FOLIAR NUTRIENT TESTING WITH THE DIAGNOSIS AND RECOMMENDATION INTEGRATED SYSTEM (DRIS) FOR BEANS

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Tissue analysis interpretation has been based upon a comparison of analytical results to some standard values, such as critical nutrient levels (CNLs), sufficiency ranges or threshold levels. While these approaches are easily applied, each nutrient is considered independently of nutrient balances. Foliar nutrient levels are much affected by plant age as well as interactions affecting nutrient uptake and distribution. The Diagnosis and Recommendation Integrated System (DRIS) was developed by Beaufils (Sumner, 1977) to cope with the difficulties inherent in interpretation of results of foliar testing.

DRIS evaluates nutrient relationships and the adequacy of each nutrient in relation to the other nutrients using ratios (or products) between each pair of nutrients. Properly chosen nutrient ratios or products vary less with plant age than do dry matter concentrations of the nutrients. Nutrient ratios of a tissue sample are compared to standard ratios called "norms". Comparison of a sample's nutrient ratios to the norms is done by calculating functions, and the functions are used to calculate index values.

MATERIALS AND METHODS

DRIS norms for beans were determined from a broad-based data set consisting of data from trials conducted in Colombia, Rwanda and Uganda on five different soil types (Wortmann et al., 1992). DRIS norms were calculated for N, P, K, Ca, Mg, Fe, Mn and Zn. The norms were tested for accuracy in predicting responses to applied N, P and K using data from on-farm fertilizer trials conducted in the Usambara Mountains of Tanzania and in central Uganda.

RESULTS

The previously available CNLs of 3.0%N, 0.25% P and 1.0% K in bean foliar tissue were inadequate (Table 1). Alternative CNLs of 4.7% N, 0.32% P and 1.4% K are proposed for beans grown in Eastern Africa. Interpretation of foliar tissue results with DRIS was more accurate than with either set of CNLs in predicting responses to applied N, P and K (Table 1). Diagnosis with DRIS was less affected by plant age than with critical nutrient levels (Table 2).

The results show that DRIS is the preferred method for interpretation of bean foliar nutrient test results. A BASIC computer program called DRISBEAN.BAS is available from the author of this paper for the calculation of DRIS index values for beans.

LITERATURE CITED

Sumner, M.E. 1977. Application of Beaufil's diagnostic indices to maize data published in the literature irrespective of age and conditions. Plant Soil 46:359-369.

Wortmann, C.S., J. Kisakye and O.T. Edje, 1992. The Diagnosis and Recommendation Integrated System for dry bean -- determination and validation of norms. Journal of Plant Nutrition 15(11):2369-2379.

TABLE 1. Summary of Predictions for Bean Yield Responses to Applied Nitrogen, Phosphorus and Potassium.

| | Response occurred | | No response occurred | |
	Correct	Incorrect	Correct	Incorrect
Nitrogen				
DRIS	32	20	35	25
CNL (3.0%N)	1	51	60	0
CNL (4.7%N)	27	25	27	33
Phosphorus				
DRIS	43	23	25	21
CNL (0.25%P)	13	53	38	8
CNL (0.32%P)	39	27	24	22
Potassium				
DRIS	43	16	37	16
CNL (1.0% K)	18	41	51	2
CNL (1.4% K)	37	22	42	17

TABLE 2. Effect of Plant Age on Foliar Diagnosis of the Nutrient Requirements of Beans.

Crop age (weeks)	N	P	K	Ca	Mg	Order of deficiency DRIS
Cultivar K20						
3	3.64[1]	0.28	1.63	3.30	0.54	Mg < K = N = P = Ca
5	4.64	0.38	2.51	2.57	0.56	Mg < K = N = P = Ca
7	4.30	0.33	1.78	2.55	0.46	K < Mg = N = P < Ca
9	4.10	0.32	1.36	3.01	0.37	K < Mg < N < P < Ca
Cultivar White Haricot						
3	3.06	0.23	1.21	4.41	1.00	K = Mg < Ca = N = P
5	4.45	0.35	1.65	2.85	0.79	K < Mg = Ca = N < P
7	4.23	0.34	1.83	2.54	0.57	K < Mg = Ca = N = P
9	4.67	0.37	1.59	2.45	0.60	K < Mg = Ca = N = P

[1] Underlined values are below the CNL's of 4.7% N, 0.32% P, 1.4% K, 1.25 % Ca and 0.30% Mg.