# FERTILIZER PLACEMENT CONSIDERATIONS FOR CONSERVATION TILLAGE

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## Introduction

The environment surrounding plant roots is extremely complex and variable. For example, it is not uncommon for the surface one to two inches of soil to be very dry while very wet conditions exist at deeper areas within the root zone. Surface soil temperatures may differ by 20 °F or more from that observed at deeper layers within the rooting zone. A zone of compactions causes by wheel traffic may create very different conditions on one side of a crop row compared to the other side where no traffic occurs. The environmental variations occurring in the root zone tend to be much greater than those which occur above ground. To most effectively understand crop response to fertility practices, we should understand how crop root systems respond to the soil environmental conditions. This is particularly true with conservation tillage systems, because we tend to create more soil environmental variability with conservation tillage than we do with conventional tillage systems.

## Tillage and the Soil Environment

Conservation tillage creates a different soil environment than that which commonly occurs with conventional tillage. Due to surface plant residue, soil temperatures tend to remain cooler during the spring warm-up. Soil water contents tend to be higher, particularly near the soil surface. Depending on traffic patterns and tillage tools used, compaction patterns may be more prevalent. With less soil mixing, fertilizer applied nutrients tend to become more concentrated in the zone of application.

Conservation tillage systems tend to create a more nonuniform soil environment than that which occurs with conventional tillage systems. This nonuniform condition may affect total root growth and root growth patterns. In general, total root growth in a nonuniform soil environment will be similar to that occurring in a uniform one. However, plants tend to grow a disproportionate amount of root mass in the most favorable portion of the rooting zone, reducing the quantity of roots in the zone least favorable for growth (Russell, 1977). This evolved survival mechanism is called root growth compensation.

## Tillage, Root Growth, and Fertilization

Two tillage systems which have the potential to create the most nonuniform soil environmental conditions are ridge tillage and no-till. By design, the ridge system results in a warm row area and cool interrow area. Wheel traffic is ideally confined to the interrow area creating a compacted area to one side of the row and likely an untrafficked area to the opposite side. The ridge will be drier than the interrow area. The most favorable root growth zone is in and below the ridge and in the interrow zone not compacted by wheel traffic. Fertilizer applications should be directed to the zones favoring root growth. Applications in the cool wet interrow zone subjected to wheel traffic will likely be less efficiently used than applications to preferred root growth zones.

No-till management has the potential to create spatial variations similar to those occurring for ridge tillage, depending upon how surface plant residue is managed. Clearing residue from the row zone will create a relatively warm and dry zone in the row compared to zones under the residue. This management practice favors rapid early plant growth and root growth in the row zone area. If plant residue remains spread uniformly on the soil surface, horizontal root growth patterns will be similar to that occurring with conventional tillage except root growth tends to be shallower. No-till conditions keep the surface soil moist for the longer period of time than conventional tillage conditions and as a result, root growth can and does occur to a greater extent near the soil surface.

Conservation tillage practices which use a tool such as a disk or chisel plow create more uniform conditions than does ridging or no-till practices. Wheel tracks tend to be removed at least near the surface to a significant extent. Plant root growth as affected by soil temperature and water conditions is similar to root growth occurring with conventional tillage.

As tillage intensity decreases, fertility uniformity in the field also tends to decrease. Moldboard plowing followed by secondary tillage operations mix fertilizer applied nutrients quite thoroughly throughout the plow lay. Less intensive primary tillage operations, such as chiseling or disking, result in horizontally uniform distributions of broadcast fertilizers. However, nutrients tend to concentrate near the soil surface more than that occurring with more intensive tillage operations. With ridge tillage or no-till, fertility tends to build in the zone of application. Banding results in zones of high fertility assuming:

1) the row positions are reasonably fixed with time; and
2) applications are directed to the same position annually.

Surface broadcast applications tend to result in surface layer fertility increases with fertility decreases in deeper layer.

Nutrient concentration zones affect root growth. Phosphate and nitrate stimulate root growth in the zones of nutrient enrichment. Potassium does not. Thus, fertilizer concentrations near the surface will tend to stimulate root growth in this zone assuming soil moisture and temperature conditions are favorable. Banding fertilizers containing phosphate or nitrogen will likely encourage root proliferation in the application zone if the tillage system does not disturb the band and if soil fertility test levels are not high or very high. The enhanced root growth resulting from nutrient concentration favors plant survival and production.

Developing bands of fertility within a field seems to be a favorable practice for soils with low fertility, particularly when application rates are not excessive. Barber (1984) indicates that fertilizer should be concentrated in roughly one third of the soil volume for maximum uptake efficiency. If application rates are high, or high soil test levels exist, placement seems to have little effect. While one subsurface band application will not result in one third of the soil volume being fertilized, repeated applications will likely result in nutrient concentration zones considerably larger than that of a single application (this assumes that the tractor driver and applicator do not perfectly match the previous year's application - an assumption normally valid for typical application).

An additional advantage of fertilizer banding is in weed control. Weeds, similar to crop plants, respond to fertility. Banded fertilizer near the plant row in a zone favorable for crop root growth favors nutrient uptake by the crop as opposed to nutrient uptake by weeds growing randomly in the field. High fertility conditions near the soil surface spread uniformly across the field seem to favor rapid early weed growth in that many weed species germinate and grow from a shallow soil depth.

## Fertility Placement Recommendations

Consider zones which may be either favorable or unfavorable for root growth when deciding upon fertilizer placement options. If potentially unfavorable zones exist, avoid placement in these zones.

If you use no-till or ridge tillage for row crop production and soil test levels are not high, attempt to place fertilizer consistently in the same position. Banding may be preferred to broadcast applications. If tillage is more uniform across the field and/or if soil test levels are high, placement is less important. If small grains and/or forage crops are part of your rotation, fertilizer placement practices other than banding may be required.

## References

Barber, Stanley A. 1984. Soil Nutrient Bioavailability. John Wiley & Sons.

Russell, R. Scott. 1977. Plant Root Systems. Their function and interaction with the soil. McGraw-Hill Book Company.