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Identification of Promising drought Tolerant Genotypes in green gram [Vigna radiata (L.)]

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Abstract: An experiment was conducted to screen 200 germplasm accessions of green gram for drought tolerance using augmented design during summer 2015 under drought stress condition. ANOVA revealed high significant differences among germplasm accessions for yield, yield component traits and also for drought tolerance traits. Mean squares attributable to 'Genotypes *vs* check entries' were significant for all the traits except seeds per pod and relative water content. Promising drought tolerant genotypes are identified based on the value of seed yield per plant under drought stress condition. The genotype LGG-583 is identified as most promising drought tolerant genotype from among 200 germplasm accessions since this genotype gave highest seed yield per plant (11.05) compared to all other genotypes under drought stress condition. Genotype LGG-595 is second most drought tolerant genotype followed by LGG-585 with values 10.73 and 9.97. Similarly, AKL-225 was most drought susceptible genotype (0.82) followed by AKL-194(0.84).

Keywords: Green gram germplasm, Drought tolerance, Promising genotypes

INTRODUCTION

Green gram [*Vigna radiata* (L.) Wilczek] also known as mung bean is an important short duration pulse crop of the tropical and subtropical countries of the world. Pulses are the major food legume crops forming cheapest source of dietary proteins for the people of south East Asian countries. Green gram is an important annual legume crop among pulse crops, grown principally for its high protein seeds that are used as human food (Singh et al., 1988 and Singh et al.,2017). The crop is considered to be potential domestic crop because of its tolerance to drought and high temperature (Batzer et al., 2022). It is quite versatile crop can be grown for seeds, green manure and forage as mixed or sole crop (Singh et al., 2023). Essential amino acids especially lysine and tryptophan are mainly found in green gram along with other proteins (Chakraborty et al., 2021). The progenitor of present day cultivated mungbean is widely distributed in the Godavari and Krishna River belts of south India and in the foothills of western Himalaya of Eastern India (Fuller, 2007; Smartt, 1990). It belongs to papilionoid subfamily of the Fabaceae family and has a diploid chromosome number of $2n=2x=22$. The protein content of pulses is twice that of cereals (20-25%) and almost equal to that of poultry and meat hence pulses are commonly called as the poor man's meat (Reddy, 2009). Because of important beneficial factors such as; short duration (90-120 days), nitrogen fixing ability, inhibition of soil erosion, soil enrichment, low input requirements and wide adaptability the mung bean crop is very popular. Despite holding such a great importance and promise, mung bean crop has not gained much attention. The crop is often grown mostly as rain-fed crop in marginal lands with limited inputs making

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it prone to a number of abiotic stresses. Among these abiotic stresses, drought is the major stress leading to heavy crop loss. Drought is the major abiotic stress severely impairing plant growth and development limiting production and performance of crop plants than any other environmental stress (Shao *et al.*, 2009). Drought, also referred to as low-moisture stress, is a multidimensional stress which not only disturbs normal metabolism and yield of crop plants but also affects all living organisms in terms of health and food. Based on the fourth assessment report by IPCC (Intergovernmental Panel on Climate Change), the average global surface temperature will rise by 1.1-6.4°C by the end of this century. Global climate change is rapidly increasing the frequency of severe drought conditions (Dai, 2012). Global climate change is rapidly increasing the frequency of severe drought conditions (Dai, 2012). Drought tolerance is defined as the ability of the crop to withstand water deficit with low tissue water potential (Basu *et al.,* 2016).

Green gram is said to be more susceptible to water deficits than any other grain legumes. Reduction in crop photosynthesis is caused by reduction in plants leaf leading to dry matter accumulation (Pandey *et al.,* 1984). Siddiqui *et al.* (2007) reported that pod setting stage and late flowering traits appear to be the most sensitive stages to soil moisture stress and yield. Various physiological processes associated with growth, development, and economic yield of a crop are affected due to water stress (Allahmoradi *et al.,* 2011). Development of drought tolerant cultivars is the most effective control measure in mitigating effects of drought on green gram production. Significant research efforts have been made over the past two decades to improve green gram adaptation to drought.

Morphological classification of crop germplasm accessions is an important step in description and classification of crop germplasm as all the breeding programmes are dependent on the magnitude of genetic variability (Uma et al., 2013). Seed colour of germplasm is one of the important quality parameters in green gram (Pandiayan et al., 2012) and there are several reports stating that during drought condition seed quality of green gram crop is severely affected. Measurement of genetic distance is one of the important criterion to judge amount of genetic variability in crop plants (Arunachalam, 1981). Germplasm evaluation / screening is the best method to assess genetic diversity and also to identify genotypes possessing trait of interest so that plant breeders can have breeding material for crop improvement programmes (Manivannan et al., 1998)

MATERIAL AND METHODS

The experiment was conducted at experimental plot of College of Agriculture, Hassan, University of Agricultural Sciences, Bangalore. The experimental site is geographically located at Southern Transitional Zone (Zone-7) of Karnataka with an altitude of 827 m above Mean Sea Level (MSL) and at 12.9652° N latitude and 75^0 33′ to 76^0 E38′ longitude. The study material consisted of 200 germplasm accessions collected from different research institutions / organizations representing different agro-climatic zones.

Layout of the experiment

The experiment was conducted in an Augmented Randomized Complete Block Design with 200 germplasm accessions and 5 check varieties. As per the augmented RCBD, the check entries were replicated twice randomly in each block. There were 5 blocks, each block had 5 plots of size 3x3 m^2 thus each block size was 15 m^2. The gross area of experimental plot was 75 m^2. The row spacing was 30 cm and inter plant distance was 10 cm. The experiment was conducted during *summer* 2015. Recommended crop production practices were followed during the crop growth period to raise healthy crop.

Imposing drought condition

Drought condition was imposed by withholding irrigation 25 days after sowing (Baroowa and Gogoi, 2015; Pooja *et al.*, 2019). Since the experiment was conducted during *summer* season, there were no unpredicted rains during the entire cropping period hence the drought condition was effectively imposed. The rainfall data of experimental site during the cropping period is given in table No.1.

Table 1: Meteorological data of experimental site for the year 2015

Year	*Months*	*Temperature (°C)*	*Relative humidity (%)*	***Rainfall (mm)***
2015	January	21.32	61.03	0.59
	February	23.10	50.72	Nil
	March	25.34	58.70	2 mm (25.03.2015)
	April	25.87	66.55	Nil

Plant sampling and data collection

Observations were recorded on five randomly chosen competitive plants from each germplasm accession for all the characters except days to 50 *per cent* flowering and days to maturity, which were recorded on plot basis. The values of five competitive plants were averaged and expressed as mean of the respective characters. The observations were taken on the traits like; Days to 50% flowering, Days to maturity, Plant height (cm), Clusters per plant, Pods per cluster, Pods per plant, Pod length (cm), Seeds per pod, test weight, Threshing %, Harvest index (%) SCMR (SPAD Chlorophyll meter reading), Leaf water potential (Mpa), Proline content ($\mu g\, g^{-1}$), Relative water content, Specific leaf area and Seed yield per plant.

RESULTS AND DISCUSSION

Assessment of Genetic Variability for Grain Yield and its Component Traits

For successful crop improvement programmes, breeders need to define and assemble the required genetic variability and select for yield indirectly through yield associated and highly heritable characters (Mather, 1949). Selection is only effective if the trait has high heritability otherwise attempts to improve character through selection will be futile.

Analysis of variance

Analysis of variance revealed highly significant mean squares attributable to germplasm accessions for all the traits. Significant mean squares were recorded for all the traits. (Table 2). Mean squares attributable to 'Genotypes *vs* check entries' were significant for all the traits except seeds per pod and relative water content. These results suggest significant differences among the germplasm accessions. The germplasm accessions as group differed significantly for all of the traits under investigation, similarly, check entries as group differed significantly for most the traits under study.

Germplasm accessions possessing maximum and minimum values for quantitative traits under drought stress condition

The genotype CNS-5 registered maximum values for the trait days to 50 *per cent* flowering (53.00) and days to maturity (81.00). The genotype LGG-577 recorded minimum values of 35.00 and 62.00 for the traits days to 50 *per cent* flowering and days to maturity respectively. The genotype IC-436723 recorded maximum value of 58.57 and genotypes IC-546481 recorded minimum value for plant height (19.18). The genotype VBNGG-2 recorded maximum value of 8.25 and genotype IC-73416 registered minimum value of 1.53 for the trait cluster per plant. For the trait pods per cluster, genotypes LGG-595 and AKL-212 recorded maximum (4.50) and minimum (1.75) values respectively. The genotype VBNGG-2 recorded maximum value of 35.72 and genotype AKL-212 recorded minimum value of 4.37 for the trait pods per plant. The genotype LGG-590 exhibited maximum value of 7.67 and the genotype KM13-12 recorded minimum value of 4.05 for the trait pod length. For the trait seeds per pod, genotype LGG-583 possessed maximum value of 9.70 and minimum value of 3.06 was exhibited by the genotype KPS-1. Minimum and maximum values for the trait test weight were 1.70 gms and 4.90 gms and these values were possessed by the genotypes VGG04-149 and AKL-195 respectively. Threshing percentage varied from 42.89 *per cent* to 69.88 *per cent* and these values were possessed by the genotypes AKL-169 and VBNGG-2 respectively. Minimum value of 20.51 exhibited by genotype CNS-9 and maximum value of 48.50 exhibited by genotype LGG-582 for the trait harvest index.

Table 2: Summary of augmented ANOVA for grain yield and component traits of germplasm accessions under drought condition

Sources of Variations	*DF*	*DFF*	*DM*	*PH*	*CPP*	*PPC*	*PPP*	*PL*	*SPP*	*TW*
Blocks (b)	4	14.74 **	8.18***	65.31**	2.23**	0.11*	25.23**	1.49**	5.05**	1.77 **
Entries (e) (Genotypes + Checks)	204	17.10 **	18.01**	84.47**	3.60**	0.51**	72.94**	0.75**	2.70**	0.35 **
Checks	4	34.57 **	37.01**	22.56**	1.40**	0.42**	12.50**	0.87**	3.98**	0.81 **
Genotypes	199	14.215 **	15.14**	85.71**	3.67**	0.51**	73.91**	0.73**	2.69**	0.31 **
Checks vs Genotypes	1	521.64 **	513.06**	85.01**	0.16**	1.45**	121.60**	4.52**	0.03	5.42 **
Error	16	1.32	0.74	0.98	0.04	0.02	0.98	0.009	0.05	0.05

Sources of Variations	*DF*	*TP*	*HI*	*SCMR*	*LWP*	*PC*	*RWC*	*SLA*	*SYPP*
Blocks (b)	4	37.12*	247.54 **	396.55 **	1.17 **	470.90 **	423.68 *	4067.34 *	2.11 **
Entries (e) (Genotypes + Checks)	204	37.20 **	54.41 *	98.71 **	2.45 **	1707.90 **	425.40 **	4283.10 **	7.01 **
Checks	4	17.09	64.39 *	24.49	0.82 **	942.07 **	63.06	1924.20	3.76 **
Genotypes	199	27.67 *	53.01 *	79.58 *	2.33 **	1712.67 **	433.68 **	4294.15**	7.10 **
Checks vs Genotypes	1	2014.79 **	293.20 **	4203.25 **	32.57 **	3822.09 **	227.32	11518.68**	0.42*
Error	16	9.83	19.57	31.14	0.03	1.48	130.64	1339.95	0.09

*Significant at P =0.05, ** Significant at P=0.01

DFF : Days to 50% flowering
DM : Days to maturity
PH : Plant height (cm)
CPP : Cluster plant^{-1}
PPC : Pods cluster^{-1}
Pods plant^{-1}
PL : Pod length (cm)
SPP : Seeds per pod
TW: test weight (g)
TP : Threshing %
HI : Harvest index (%)
SCMR : SPAD Chlorophyll meter reading
LWP : Leaf water potential(Mpa)
PC : Proline content (µg g^{-1})
RWC : Relative water content (%)
SLA : Specific leaf area
SYPP : Seed yield plant^{-1}

Spad chlorophyll meter reading had range of values from 36.58 to 72.91 and these values were recorded by genotype IC-39605 and LGG-579 respectively. Leaf water potential had maximum value of -8.14 and minimum value of -2.15 values registered by the genotypes AKL-39 and AKL-216 respectively. Proline content values ranged from 62.70 ($\mu g\, g^{-1}$) to 201.33($\mu g\, g^{-1}$) and these values were possessed by the genotypes COGG-954 and VGG10-010 respectively. The genotype AKL-79 exhibited maximum value of 99.11 and the genotype PLM-92 recorded minimum value of 33.62 for the trait relative water content. Specific leaf area had a minimum value of 31.96 and maximum of 265.30 possessed by genotypes CGG-973 and KM13-9 respectively. The genotype LGG-583 recorded maximum value of 11.05 and genotype LGG-593 registered minimum value of 0.73 for the trait seed yield per plant (table 3).

Identification of promising drought tolerant genotypes

Drought tolerant genotypes are identified based on the trait seed yield under drought stress condition. Ultimate aim of any plant breeding programme is to develop varieties tolerant for abiotic stress with moderately good yielding ability. There could be many other genotypes possessing higher level of drought tolerance for physiological and other drought tolerance adaptive traits but with low yielding ability, such genotypes are useful for developing mapping population and also to study genetic mechanisms governing drought tolerance. But genotypes possessing drought tolerance coupled with fairly good yielding ability will find immediate application / utility in plant hybridization programmes to develop drought tolerant varieties. Hence the genotypes identified as drought tolerant in this study are the ones who gave higher yield under drought stress condition. The genotype LGG-583 is identified as most drought tolerant promising genotype from among 200 germplasm accessions since this genotype gave highest seed yield per plant (11.05) compared to all other genotypes under drought stress condition. Genotype LGG-595 is second most drought tolerant genotype followed by LGG-585 with values 10.73 and 9.97. Similarly genotype AKL-225 was most drought susceptible (0.82) followed by AKL-194(0.84). List of other drought tolerant and susceptible genotypes is given in table 4.

Table 3: List of promising genotypes identified as drought tolerant and susceptible

List of drought tolerant genotypes		*Seed yield per plant (gm)*	*List of drought susceptible genotypes*		*Seed yield per plant (gm)*
Sl. No	*Genotype*		*Sl. No*	*Genotype*	
1	LGG-583	11.05	**1**	AKL-225	0.82
2	LGG-595	10.73	**2**	AKL-194	0.84
3	IC-436624	9.97	**3**	AKL-212	0.92
4	LGG-585	9.57	**4**	KM13-16	0.95
5	IC-436723	9.54	**5**	IPM99-125	0.96
6	TARM-2013	9.42			
7	AKL-228	9.35			
8	VGG10-010	9.27			
9	VGG04-011	9.24			
10	IC-436746	9.13			

CONCLUSIONS

The study identified genotype LGG-583 as most drought tolerant promising genotype from among 200 germplasm accessions since this genotype gave highest seed yield per plant (11.05) compared to all other genotypes under drought stress condition. Genotype LGG-595 is second most drought tolerant genotype followed by LGG-585 with values 10.73 and 9.97. Similarly genotype AKL-225 was most drought susceptible (0.82) followed by AKL-194(0.84).

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