Journal of Applied and Natural Science 6 (2): 782-785 (2014)

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Genotype and environment interaction and stability analysis for seed yield in yellow mung bean (*Vigna radiata* L.)

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Received: August 21, 2014; Revised received: October 16, 2014; Accepted: December 08, 2014

Abstract: Nine yellow seeded mung (*Vigna radiata* L.) genotypes were evaluated along with three checks for their yield performance during three years (2007, 2010 and 2011). Pooled analysis of variance and stability analysis were performed. The genotypic (G) × environment (E) interaction and both variance due to genotypes and environment were significant. The portioning of G × E interaction into linear and non-linear components indicated that both predictable and unpredictable components shared the interaction. On the basis of stability parameters, the top yielding genotypes such as BGS-9 (605.444 Kg/Ha), Sel-4 (519.778 Kg/Ha) and China mung (567.000 Kg/Ha) exhibited high mean yield. Based on stability parameters the genotypes YM-5 (459.889 Kg/Ha), YM-8 (451.333 Kg/Ha) exhibited low mean performance along with regression value nearer to unity (bi=1) and non significant deviation from regression (S^2 di=0) indicating the high stability and wider adaptability across the three environments. The genotypes BGS-9 (605.444 Kg/Ha) and Sel-4 (519.778 Kg/Ha) exhibited high mean value and bi values (bi>1) and non significant deviation (S^2 di < 0) value indicating adapted for high performance environments (These genotypes are sensitive to environments and give maximum yield when inputs are not limited).

Keywords: G × E Interaction Green gram, Seed Yield, Stability analysis, *Vigna radiata* (L.) and Yellow mung

INTRODUCTION

Mung bean [*Vigna radiata* (L.) Wilczek], one of the Asiatic species is an important grain legume in Karnataka. Yellow mung, having yellow seed coat is cultivated in small packets of North Eastern Transitional Zone of Karnataka consisting of Bidar district. In general mung bean is mostly grown under dry land farming systems where erratic rains often expose the crop under moisture stress (Azab, 1997). Due to short duration and wide adaptability, it is grown throughout the year in double and multiple cropping systems. It is also grown as a mixed, inter and relay crop (Chakravorty and Khanikar, 2002).

Crop varieties or genotypes grown in different environments would frequently encounter significant fluctuations in yield performance. The fluctuations of crop performance with changing environments, technically termed as genotype and environment (G × E) interaction, potentially presents limitations on selection and recommendation of varieties for target set of environments. The G×E interactions have immense importance in breeding programmes for identifying stable genotypes that are widely or specifically adapted to unique environments (Verma *et al.,* 2008). The assessment of stability and wider adaptability of breeding lines against biotic and abiotic stresses is a pre requisite in any breeding programme. Various workers emphasized the importance of genotypes over environment, the linear regression of genotypes over environmental index and the deviation from regression coefficient for determination of stability and adaptation of genotypes for yield and other important yield contributing traits in mung bean (Abbas *et al.,* 2008). Stability in performance of a genotype over a wide range of environment is a desirable attribute and depends upon the magnitude of the GE interactions. Abbas *et al.* (2008) carried out stability analysis in mung bean and indicated that GE interactions were highly significant and were cross over in type.

The yield of mung bean fluctuates due to suitability of varieties to different growing environments. A specific genotype does not always exhibit the same phenotypic traits under all environments and different genotypes respond differently to specific location (Kamannavar *et al.*, 2011). Therefore, knowledge of G × E interaction and yield stability are important for breeding new cultivars with improved adaptation to environmental constraints prevailing in the target environments. In view of this, the present studies were conducted to know genotype-environment interaction and to identify stable and high yielding yellow mung bean genotypes under changing environments.

MATERIALS AND METHODS

The materials for the present investigation consists of nine genotypes of yellow mung *V. radiata* and three

ISSN : 0974-9411 (Print), 2231-5209 (Online)

genotypes of green gram (Table 1) evaluated during *kharif* season of the years 2007, 2010 and 2011 at Agricultural Research Station, Bidar, Karnataka state, which consists of north eastern transitional zone (Zone 1) having medium black clay laterite soil type. The mean annual rainfall is 937.3 mm. The experiments were conducted in randomized block design replicated thrice in each year/environment with row spacing of 30 cms and plant to plant distance of 10 cms. Recommended package of practices were followed for raising the good crop. The crop was harvested at the time of 90% pod maturity and yield data were recorded in Kg/Ha. Stability parameters were worked out as suggested by Eberhart and Russell (1966) using computer software written in "INDOSTAT"

RESULTS AND DISCUSSION

Stability analysis: Development of a stable variety is one of the major objectives of all breeding programmes. Phenotypic ally stable varieties are usually sought for commercial production of crop plants Several models were proposed for stability analysis. Stability is the ability to show a minimum interaction with the environment (Eberhart and Russell, 1966). Hence, the stability of genotype performance is directly related to the effect of G × E (Campbell and Jones, 2005). The adaptability of a variety over diverse environments is usually tested by the degree of its interaction with different environments under which it is tested (Finlay and Wilkinson, 1963). A variety or genotype is considered to be more adaptive/stable one, if it has high mean yield but a low degree of fluctuation in yielding ability when grown over diverse environments. A specific genotype does not always exhibit the same phenotypic traits under all environments and different genotypes respond differently to specific location.

Therefore, knowledge of G × E interaction and yield stability are important for breeding new cultivars with improved adaptation to environmental constraints prevailing in the target environments. The present research studies were conducted to know genotype -environment interaction and to identify stable and high yielding yellow mung bean genotypes under changing environments.

Pooled analysis of variance for stability of yield (Table 2) revealed the existence of substantial variability among the genotypes for seed yield. Significance of genotype × year interaction revealed that genotypes interacted significantly with environments/years (Singh *et. al.*, 2013) The partitioning of interaction showed that both linear and non linear (pooled deviation) components of interaction were highly significant indicating that both predictable and unpredictable components shared G × E interaction. The G × E (linear) interaction was highly significant when tested against pooled deviation, which revealed that there are genetic differences among genotypes for their regression on the environmental index. These results are in agreement with those reported by Natarajan (2001) in black gram (*Vigna mungo* L.) and Manivannan *et al*. (1998), Patel *et al*. (2009) and Kamannavar *et al.* (2011) in green gram **(***Vigna radiata* L).

Eberhart and Russel (1966) and Westerman (1971) emphasized that both linear (bi) and non-linear (S^2 di) components of G X E interaction should be considered in judging the phenotypic stability of a particular genotype. From the ANOVA table, the value for the genotype × environment (linear) sum of squares was not as a

Table 1. Ancillary data of genotypes of yellow moong (*V. radiata* L).

Genotype	Days to 50% flowering	Days to maturity	Plant height (cm)	Pods/ plant	Pod length (cm)	Seeds /pod	100 seed wt (gram)
Yellow mung-1 (YM-1)	32	60	50.2	19.2	8.0	11.4	3.64
Yellow mung-2 (YM-2)	32	58	48.4	21	7.8	12.2	3.00
Yellow mung-3 (YM-3)	32	59	52.6	20.6	7.8	12.0	3.42
Yellow mung-4 (YM-4)	33	60	47.4	20.0	8.2	12.6	3.40
Yellow mung-5 (YM-5)	33	60	48.0	18.2	6.8	12.6	2.82
Yellow mung-6 (YM-6)	33	58	56.6	17.6	7.0	11.8	3.30
Yellow mung-7 (YM-7)	33	64	47.6	16.8	7.2	12.0	3.38
Yellow mung-8 (YM-8)	32	60	44.4	17.0	7.4	12.0	3.20
Yellow mung-9 (YM-9)	31	63	50.6	16.4	7.2	12.2	3.50
Sel-4	32	65	57.8	18.6	9.6	12.0	3.94
BGS-9	33	66	60.0	17.2	12.8	14.0	4.56
China mung	31	65	53.6	17.0	9.8	12.6	4.30

Table 2. Pooled analysis of variance for grain yield of yellow mung (*V. radiata* L.).

Source of variance	DF	Mean sum of squares
Replication with error	06	4245.515
Genotype	11	8723.315 *
Environment + (Genotype × Environment)	24	83282.234***
Environment	02	965461.552***
Genotype × Environment	22	3084.114
Environment (Linear)	01	1930923.105***
Genotype × Environment (Linear)	11	3327.262
Pooled deviation	12	2604.219*
Pooled error	66	1082.956

*Significance at 5% level, ** Significance at 1% level

large portion of the G × E interaction, when compared with the environment E (linear) sum of squares and the residual. Table 2 shows the variation among the genotypes and G × E interaction was significant. It means that genotypes exhibited different performance in different years /environments which is due to their different genetic makeup or the variation due to the environments or both.

The environmental indices for grain yield indicated that the year 2007 (215.852) followed by year 2011 (105.407) were the most favourable environments for the better expression of traits as revealed by high and positive environmental indices, while, the year 2010 (-321.259) was unfavourable environment due to high negative environmental indices (Table 3).

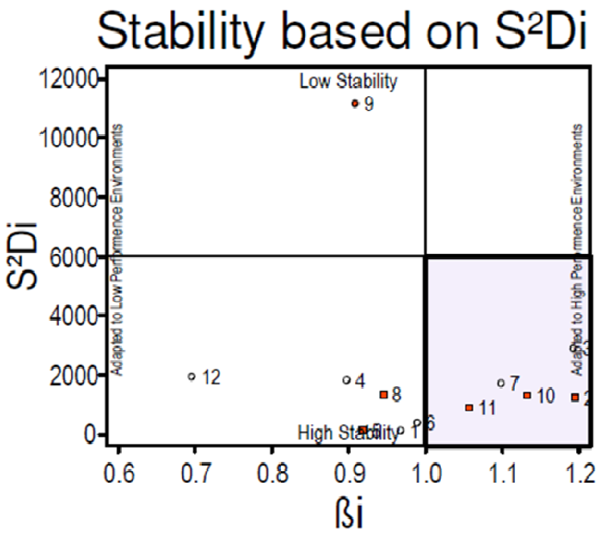

Fig. 1. *Stability of (Vigna radiata L) genotypes based on S²Di values.*

The promising genotypes during the year 2007 were BGS-9 (846.667 Kg/Ha) followed by YM-3 (761.667 Kg/Ha) and Sel-4 (760.000 Kg/Ha). In the year 2010 the genotypes China mung (232.333) followed by BGS -9 (267.333) and YM- 4 (180.333) performed better. The genotypes namely, BGS-9 (605.444 Kg/Ha) followed by China mung (537.889 Kg/Ha) and Sel-4 (519.778 Kg/Ha) performed better in the year 2011.

According to Eberhart and Russell (1966) model, a stable variety is one which has above average mean yield, a regression coefficient of unity (bi=1) and non significant mean square for deviations from regression (S^2 di=0). High value of regression (bi>1) indicates that the variety is more responsive for input rich environment, while, low value of regression (bi<1), is an indication that the variety may be adopted in poor environment. The phenotypic stability of genotypes was estimated by mean performance over years (x), the regression coefficient (b) and deviation from regression. Based on stability parameters the genotypes YM-5 (459.889 Kg/Ha), YM-8 (451.333 Kg/Ha) exhibited low mean performance along with regression value nearer to unity (bi=1) and non significant deviation from regression (s^2 di=0) indicating the high stability and wider adaptability across the three environments. The genotypes BGS-9 (605.444 Kg/Ha) and Sel-4 (519.778 Kg/Ha) exhibited high mean value and bi values (bi>1) and non significant deviation (s2 di < 0) value indicating adapted for high performance environments (Table 3 and Fig. 1).

Genotype YM-2 (457.556 Kg/Ha) exhibiting low mean performance but bi>1 and non significant deviation (s2 di < 0) and China mung (537.889 Kg/Ha) also exhibited high mean value but bi<1 and significant deviation indicating adapted for low performance environments. The simultaneous consideration of these stability parameters for the individual genotype revealed that genotypes such as BGS-9, Sel-4 and China mung are high yielders and showed stable performance across the environments. The stability of genotypes for seed yield and its components in mung bean (*Vigna radiata* L) has also been reported by Manivannan *et al*. (1998), and Patel *et al*. (2009) and Nath *et al*.(2013).

The presence of G × E interaction among the genotypes of yellow mung bean was revealed by present investigation. High yielding genotypes with wider adaptation and genotypes with specific adaptation to target environment were identified.

Conclusion

Stability in performance is one of the most desirable properties of a genotype to be released as a variety for wide cultivation. From the present study, it is concluded that, the genotypes BGS-9, Sel-4 and China mung are high yielders and showed stable performance across the environments may be useful in a breeding programme for evolving high yielding mung bean varieties well adopted to varying environments.

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Table 3. Mean performance and stability parameters for grain yield of yellow mung (*V. radiata* L.) cultivars over the seasons.

Genotype	Grain yield (Kg/Ha)				bi	S^2di
	2007	2010	2011	Mean		
YM-01	690.000	152.667	530.000	457.556	0.968	118.379
YM-02	723.333	077.000	577.667	459.333	1.195	-1249.168
YM-03	761.667	091.333	539.667	464.222	1.193	2886.498
YM-04	688.333	180.333	511.000	459.889	0.898	1827.283
YM-05	636.667	159.333	583.667	459.889	0.918	-128.122
YM-06	673.333	160.667	621.667	485.222	0.990	380.123
YM-07	616.667	051.667	572.000	413.444	1.099	1709.719
YM-08	656.667	148.000	549.333	451.333	0.945	-1342.036
YM-09	543.333	106.000	598.000	415.778	0.909	11148.149 **
Sel-4	760.000	155.000	644.333	519.778	1.132	-1300.896
BGS-9	846.667	267.333	700.333	605.444	1.057	-890.683
China mung	723.333	323.333	567.000	537.889	0.696	1933.349
Environmental index	215.852	-321.259	105.407			
CV %	09.486	19.377	11.515			
CD @ 5 %	111.367	51.259	113.649			

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