TRENDS IN SOIL TEST P AND K IN IOWA[1]

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HISTORICAL BACKGROUND

The Iowa State University Soil Testing Laboratory has provided soil test information to Iowa farmers since 1931 when Professor Firkins began the service for no charge. The predecessor of today's lab was initiated in February, 1946 (Eik[2]). The lab's records provide us with valuable information on the trends in the plant nutrient status of Iowa's soils (Figure 1).

During the period from 1960 to 1981, the consumption of nitrogen (N), phosphate (P), and potash (K) fertilizer materials rose from 7.5 million nutrient tons to a high of 23.7 million nutrient tons (Vroomen, 1987). Nearly 3 million tons, or about 28.2 percent of the total U.S. nutrient consumption of N, P, and K was applied to corn acres in 1964. By 1985, plant nutrients applied to corn more than tripled to 9.5 million tons, accounting for 43.8 percent of total plant nutrient consumption in the U.S. (Vroomen, 1987).

The dramatic increase in the quantity of fertilizer applied to corn was due to higher rates of application and an increase in the overall corn acreage. Application rates of N and K increased 140 percent and rates of P application increased 46 percent from 1964 to 1985. Corn acreage increased nearly 36 percent during the same period.

SOIL NUTRIENT TRENDS

The preceding data indicate that the fertilizer industry and farmers have done an excellent job of transferring fertilizer P and K from mines to midwest fields. Voss (1987) points out that even though crop yields and row crop acreage have increased, fertilizer P and K use has been nearly equal to or has exceeded crop removal since 1970 (Table 1). A recent summary of data from the Iowa State University Soil Testing Laboratory (Killorn, et al, 1990) indicates that the average soil tests for P and K in Iowa have increased steadily since the 1950's. From the beginning of our records until 1954 92% and 70% of the samples tested very low, low, or medium P and K, respectively (Figure 1). During the period 1986-1990 more than 70 percent of the K samples and nearly 60% of the P samples tested in the high or very high interpretational categories.

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[1]Presented at the 20th North Central Extension-Industry Soil Fertility Workshop, November 14-15, 1990, Bridgeton, MO.
[2]Dr. K. Eik, personal communication.

Table 1. Crop removal, fertilizer use and ratio of use to removal of P and K for selected years in Iowa.

Year	Crop Removal[1] P	Crop Removal[1] K	Fertilizer Use[1] P	Fertilizer Use[1] K	Use/Removal P	Use/Removal K
			------------tons--------------			
1940	65,693	179,137	1,197	732	0.018	0.004
1945	64,571	177,784	10,226	6,239	0.158	0.035
1950	73,742	205,058	23,318	12,499	0.316	0.061
1955	78,903	223,406	44,001	41,325	0.558	0.185
1960	103,263	284,027	50,631	53,815	0.490	0.189
1965	112,845	308,422	99,207	115,700	0.879	0.375
1970	125,524	341,683	180,955	288,257	1.442	0.844
1975	153,009	397,154	186,785	367,546	1.221	0.925
1980	184,200	491,339	211,765	520,689	1.090	1.060
1984	179,816	444,455	174,516	502,984	0.971	1.132
1985	206,022	483,231	161,746	446,171	0.785	0.923
1986	207,071	506,991	136,920	374,428	0.661	0.739
1987	179,800	451,615	125,846	365,195	0.700	0.890
1988	131,894	359,753	147,800	397,990	1.121	1.106
1989	187,229	455,930	132,953	385,951	0.710	0.847

[1]Removal and use are expressed in elemental P and K.
Data from R. Voss

HISTORICAL USE OF SOIL TEST DATA

The major "tool" used to increase corn yields during the past 25 years has been fertilizer. Soil test data have provided the foundation for making profitable fertilizer recommendations. The first task was to convince farmers that fertilizer would increase yields and profits. Dramatic responses to additions of fertilizer were demonstrated in the 1940's and 1950's. However, it was not until the 1960's that fertilizer usage began its dramatic increase. The increased usage was probably due to the increased yield potential of newly developed corn hybrids, more intensive row crop production, high prices for grain, and low fertilizer costs. Another factor may have the substitution of capital for labor as midwest farmers moved from farming based on a diverse mix of livestock and crops to the less labor intensive row crop farming of today. This change in cultural practices resulted in replacement of on-farm generated sources of nutrients, i.e. N from alfalfa, and N, P, and K from animal manure, with commercial fertilizers.

The soil tests in use today were developed to predict the amount of fertilizer required to produce optimum economic yields on soils that, at least in Iowa, were almost always low in both P and K (Figure 1). One major use of soil tests has been to provide data to convince farmers of the benefit of fertilizer applications. It is apparent from the data in Figure 1 that it is time to become concerned about appropriate profitable fertilizer management on high testing soils as well as on low testing soils.

The number of soils that now test in the high and very high categories force us to ask some penetrating questions about proper management. For instance, will a profitable yield response be obtained from a fertilizer application to a soil that tests high or very high? If additions of fertilizer to high and very high testing soils do not produce profitable yield increases, how long can these soils be cropped before fertilizer is again required? How long before the soil test will drop into the medium interpretational category if fertilizer is not applied? How much fertilizer must be applied to maintain a high soil test? Is it desirable to maintain a high soil test? The answers to these questions cannot be extracted from the calibration data generated in the early days of soil testing. In fact, a whole new approach is required to manage high testing soils properly.

CROP RESPONSE TO NUTRIENTS ADDED TO HIGH TESTING SOILS

Research was begun in 1974 and 1975 to answer the preceding questions (Voss, 1987). Fertilizer was added to large blocks to create high and very high levels of soil test P or K. The following year annual rates of P or K were added to simulate 0.5, 1, and 1.5 times estimated crop removal of the nutrients in a corn-soybean rotation. The results from all the sites and both nutrients show similar trends, so only results from one site are presented here.

Figure 2 shows the rate of decline of soil test P and K where no fertilizer has been added since the beginning of the study in 1975. The P soil test levels have decreased at a modest rate in this fine textured Clarion-Webster soil association. At the same time, yields have been optimum as long as the soil test remained in the high range. The same is true for the K soil test, although there tends to be more variability over time.

The effect of soil test P level on relative yields of corn and soybeans is shown in Figure 3. Relative yields were calculated by dividing all yields in a year by the highest actual mean plot yield obtained that year. The results are in percent of maximum yield. The results shown are from plots that have not received fertilizer since 1975. There is a large response when the soil test is in the very low or low range. Figure 3 also shows that soils that test in the high or very high range should yield 95 - 100% of the potential yield without additional fertilizer.

Similar results are shown for K in Figure 4. There is little effect of additional K fertilizer if the soil test is high or very high. There is a dramatic decline in yields when the soil test level falls into the very low and low ranges.

These results clearly indicate that high and very high testing soils must be managed differently than very low and low testing soils. The use of soil testing is critical to separate the "lows" and the "highs" and to help define the management required.

- THE NEXT STEP

The preceding discussion indicates that we are now dealing with two distinctly different situations that require distinctly different management. There are still many farmers with fields that test very low and low in P and K. Fertilizer is required to optimize yields in these fields. The role of the dealer will remain the same for these clients. They will require soil test information and recommendations based on solid calibration data.

Those farmers who are farming soils that test high or very high in P and K need a different kind of service. They need to develop a comprehensive soil testing program where fields are sampled at regular intervals (and probably shorter intervals than before) and a comprehensive record keeping system to keep track of trends in soil tests. A recent survey in Iowa (Padgett and Miller, 1986) indicates that nearly 70% of the soil samples are taken by local fertilizer dealers or cooperatives. Increasingly, the dealer will need to provide service to these farmers, though not always fertilizer. It will be necessary to sell this service to pay the costs. This means changing the marketing orientation for some customers from product sales to service.

Change is inevitable in the fertilizer industry. Old fertilizer practices have created a clientele with different needs than they had 25 years ago. We must be responsive to those needs and develop new programs to help them manage their fertilizer programs. In most instances this may mean providing service for a price instead of product. Still, the best tool available to help make wise decisions on fertilizer management is the soil test.

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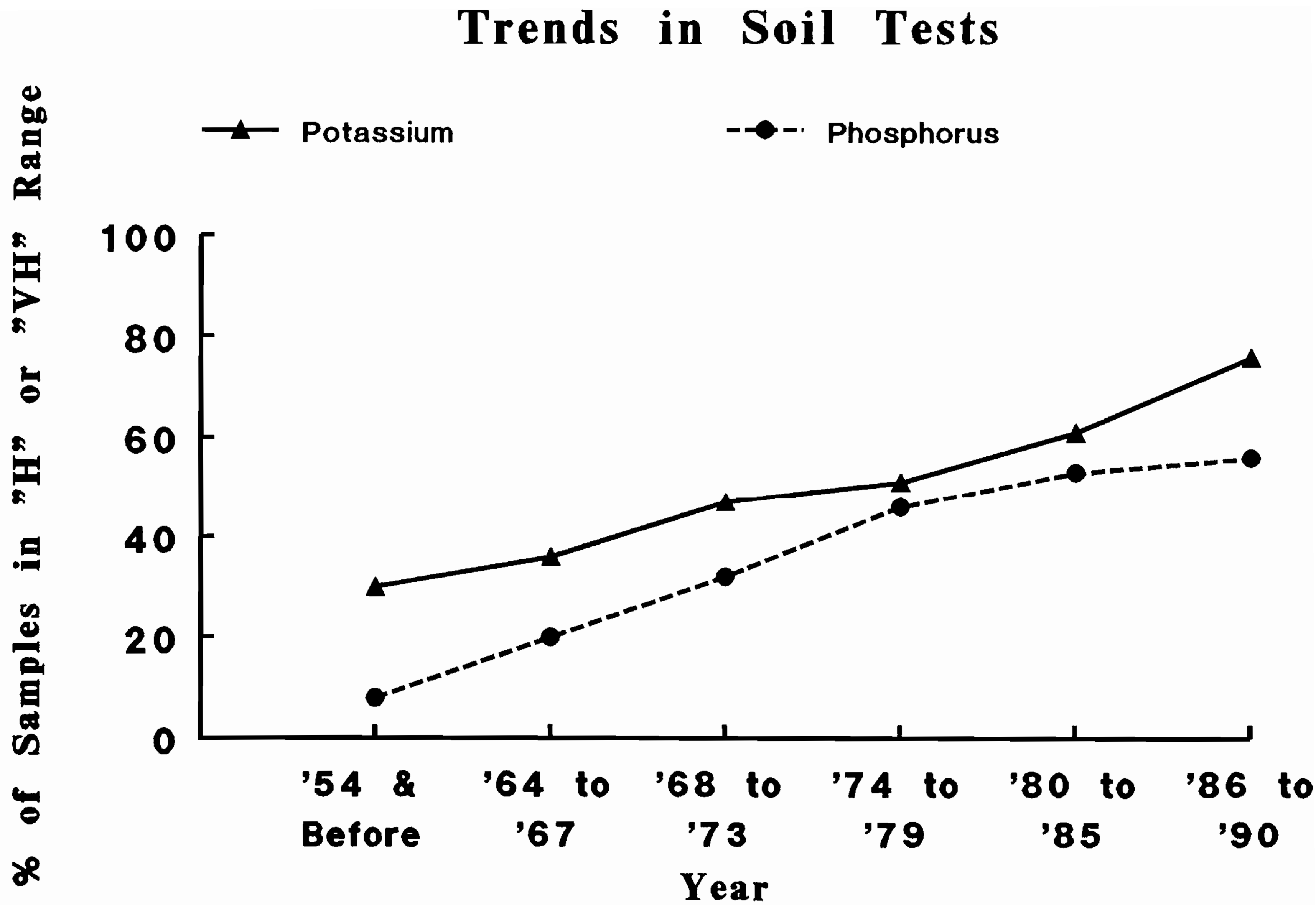


Figure 1. Trends in P and K soil tests in Iowa.

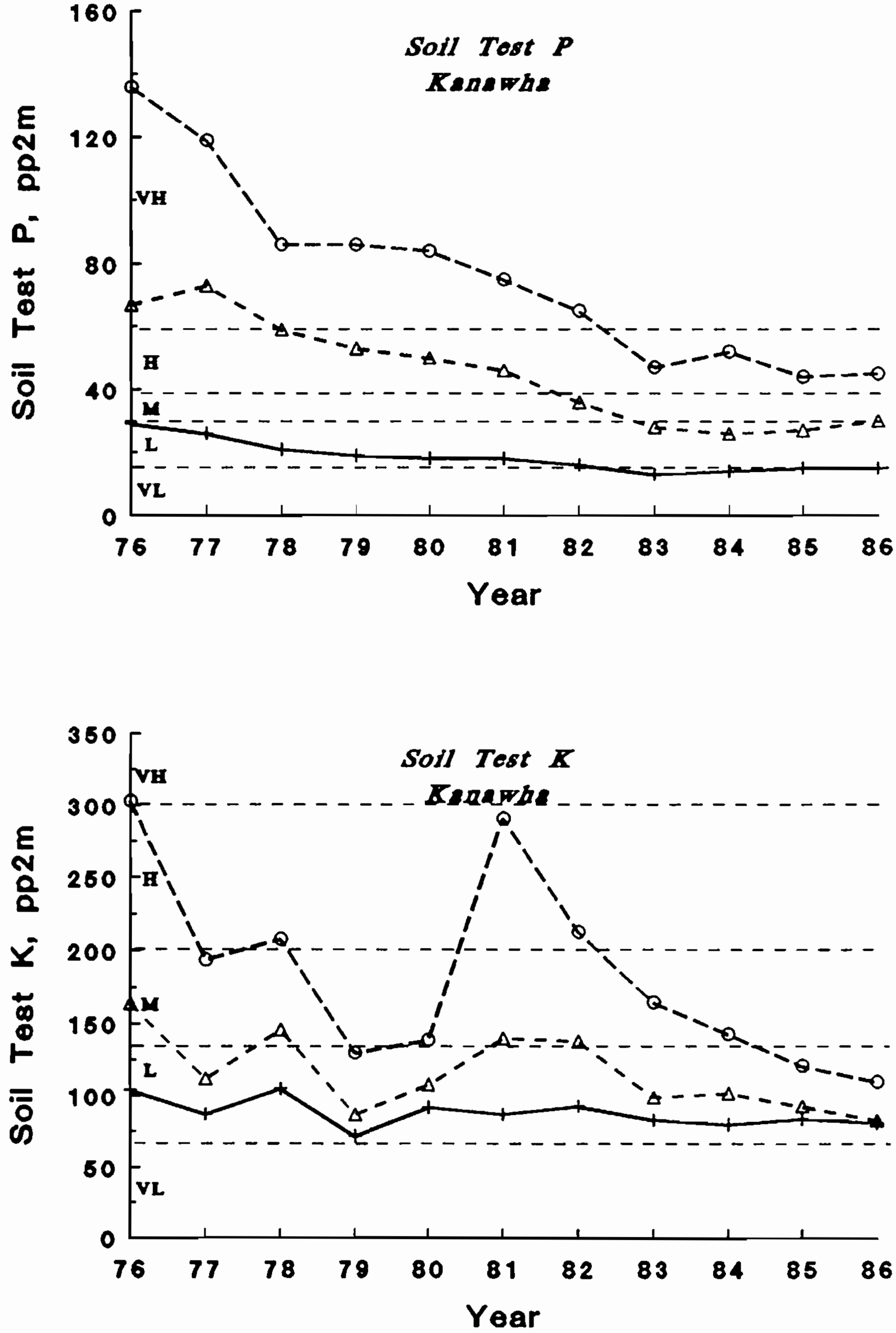


Figure 2. Decline in soil test P and K for different initial soil levels due to not applying fertilizer to a corn-soybean sequence over an 11 year period (from Voss, 1987).

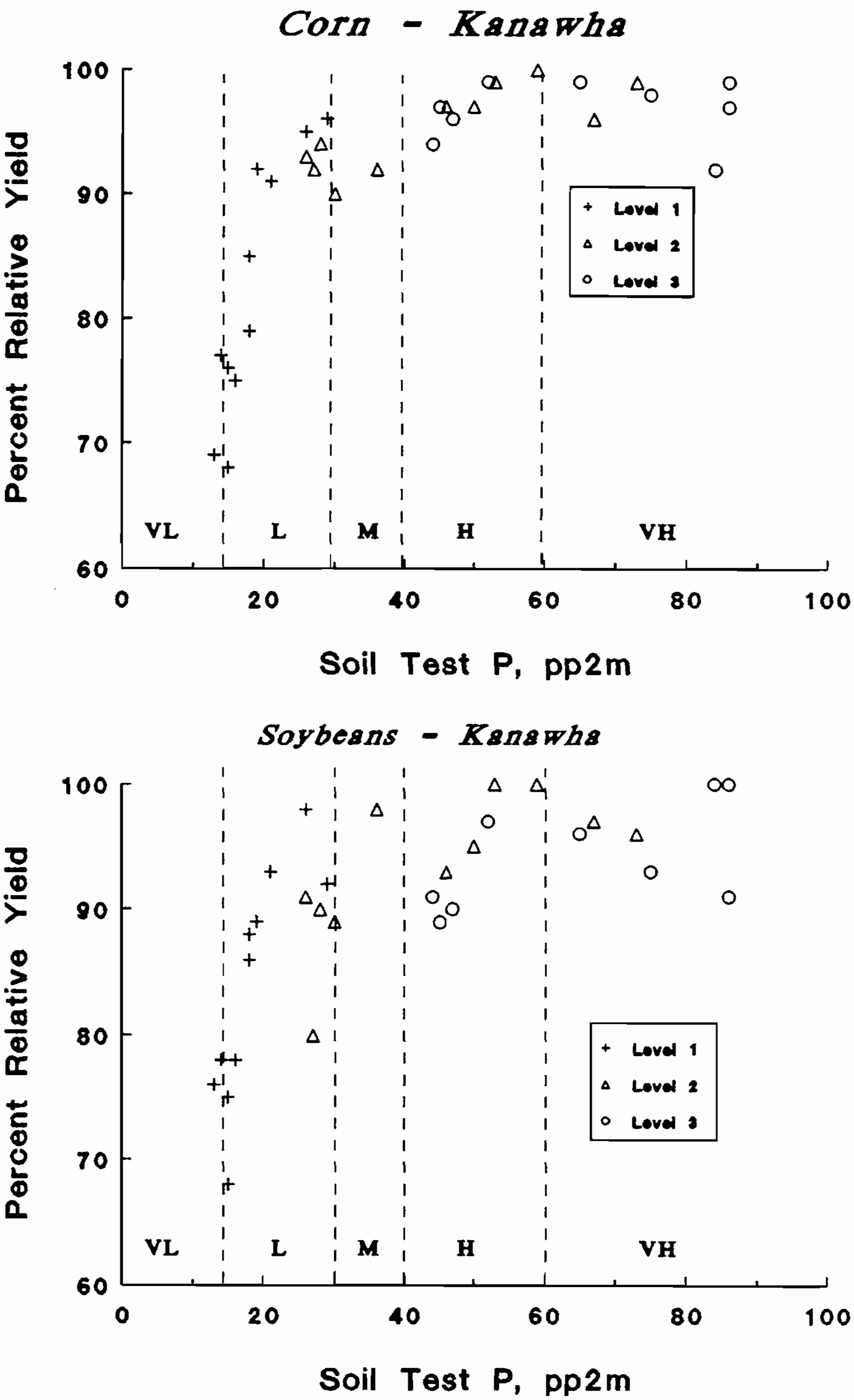
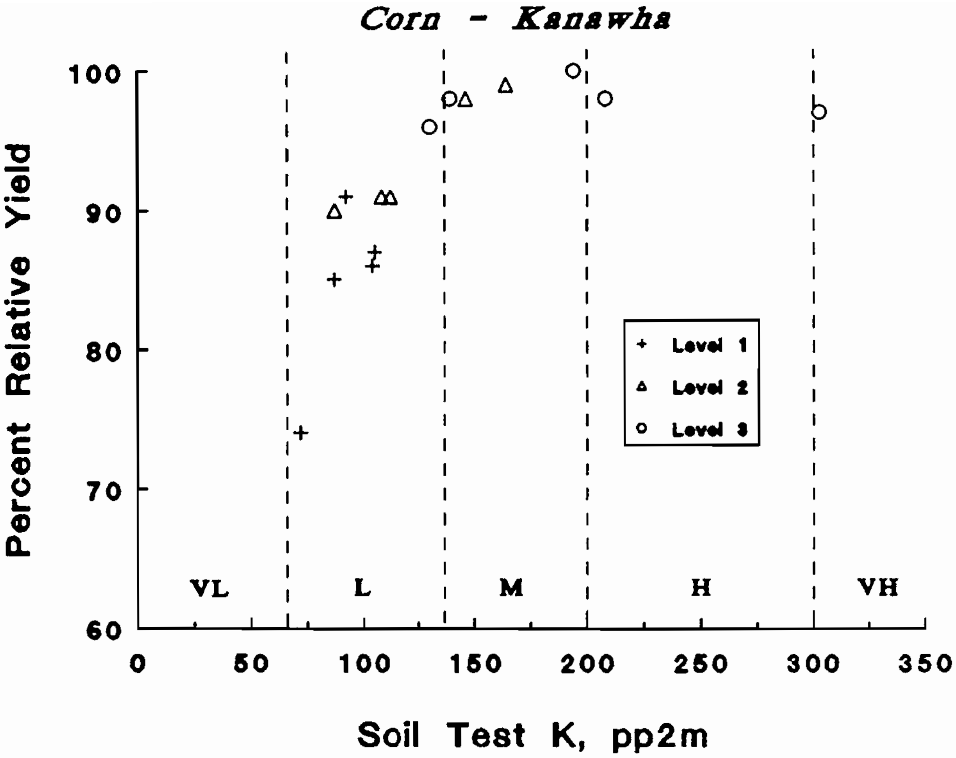


Figure 3. Effect of P soil test level on percent relative corn and soybean yields over an 11 year period (from Voss, 1987).



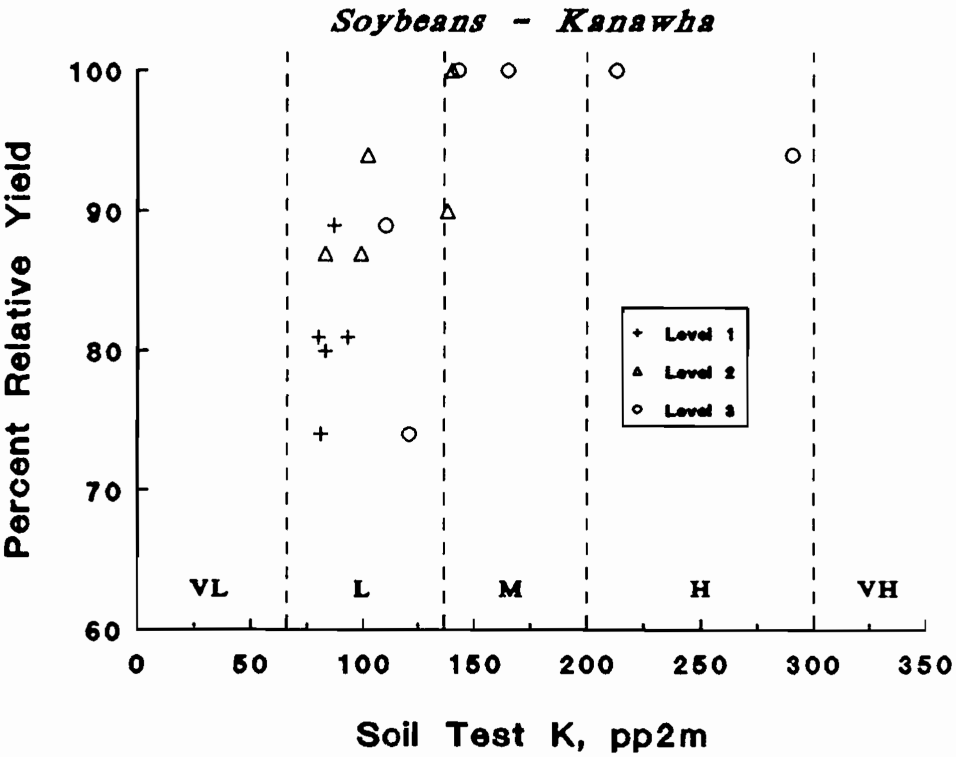


Figure 4. Effect of K soil test level on percent relative corn and soybean yields over an 11 year period (from Voss, 1987).

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