Functional Food Components: A Role for Potassium?

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The functional food components in soybeans which are regarded as having important beneficial effects on human health include isoflavones such as genistein, daidzein, glycitein, and their respective glucosides. These phytochemicals are thought to be responsible for the reduced rates of cancer, heart disease, menopausal symptoms, and osteoporosis observed in people who regularly consume soybeans and soy foods.

Field trials in two consecutive years in Ontario indicate that when soybean yields respond to potassium (K), isoflavone levels also increase.

Isoflavone levels in soybeans vary by more than threefold depending on variety and growing conditions. Our objective was to determine whether soil fertility contributes to this variation.

Soybeans grown at various levels of fertility in seven Ontario field trials were analyzed for total isoflavone content. Two of these trials involved a K fertilizer variable, and the others included various levels of lime and other nutrients added to the soil. Sites ranged from low to very high [35 to 190 parts per million (ppm)] in soil test K and medium to very high (13 to 60 ppm) in Olsen soil test phosphorus (P).

There are 12 isoflavones in soybeans, consisting of three aglycones (daidzein, genistein, and glycitein), their glycosides, and their corresponding acetyl and malonyl derivatives. The results of the total isoflavone concentration presented here have been normalized to three aglycones. Thus the overall levels of isoflavones may appear to be lower than those in other reports. The molecular weight (MW) of aglycone is about 54 percent of the MW of the glycoside forms.

At a site near Paris, Ontario, we compared soybeans with and without muriate of potash (MOP) fertilizer applied in bands 15 inches apart and about 3 inches deep. This trial was conducted in both 1998 and 1999. The soil test K (ammonium acetate extractable) in the top 6 inches was about 35 ppm.

Soybean yield and all three of the major isoflavone compounds showed a definite positive response to added K (**Table 1**). It is not known whether K plays a specific role in isoflavone synthesis, but it may, since K is an important enzyme cofactor for many plant metabolic reactions. It is possible that the reason for the observed effect was that K stimulated plant growth, since yields

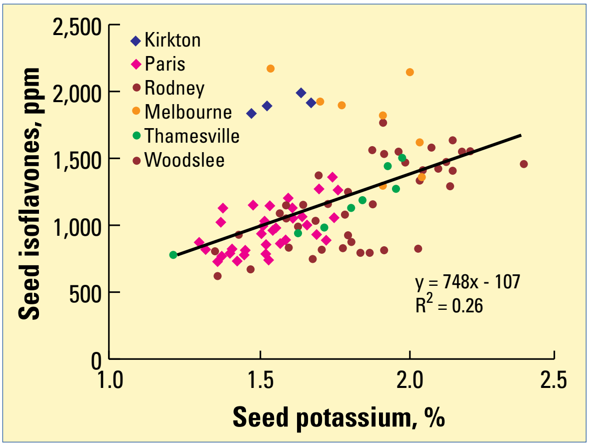

Figure 1. Isoflavone levels in soybeans from six Ontario sites in relation to soybean K content at harvest in 1998.

were also boosted by K.

Across six sites in 1998, there was a significant positive correlation between seed K and isoflavone concentrations in the harvested soybeans (**Figure 1**). There was also substantial variability between different sites and varieties, but since each variety was grown at a separate site, the effect of location could not be separated from the effect of variety.

TABLE 1. Band-applied K fertilizer boosted soybean yield and isoflavone content in a field at Paris, Ontario. Mean of two years, 1998-99, and three soybean row widths (7.5, 15 and 30 inches).

	Isoflavones, ppm				Yield,
K fertilizer rate	Genistein	Daidzein	Glycitein	Total	bu/A
90 lb K_2O/A banded	688	579	122	1,389	37.4
No K	537	499	109	1,145	31.8
Difference	28%	16%	12%	21%	17%

The positive correlation indicates that K could be one of the important factors controlling isoflavone levels. In a subset of the data comprising about half of the samples, the positive correlation with K was maintained even though there was no relationship of isoflavone levels with seed P. The reason for the lack of association with seed P may be that there was less variation in soil P fertility, or that there was less involvement of P in controlling isoflavone levels.

Across these sites, there was also an independent positive relationship between yield and isoflavone concentration (**Figure 2**). There was no significant correlation between yield and seed K.

The significant and positive correlation of isoflavone levels with yield is very encouraging, as it suggests that high yield is compatible with quality from a functional food perspective. Indeed, further research in this area may supply convincing information to consumers that modern high-yield agriculture can produce high quality food, rather than the "empty calories" that many perceive to be associated with high intensity production.

These observations reveal a significant role of plant mineral nutrition in the control of phytochemical levels in soybeans. This opens up a huge research opportunity to explore impacts of plant nutrition on a host of crop phytochemicals. In addition, this work implies that the introduction of crop varieties that are genetically enhanced in their functional food components may call for changes in the management of soil fertility in order to maximize their expression. BC

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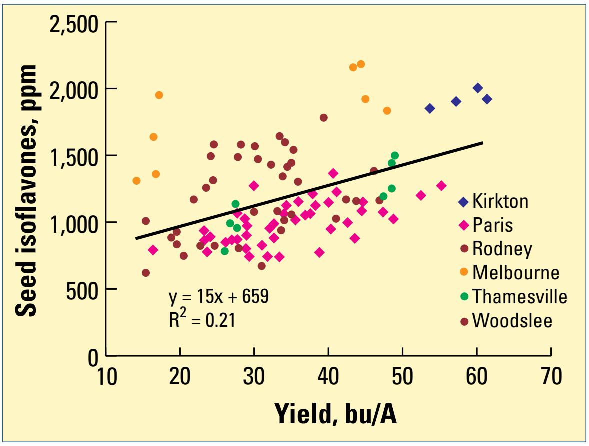

Figure 2. Isoflavone levels in soybeans from six Ontario sites in relation to soybean yield in 1998.