by Dr. Stanley Barber

"There must be phosphorus uptake by half of the root system."

Dr. Stanley Barber, Purdue University distinguished professor emeritus, stresses nutrient placement as key to maximizing crop yields, during interview with Fluid Journal.

FJ: What factors affect phosphorus movement to the roots?

The main factor affecting phosphorus movement to the roots is a process called diffusion, which is simply the motion of the molecules causing phosphorus movement along a concentrated gradient to the lower level at the root surface. This is gradual. In a day, you wouldn't expect phosphorus to move more than 500ths of an inch. So it's only the phosphorus nearer the plant root that gets there. This is significant when you realize corn or soybean roots occupy a mere one percent of soil volume. The rate at which P moves is going to depend upon the soil. In high-P soils it will move faster—and farther. Since phosphorus moves in soil water, it will diffuse faster in soils that hold more water and have what we call field capacity, which holds 30 to 50 percent water. By contrast, it will move slower in sandy soils with only about 10 percent water.

FJ: What about deep placement of P in reduced tillage fields? A lot of people are thinking about it.

You're talking about subsurface placement.

FJ: Yes.

Subsurface placement will put phosphorus where the soil is moist more of the time. If it is placed below the plow layer, the soil may also be lower in phosphorus. The difficulty with this type of placement is that it may place the

phosphorus in only one percent or less of the soil volume and not enough roots will be absorbing phosphorus to be very effective for increasing yield. If five to twenty percent of the soil volume were fertilized, it could be effective; however, it may not show much benefit where surface application is also used. If it were done several times, it might fertilize enough soil to be effective.

FJ: What about nitrogen applied with phosphorus? Will it enhance P uptake, for example?

Placing nitrogen with phosphorus in the band will stimulate root growth in the fertilizer soil, since nitrogen stimulates root growth just as phosphorus does. The increased root growth increases phosphorus uptake. As the amount of root stimulation increases, the greater the difference in P or N levels between fertilized and unfertilized soil. Of course, remember, nitrogen also has its own properties. It can convert to nitrate, which can move from where it was placed. Thus, you don't have a concentrated band all the time like you do with phosphorus.

FJ: We know that nitrification inhibitors may keep nitrogen in the ammonium form longer. Could this affect root growth?

Added ammonium usually stimulates root growth in the band. Keeping nitrogen as ammonium keeps nitrogen in the band longer and should produce a greater effect on root growth and hence phosphate uptake.

FJ: What about the longevity of phosphate bands?

I've never researched this, but I would assume that the band would remain for several years. Phosphorus gradually gets fixed by the soil. The higher P concentration, such as occurs in the band, extends the time the band will be present. The longevity will also vary with the soil.

FJ: You've studied band placement for years. What do you think of surface banding versus broadcast in reduced till?

The surface banding studies of phosphorus I've done rely on enough tillage to mix it with up to 15 percent of the topsoil. This fertilizes enough soil to

be effective during plant growth. In no-till there is not enough tillage. Reduced tillage will give an intermediate amount of mixing. The benefit of banding may depend on the soil and vary from the same benefit to little benefit. It all depends on root growth stimulation in the band and the amount of roots contacting the phosphorus in the band or strip, as I often have called it.

FJ: What practical difference is there between surface and subsurface banding of P and K? How can growers take advantage of each method?

Well, I'd assume it's a matter of what type of tillage they're using and type of crop. I would expect we're talking about corn or soybeans here. There is a difference between P and K, because P stimulates root growth in the fertilized zone while K does not. With surface banding you are usually relying on tillage to mix P and K with some of the soil. With subsurface banding into an untilled soil layer there may be little mixing and not the chance for fertilizing as many roots. In subsurface applications down to 18 inches I've not had much success in increasing yield. However, there are soils where this does work and you should contact your local specialist. So the practical differences are determined by the individual situation. The grower has to account for his own particular operation and make the right choice.

FJ: Would you expand a bit on the amount of soil needing fertilization to promote best nutrient uptake. You mentioned earlier about the band occupying five percent of soil volume.

Let's put that between five and twenty percent of soil volume. You want to maximize the proportion of roots growing in the fertilized volume because plant roots have a maximum absorption rate. Increasing uptake comes by getting more roots in the fertilized volume. This has a greater effect than increasing the P or K level in a small soil volume and smaller number of roots. They're already absorbing nutrients at a maximum rate. So, fertilizing a greater volume of soil is a definite advantage to growers. They will be fertilizing a greater volume of roots. A good rule of thumb is there must be phosphorus uptake by half of the root system in order to maximize yields.

FJ: When one goes to no-till, it's difficult to say I want to fertilize five percent of the soil—or twenty percent which would be the objective. That's where the problem lies, doesn't it?

That's where the problem lies. What I'm saying is that when you're surface broadcasting in no-till you're fertilizing a pretty small volume of soil, because you're not mixing it with depth. However, you may be fertilizing five percent of the topsoil. Having all the topsoil well fertilized is the optimum situation and there will be little advantage in banding.
Fertilizing a smaller soil volume is done to use fertilizer more efficiently.

FJ: Then it's a question of patience if you want to build to levels in the five to twenty percent range. It might take the grower switching to no-till a while to get there. We 're talking a number of years.

Yes. You have to build gradually. That can span some years. Of course, don't forget, a lot of these fields that formerly had been tilled and plowed already may have been well fertilized. They could have fairly good fertility levels down into the plow layer.

FJ: But after a few years they're going to exhaust a lot of these nutrients.

That's right. It will vary by nutrient, since N and K will be depleted most rapidly.

FJ: So we're talking about a long-term program.

Yes. By banding it down in the soil in a long-term program you'll see a gradual buildup. The important thing is to fertilize a sufficient layer of soil so that it can supply the plant by stimulating enough plant root growth in the fertilized volume.

FJ: How would you manage N under no-till?

I personally haven't conducted research in this area, but there are plenty of studies showing that efficiency improves in no-till when the N is placed under the residue, not on the surface where it can volatilize.

FJ: Let's say a grower is considering a switch to no-till or reduced tillage. He has been injecting ammonia and surface broadcasting P and K. What advice would you give him?

He may have built up a good level of P and K in the soil where he has been broadcasting and tilling the soil. Using no-till, broadcast P and K will remain near the surface but residue accumulation frequently maintains soil moisture there and a favorable place for root growth and nutrient uptake. If you band fertilizer on the surface, the higher concentration will cause nutrients to move a little deeper into the soil. Where reduced tillage is used after broadcasting fertilizer, it will be mixed deeper into the soil than with no-till, and banding could be an advantage. I would say it's a question of how much of an advantage you're going to have by placing some of the P and K four or five inches into the soil. In many cases, it

may be an advantage but will vary by soil type. Quite often, however, repeating what has been used will work just as well. For the long haul, it may be to the grower's advantage to till it more deeply occasionally.

FJ: Would you say that starter fertilizer is a good way of getting some P and K down?

Yes, but not for a lot of the P and K, because it's not mixed with much soil.

FJ: Instead of thinking of it as starter, we like to think of it as planter-applied nutrients. In other words, it gives us an opportunity to get some NPK and other elements under the residue.

We've made several studies of root distribution with depth out from the row, measuring every two inches. We did this for no-till and for conventional tillage. The highest root density attained was what you might expect right in the row halfway between the plants. The next highest concentration of roots was midway between the rows, where you've got plant roots coming from both sides. A lot of people aren't aware of this.

FJ: Under those conditions, side-dressing N down the middle would be a good program, wouldn't 'it?

Yes, you don't need to put it closer to the row.

FJ: We have more and more corn growers doing a lot of sidedressing. Does that sound logical?

I would say so. You'll reach a lot of roots because corn roots tend to grow sideways as well as down. You get higher concentration of roots at mid-row even though corn rows are spaced far apart. However, when the plant doesn't grow very big you may not get that highest concentration of roots in the middle of the row. As I said before, with healthy plants, you have roots from both rows meeting in the middle.