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Kueneman, E.A. 1978. Evaluation of the yield potential of growth habits of dry beans (Phaseolus vulgaris L.) and determination of plant types for high density plantings. Ph.D. Thesis. Cornell Univ., Ithaca, NY, U.S.A.

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COMMENTS ON PLANT ARRANGEMENT, PLANT DENSITY, AND GENOTYPE X SPACING INTERACTION EFFECTS ON YIELDS OF BEANS GROWN IN MONOCULTURE. II. PLANT TYPES FOR HIGH DENSITY PLANTINGS

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Three sets of experiments, equidistant spacing in 1975 and 1977, systematic spacing or fan design in 1975 and 1977 and a row spacing in 1976 were conducted to confirm previously observed genotype x spacing interactions and to determine which morphological characteristics contribute to increases in yield in response to close spacing (Kueneman, 1978). General characteristics of the 6 genotypes used in these experiments are summarized in Table 1.

Two very different plant types demonstrated potential for high yields and propensity to maximize yields at high plant densities. One plant type, characterized by L-1, is of short, compact stature, has numerous, vertical branches, and has an open canopy with many, small, vertically-displayed leaves. The small, vertically-displayed leaves minimize intraplant competition for light, and compact plant type minimizes the amount of competition among neighboring plants. L-1 has determinate growth habit; probably a genotype with indeterminate short vine habit, other characteristics being the same, would also respond. The other density responsive plant type, characterized by VEN and NEP, (Table I), is indeterminate, non-twining, erect, and has few branches. Most of its pods are set on racemes borne on the main stem so that reduction in branch number, in response to crowding of plants, results in less severe reduction of pods per plant than occurs for genotypes which set most of their pods on lateral branches.

Evidence indicating that these two types (small-compact and indeterminate minimal-branching) are most responsive came from several experiments. In the equidistant spacing experiments, with plant populations ranging from 25 to 100 plants/m^2, L-1 and NEP gave large, significant yield increases in response to close spacing in 1975; L-1 and VEN were the best yielding genotypes in the 1977 equidistant spacing experiments where no genotypes responded positively to close spacing due to drought stress. In 1975, genotypes L-1, NEP, and VEN gave yield increases as plant density increased from 91 to 299 plants/m^2 in the systematic spacing experiments, whereas other genotypes responded only at the highest density interval (169 to 299 plants/m^2). When the systematic spacing trial was repeated in 1977, only L-1 and VEN responded significantly to close spacing; NEP also responded, but its yields were low due to white-mold-induced seed decay. When the five genotypes were grown in row-spacing experiments, however, all genotypes responded to closer between-row spacing with higher yields. But VEN gave a larger yield increase than other genotypes when row spacing was reduced from 45 to 30 cm. Although L-1 is very responsive

Table 1. General characteristics of bean varieties in spacing studies at Aurora 1975, 1976, 1977.

Genotype**	Maturity	Growth Habit	Root Type	Seed Type	Leaf Size*	Amount of Branching	Harvest Index
RKL	early	determinate-compact	fibrous	kidney-r# large	M	M	medium
RKO	late	determinate-large	fibrous	kidney-r large	L	L	low
L-1	early	determinate-very compact	fibrous	oblong-w medium	S	L	high
NEP	late	indeterminate erect	tap	oval-w small	M	S	high
VEN	late	indeterminate erect	tap	kidney-b small	M	S	high
SBR	early	determinate-compact	fibrous	oval-bu medium	M	M	high

Color code for seeds: r = red, w = white, b = black, bu = buff

* Size code: S = small, M = medium, L = large

** Genotype code: RKL = Redkloud, RKO = Redkote, NEP = Nep II, VEN = Venezuela-s-182-R, SBR = Swedish Brown

to close spacing, genetic improvements for responsiveness may be possible by adding stiffer straw and a stronger root system.

In the experiments that have been mentioned briefly, as well as in other experiments (Kueneman, 1978), genotypes that respond to close spacing maintain high harvest index (HI) value whereas non-responsive genotypes either have relatively low HI or the HI drops as density increases. The stability of HI in response to plant density is characterized by θ in the linear regression equation first presented by Kira (1956): $\log W = \log k + \theta \log w$ where W = total weight per plant, w = weight of seed per plant, and where θ and k are constants. If $\theta = 1$, the HI is constant over densities; if $\theta < 1$, the HI decreases as density increases and if $\theta > 1$ the HI increases as density increases. The value of θ can be estimated by growing plants at few (2 or 3) densities and should be a valuable criterion for selection of genotypes for high density planting. The value of θ is also an exponent in the equation proposed by Bleasdale (1976) that allows the prediction of yield over varying densities by growing plants at only two or three densities. Bleasdale's equation was tested on data from two genotypes with different yield-density curves. His equation seems adequate and should be useful to breeders who need to evaluate genotype-density responses for segregating and/or advanced populations of dry beans where the amount of seed available is frequently limiting.

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INHERITANCE OF GROWTH HABIT IN INDETERMINATE LINES OF Phaseolus vulgaris L.

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At the International Center of Tropical Agriculture, certain bean lines were observed to be either an indeterminate bush or an indeterminate climbing type depending upon their cropping location. Our investigation was originally concerned with the environmental conditions causing this change in growth habit. In a previous paper (1) the authors showed that this morphological instability depends upon the quality of light the plant perceives and is controlled through the phytochrome system.

To investigate the inheritance of this response, crosses were made between three lines that had shown this instability (P17-A, P6-E and P212-A)