Stability of grasspea (*Lathyrus sativus* L.) varieties for ODAP content and grain yield in Ethiopia

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Introduction

Grasspea (*Lathyrus sativus* L.) is a popular food and feed crop in some Asian and African countries, such as India, Pakistan, Bangladesh and Ethiopia because of its resistance to drought, flood and moderate salinity. Grasspea becomes the only available source of food for the poor section of the population and sometimes a means of survival in times of drought induced famine. Therefore it is called the "poor mans' insurance crop".

In Ethiopia, grasspea is an important pulse crop grown in the cambisol and vertisol soil-type areas. It occupies 8.7% of the total area and 7.6% of the total production of food legumes in the country [9]. According to the recent Ethiopian Central Statistical Authority report [2] grasspea is the third most important pulse crop, after faba bean and chickpea, with an area of 142 170 ha and production of 104 740 tonnes. However, excessive consumption of the seeds can cause an upper motor neuron disease called "neurolathyrism" in humans, characterised by paralysis of the lower limbs, due to the presence of the toxin oxalyl-diamino-propionic acid (ODAP).

The breeding station at Adet Research Center has identified some varieties with low ODAP content in multi-location trials conducted in the potential growing areas of north-west Ethiopia [10]. However, genotype, environment and their interactions were found to be significant for ODAP content and grain yield. The change in ODAP content of the varieties from location to location, and from season to season, creates difficulty in identifying varieties with stable ODAP content and fairly good grain yield potential. In such cases, stability analysis is useful to identify varieties that show minimum interaction with environment [1].

Statistical approaches to the study of quality criteria such as variance component analyses and joint regression methods of Yates and Cochram have been further developed [4,5] and widely adopted. A stable genotype is one having a high mean yield, a regression coefficient close to 1 and a minimum deviation from regression [4]. This study was made to identify the most stable varieties for ODAP content and grain yield among the landraces and some Canadian varieties.

Material and Methods

Twenty grasspea varieties were tested using randomised complete block design with 4 replications at Adet, Woreta and Bichena in 1994 and 1995. The 1995 data at Bichena was not included in this study since the trial was damaged by excessive flooding. Table 1 shows the soil characteristics of the locations. The plot sizes were 4 m^2 (5m length, 4 rows at 20 cm apart) at a seeding rate of 40 kg/ha. The seeds were sown into residual moisture, starting in mid-September, following farmers' practice and the rainfall situation. Each year x location interaction was considered as an individual environment. Ten varieties with relatively low ODAP content were used for stability analysis, since the objective was to identify varieties stable low toxin content.

Table 1. Physiographic features and soil characteristics of the test locations.

	Location		
	Adet	**Woreta**	**Bichena**
Alititude (m a.s.l.)	2240	1900	2600
Annual rainfall (mm)	1230	1052	1077
Soil order	Vertisol	Vertisol	Pellic vertisol
pH (H_2O)	6.0	6.0	8.0
Organic matter (%)	1.6	1.5	3.3
NC (%)	0.17	0.15	0.15
P (ppm Bray II)	1.8	5.8	2.6

ODAP content analysis was performed at the Addis Ababa University, Chemistry Department. Samples of analysis were taken from seeds from a bulk of all replicates for reasons of practicality. Analysis of variance involving sites and years was done for ODAP content and grain yield. Mean comparison method of stability analysis was followed. Regression coefficients (b), deviations from regression (sd) and coefficients of determination (r^2) were used as stability indices. The b values were tested for difference from unity using a t-test.

Results and Discussion

There was a wide range in ODAP content (0.300 to 0.529%) and in grain yield (0.32 to 3.0 t/ha) among the varieties in different environments (data not shown). This wide range of variation indicates the importance of stability analysis (7).

According to the combined analysis (Table 2) genotypes and environments have significant effects on both ODAP content and grain yield, even though the relative importance of the environmental component of variance was larger than the genotype component for both grain yield and ODAP content. This result coincides with the stability result reported by Dahiya [3]. Similar results for most of the quality traits of bread wheat have been previously observed [8]. Acc. No. 201513 (a landrace) and LS 82 46 (a Canadian variety) had b values for ODAP content significantly different from unity indicating that they are unstable over a wide range of environments (Table 3). These two varieties, however, remain low in ODAP content across environments and do not change in ranking, despite season and locational fluctuations.

The regression coefficient (b) is significantly different from unity for grain yield in Acc. No. 46008 and 46070. For these 2 varieties the coefficient of determination (r^2) is 99%, indicating that the variation is attributed to the linear regression. Varieties with r^2 significantly different from unity are not stable [4], and accordingly such varieties show high yield in suitable environments and vice versa. On the other hand, b values for ODAP content of these varieties were not significantly different from unity implying that they were stable in this regard. There were positive correlations between mean ODAP contents and regression coefficients (r = 0.437) and mean grain yields with regression coefficients (r = 0.323) indicating that the ODAP content and grain yield of the varieties increase with favourably good environments. The correlation between standard error and r^2 values were negative (r = -0.0806, and r = -0.859**) for ODAP content and grain yield, respectively, implying stability of the varieties. Similar result for grain yield stability on wheat was reported by Getenet [6]. About 64 to 97% of the variation in ODAP content and 85 to 99% fo the variation in grain yield of the individual varieties, in the case of landraces (acc# 1-5), were explained by the variation in environmental index (Table 3) which showed that the regression coefficients had considerable predictive values for the varieties of interest to both ODAP content and grain yield. In the case of the Canadian varieties (No. 6-10), the values of r^2 for both ODAP content and grain yield were low, the range being 5.2 to 81.9% and 34.2 to 83.9%, respectively (Table 3). In this case the deviation mean square (s^2d) and the mean values of the characters concerned, have the main role in determining stability than environmental index.

The introduced Canadian varieties are not able to keep up their original low ODAP content. LS8246 for example showed a dramatic increase from season to season and from location to location. This holds true for all the Canadian varieties indicating that they are unsuitable.

Table 2. Analysis of variance for ODAP content and grain yield of 20 grass pea varieties over five environments (1994-95).

Source of variation	df	Mean squares ODAP (%)	Grain yield (t/ha)
Genotype (G)	19	0.002*	0.117*
Environment (E)	4	0.066*	9.483*
G x E	76	0.001**	0.07*
CV (%)		8.61	10.3

* significant at P<0.05; ** significant at P<0.01.

Table 3. Genotypic means, regression coefficients, deviation from regression and coefficient of determination for ODAP content and grain yield of 10 grass pea varieties over 5 environments.

	Grain yield (t/ha)				ODAP (%)			
Variety	**mean**	**b**	**sd**	**r^2**	**mean**	**b**	**sd**	**r^2**
Acc#201513	0.309	0.497*	0.214	0.642	3.3	1.233	0.208	0.921
Acc#46057	0.355	0.921	0.359	0.687	3.3	0.944	0.229	0.850
Acc#46008	0.344	0.512	0.142	0.813	3.5	1.267**	0.019	0.999
Acc#46070	0.342	0.804	0.078	0.972	3.4	1.790*	0.065	0.991
Acc#46053	0.342	1.064	0.114	0.967	3.4	1.060	0.201	0.903
LS8246	0.365	-0.212*	0.524	0.052	2.1	1.400	0.371	0.779
Nc 8a 7	0.517	0.920	0.170	0.619	1.7	0.900	0.613	0.440
Nc 8a 84	0.597	0.640	0.460	0.394	1.7	1.300	0.632	0.595
Nc 8a 157	0.494	1.490*	0.406	0.819	1.5	1.200	0.308	0.839
Nc 8a 74	0.493	1.18	0.505	0.394	1.8	0.600	0.443	0.342

* significant at P<0.05

Conclusions

This study suggests that environment, genotype and their interaction affects the ODAP content and grain yield performance of grass pea varieties. The ODAP content is significantly affected by both the genotype and environment thought the variation by the environmental component is high. A stable variety for grain yield may not be stable for ODAP content and vice versa. As toxicity is the major bottleneck of grass pea production, stability of ODAP content needs more attention than grain yield. Accordingly, varieties LS8246 and Acc No. 201513 are low in ODAP content across locations and can be used over wider environments even though their ODAP value changes in amount.

As such studies had not been previously conducted on grass pea in Ethiopia, this information may be important in evaluation of varieties before release. However, much information should be generated in the future in more environments since this study was carried out in limited number of locations in north-west Ethiopia.

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