Phosphorus Variability in Fields with Homestead Histories

By J.L. Kleinjan, C.G. Carlson, and D.E. Clay

Historical management practices can have a significant impact on soil test P levels. The Homestead Acts of the early 19th century resulted in the formation of 160-acre farms in South Dakota. Many of these farms had small areas where livestock were confined. When manure accumulated in or near these areas for extended periods of time, soil test P levels became higher in them than in the surrounding field. These areas of elevated P soil test levels, termed "hot spots", are still evident today and have been detected through more intensive soil sampling procedures **(Figure 1)**.

When collecting cores, avoiding areas known to have elevated levels of phosphorus (P) produces samples that are more representative of the soil test P levels present in the majority of the field.

Hot spots can affect fertility evaluations of a field. A common practice in the western Corn Belt is to take a single composite soil sample from a field to determine the average fertility level. When cores unknowingly taken from a hot spot are mixed with cores from the remainder of the field, soil test results become too elevated to accurately represent the average fertility of the majority of the field. Depending on levels present, this may result in under-fertilization of significant areas. If hot spots can be avoided during sample collection, it may be possible to more accurately represent the fertility of a field and to reduce the variability in

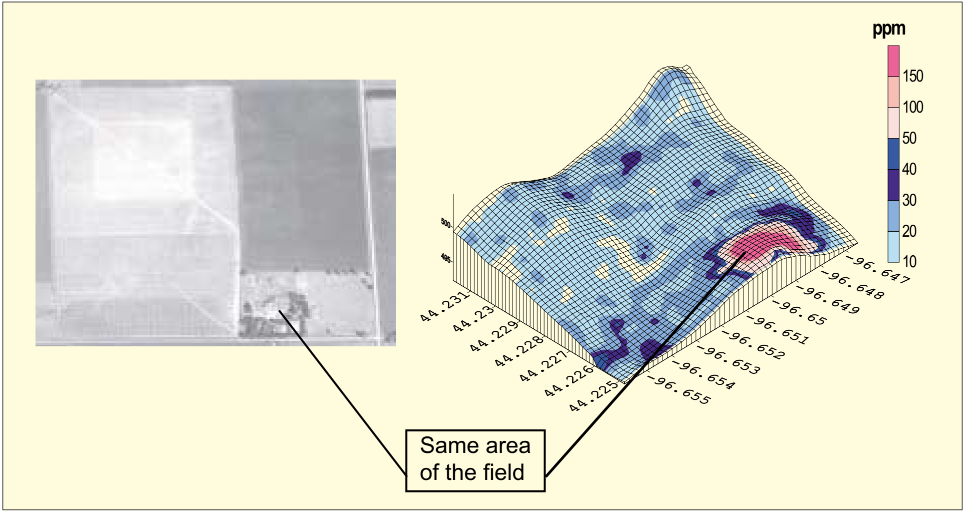

Figure 1. A 1956 historical aerial photograph showing the location of farmstead buildings now removed (left) and a map of soil test P showing elevated levels in the same approximate location (right).

TABLE 1. Proportional area and average Olsen P soil test levels for various areas within fields.

Field ID	Estimated hot spot radius, ft.	Proportion of field area, %		Average Olsen P soil test level of each area, ppm		
		Hot spot	Non hot spot	Whole field	Hot spot	Non hot spot
1	590	11	89	23.5	76.6	16.9
2	590	21	79	31.9	91.7	16.2
3	490	9	91	21.1	71.3	16.0
4	1,310	29	71	42.0	96.2	19.9
5	660	19	81	7.4	13.2	6.1
6	490	3	97	7.0	17.1	6.6
7	660	19	81	10.1	26.0	6.5
8	660	23	77	40.2	85.6	27.0
9	660	16	84	9.9	23.4	7.4
10	660	18	82	13.3	21.3	11.6
11	590	26	74	21.4	31.5	17.8
12	N/A	10	90	16.6	40.3	13.9
Average		**17**	**83**			

a set of intensive soil samples taken from it.

A study was conducted on 12 fields in six counties in eastern South Dakota (**Figure 2**). Historical information about manure applications, fertilization, tillage, and other factors affecting soil test P levels (such as livestock over-wintering) was obtained through producer correspondence and aerial imagery. Intensive soil samples (0 to 6 in.) were collected using various approaches from 1995-2000 and analyzed for Olsen P [parts per million (ppm)]. Aerial photographs from 1939 to 1984 were collected from Natural Resources Conservation Service centers. Recent (less than 10 yr. old) aerial photographs were obtained online at >**www.terraserver.com**<.

Contour maps were created of Olsen P levels in each field, using the kriging interpolation technique. An exponential decay function was used to describe the relationship

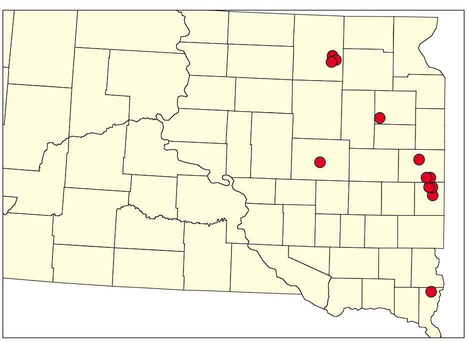

Figure 2. Location of study fields in eastern South Dakota.

between Olsen P level and distance from the center of the hot spot. The distance where the slope of the regression line decreased toward zero was taken to be the approximate cutoff point for the hot spot radius. The extent of the non hot spot area was figured by subtracting the calculated hot spot area from the total field area.

Each field studied contained a P hot spot. **Table 1** shows the porportional size of both hot spot and non hot spot areas in each field. Radii of hot spots ranged from approximately 490 to 1,310 ft., with 660 ft. being most common. Hot spots ranged from 3 to 29% of the total field area with Olsen P levels 7.1 to 76.3 ppm higher than the remainder of the field. In three of the fields (6, 7, and 9), average soil test levels from hot spots indicated no need for P fertilization, whereas average levels from non hot spot areas did.

Excluding hot spots from sampling has the potential to reduce variability in Olsen P levels, as measured by the coefficient of variation (CV). Variability in samples across the whole field was compared to variability of only non hot spot areas (**Table 2**). In all but one case (field 11), non hot spot areas were less variable than the entire field. On average, non hot spots had a CV of 55.2% compared to an average whole field CV of 95.9%.

Avoiding hot spots while sampling is critical for collecting representative samples. As shown in **Table 1**, hot spots uncovered in this study make up a minor portion of the total

TABLE 2. Coefficient of variation for samples collected across the whole field, the hot spot, and the non hot spot areas in each field.

	CV			Reduction in CV
Field ID	Whole field	Hot spot	Non hot spot	(whole field - non hot spot)
	%			
1	112.3	66.2	59.2	53.1
2	190.9	126.6	56.2	134.7
3	116.6	83.3	37.5	79.1
4	107.1	47.7	90.5	16.6
5	58.1	58.3	24.6	33.5
6	57.1	60.2	47.0	10.1
7	114.9	83.1	27.7	87.2
8	75.4	33.1	50.0	25.4
9	90.9	64.5	54.1	36.8
10	58.6	46.0	52.6	6.0
11	69.6	47.0	75.8	-6.2
12	99.4	80.1	87.1	12.3
Average	**95.9**	**66.3**	**55.2**	**40.7**

field area. However, as **Table 2** demonstrates, they contribute greatly to soil test P variability. When attempting to collect a soil sample, including cores from hot spot areas inflates results beyond what is representative of the majority of the field. Collecting cores only from the less variable non hot spot areas increases the probability that a representative sample can indeed be collected. It also increases the chances that fertilizer recommendations based on the soil sample will be appropriate for the majority of the field area.

Conclusion

Reviewing old field photos is useful for determining where farmsteads were and where high concentrations of nutrients are now likely to be. When taking a composite sample, avoiding the collection of cores in close proximity to a farmstead or abandoned farmstead will result in more representative samples and more accurate fertilizer recommendations.

Mr. Kleinjan is a research associate (e-mail: jonathan_kleinjan@sdstate.edu); Dr. Carlson (e-mail: carlson@ces.sdstate.edu) and Dr. Clay are with the Plant Science Department, South Dakota State University, Brookings.

TOOLBOX

PKalc Software Checks Nutrient Budgets

"Toolbox" is a feature on the PPI/PPIC website which holds free downloadable software tools for improved nutrient management.

One useful tool is called PKalc (v.1.13), a simple nutrient budget calculator which helps users determine if phosphorus (P) and potassium (K) nutrient additions are keeping up with removal by crops. It is an Excel spreadsheet which enables developing a multi-year, multi-crop nutrient budget. PKalc was originated as part of a project supported by a grant from USDA-Cooperative State Research, Education, and Extension Service (CSREES), through the Initiative for Future Agriculture and Food Systems (IFAFS).

Users of PKalc input crops grown and yields, plus a list of nutrients added (fertilizer and manure). The program then estimates total crop nutrient removal and calculates total nutrient additions and the resulting net budget of P and K. Default crop removal coefficients can be changed if the user prefers. The estimated net P and K budgets are intended to get farmers and their consultants thinking about whether or not fertilization programs are meeting goals.

Detailed user instructions are included as pop-up comments within the spreadsheet. A Quick Start Guide and Power Point slide set also provide background information and selected state-level data.

PKalc and other useful programs can be accessed for free at:

>**www.ppi-ppic.org/toolbox**<.