha^{-1} more than the check.

Table 1. Budgeted costs of materials, machinery, and labor used to develop treatment cost differences for various applications of fertilizer, rates of a fertilizer additive, and a plant-growth regulator.

Cost item	Cost
	\$ ha^{-1}
Material costs	
11-16-0 (\$0.38 L^{-1} x 2.33 L ha^{-1})	0.89
Asset (\$18.49 L^{-1} x 0.15 L ha^{-1})	2.77
Asset RTU 1.17 L^{-1} (\$6.59 L^{-1} x 1.17 L ha^{-1})	7.71
Asset RTU 1.75 L^{-1} (\$6.59 L^{-1} x 1.75 L ha^{-1})	11.53
Asset RTU 2.33 L^{-1} (\$6.59 L^{-1} x 2.33 L ha^{-1})	15.35
PGR-IV [\$50.72 L^{-1} x (0.07 + 0.29 + 0.29) L ha^{-1}]	32.97
Foliar application costs for PGR-IV	
Variable machinery (\$33.54 h^{-1} x 0.074 h ha^{-1} x 2 applications)	4.96
Fixed machinery (\$88.79 h^{-1} x 0.074 h ha^{-1} x 2 applications)	13.14
Labor (\$6.75 h^{-1} x 0.074 h ha^{-1} x 1.25 x 2 applications)	1.25
Total	19.35
Material plus application costs by treatment	
11-16-0	0.89
11-16-0 + Asset	3.66
Asset RTU 1.17 L^{-1}	7.71
Asset RTU 1.75 L^{-1}	11.53
Asset RTU 2.33 L^{-1}	15.35
PGR-IV	52.32

Asset RTU applied at 2.33 L ha^{-1} consistently produced the highest yield mean in each year for both disk-till and no-till (Table 2); however, the mean of this treatment was not significantly different from all other treatment means in either year or for the 2-yr mean. The rankings of yield means for the other treatments were not consistent across years for the disk-till or no-till systems.

In a comparison of 2-yr yield means for disk-till, Asset RTU applied at 2.33 L ha^{-1} significantly increased yields (α = 0.05) relative to the 11-16-0 (7%), 11-16-0 + Asset (10%), Asset RTU applied at 1.17 L ha1 (7%), PGR-IV (6%) treatments, and the check (8%). Asset RTU applied at 1.75 L ha^{-1} increased yields by 7% relative to the 11-16-0 + Asset treatment. Other treatments were not significantly different from one another.

For no-till, Asset RTU applied at 2.33 L ha^{-1} increased yields significantly (α = 0.05) compared with 11-16-0 + Asset (5%), Asset RTU applied at 1.17 L ha^{-1} (5%), PGR-IV (12%), and the check (15%). Asset RTU applied at 1.75 L ha^{-1} increased yields by 12% compared with both the check and the PGR-IV treatment. The 11-16-0 treatment increased yields by 10% and 9% relative to the check and the PGR-IV treatment. Additional no-till treatments were not significantly different.

Annual and 2-yr net-revenue means are presented in Tables 3 and 4. Again, for disk-till (Table 3), Asset RTU applied at 2.33 L ha^{-1} consistently produced the highest net-revenue mean in each year and for the 2-yr yield mean, although its mean was not significantly different (α = 0.05) from all other treatment means in either of the two years or for the 2-yr yield mean. For no-till (Table 4), Asset RTU applied at 2.33 L ha^{-1} produced the highest net-revenue mean in 1996 and for the 2-yr average. In 1997, Asset RTU applied at 2.33 and 1.75 L ha^{-1} produced the highest net-revenue means. The rankings of net-revenue means for the other treatments were not consistent across years. For example, the PGR-IV treatment had the lowest net-revenue mean for the disk-till system in 1996, while the 11-16-0 + Asset treatment had the lowest net-revenue mean in 1997. For no-till, the PGR-IV treatment had the lowest net-revenue mean in 1996, and the check had the lowest net-revenue mean in 1997.

Tables 3 and 4 present estimated differences in net revenues (which are also break-even cost differences) and break-even cotton lint prices between pairs of treatments, based on 2-yr net-revenue means and cost differences calculated from Table 1. A positive (vs. negative) net-revenue difference indicates that the treatment in the column produced higher (vs. lower) net revenue than the treatment in the row for a cotton lint price of \$1.38 kg^{-1} and the costs reported in Table 1.

The 2-yr net-revenue means for disk-till (Table 3) followed the same pattern as the 2-yr yield means presented in Table 2. Compared with the check, Asset RTU applied at 2.33 L ha^{-1} increased net-revenue by \$132 ha^{-1} (7%). Also, Asset RTU applied at 2.33 L ha^{-1} increased net-revenue by \$117 ha^{-1} (6%) compared with 11-16-0, \$165 ha^{-1} (9%) compared with 11-16-0 + Asset, \$130 ha^{-1} (7%) compared with Asset applied at 1.17 L ha^{-1}, and \$147 ha^{-1} (8%) compared with PGR-IV. Asset RTU applied at 1.75 L ha^{-1} increased net-revenue \$111 ha^{-1} (4%) compared with the 11-16-0 + Asset treatment.

For the no-till system, 2-yr net-revenue means (Table 4) did not follow the same significance pattern as the 2-yr yield means (Table 2). Compared to the no-till check, Asset RTU applied at 2.33 and 1.75 L ha^{-1} and 11-16-0 increased net-revenue by \$222 ha^{-1} (14%), \$176 ha^{-1} (11%), and \$148 ha^{-1} (10%), respectively. Additionally, Asset

Table 2. Yield means for various applications of a starter fertilizer, fertilizer additives and PGR-IV for disk-till and no-till.

Yield mean and treatment	Check	11-16-0	11-16-0 + Asset	Asset RTU 1.17 L	Asset RTU 1.75 L	Asset RTU 2.33 L	PGR-IV
	kg ha^{-1}						
Disk-till							
1996 yield mean	1202 d†	1217 cd	1210 d	1255 bcd	1324 abc	1329 ab	1203 d
1997 yield mean	1440 ab	1448 ab	1389 bc	1400 bc	1448 ab	1526 a	1492 ab
2-yr yield mean	1321 bc	1332 bc	1300 c	1328 bc	1386 ab	1427 a	1348 bc
No-till							
1996 yield mean	1231 bcd	1296 abc	1242 bcd	1290 abc	1323 ab	1393 a	1192 cd
1997 yield mean	1013 f	1165b cde	1144 cdef	1095 def	1194 bcd	1195 abcde	1058 ef
2-yr yield mean	1122 c	1230 ab	1193 bc	1193 bc	1258 ab	1294 a	1125 c

† Yield means followed by same letter in a row are not significantly different at α = 0.05.

Table 3. Net-revenue means, net-revenue differences, and break-even cotton lint prices for various applications of a starter fertilizer, fertilizer additives, and a plant growth regulator for disk-till.

Yield mean and treatment (row)	Check	11-16-0	11-16-0 + Asset	Treatment Asset RTU 1.17 L	Asset RTU 1.75 L	Asset RTU 2.33 L	PGR-IV
	$ ha^{-1} or $ kg^{-1}						
Net-revenue							
1996 yield mean	1699 bcd†	1788 abc	1710 bcd	1773 abc	1814 ab	1907 a	1592 cd
1997 yield mean	1398 ab	1607 abc	1389 bcd	1504 cd	1636 abc	1634 abc	1407 d
2-yr yield mean	1548 bc	1697 a	1300 ab	1639 ab	1725 a	1771 a	1500 c
Check							
Net-revenue difference‡	—	14	-33	2	78	132	-15
Break-even lint prices§	—	0.08	-0.17	1.10	0.18	0.14	1.94
11-16-0							
Net-revenue difference‡		—	-48	-13	63	117	-30
Break-even lint prices§		—	-0.09	-1.71	0.20	0.15	3.22
11-16-0 + Asset							
Net-revenue difference‡			—	35	111	165	18
Break-even lint prices§			—	0.14	0.09	0.09	1.01
Asset RTU 1.17 L^{-1}							
Net-revenue difference‡				—	76	130	17
Break-even lint prices§				—	0.07	0.08	2.23
Asset RTU 1.75 L^{-1}							
Net-revenue difference‡					—	54	93
Break-even lint prices§					—	0.09	1.07
Asset RTU 2.33 L^{-1}							
Net-revenue difference‡						—	147
Break-even lint prices§						—	0.47

† Net-revenue means followed by same letter in a row are not significantly different at $\alpha = 0.05$.
‡ Two-yr net-revenue mean of treatment in column minus treatment in row. Net-revenue difference is also the break- even cost difference required for treatment in column to have equal net revenue with treatment in row.
§ Cotton lint price required for treatment in column to break even with treatment in row.

Table 4. Net-revenue means, net-revenue differences, and break-even cotton lint prices for various applications of a starter fertilizer, fertilizer additive, and a plant growth regulator for no-till.

Yield mean and treatment (row)	Check	11-16-0	11-16-0 + Asset	Treatment Asset RTU 1.17 L	Asset RTU 1.75 L	Asset RTU 2.33 L	PGR-IV
	$ ha^{-1} or $ kg^{-1}						
Net-revenue							
1996 yield mean	1699 bcd†	1788 abc	1710 bcd	1773 abc	1814 ab	1907 a	1592 cd
1997 yield mean	1398 ab	1607 abc	1389 bcd	1504 cd	1636 abc	1634 abc	1407 d
2-yr yield mean	1548 bc	1697 a	1300 ab	1639 ab	1725 a	1771 a	1500 c
Check							
Net-revenue difference‡	—	148	94	90	176	222	-48
Break-even lint prices§	—	0.01	0.05	0.11	0.08	0.09	17.44
11-16-0							
Net-revenue difference‡		—	-55	-58	28	74	-197
Break-even lint prices§		—	-0.07	-0.18	0.38	0.23	-0.49
11-16-0 + Asset							
Net-revenue difference‡			—	-3	83	129	-142
Break-even lint prices§			—	0	0.12	0.12	-0.72
Asset RTU 1.17 L^{-1}							
Net-revenue difference‡				—	86	132	-139
Break-even lint prices§				—	0.06	0.08	-0.66
Asset RTU 1.75 L^{-1}							
Net-revenue difference‡					—	46	-225
Break-even lint prices§					—	0.11	-0.31
Asset RTU 2.33 L^{-1}							
Net-revenue difference‡						—	-271
Break-even lint prices§						—	-0.22

† Net-revenue means followed by same letter in a row are not significantly different at $\alpha = 0.05$.
‡ Two-yr net-revenue mean of treatment in column minus treatment in row. Net-revenue difference is also the break- even cost difference required for treatment in column to have equal net revenue with treatment in row.
§ Cotton lint price required for treatment in column to break even with treatment in row.

RTU applied at 2.33 and 1.75 L ha^{-1}, and 11-16-0 increased net-revenue when compared to the PGR-IV treatment by \$271 ha^{-1} (18%), \$225 ha^{-1} (15%), and \$197 ha^{-1} (13%), respectively. The PGR-IV treatment provided significantly lower net-revenue than all treatments except the check.

Only one break-even lint price in Tables 3 and 4 (disk-till Asset RTU at 1.17 L ha^{-1} compared with the check) was within two standard deviations (\$0.88 to \$1.88 kg^{-1}) of the mean cotton lint price of \$1.38 kg^{-1}. Furthermore, break-even cost differences between treatments, which are equal to the net revenue differences reported in Tables 3 and 4, are all unlikely to occur in the near future. (See Table 1 to compare break-even cost differences in Tables 3 and 4 with budgeted cost differences.) These break-even lint prices and cost differences suggest that a producer’s economic choice among treatments is not sensitive to changes in lint prices and costs. For comparisons between treatments with significantly different mean yields, the break-even analysis supports the statistical analysis of net revenue means. Comparisons of net revenue means between treatments whose mean yields are not significantly different should be viewed with caution due to the influence of high yield variation on net revenues.

CONCLUSIONS

Results suggest that disk-till producers who farm a Loring silt loam (Oxyaquic Fragiudalf) may increase net revenues by in-furrow application of Asset RTU at 2.33 L ha^{-1}, while other treatments may not produce significantly higher net revenues than the check. For no-till producers, Asset RTU applied at 1.75 and 2.33 L ha^{-1} and 11-16-0 may increase net revenues compared with the check and the PGR-IV treatment. Of these three no-till treatments, Asset RTU applied at 2.33 L ha^{-1} resulted in the largest increase in net revenue of \$223 ha^{-1} compared with the untreated no-till check and \$271 ha^{-1} when compared with the PGR-IV treatment. Results suggest that PGR-IV would not be an economically sound alternative for cotton producers using either tillage system due to its higher cost without an adequate corresponding increase in yield.

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