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Factor analysis of Phonological and Morphological Traits in Common bean (*Phaseolus vulgaris* L.)

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ABSTRACT: To evaluate and classify phonological and morphological traits of 64 Common bean (*Phaseolus vulgaris* L.) genotypes, a triple lattice experiment was conducted at the research farm of Espiran in 2014. Each plot consisted 5 rows, 3 m length with row spacing of 30 cm and within row spacing of 12.5 cm. 24 seeds were seeded in each row. Fertilizer applications, weed control and other agricultural practices were done on 10 randomly selected plants of each plot. Factor analysis based on principal component method revealed four important factors which accounted for 74% of the total variation. The eigenvalues of these four factors were 4.42, 3.11, 1.74 and 1.17, respectively. The first factor which accounted for32% of the variation was related with days to maturity, number of primary branches, mean number of seeds/pod, seed thickness average and seed yield. This factor was regarded as yield primary factor. All variable in factor 1, unless days to maturity had positive loadings. The second factor, which accounted for 22% of the variation, was associated positively with 100 seed weight, seed length and seed with. This factor is named single seed factor. In the fourth factor which accounted for 8% of the variation, the number of pods/plant had high positive value of loadings. This factor is named yield secondary factor.

Key Words: Common bean, Factor analysis, Morphological traits, Phonological traits.

INTRODUCTION

Common bean (*Phaseolus vulgaris*) is the most important food legume on earth, providing scarce nutrients to many people in developing countries. For more than 300 million of the world's people, an inexpensive bowl of common bean is the centerpiece of the daily diet. This staple is the world's most important food legume, far outdistancing chickpea, faba beans, lentils, and cowpeas. The global bean harvest of 18 million tons annually. Nutritionists characterize the common bean as a nearly perfect food because of its high protein content and generous amounts of fiber, complex carbohydrates, and other dietary necessities (Pachico, 1999).

The common bean was domesticated more than 7,000 years ago in two centers of origin-Mesoamerica (Mexico and Central America) and the Andean region. Beans are grown from sea level to more than 3,000 meters chiefly by small farmers with average land holding of less than 1 hectare, without irrigation, and using little or no fertilizers or pesticides (Pachico, 1999).

Factor analysis is a statistical model that assumes that a small number of unobserved (i.e., latent) constructs are responsible for the correlation among a large number of observed variables. (Bramel, 1984). The latent constructs, for example, academic ability, cannot be directly observed, but they affect observable variables, such as French, English, and Mathematics scores. Specifically, factor analysis assumes that the variance of each observed variable comes from two parts: a common part shared with other variables that cause correlation among them, and a unique part that is different from other variables. The common parts are called factors, and these factors represent the latent constructs (Wang, 2001). Another using of factor analysis is the introduction of essential multivariate analysis (Guertin and Bailey, 1982).

In determining the potential of genetically different lines and cultivars, breeders have to observe many different characters that influence yield. Accurate evaluation of these characters is more difficult by the genotype because environment interaction (Tadesse *et al.*, 2001).

This study was undertaken in order to determine the dependence relationship between yield components and morphological characters of several genotypes of common bean using factor analysis.

MATERIALS AND METHODS

Sixty four Common bean genotypes were planted in the beginning of June 2014 at the Research Farm of Espiran on raised bed in a triple lattice design. The plots were 3m long and 1m apart. Seeds were hand sown in a manner that in each plot 5 rows, 50 cm between and 12.5 cm within row spacing was achieved. Fertilizer application, irrigation, weed control and other agricultural practices were done uniformly for all plots. Observations on 14 characters were recorded on 10 randomly selected plants in each plot with considering borders. Factor analysis calculations were performed using SAS factor analysis program. Estimates of factor loadings were based on data from all replications for all populations. The principal factor analysis method explained by Harman (1976) was followed in the extraction of the factor loadings. The array of communality, the amount of the variance of a variable accounted by the common factor together, was estimated by the highest correlation coefficient in each array as suggested by Seiller and Stafford (1985). The number of factors was estimated using the orthogonal maximum likelihood method. (Rao, 1952). The varimax rotation method was used in order to make each factor uniquely defined as a distinct cluster of inter correlated variables (Rao, 1952). The factor loadings of the rotated matrix, the percentage variability explained by each factor and the communalities for each variable were determined.

RESULTS

The total variance and eigen values explained by factors are indicated in Table 1. The first 4 factors which accounted for more than 74% of the total variance are important. The contribution of factors 1-4 to the total variance were 31.64, 22.25, 12.41 and 8.33 percentage, respectively. A principal factor matrix after orthogonal rotation for these 4 factors is given in Table 2.

Table 1: Total variance and eigen values explained for each factor based on 14 different characters of 64 common bean genotype populations.

Factor	Eigen value	Variance%	Cumulative%
1	4.42	31.64	31.64
2	3.11	22.25	53.89
3	1.74	12.41	66.31
4	1.17	8.33	74.64
5	0.88	6.29	80.93
6	0.73	5.20	86.13
7	0.53	3.78	89.91
8	0.46	3.28	93.19
9	0.31	2.23	95.42
10	0.22	1.56	96.98
11	0.18	1.35	98.32
12	0.12	0.89	99.21
13	0.09	0.71	99.93
14	0.01	0.07	1.00

The values in the table or factor loadings indicate the contribution of each variable to the factors. To interpreted the result, only those factor loadings having greater values which are bold in Table 2, are considered. Factor 1, which accounted for about 32% of the variation, was strongly associated with days to maturity, number of primary branches, mean number of seeds/pod, seed thickness and seed yield. This factor was regarded as yield primary factor, since it included those traits which were highly related to seed yield. All variables in factor 1, unless days to maturity had positive loadings. The sign of the loading in Table 2 indicates the direction of the relationship between the factor and the variable.

Factor 2, which accounts for about 22% of the variation was named single seed factor , since it consisted of 100 seed weight, seed length and seed width, which are strongly associated with single seed weight. In this factor all 3 variables had positive loadings. Factor 3, was named fertility factor, which is positively associated with pod length and number of seeds/longest pod and negatively associated with day to flowering and accounted for about 12% of the total variation. Ultimately, the forth factor which is named yield secondary factor accounts for about 8% of the variation. The variable, number of pods/plant, had high positive value of loadings in this factor.

Table 2: Principal factor matrix after varimax rotation for 14 characters of 64 population of common bean. Numbers in bold are those with factor loading high values.

Variables	Factor				Proportion of variance explained by underlying factors
	1	2	3	4	
Days to flowering(day)	-0.149	-0.219	**-0.733**	-0.065	0.612
Days to pod formation(day)	0.259	-0.576	-0.488	-0.232	0.689
Days to maturity (day)	**-0.748**	0.069	-0.135	0.019	0.583
Plant height(cm)	-0.595	-0.041	-0.170	0.095	0.553
No. of primary branches(number)	**0.821**	-0.001	-0.080	0.103	0.691
No. of pods/plant (number)	-0.064	-0.149	0.045	**0.953**	0.938
Longest pod length (cm)	-0.028	0.548	0.567	-0.084	0.630
No. of seeds/longest pod(number)	-0.260	-0.388	**0.727**	-0.013	0.748
No. of seeds/pod (number)	**0.862**	-0.367	-0.147	-0.087	0.908
100 seeds weight(gr)	-0.084	**0.932**	0.008	-0.120	0.892
Seed length(mm)	-0.008	**0.815**	0.250	0.056	0.731
Seed width (mm)	-0.146	**0.818**	-0.154	-0.156	0.739
Seed thickness (mm)	**0.898**	-0.213	-0.247	-0.111	0.927
Seed yield (gr/plant)	**0.706**	0.033	0.004	0.548	0.802

DISCUSSION

Wuletaw Tadesse and Endashwa Bekele (2001) reported on factor analysis of components of yield in grass pea. They indicated that number of primary branches and number of pods/plant were associated with plant productivity, which is in agreement with findings of the present study. But days to maturity which was not associated with plant productivity in this study, is negatively associated with yield primary factor in our study.

In a factor analysis of seed yield related traits in spring wheat. 4 factors were extracted. 31% of the total variance accounted by the first factor in which number of spike per plant and number of spikelet per spike were considered important (Walton, 1971).

To study of physiological and morphological traits related with yield in common bean (*Phaseolus vulgaris*) factor analysis was used. The first 3 factors which accounted 77% of total variance were named weight, number and plant architect factors, respectively (Denis, Adams, 1972).

The results of this study indicates that selection of variables such as number of primary branches, mean seed number/pod, seed thickness and seed yield per plant in factor 1 could enable the breeders to better realize the desired increment in seed yield of common bean.

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