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WHEN 1 + 1 = 3

1 + 1 = 3? No, this isn't "one weird trick" or "doctors hate this man" gimmick that plague the margins on your webpages. It's just the wonder of nature revealing itself. One thing about science is that it is surprising. It challenges your assumptions and reminds you that you are a mere mortal in a vast universe.

My universe is that of soils and plants, and specifically, how plants respond to the nutrients in the soil and in the fertilizers we apply. Most of the studies I read look at plant responses to one nutrient, and of those, nitrogen (N) gets the most attention. But occasionally, or more accurately, rarely, I come across a study that looks at two or more nutrients. And that's when the simple mathematical laws of addition don't always work.

Take a thirty-year study from Kansas. Looking at corn grain yield response on a soil that was deficient in both N and phosphorus (P). The study compared yield responses to N applied alone, P applied alone, and N and P both applied. The average increase in yield (bu/A) was 60 bu/A for N, 23 bu/A for P, but 115 bu/A for N+P. Did you see it? The wonder of nature? Let's break it down.

We might expect that when N and P were applied together, the yield response would be the same as the responses to N and P added together. Instead the response was more than that.

Increase in corn grain yield (bu/A):

N alone: 60

P alone: 23

N + P together: 60 + 23 = ~~83~~ 115

(Source: Schelegel et al. 1996. *J. Prod. Agric.* 9:114-118)

What happened was an interaction. To quote from the widely read book *Soil Fertility and Fertilizers*, "An interaction takes place when the response of two or more inputs used in combination is unequal to the sum of their individual responses." Unequal is right. The increase in yield in this study was actually 115 bu/A, which was 32 bu/A more than the sum of the yield increases from the individual nutrients. This is an example of a positive interaction.

And now a four-year study from Ohio looking at corn grain yield on a soil deficient in both N and potassium (K). The study looked at yield increases from only increasing the soil test level of K, only applying N, or doing both. The results:

Increase in corn grain yield (bu/A):

Only increasing soil test K: 2

Only applying N: 59

Increasing soil test K + applying N: 2 + 59 = ~~61~~ 95

(Source: Johnson et al. 1997. *Better Crops.* 81(2):3-5)

Again, we see the wonder of a positive interaction, where correcting two nutrient deficiencies at the same time resulted in a greater yield increase than when the responses to each nutrient were simply added together.

I've picked two examples that were great at showing 1+1=3. It doesn't always work that way. Sometimes 1+1=1, when adding two needed nutrients doesn't perform any better than just adding one (a negative interaction), and sometimes 1+1 does in fact equal 2 (no interaction). Interactions aren't guaranteed, and when they do happen, they don't always put a "3" in the universe. Sometimes you get a "1."

So often, when I hear people talking about the 4Rs, they refer to the "right source, rate, time, and place" of a single nutrient. But the way nature bends 1+1 reminds us to think more broadly and to apply the 4R principles to all nutrients that plants need and to manage them the best we can to achieve that wondrous "3."

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