**ABSTRACT**

Nonpoint-source pollution of surface water by the transport of sediment, N, and P in agricultural runoff is one of the nation's major water quality concerns. Consequently, concentrations and amounts of sediment, N, and P in runoff from conventional till (CT), reduced till (RT), and no till (NT), sorghum (Sorghum bicolor (L.) Moench.) watersheds in the Southern Plains, were measured during a 5-yr period to evaluate water quality impacts of sorghum culture. Mean annual sediment and total N and P loss in runoff from NT (8877, 7.28, and 2.5 kg ha⁻¹ yr⁻¹, respectively) were lower than from CT sorghum (20,500, 10.0, and 3.0 kg ha⁻¹ yr⁻¹, respectively). In contrast, tillage effects on soluble N and P losses were generally small and less consistent, although soil P concentrations exceeded limits associated with accelerated eutrophication (0.01 mg L⁻¹). Predicted losses of soluble N and particulate N and P using desorption kinetics and enrichment ratio relationships were not significantly different from measured values for all tillage practices (r² ranged from 0.66 to 0.99). Overall, conservation tillage (NT and RT) reduced sediment, N, and P transport in runoff relative to CT and thereby lessened the potential impact of sorghum culture on surface water quality in the Southern Plains.

There is a growing awareness of the importance of conserving soil and nutrients on the land to prevent nonpoint-source pollution of surface water. This is particularly important in the Southern Plains, where sediments, N, and P transport in agricultural runoff is a major concern. The use of conservation tillage practices, such as no till (NT) and reduced till (RT), can significantly reduce these losses. The study by Sharpley et al. (1991) provides a comprehensive analysis of the effects of different tillage practices on sediment, N, and P transport in sorghum (Sorghum bicolor (L.) Moench.) fields in the Southern Plains.

The authors measured annual sediment and total N and P loss in runoff from CT, RT, and NT sorghum watersheds in the Southern Plains. The results showed that NT sorghum had the lowest losses of sediment, N, and P in runoff, with NT having lower sediment and total N and P losses than CT sorghum (8877, 7.28, and 2.5 kg ha⁻¹ yr⁻¹, respectively) during a 5-yr period. The authors also used desorption kinetics and enrichment ratio relationships to predict the losses of soluble N and P, finding that these losses were generally small and less consistent across the different tillage practices.

The study highlights the importance of conservation tillage practices in reducing nonpoint-source pollution of surface water. Conservation tillage practices can decrease soil erosion and on-farm energy use, and increase water use efficiency. The authors conclude that conservation tillage (NT and RT) reduced sediment, N, and P transport in runoff relative to CT, thereby lessening the potential impact of sorghum culture on surface water quality in the Southern Plains.

The results of this study can be used to guide agricultural practices in the Southern Plains and other areas with similar environmental concerns. The findings emphasize the importance of adopting conservation practices to mitigate the impacts of nonpoint-source pollution on surface water quality.
where units of soil N and P are mg kg⁻¹ and those for sediment concentration in runoff are g L⁻¹. The ERs were predicted from soil loss (kg ha⁻¹) using the following equation developed by Sharpley (1985b):

\[
\ln(ER) = 1.21 - 0.16 \ln(\text{soil loss})
\]

This study investigates the transport of sediment, N, and P in runoff from sorghum under conservation and conventional tillage in the Southern Plains during a 5-yr period. Predictions of N and P transport in runoff using Eq. [1] to [5] are compared with measured values.

**MATERIALS AND METHODS**

**Study Area**

The 11 watersheds used in the study are representative of agricultural land under sorghum in the Southern Plains with the location characteristics and management of the watersheds summarized in Table 1. At Bushland, TX, the watersheds were in a sorghum–fallow–winter wheat rotation; at Ft. Cobb, OK, a sorghum–peanut (Arachis hypogena L.) rotation; and at Riesel, TX, a sorghum–oat (Avena sativa L.)–cotton rotation. Only the sorghum component of the rotation each year is presented for the three locations. At Bushland, RT consisted of stubble mulch tillage, with sweeps to kill weeds and leave the crop residue on the surface for wind erosion control. Conventional tillage at Ft. Cobb consisted of plowing (chisel or moldboard), followed by harrowing and disking prior to planting. At Riesel, CT consisted of chisel plowing and harrowing only. Fertilizer N and P was broadcast during harrowing in March at Ft. Cobb and in December or January at Riesel at rates determined by soil test recommendations (Table 1). An unfertilized Native Grass (NG) watershed adjacent to the sorghum watersheds at Bushland and Klein Grass (KG), Coastal Bermuda Grass (CBG), and Wintergreen Harding Grass (WHG) watersheds at Riesel are included for comparison. The major soil type on the Bushland, Ft. Cobb, and Riesel watersheds are Pullman clay loam (fine, mixed, thermic Torrertic Paleustoll), Cobb fine sandy land, Ft. Cobb, and Riesel watersheds are Pullman clay loam (fine-loamy, mixed, thermic Udic Haplustalf), and Klein Grass–Panicum coloratum L.; Coastal Bermuda grass—Cynadon dactylon L.; and Wintergreen Harding grass—Phalaris aquatica L.

Watershed runoff was measured using precalibrated flumes or weirs equipped with water level recorders, and 5 to 15 samples were collected automatically during each runoff event. The samples were composited in proportion to flow, to provide a single representative sample, which was stored at 277 K until analysis. Surface soil samples (0–50 mm depth) were collected annually in March at four sites near the flume of each watershed, composited, air dried, and sieved (2 mm).

**Chemical Analysis**

Runoff. Aliquots of each composited runoff sample were centrifuged (266 km s⁻¹ for 5 min) and filtered (0.45 μm) prior to conductivity, pH, NO₃-N, ammonium-N (NH₄-N), and SP determinations, while total Kjeldahl N (TKN) and TP were determined on unfiltered samples. Conductivity and pH were determined using a Wheatstone bridge and glass electrode, respectively. Analyses for NO₃-N, NH₄-N, and TKN concentration were made by standard automated methods described in Methods for Chemical Analysis of Waters and Wastes (USEPA, 1979). Total N (TN) was calculated as the sum of NO₃-N and TKN, and particle N (PN) as the difference between TKN and NH₄-N. Soluble P was determined using the colorimetric method of Murphy and Riley (1962), as was TP following perchloric acid digestion of unfiltered samples (O’Connor and Syers, 1975). Particulate P (PP) was calculated as the difference between TP and SP. Suspended sediment concentration of runoff was determined by gravimetric analysis following evaporation to dryness (378 K) of duplicate 250-mL aliquots of unfiltered runoff.

Soil. Available P content of surface soil was determined using the Bray-I P procedure (Bray and Kurtz, 1945) and TP was determined by digestion with perchloric acid (Olsen and Sommers, 1982). The concentration of P was measured on all neutralized filtrates of soil extracts by the method of Murphy and Riley (1962). Total N was determined by a semimicro-Kjeldahl procedure (Bremner, 1965).

Measured and predicted SP, TP, and PN concentrations in runoff were compared using linear regression analysis, analysis of variance for paired data, and standard error of the predicted value. In the latter analysis, the measured value (x) was assumed to be correct and have no error, with the standard error in the predicted value (y), representing all variability associated with the predictive equations.

**Table 1. Watershed characteristics.**

<table>
<thead>
<tr>
<th>Watershed</th>
<th>MLRA†</th>
<th>Management</th>
<th>Size</th>
<th>Approx. slope</th>
<th>Period</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ha</td>
<td>%</td>
<td></td>
<td>kg ha⁻¹ yr⁻¹</td>
</tr>
<tr>
<td>Bushland, TX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>HP</td>
<td>No till sorghum‡</td>
<td>3.0</td>
<td>1</td>
<td>1984–1988</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>Reduced till sorghum</td>
<td>2.6</td>
<td>1</td>
<td>1984–1988</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N/S</td>
<td>Native grass: idle</td>
<td>0.04</td>
<td>1</td>
<td>1978–1980</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ft. Cobb, OK</td>
<td>RRP and CT</td>
<td>Conventional till sorghum</td>
<td>2.6</td>
<td>2</td>
<td>1984–1988</td>
<td>20</td>
</tr>
<tr>
<td>FC1</td>
<td>2</td>
<td>Conventional till sorghum</td>
<td>2.1</td>
<td>2</td>
<td>1984–1988</td>
<td>20</td>
</tr>
<tr>
<td>Y6</td>
<td>BP</td>
<td>Conventional till sorghum</td>
<td>6.6</td>
<td>3</td>
<td>1976–1982</td>
<td>146</td>
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<tr>
<td>Y8</td>
<td>8</td>
<td>Conventional till sorghum</td>
<td>8.4</td>
<td>2</td>
<td>1976–1982</td>
<td>141</td>
</tr>
<tr>
<td>Y10</td>
<td>7.5</td>
<td>Conventional till sorghum</td>
<td>7.5</td>
<td>2</td>
<td>1976–1982</td>
<td>75</td>
</tr>
<tr>
<td>Y14</td>
<td>Klein grass§</td>
<td>1.08</td>
<td>1</td>
<td>1976–1982</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>W10</td>
<td>Coastal bermuda grass</td>
<td>7.97</td>
<td>2</td>
<td>1976–1982</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>SW11</td>
<td>Wintergreen Harding grass</td>
<td>2.27</td>
<td>1</td>
<td>1976–1982</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

† Major Land Resource Area: BP–Texas Blackland Prairies; CT–Cross Timbers; HP–Southern High Plains; RRP–Central Rolling Red Plains.
‡ Weed control primarily with phenoxy and glyphosate herbicides.
§ Scientific names of introduced grasses are: Klein grass–Panicum coloratum L.; Coastal Bermuda grass—Cynadon dactylon L.; and Wintergreen Harding grass—Phalaris aquatica L.

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RESULTS AND DISCUSSION

Runoff and Sediment Discharge

Mean annual runoff from NT sorghum watersheds at Bushland was significantly greater than from the RT watersheds (Table 2) because of reduced infiltration on NT resulting from increased surface sealing and decreased surface detention storage (Jones et al., 1987). At Riesel, no consistent difference in runoff volume from CT sorghum and NG watersheds was observed during the same study period (Table 2). The average mean annual rainfall during the study period at each location (540, 900, and 960 mm for Bushland, Ft. Cobb, and Riesel, respectively) was slightly greater than the 20-yr average (460, 750, and 860 mm for Bushland, Ft. Cobb, and Riesel, respectively). Consequently, runoff may be above long-term averages for the area.

Conservation tillage of sorghum reduced mean annual sediment discharge in runoff, with values of 280, 520, and 8800 kg ha⁻¹ yr⁻¹ averaged for NT, RT, and CT practices, respectively (Table 2). Although sediment discharge from NT and RT sorghum at Bushland were similar, they were significantly lower than those from CT sorghum at Ft. Cobb and Riesel (Table 2). Mean annual sediment discharge from the CT watersheds at Ft. Cobb (16 150 kg ha⁻¹ yr⁻¹) exceeded T values (4 500 kg ha⁻¹ yr⁻¹; SCS, 1979). In contrast, sediment discharge from the CT watersheds at Riesel (2 810 kg ha⁻¹ yr⁻¹) were lower than T values (11 200 kg ha⁻¹ yr⁻¹), which may be attributed to less cultivation of the soil prior to seedbed preparation and planting at Riesel compared with Ft. Cobb. As expected, mean annual discharge from NT (280 kg ha⁻¹ yr⁻¹) and RT (520 kg ha⁻¹ yr⁻¹) was appreciably lower than the T value for Pullman clay loam (11 200 kg ha⁻¹ yr⁻¹).

Nutrient Discharge

Concentration No consistent effect of tillage practice on soluble N and P concentrations in runoff from the NT and RT watersheds at Bushland was observed (Table 2). Similarly, at Riesel no difference in NH₂-N or SP concentration in runoff from CT sorghum and NG watersheds was found, although NO₃-N concentrations were greater from the former management. Concentrations of particulate nutrients, however, were significantly affected by tillage practice (Table 2). For example, mean annual particulate N (TN-NH₂-N) and PP concentration were greater in runoff from RT (6.95 and 1.86 mg L⁻¹, respectively) compared with NT sorghum (2.28 and 0.60 mg L⁻¹, respectively) at Bushland (Table 2). Particulate N and PP concentrations in runoff from CT sorghum at Riesel (5.55 and 1.82 mg L⁻¹, respectively) were also appreciably greater than from NG (1.79 and 0.31 mg L⁻¹, respectively).

Overall, pH and NO₃-N, NH₂-N, and SP concentrations in runoff were greater than those in rainfall at each location (Table 2). It is apparent that the buffering capacity of the area soils increased the pH of rainfall/runoff water during contact with surface soil.

From an environmental standpoint, NO₃-N concentrations (Table 2) were less than 10 and 100 mg L⁻¹, considered acceptable levels for human and livestock consumption, respectively (USEPA, 1973). In general, NH₂-N concentrations were below limits of 0.5 and 2.5 mg L⁻¹ recommended for human consumption and fish survival (USEPA, 1973). Soluble and TP concentrations in runoff (Table 2) were consistently greater than critical values of 0.01 and 0.02 mg L⁻¹, respectively.

Table 2. Mean annual sediment discharge, runoff volume, flow-weighted N and P concentration, conductivity, and pH of surface runoff and rainfall.

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Management</th>
<th>Events</th>
<th>Sediment discharge</th>
<th>Runoff volume</th>
<th>NO₃-N</th>
<th>NH₂-N</th>
<th>Total N</th>
<th>Soluble P</th>
<th>Total P</th>
<th>Conductivity</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bushland, TX</td>
<td>NT</td>
<td>18</td>
<td>280a</td>
<td>3.13a</td>
<td>1.27a</td>
<td>0.18a</td>
<td>2.46a</td>
<td>0.22a</td>
<td>0.82a</td>
<td>76a</td>
<td>7.62a</td>
</tr>
<tr>
<td></td>
<td>RT</td>
<td>13</td>
<td>520a</td>
<td>2.12a</td>
<td>2.17a</td>
<td>0.36a</td>
<td>7.31a</td>
<td>0.19a</td>
<td>2.05a</td>
<td>71a</td>
<td>7.49a</td>
</tr>
<tr>
<td></td>
<td>NG</td>
<td>4</td>
<td>60</td>
<td>1.20</td>
<td>0.50</td>
<td>1.23</td>
<td>4.40</td>
<td>0.67</td>
<td>0.78</td>
<td>-§</td>
<td>-</td>
</tr>
<tr>
<td>Rain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.44</td>
<td>1.01</td>
<td>0.04</td>
<td></td>
<td>41</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>Ft. Cobb, OK</td>
<td>CT</td>
<td>18</td>
<td>21190</td>
<td>14.95</td>
<td>0.66</td>
<td>0.08</td>
<td>12.09</td>
<td>0.19</td>
<td>3.85</td>
<td>39</td>
<td>7.26</td>
</tr>
<tr>
<td>FC1</td>
<td>CT</td>
<td>6</td>
<td>8600</td>
<td>7.85</td>
<td>0.61</td>
<td>0.09</td>
<td>12.55</td>
<td>0.21</td>
<td>3.91</td>
<td>44</td>
<td>7.53</td>
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<tr>
<td>FC2</td>
<td>CT</td>
<td>6</td>
<td>16150b</td>
<td>12.11b</td>
<td>0.64a</td>
<td>0.08a</td>
<td>12.27b</td>
<td>0.20a</td>
<td>3.87b</td>
<td>41b</td>
<td>7.37a</td>
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<tr>
<td>Mean†</td>
<td></td>
<td></td>
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<td></td>
<td>0.37</td>
<td>0.33</td>
<td>-</td>
<td>0.01</td>
<td>-</td>
<td>58</td>
<td>5.9</td>
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<tr>
<td>Rain</td>
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<tr>
<td>Riesel, TX</td>
<td>CT</td>
<td>3</td>
<td>610</td>
<td>6.65</td>
<td>2.35</td>
<td>0.40</td>
<td>4.69</td>
<td>0.05</td>
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<td>Y6</td>
<td>CT</td>
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<td>2230</td>
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<td>3.87</td>
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<td>1.34</td>
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<td>15.54</td>
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<td>CT</td>
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<td>600</td>
<td>15.17</td>
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<td>0.12a</td>
<td>5.67a</td>
<td>0.07a</td>
<td>1.89a</td>
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<td>Y14</td>
<td>KG</td>
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<td>0.19</td>
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<td>0.36</td>
<td>0.98</td>
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</tr>
<tr>
<td>SW11</td>
<td>WHG</td>
<td>27</td>
<td>520a</td>
<td>13.15b</td>
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<td>0.45a</td>
<td>2.24a</td>
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<tr>
<td>Mean</td>
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<td></td>
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</tr>
</tbody>
</table>

† Means for a given water quality parameter followed by the same letter are not significantly different between tillage treatments at the 5% level as determined by analysis of variance and Duncan’s Multiple Range test.
‡ Data from Smith et al. (1983). As these data are from a different period, they have not been included in the statistical analysis.
§ Not determined.
† Means calculated for similar land management at a given location.
off sediment decreased as sediment concentration of
respectively (Table 3). The TN and PP content of run-
NT, and 30 and 70% from NG at Bushland and Riesel,
with sediment compared with 89% from RT, 71% from
ample, 95% of the mean annual TP loss was associated
appreciably greater for CT than RT and NT. For ex-
proportion of N and P lost in particulate form was
RT and NT than from CT sorghum (Table 3). The
lower annual SP losses in runoff than input in rainfall,
unfertilized watersheds at Bushland had consistently
no difference between tillage practices. While only the
amounts of SP showed
from CT sorghum at Ft. Cobb and Riesel were greater
from NT and RT sorghum at Bushland
and Ft. Cobb watersheds as irrigation water.

Lab., 1954). At the present time, no salt damage to
crop yields (Branson et al., 1975; U.S. Salinity
ductivity of runoff was observed (Table 2). Conduc-
tivity is frequently used as an index of total soluble
salt concentration, an important criterion of irrigation
water quality, because high salinity levels (generally
when conductivity exceeds 8 000 dS m$^{-1}\times 10^3$) can
reduce crop yields (Branson et al., 1975; U.S. Salinity
Lab., 1954). At the present time, no salt damage to
crops would result from the use of runoff from Bush-
land and Ft. Cobb watersheds as irrigation water.

Amount. Mean annual amounts of NO$_3$-N in runoff
from CT sorghum at Ft. Cobb and Riesel were greater
than losses from NT and RT sorghum at Bushland
(Table 3). In contrast, annual amounts of SP showed
no difference between tillage practices. While only the
unfertilized watersheds at Bushland had consistently
lower annual SP losses in runoff than input in rainfall,
NO$_3$-N and NH$_4$-N input in rainfall was conserved at
each location (Table 3).

Annual TN and PP losses were lower in runoff from
RT and NT than from CT sorghum (Table 3). The propor-
tion of N and P lost in particulate form was appreciably
greater for CT than RT and NT. For example, 95% of the mean annual TP loss was associated
with sediment compared with 89% from RT, 71% from
NT, and 30 and 70% from NG at Bushland and Riesel,
respectively (Table 3). The TN and PP content of run-
of sediment decreased as sediment concentration of
individual runoff events increased for all watersheds and locations (Fig. 1). This can be attributed to an
increased transport of silt-sized (2–20 μm) particles of
lower P content than finer clay-sized (<2 μm) particles
as sediment concentration of runoff increases. The
logarithmic relationship between sediment concentration
and N and P content of runoff sediment shown in Fig.
1 was similar for all management practices. The de-
crease in TN content of runoff sediment, however, was
greater than that of PP for a given increase in sediment
concentration, as represented by regression slope val-
ues for TN (~0.36) and PP (~0.30). This difference
between TN and PP may result from the fact that TN
is mainly of organic origin and will, thus, be lighter
than PP, which is comprised mainly of P sorbed by
sediment material. Knoblauch et al. (1942) and Neal
(1944) obtained higher ERs for organic matter (4.31)
and TN (4.12) than for TP (1.84) in runoff from Col-
lington sandy loam in New Jersey. Recently, Sharpley
(1985) reported ERs of 2.00 and 1.56 for organic C
and clay in runoff from several soils using simulated
rainfall.

Direct estimation of fertilizer N and P loss in runoff
is difficult due to unaccountable losses from native soil
sources. Although nutrient losses in runoff from CT
sorghum at Ft. Cobb may constitute a modest eco-
omic loss to the farmer, the data indicate that trans-
port from all management practices can be of envi-
ronmental concern.

Prediction

The concentration of SP, PP, and TN of individual
runoff events was predicted using Eq. [1] through [5],
soil loss, Bray-IP, TP, and TN content of surface soil
before runoff. Using these predicted concentrations
and runoff volume, annual SP, PP, and TN losses were
calculated. Measured and predicted mean annual
amounts of SP and PP in runoff were not significantly

<table>
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<th>Watershed</th>
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<th>NO$_3$-N</th>
<th>NH$_4$-N</th>
<th>Particulate N</th>
<th>Total N</th>
<th>Soluble P</th>
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†Means for a given water quality parameter followed by the same letter are not significantly different between tillage treatments at the 5% level as determined by analysis of variance and Duncan's multiple range test.
different (at 1% level) for all management practices with $r^2$ values ranging from 0.62 to 0.99 (Fig. 2). Total N transport was also accurately predicted, with $r^2$ values of 0.93, 0.94, 0.66, and 0.95 for correlations between measured and predicted loss from CT, RT, NT, and NG watersheds, respectively (data not presented). Prediction errors for SP, PP, and TN were 0.03, 0.22, and 1.32 kg ha$^{-1}$ yr$^{-1}$, respectively, representing 18, 17, and 27% of measured mean annual losses, respectively.

Earlier testing of Eq. [5] showed that the relationship between soil loss and ER varied between watersheds (Sharpley et al., 1985). Consequently, making slope and intercept of Eq. [5] a function of factors affecting soil loss or runoff energy such as rainfall intensity, vegetative cover, and management should improve ER prediction and, thereby, N and P transport in runoff. This improvement will be of particular importance for TN where prediction errors were greater than for SP and PP.

**CONCLUSIONS**

Conservation tillage was more effective in reducing sediment and associated N and P loss than soluble nutrient loss. Annual soluble N and P loss, however, was generally small compared with rainfall and fertilizer inputs. Although N transport from sorghum culture under all tillage practices posed no water quality problems at the present time, P loss in runoff was greater than limits recognized as stimulating accelerated eutrophication of surface waters (0.01 and 0.02 mg L$^{-1}$ for soluble and total P, respectively). Limits were exceeded even for unfertilized native grass watersheds, emphasizing the difficulty in attaining or maintaining these P limits in runoff from any conservation or conventional tillage practice.

Losses of soluble and total N and P from sorghum (Table 3) were of the same order of magnitude as from winter wheat culture in the Southern Plains (<3, 1, 20, 1, and 5 kg ha$^{-1}$ yr$^{-1}$ for NO$_3$-N, NH$_4$-N, TN, SP, and TP, respectively) (Smith et al., 1990). Apparently, the lack of surface soil cover associated with sorghum culture, during the winter months of high rainfall potential, did not dramatically affect sediment and nutrient loss in runoff compared with winter wheat.

No evidence of NO$_3$-N build-up in the soil profile (0–180 cm) or in the groundwater on the Ft. Cobb watersheds was found by Smith et al. (1987). Wells are being constructed at the study watersheds to sample groundwater, however, in order to monitor future impacts of agricultural management practice on the N and P content of groundwater.

**REFERENCES**


Conservation or reduced tillage wheat cultural practices continue to increase in usage (Christensen and Norris, 1983; Follett et al., 1987). These practices, which maintain wheat residues at or near the soil surface, can reduce seedbed preparation time, enhance soil conservation, and increase soil profile water storage during the summer fallow period (Johnston et al., 1981; Unger and McCalla, 1980). Consequently, these practices have several attractive features from an agronomic standpoint. Adoption of the practices, however, has created a concurrent need for more detailed information on associated surface runoff and groundwater quality (Crosson, 1981). Relative to the more humid areas, water quality information regarding conservation tillage in the Southern Plains is particularly sparse. The few studies to date, have considered water quality impacts only in a general sense (e.g., Berg et al., 1988; Smith et al., 1987). Moreover, studies encompassing the combined effects of tillage on both surface runoff and groundwater quality are lacking. In the present study, surface and groundwater quality impacts associated with wheat cultural practices are considered for the High Plain, Reddish Prairie, and Rolling Red Plain land resource areas of Oklahoma and Texas. During the 4 to 6 yr study periods, RT and NT practices were superior to CT for reducing sediment and associated particulate nutrient discharge. Mean annual discharge ranged from 230 to 15 900 kg ha⁻¹ for sediment, 1 to 27 kg ha⁻¹ for total N, and 0.1 to 6 kg ha⁻¹ for total P. Irrespective of tillage practice, annual soluble nutrient losses in surface runoff water tended to be small, often < 1 kg ha⁻¹ N or P. Successful prediction of soluble P, particulate P, and particulate N losses was achieved using appropriate kinetic desorption and enrichment ratio procedures. Soluble N in runoff posed no particular water quality problem, but recommended P levels were exceeded, even from baseline, unfertilized grassland watersheds. With regard to groundwater quality, elevated levels of NO₃ (e.g., S. J. Smith, A. N. Sharpley, J. W. Naney, W. A. Berg, and O. R. Jones

**ABSTRACT**

Water quality information regarding wheat culture in the Southern Plains is sparse. The objective of this study is to determine the extent to which the area’s surface and ground-water quality is influenced by different wheat cultural practices. Concentrations and amounts of sediment, N and P in surface runoff water were determined for conventional till (CT), reduced till (RT), and no till (NT) wheat (Triticum aestivum L.) watersheds in the High Plain, Reddish Prairie, and Rolling Red Plain land resource areas of Oklahoma and Texas. During the 4 to 6 yr study periods, RT and NT practices were superior to CT for reducing sediment and associated particulate nutrient discharge. Mean annual discharge ranged from 230 to 15 900 kg ha⁻¹ for sediment, 1 to 27 kg ha⁻¹ for total N, and 0.1 to 6 kg ha⁻¹ for total P. Irrespective of tillage practice, annual soluble nutrient losses in surface runoff water tended to be small, often < 1 kg ha⁻¹ N or P. Successful prediction of soluble P, particulate P, and particulate N losses was achieved using appropriate kinetic desorption and enrichment ratio procedures. Soluble N in runoff posed no particular water quality problem, but recommended P levels were exceeded, even from baseline, unfertilized grassland watersheds. With regard to groundwater quality, elevated levels of NO₃ (e.g., 34 mg N L⁻¹ maximum) were observed on one Reddish Prairie NT watershed.