Screening for Drought tolerance in Eastern Africa

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Introduction

Drought is one of the most important constraints to bean production in East, Central and Southern Africa. Over 396,000 t of grain are lost annually in Africa due to drought (Wortmann et al, 1998). Drought may occur early in the season, mid-season or late in the cropping season. Drought is ranked as major constraint to bean production in Kenya, Ethiopia, parts of south western Uganda, northern and central Tanzania, South Africa, southern Rwanda, Sudan, Angola, central plateau of Madagascar and southeast DR Congo. Although the adverse effects of drought can be alleviated through irrigation, few smallholder bean growers in East and Central Africa (except in Sudan) have access to irrigation water. Bean production in this region is predominantly rain fed. Crop failures are frequent. Growing drought tolerant bean cultivars is probably the most cost-effective strategy for smallholder, resource-poor farmers in drought prone environments. However, few drought tolerant cultivars are available in sub-Saharan Africa. CIAT has been screening bean cultivars for drought since 1983 (Laing et al, 1983) as part of integrated genetic improvement of the common bean (Teran and Singh, 2002). Recently, an international drought nursery was constituted which included the most promising drought tolerant lines. This report highlights the performance of this nursery in trials conducted in Eastern Africa.

Materials and Methods

Thirty-six drought tolerant bean lines including two susceptible checks were evaluated at Thika, Kenya in 2001, 2002 and 2003. Each year, the trial was laid out in 6 x 6 lattice design with three replicates. The 36 genotypes were evaluated in drought stressed and non-stressed environments for the three cropping seasons. Each entry was sown on four, 5 m rows. Data was recorded from the two inner rows. Entries in non-stressed plots were provided with 1 to 2 supplemental irrigations. In stressed plots, the entries were grown under natural rain fed conditions. For data analysis, the cropping seasons (environments) and replications were considered as random effects, whereas irrigation treatments (stress levels) and genotypes were fixed effects. All data was analyzed using Genstat (6ed, 2002) statistical package. Two local cultivars, GLP x 92 and GLP 585 were included as checks.

Results and Discussion

There were significant grain yield differences due to environments, stress levels and genotypes (Table 1). Significant environment x stress levels, genotype x stress level, genotype x environment interactions were detected. This indicated that performance of the genotypes varied with stress level and with environments. Yield reduction due to drought was highest in 2001 (58%) but remained at 40% in 2002 and 2003. The ten most promising lines under both stress and no stress conditions are shown in Table 1. SEA 16 and SEA 20 consistently ranked among the top five best yielding lines under stress conditions for the three seasons. RAB 608, RAB 636 and INIB 35 ranked among the top five for two seasons under stress conditions. However, SEA 23, RAB 608, SEA 16 and RAB 618 were the best yielding lines under stress and no stress environments. These four lines out yielded all the checks. These results indicate new possibilities of stabilizing bean yields in drought prone environments in Eastern Africa. These lines are potential sources for breeding drought tolerant marketable bean cultivars.

Table 1. Grain yield (kg ha-[1]) of drought tolerant lines grown under stress and no stress conditions over three seasons at Thika, Kenya, 2001-2003.

Genotype	2001		2002		2003		
	No stress	Stress	No stress	Stress	No stress	Stress	Mean
RAB 608	1435	986	935	513	3031	739	1273
SEA 23	2780	562	1048	585	2405	1032	1402
RAB 636	1196	621	1075	443	2551	983	1145
SEA 16	1885	792	1236	972	1467	1105	1243
RAB 618	1551	564	861	896	1956	861	1115
Pinto Villa	1437	279	1188	407	2119	836	1044
SEA 20	1298	806	1704	681	1139	862	1082
INB 38	1370	528	1269	1091	1149	841	1041
INB 35	1432	881	1207	992	1287	697	1083
INB 39	1468	388	1162	828	1180	823	948
Checks							
Tio Canela	1253	300	1264	664	1591	1059	1022
SEA 5	1934	570	1316	546	1040	546	992
GLP x 92	698	676	1124	265	1288	757	801
GLP 585	1154	685	1267	512	1113	523	876
Trial mean	1561	654	1072	652	1340	801	1037
Reps/Environments							
Environments (E)		**					
Stress levels (S)		**					
Genotypes (G)		*					
E x S		NS					
G x E		**					
G x S		**					
G x E x S		**					
Residual							

*, **: Significant at 5 and 1% probability levels, respectively; NS= not significant

References

Laing, D.R., P. J. Krechmer, S. Zuluaga and P. G. Jones. IRRI, Los Banos, Phillipines
Wortmann, C.S, R.A. Kirkby, C. A. Eledu and D. J. Allan. Bean Atlas. CIAT, Colombia
Teran, H. and S.P. Singh. 2002. Crop Science 42: 64-70.