

**ON THE RELATIONSHIP BETWEEN EFFICIENCY OF
UTILIZATION OF NITROGEN, PHOSPHORUS
AND POTASSIUM BY SEVERAL BEAN
VARIETIES (*Phaseolus vulgaris* L.)
AND YIELD POTENTIAL ***

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INTRODUCTION

As a rule, in the past most of the research efforts in the integrated fields of plant nutrition, soil fertility and fertilization had the goal of adapting soils to crops. This was based on the well known principle that, among the three media which provide nourishment for plants, air, water, and soil, the latter is the one that man can modify more easily rendering it more productive whenever necessary. It is a rather recent development that which aims to adapt crops to soils through selection and breeding; a fairly familiar example is given by the screening of lines and cultivars which are more tolerant to aluminum toxicity thereby saving liming materials (see the review by PEARSON, 1975).

Part of the same trend corresponds to the concept of efficiency of utilization of nutrients which has been variously de-

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fined in the literature (SMITH, 1934; LONERAGAN & ASHER, 1967; CLARK & BROWN, 1974; O'SULLIVAN *et al.* 1974; AMARAL, 1975; FOX, 1978; MALAVOLTA & AMARAL, 1978; SILVA, 1980). As a corollary of this idea two major consequences developed namely: (1) there are lines, cultivars or species which are to some extent wasteful in their use of nutrients for yield formation; (2) it is possible to grow more food and fiber in the field with less nutrients taken up.

MATERIAL AND METHODS

Ninety commercial bean varieties secured from various sources (IAC, SP, Brazil; Sec. Agricultura, PR; U. Federal de Viçosa, MG; Est. Exptal. Uberaba, MG) were grown in full strength nutrient solution until their life cycle was completed. After recording the dry matter of the various organs (roots, stems, branches, leaves, pods and grains) chemical analyses (N, P and K) were carried out.

Yield potential was obtained by multiplying the weight of grain produced per plant by the factor of 250,000 which corresponds to the bean population in one hectare.

Efficiency of utilization of a nutrient was defined and calculated as follows:

$$E = \text{yield} \cdot \text{absorption}^{-1} \cdot \text{time}^{-1}$$

where

E = efficiency of utilization,

yield = weight of grain, g/plant

absorption = grams of nutrient (N, P or K) accumulated
in the whole plant

time = life cycle in days

Simple correlation coefficients between E values and yield were calculated by standard procedures. After establishing arbitrary classes for yield potential, the average value were used to establish «r» data corresponding to mean E figures within each class.

RESULTS AND DISCUSSION

The values of the correlation coefficients between E figures and grain production were the following, all of them significant at the 1% level of probability: N - 0.671; P - 0.762; K - 0.637.

Tabela 1 summarizes the results obtained is the calculation of E values for the several cultivars and the corresponding average yield potentials.

TABELE I - Relationship between efficiency of utilization of N, P and K and yield potential.

Number of cultivars	Efficiency of utilization			Yield potential kg/ha
	N	P	K	
15	0.19	1.43	0.27	4,409
22	.17	1.28	.21	3,539
23	.13	0.97	.17	2,420
22	.11	.77	.13	1,476
8	.06	.48	.07	760

These data allowed for the determination of the correlation coefficients as well as for the establishment of the regression equations, as shown in Table 2.

TABELE II - Coefficients of correlation and regression equations for efficiency of utilization (X) and yield potential (Y).

Element	r	equation
N	0.99524**	$Y = 384.69 - 1373.50 X + 118720 X^2$
P	0.99796**	$Y = -107.29 + 1076.99 X + 1437.52 X^2$
K	0.99087**	$Y = -451.21 + 14989.86 X + 12633.78 X^2$

** significant at the 1 per cent level

As a matter of practical interest, Table 3 lists the varieties with higher E values which are also those with higher average yield potentials.

TABELE III - Varieties with higher efficiency of utilization and higher yield potential (*).

Mulatinho 1208	Aeté - 1	Bico de Ouro
Mulatinho	Roxinho	S. Cuva 168/N
Composto 388	Chumbinho brilhante	Chuveiro de Prata
Chumbinho opaco	Lambe beijo	Rosinha G-2
Guatemala 344	Roxinho V. Branca	México 200

(*) in decreasing order of yield potential

One can see that efficiency of utilization of a given nutrient and yield potential correlate quite well. In other words: it seems that higher productions are associated with better utilization of nutrients for yield formation. E values, therefore, may represent an useful parameter in programs of breeding or selection of crops more adapted to low levels of soil fertility which nevertheless are capable of high productions per unit of area.

SUMMARY AND CONCLUSIONS

Ninety bean (*Phaseolus vulgaris* L.) varieties were grown in nutrient solution till maturity. Grain production per plant was converted in yield per hectare and this was called «yield potential». By dividing the production per plant by the amount each of N, P and K taken up per day an estimate was obtained of the efficiency, E, of utilization of the three nutrients. Highly significant correlation coefficients were found to exist between E values and yield potential which suggests that this parameter may be useful in selection and breeding programs.

LITERATURE CITED

- AMARAL, F.A.L., 1975. Eficiência de utilização de nitrogênio, fósforo e potássio de 104 variedades de feijoeiro (*Phaseolus vulgaris* L.). Thesis for Ph.D. in Soils and Plant Nutrition, E.S.A. «Luiz de Queiroz», USP, Piracicaba.
- CLARK, R.B. & J.C. BROWN, 1974. Differential mineral uptake by maize inbreds. **Comm. Soil Sci. Plant Anal.** 5: 213-227.
- FOX, R.H., 1978. Selection for phosphorus efficiency in corn. **Comm. Soil Plant Anal.** 9: 13-37.
- LONERAGAN, J.F. & C.J. ASHER, 1967. Response of plants to phosphate concentration in solution culture. II. Rate of phosphate absorption and its relation to growth. **Soil Sci.** 103: 311-318.
- MALAVOLTA, E. & F.A.L. AMARAL, 1978. Nutritional efficiency of 104 bean varieties (*Phaseolus vulgaris* L.) 8th, Internatl. Coll. **Plant Anal. and Fertilizer Problems** (Auckland) 2: 313-317.
- O'SULLIVAN, J., W.H. GABELMAN & G.C. GERLOFF, 1974. Variations in efficiency of nitrogen utilization in tomatoes (*Lycopersicum esculentum* Mill) grown under nitrogen stress. **J. Amer. Soc. Hort. Sci.** 99: 543-547.
- PEARSON, R.W., 1975. Soil acidity and liming in the humid tropics. **Cornell Internatl. Agron. Bull.** 30.
- SILVA, A.C.D.A., 1980. Avaliação de milho (*Zea mays* L.) para eficiência ao fósforo usando diferentes doses de adubação fosfatada em solos com alumínio tóxico. Thesis for M.S. un Genetics and Plant Breeding, E.S.A. «Luiz de Queiroz», USP, Piracicaba.
- SMITH, S.N., 1938. Response of in bred lines and crosses in maize to variations of N and P supplied as nutrients. **J. Amer. Soc. Agron.** 26: 785-804.