K A N S A S

# Best Management Practices to Minimize Phosphorus Runoff Losses from Cropland

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Cropland runoff losses of P occur in particulate and soluble P forms. Particulate P is that associated with the sediment and organic particles in the runoff water. Generally, it accounts for most of the total cropland P being lost. It is the form of P in runoff from cropland which is the most difficult to discern as to its impact on water quality.

The soluble form of P is that which is dissolved in the solution phase of the runoff water. It is usually a much smaller quantity compared to the particulate P portion, but it is nearly all readily useable P and it can have an immediate and significant impact on water quality.

The key to preventing cropland P runoff losses is the control of runoff, the prevention of soil erosion, and the placement of P-containing fertilizers and manures to keep the P concentration in the near-surface soil zones as low as possible.

Research indicates that placement of fertilizer and manure containing phosphorus (P) deeper below the surface can be an important practice for reducing bioavailable P losses.

Cropping systems, such as no-till, which loosen very little soil at the surface and incorporate very little crop residue, are one of the most effective means for reducing soil losses. Many fields must use no-till to meet conservation compliance requirements. No-till provides essentially no opportunity for incorporating P fertilizers and manures. When these P containing materials are surface applied, P accumulates and remains in the near-surface soil zone. So while no-till might effectively reduce particulate P losses, it might accentuate soluble P losses. The solution is to place P fertilizers and manures deeper, below the critical interface zone (approximately the top one-inch of soil). Use of no-till on some soils and under certain environmental conditions can nearly eliminate runoff, while in other situations no-till may result in similar or increased

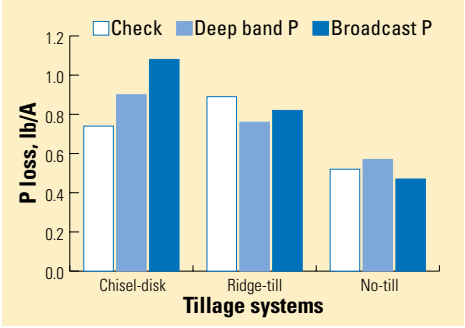


**Figure 1.** Particulate P losses as influenced by tillage and P placement, 3-year average, Kansas.

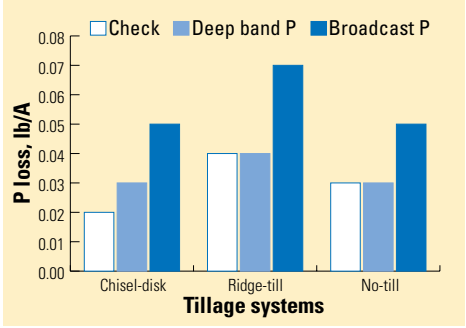


**Figure 2.** Bioavailable particulate P losses as influenced by tillage and P placement, 3-year average, Kansas.

runoff compared to tilled soils.

From a water quality perspective, there needs to be a balanced control of all forms of cropland P losses.

## Kansas Research

Recent research in Kansas confirms the importance of injecting P fertilizers in conservation tillage systems and the incorporation of P fertilizers in tilled systems for best overall protection of surface water.

Research was conducted during 1995-1997 on a somewhat poorly drained, 1.5 percent sloped soil to measure the effects of tillage and P fertilizer placement on soil erosion and bioavailable P losses in runoff water. Bioavailable P is that which is useable by aquatic plants. It includes basically all of the soluble P in runoff water and a portion of the particulate P. Bioavailable P was measured by the FeO-strip method. The tillage and fertilizer systems evaluated were a chisel-disk-field cultivated system, a ridge-till system, and a no-till system. Fertilizer treatments were a P check, 50 lb $P_2O_5$/A surface broadcast, and 50 lb $P_2O_5$/A preplant, deep-banded (coulter-knifed at approximately 4-inch depth on 15-inch centers). Runoff from natural rainfall was collected during three grain sorghum fertilization and planting periods, 1995-1997.

## Runoff and Soil Loss

Total runoff varied with rainfall, tillage systems, and years. Runoff, on average, was highest in ridge-till and no-till. Chisel-disk produced the least runoff. This was because tillage in the chisel-disk system loosened and dried the soil prior to some rainfall events which increased infiltration and reduced runoff. The amount of rainfall that ran off was 18 percent for the chisel-disk system, 32 percent for the ridge-till system, and 30 percent for the no-till system. Soil losses followed the pattern chisel-disk > ridge-till > no-till. On average, soil losses were 0.8 ton/A for chisel-disk, 0.6 ton/A for ridge-till, and 0.3 ton/A for no-till. Compared to chisel-disk, ridge-till lowered soil losses by 25 percent and no-till by 60 percent.

## Phosphorus Losses

Losses of P in the runoff water also varied with rainfall, tillage systems, and years, but P fertilizer placement had the most effect. Particulate P losses on average were highest for chisel-disk and ridge-till and lowest in no-till (**Figure 1**). These differences generally parallel soil losses, since most of the particulate P losses were sediment-associated. The FeO-extractable P showed that roughly 5 percent of particulate P was bioavailable (**Figure 2**). Soluble P losses were highest with no-till followed by ridge-till and chisel-disk (**Figure 3**). Loss of soluble P in chisel-disk was least because of the incorporation of broadcast P. In ridge-till, where fertilizer P was only partially covered by shaving of the ridge at planting, soluble P losses were moderate. In no-till, where broadcast P remained exposed on the soil surface, soluble P losses were nearly six times greater than in the control. In contrast, deep-banded P increased soluble P losses

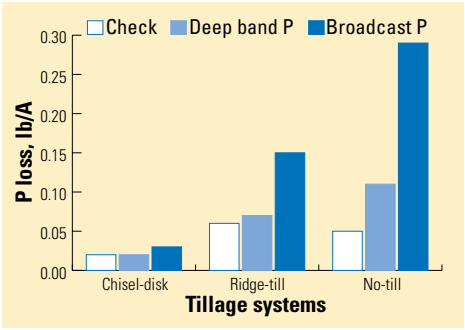


**Figure 3.** Soluble P losses as influenced by tillage and P placement, 3-year average, Kansas.

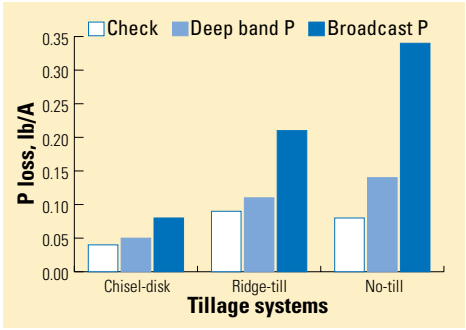


**Figure 4.** Total bioavailable P losses as influenced by tillage and P placement, 3-year average, Kansas.

only slightly over the control in all of the tillage systems.

Total bioavailable P losses (**Figure 4**) followed the same general pattern of loss as that for soluble P. This was because nearly all of the bioavailable P that was lost was in the form of soluble P. Under conditions with more soil loss, the percentage of contribution of bioavailable P from particulate P would likely have been greater. Nearly all of the bioavailable P that was lost occurred during the first couple of runoff events after the P fertilizer was applied. This pattern of P loss suggests that broadcast P should be incorporated before first runoff occurs.

The results of this study suggest that on fields where conservation tillage systems do not significantly reduce runoff, fertilizer P needs to be subsurface applied to prevent elevated levels of bioavailable P losses. In tilled systems, fertilizer P should be subsurface applied or incorporated before first runoff occurs.

The following are some cropland BMPs that can help minimize P losses in surface water runoff:

- subsurface apply or incorporate P fertilizer and manure prior to first runoff
- avoid surface soil buildup of soil test P
- periodically invert P-stratified soils
- use conservation tillage, terraces, contour farming, grass waterways, vegetative filter strips, cover crops, and other impoundments where appropriate to reduce runoff and soil loss. BC

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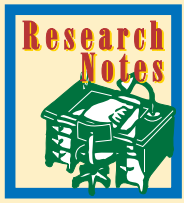


## *Quebec: Phytotoxicity of Banded Urea Amended with Triple Superphosphate and Potassium Chloride*

Laboratory and field experiments were conducted to study the phytotoxicity of banded urea amended with triple superphosphate (TSP) and muriate of potash (KCl). In the laboratory, three soils were used to evaluate the effects of band placement of four rates of TSP and two rates of KCl on corn germination and growth compared to an unfertilized control. Field experiments were conducted on two soils, using two rates of urea and three rates of TSP, either compacted or blended. Results were as follows.

- In the laboratory, ammonia, nitrite and pH decreased with TSP and KCl, due to delayed hydrolysis of urea.
- Soil electrical conductivity (EC) increased with KCl, but was not affected by TSP.
- Corn growth decreased with increased soil ammonia concentration and EC.
- In the field study, corn germination increased with banded TSP and decreased with banded urea at day 10 after planting. No difference was found at day 20.
- Compacted mixtures of urea and TSP...compared to blended mixtures at the same phosphorus (P) rate... increased corn germination, growth, nitrogen (N) uptake, and yield.

Researchers concluded that compaction of urea and TSP might provide an effective way to improve the efficiency of banded urea for corn production. BC

*Source: Agron. J. 90:734-739 (1998)*