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SCREENING YARD LONG BEAN GENOTYPES FOR DROUGHT TOLERANT TRAITS UNDER FIELD AND POLYHOUSE CONDITION

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Abstract

Yard long bean (*Vigna unguiculata* ssp. *sesquipedalis* (L.) Verdcourt) is an important legume vegetable. Due to climate change and erratic rainfall, the crop experiences continuous water deficit that affects its growth and yield. In summer season the pod production is heavily affected by moisture stress. Development of high yielding varieties of yard long bean with drought tolerance is essential for its sustainable production. A total of 100 germplasm lines of yard long beanwere screened to identify drought tolerant genotypes. Evaluation was carried out at the seedling stage in field and polyhouse condition. Moisture Stress was imposed to the seedlings by withholding irrigation until 75% of most susceptible genotypes have completely wilted. Irrigation was resumed for the survival of the tolerant lines. Based on the days taken to critical stress level, permanent wilting point and relative leaf water content genotypes were evaluated for their drought tolerance. Analysis revealed significant differences among genotypes. Days taken for reaching critical stress level were found to be 6 days. Out of the 100 genotypes, the screening helps to identify 18 drought tolerant genotypes that perform well both under field and polyhouse condition. These genotypes can be used as parental lines in thefuture development of climate smart drought tolerant varieties of yard long bean.

***Keywords*:** yard long bean, drought tolerant, genotypes, polyhouse, water stress.

Introduction

Yard long bean (*Vigna unguiculata* ssp. *sesquipedalis* (L.) Verdcourt) is a highly remunerative vegetable crop in Kerala. The crop is mainly grown for its very long, slender and succulent pods which may be white, light green, dark green or brownish red in colour. The crop is a vigorous climbing annual which grows up to a height of three to four meters but a few important kinds are of dwarf, intermediate and semiclimbers (George, 2008). The pods are highly nutritive containing 23 to 26 per cent of digestible protein and high dietary fiber along with vitamin A, vitamin C, thiamin, riboflavin, calcium, phosphorus, sodium, potassium and magnesium. It is also a good source of micronutrients (Ano and Ubochi, 2008). Apart from pods, the young leaves and green seeds are also used as vegetable. It is a true diploid (2n=22) self-pollinated species. Being a legume, yard long bean is an integral part of sustainable agriculture.

The crop is mainly grown under rainfed conditionsof Kerala. Despite all its economic and nutritional importance, its production is subjected to a wide range of biotic and abiotic constraints. Among abiotic stresses drought is the main abiotic factor that adversely affects the crop growth and production.Drought stress occurring at seedling stage could be detrimental to cowpea production (Verbree *et al.,* 2015). Development of high yielding varieties with resistance to biotic and abiotic stresses is essential for the sustainable production of the crop. Germplasm are the live information source of many valuable traits. Collection and utilization of such tolerant genotypes provide greater scope for the development of new and improved climate resilient varieties. With this background the current study was undertaken to screen the available germplasm of yard long bean to identify drought tolerant genotype.

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Materials and Method

The material used in the research comprised of landraces and cultivars of 100 yard long bean genotypes collected from different agroclimatic zones of Kerala. The genotypes were evaluated for water stress tolerance both under controlled polyhouse and field conditions at the seedling stage. The experiments were laid out in a completely randomized design with two replications. In the polyhouse seedling were grown in growbags and two plants per bag were maintained with five growbag per treatment. The field study was conducted during March when the average day time temperature ranged from 30˚C - 34˚C.In the field seedling were raised in progeny rows with five plants per row.

The plants were well irrigated in their initial stages of development. Moisture Stress was imposed by withdrawing irrigation after 21 to 25 days of initial seedling growth. The variation in morphology and physiological processes of plants during drought stress was studied both under controlled and field conditions. Watering resumed until all the susceptible lineshave completely wilted.Based on the days taken to critical stress level, permanent wilting percentage and relative leaf water content genotypes were recorded for their degree of tolerance to drought stress.

According to Nemeskeri and Helyes (2019) physiological response of plants during moisture stress can be used as stress markers for screening drought tolerance. Relative leaf water content is considered as a measure of plant water status, reflecting the metabolic activity in tissues and can be used as stress marker for screening dehydration tolerance. The relative leaf water content was calculated using the following formula and expressed as percent.

RWC (%) = [(FW - DW) / (TW - DW)) x 100

Where, FW is the fresh weight; DW is the dry weight and TW is the turgid weight.

Permanent wilting percentage is another parameter which determinesthe soil moisture on a dry-weight basis using the gravimetric method:

Soil moisture = (fresh weight – dry weight) / dry weight.

The data were submitted to the analysis of variance (ANOVA).

Result and Discussion

The Results revealed significant difference and variation among the 100 yard long bean genotypes for drought tolerance. Similar results were observed in morphological and physiological indicators among the genotypes under field and polyhouse condition. According to Singh *et al*. (1999) seedling stage screening of germplasm in pots is a viable and effective means of identifying drought tolerant varieties as the same phenomenon is also confirmed at the flowering stage. Moreover, the method is simple and reliable for screening a large number of germplasms. Plant greenness score and recovery rate at seedling stage have been reported as accurate parameters for evaluating drought tolerance in cowpea (Ravelombola *et al.,* 2018).

Based on the level of resistance displayed and symptoms of wilting from the day of imposition of water stress genotypes were recorded for their degree of tolerance to water stress. The wilting is observable in plants as rolling, drooping and folding of leaves or young stem. Wilting occurs when transpiration exceeds the rate of water absorption from soil or due to inadequate soil moisture. The results showed significant variation among genotypes in the number of days for reaching critical stress level under both conditions. Number of days for reaching critical stress level varied from 3 to 10 days under polyhouse and from 4 to 9 days in the field condition. The mean critical day for determining water stress tolerant and susceptible genotype was found to be 6^{th} day both under field and polyhouse condition. Verbree *et al*. (2015) opined that the Plant greenness score has helped to identify wilting status of cowpea plants under drought stress. Drought-tolerant genotypes were slow-wilting, whereas those that were more drought susceptible were fast-wilting (Ravelombola *et al.*, 2020).

Severe moistures stress leads to cell membrane damage which results in electrolyte leakage. As stress prolongs the damage increases. Relative leaf water content was estimated on the third day of irrigation withdrawal. Significant difference in relative water content was found among the 100 yard long bean genotypes (Fig. 1). The RWC values across stress treatments ranged 45.69-73.85% under polyhouse and 57.72-78.43% in the field condition. The mean value of RWC was 61.37% and 65.38% for genotypes in poly house and field respectively. Genotypes which show consistent higher RWC across stress treatment under field and polyhouse were selected as drought tolerant. According to Blum *et al*. (2001) higher values of RWC and osmotic adjustment confers for better growth and development of plants under moisture stress. Diallo *et al.* (2001) reported higher values of relative water content in well-watered cowpea than in water stressed plants.

Permanent wilting percentage (PWP) is the minimum amount of water left in the soil that the plant requires not to wilt (Briggs and Shantz, 1912). Ajay *et al.* (2018) reported permanent wilting percentage as one of the best traits for screening dehydration tolerance in cowpea seedling under controlled condition. Analysis of variance for PWP recorded significant variation among 100 genotypes in the range of 10.2-18.9 under polyhouse and 14.3-19 in the field condition. The mean value of PWP was 14.54 and 17.39 for genotypes in polyhouse and field respectively. The screening help to identify drought tolerant genotypes that perform well both under field and polyhouse condition. Every plant has its own defense mechanism to reduce the severity of stress. The genotypes that have low PWP and better adaptation to drought stress across stress treatment under field and polyhouse were selected as drought tolerant.

Conclusion

Yard long bean is an underexploited vegetable which is highly nutritious in terms of proteins and vitamins. Development of stress tolerant varieties can extend its cultivation to new areas. In the present investigationout of the 100 genotypes screened, 18 drought tolerant genotypes were identified based on the better and consistentperformance across stress treatment. The genotypes identified in the study would serve as potential donors of water stress resistance and can be used to broaden the genetic base of existing cultivar.

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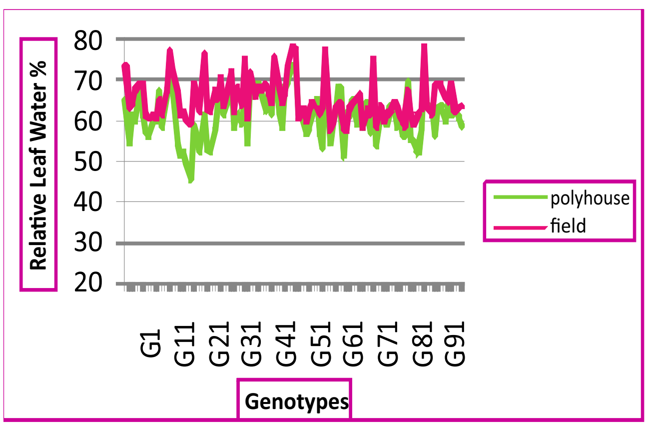

Fig. 1: Variation in Relative Leaf Water content among genotypes under drought stress

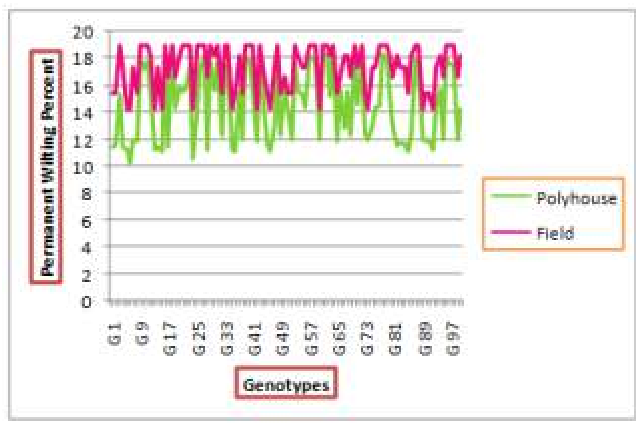

Fig. 2: Variation in Permanent Wilting Percentage among genotypes under drought stress

Table 1: List of identified drought tolerant genotypes

S. No.	Geotypes	S. No.	Genotypes
1	G1 - Acc 5	**10**	G42 - Kollam
2	G5 - Acc 1339	**11**	G45 - Kottarakara
3	G6 - Adoor	**12**	G46 - Kottayam
4	G14 - Anchal	**13**	G49 - Kozha
5	G15 - Aranmula	**14**	G50 - Kulashegarapuram
6	G24 - Elamadu	**15**	G51 - Kulathupuzha
7	G32 - Kalliyoor	**16**	G60 - Muttathukonam
8	G36 - Kattampally	**17**	G74 - Nilamel
9	G38 - Kilimanoor	**18**	G89 - Pongamoodu