Factor analysis of components of yield in grasspea (*Lathyrus sativus* L.).

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Introduction

Grasspea (*Lathyrus sativus* L.) is one of the many crops that has its primary genetic diversity in Ethiopia[1,6,7]. It is a unique crop plant that was already in use in Neolithic times, and presently considered as a model crop for sustainable agriculture with a great future. The plant is unique in that it can thrive under adverse environmental conditions such as drought and flooding.

According to Kaul (1990), around 80% of global land is rain fed, and a good part of it lies in the developing world. It is believed that toxin free strains of grasspea could have an important role in human and livestock nutrition in the resource poor countries that have large areas of semi-arid land.

In Ethiopia, grasspea is grown in the cambisol and vertisol soils. It occupies 8.7% of the total area and 7.6% of the total production of food legumes in the country (Woldamlak and Alelign, 1990). According to the recent Ethiopian Central Statistical Authority (CSA, 1998) report, grasspea is the third most important pulse crop after fababean and chickpea with 142 170 ha of production area and 104 744 t of production.

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 made more difficult by the genotype by environment interaction.

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

Material and Methods

Fifty grasspea genotypes were planted at the beginning of September 1998 at the Adet Research Center on raised bed in a randomized complete block design with three replications. The plots were 5m long and 1 m apart. The trial was not supplied with irrigation and fertilizer. Estimates of factor loadings were based on data from all replications for all populations. Factor analysis calculations were performed using SPSS factor analysis program. Simple correlation coefficients were calculated for 10 characteristics of 50 genotypes.

Observations on 10 yield related components: Plant height (cm), biomass (g), number of primary branches/plant, days to flowering, days to maturity, number of pods/plant, number of seeds/pod, 100 seed weight (g), seed yield/plant and harvest index were recorded.

Factor analysis is a multivariate analysis method which aims to explain the correlation between a large set of variables in terms of a small number of underlying independent factors. It is assumed that each of the variables measured depends upon the underlying factors but is also subject to random errors. 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 factors 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 maximum likelihood method of Rao (1952). The Varimax rotation method (an orthogonal rotation) was used in order to make each factor uniquely defined as a distinct cluster of intercorrelated 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 and Discussion

The total variance explained by factors is indicated in Table 1, only the first 3 factors which account for 62% of the total variance are important. A principal factor matrix after orthogonal rotation for these 3 factors given in Table 2. The values in the table, or loadings, indicate the contribution of each variable to the factors. For the purposes of interpretation only those factor loadings greater than 0.5 were considered important, these values are highlighted in bold in Table 2.

Factor 1, which accounted for about 40% of the variation, was strongly associated with biomass, number of primary branches, number of pods per plant, plant height and seed yield per plant. This factor was regarded as a productivity per plant factor since it included several traits which are components of yield. All variables had positive loadings in factor 1. The sign of the loading indicates the direction of the relation ship between the factor and the variable.

Factor 2 which accounts for about 12% of the variation was named a reproductive (fertility) factor since it consisted of days to flowering, days to maturity and seeds per pod which are associated with fertility. Again all these variables had positive loadings. The third factor was named an efficiency factor since it contained only harvest index, which is the ratio of yield to the total biomass. This of course indicates the efficiency of the plant to convert the available resource into seed yield. Factors 2 and 3 each account for about 10% of the variation.

Seiller and Stafford (1985) indicated that seeds per pod and 100 seed weight were regarded as yield per unit area factor in the crop guar. However, in this study 100 seed weight was not included in any of the factors since it had very low loadings (less than 0.50). Seeds per pod was regarded as an economic factor in cluster bean by Rao and Paroda (1982). In this study, however, it is grouped with days to flowering and days to maturity (factor 2).

This study indicated that selection of variables in the productivity per plant factor (factor 1) could enable breeders to better realize the desired increment in seed yield of grasspea.

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Table 1. Total variance explained for each factor based on 10 different characters of 50 grasspea populations.

Factor	% of variance	Cumulative %
1	39.7	39.7
2	11.5	51.2
3	10.9	62.1
4	9.9	72.1
5	8.3	80.3
6	7.3	87.7
7	5.3	93
8	3.3	96.3
9	2.1	98.3
10	1.7	100.0

Table 2. Principal factor matrix after varimax rotation for 10 characters of 50 populations of grasspea. Numbers in bold are those with factor loadings greater than 0.50.

	Factor			Proportion of variance explained
Variables	**1**	**2**	**3**	**by the underlying factors**
Days to flowering	-0.039	**0.776**	-0.248	0.666
Biomass	**0.878**	0.187	-0.122	0.820
Days to maturity	0.484	**0.667**	0.149	0.701
Harvest Index	0.142	-0.038	**0.826**	0.705
No. primary branches	**0.550**	0.009	-0.294	0.389
No. pods/plant	**0.890**	0.172	0.054	0.825
Plant height	**0.675**	0.343	0.166	0.601
Seeds/pod	0.263	**0.642**	0.227	0.534
100 seed weight	0.076	-0.039	-0.390	0.159
Seed yield/plant	**0.886**	0.088	0.119	0.807

References

1. Asfaw T, Geletu B, Alem B. 1994. Role of cool season food legumes in Ethiopia. Pp. 3-18. In: Asfaw T, Saxena M, Solh M, Geletu B. (Eds.) Cool season food legumes of Ethiopia. Proceedings of the First National Food legumes Conference, 16-20 December 1993, Addis Ababa, Ethiopia.
2. Ethiopian Central Statistical Authority (CSA). 1998. Agricultural sample survey, area and production of major crops. Statistical Bulletin 189.
3. Harman HH. 1976. Modern factor analysis, 3rd Ed. University of Chicago Press, Chicago.
4. Rao CR. 1952. Advanced statistical method in biometric research. John Wiley and Sons, New York.
5. Seiller GJ and Stafford RE. 1985. Factor analysis of components in Guar. Crop Sci. **25**, 905-908.
6. Thulin M. 1983. Leguminosae of Ethiopia. Opera Bot. 68, 1-23.
7. Vavilov NI. 1951. The origin, variation, immunity and breeding of cultivated plants. Chron Botan 13, 1-36.
8. Walton PD. 1972. Factor analysis of yield in spring wheat (*Triticum aestivum* L.). Crop Sci. 12, 731-733.
9. Woldeamlak A, Alelign K. 1990. Status of grasspea (*Lathyrus sativus*) production in Ethiopia. IAR Newsletter of Agricultural Research (Ethiopia) Vol. 5. Addis Ababa.