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Transgressive Segregants in F_2 Populations of Three Superior Crosses *viz.*, ML 267×LGG 528, MGG 390×LM 95, LM 95×EC 362096 in Mungbean

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ABSTRACT

Background: Among several reasons for low productivity in mungbean, various biotic and abiotic factors play a major role. Although intensive research work has been done on genetic architecture of yield and yield attributes of mungbean but limited work was done on yield attributes along with water use efficiency (WUE) and heat stress tolerance related traits. The present study is aimed to identify the genetic potential of mungbean genotypes with high yield and drought and heat stress tolerance.

Methods: The F_2 seed was harvested from selfed F_1 population during 2017-18 from three superior crosses *viz*., ML 267×LGG 528, MGG 390×LM 95 and LM 95×EC 362096. These crosses were selected based on their *per se* performance of yield, yield attributes and WUE related traits. Genetic analysis was carried out in F_2 populations of three crosses for fourteen quantitative characters to identify the number of transgressive segregants in desirable direction.

Result: A good number of transgressive segregants in desirable direction were observed for plant height, number of pods per cluster, harvest index, SLA, SLW and relative injury in the cross ML 267×LGG 528: for plant height, number of branches per plant, SCMR, SLA, SLW and relative injury in the cross MGG 390×LM 95 and for plant height, number of pods per cluster, number of pods per plant SCMR, SLA, SLW, relative injury and seed yield in the cross LM 95×EC 362096.

Key words: Heat tolerance, Mungbean, Transgressive segregants, Water use efficiency, Yield attributes.

INTRODUCTION

Green gram, popularly known as mung bean is the third important legume after chickpea and pigeon pea. It is a self pollinating, short duration legume that belongs to family Fabaceae with a chromosome number of 2n=22. Our national production and productivity levels of mungbean are low, which indirectly affects the nutrient availability of people resulting in malnutrition. Among several reasons for low productivity, various biotic and abiotic factors play a major role. Among the abiotic stresses, drought stress and heat stress are prominent, which seriously influences the mungbean productivity. Water deficits and high temperature occur together in many environments and both stresses can interact to reduce yields. Although intensive research work has been done on genetic architecture of yield and yield attributes of mungbean but limited work was done on yield attributes along with water use efficiency (WUE) and heat stress tolerance related traits. Realizing the significance of drought and heat stress on yield components there is an immediate need to enhance the genetic potential of mungbean genotypes with high yield and drought and heat stress tolerance.

Water use efficiency is one of the genetic characters which can contribute to higher productivity under scarce water resources. Hence, a proper understanding and appreciation of the differences in water use efficiency and relationship of water use efficiency with other parameters are essential to plan strategies for yield improvement in water scarce areas. Assessment of inter-relationship among surrogate traits of water use efficiency with yield and its components is essential for formulating selection strategy to combine water use efficiency conferring traits with higher yield.

So far, the approach to breeding cultivars with superior yield performance under water limited conditions has remained empirical, *via;* selection for yield under stress conditions. More rapid progress may be achieved by a prior knowledge of the physiological basis of surrogate traits related to WUE, such as specific leaf area (SLA), soil and

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plant analytical development chlorophyll meter reading (SCMR) and specific leaf weight (SLW). SLA is negatively correlated with WUE whereas SCMR is positively associated with WUE (Nageswara Rao *et al.,* 2001). Hence, these traits could be used for selecting higher water use efficient green gram genotypes. This provides sufficient justification for the use of SLA and SCMR as potential surrogate traits for selecting genotypes with enhanced WUE (Nageswara Rao *et al.,* 2001). The possible relationship between SLW and WUE is based on the fact that SLW would be an indicator of leaf photosynthetic capacity. Plants with higher SLW had increased cell wall constituents, non-structural carbohydrates and often some specific proteins (Brown and Byrd, 1997). The trait is reported to be associated with drought tolerance of plants and is suggested as a useful selection criterion for plants breed for low rainfall targeted areas (Thumma *et al.,* 1998). Cultivars with more SLW had thick leaves (reduced surface area to volume ratio) and exhibit improved water use efficiency (Brown and Byrd, 1997; Thumma *et al.,* 1998).

High temperature stress during germination and flowering causes considerable yield losses in mungbean. Temperature is rising day by day, which highly affects the crop at different phenophases, ultimately yield. It causes cell death, burning, flower drop, pollen abortion, shortening the grain filling duration etc. (Khalil *et al.,* 2009). Thus there is a dire need to develop heat tolerant varieties in this challenging era. Heat tolerance is determined by measuring relative injury percentage. Cell membrane integrity is tested by exposing leaves to high temperature and computing relative injury to the membranes in terms of electrolytes leakage. Lower leakage indicates lower the injury and higher the thermo tolerance.

Combination of different water use efficiency and high temperature tolerance traits is relevant, rather than a single trait used as a selection criteria. However, breeding for drought and high temperature tolerance has unfortunately remained neglected in mungbean. Due to complex nature of these stresses and lack of appropriate screening techniques, outcomes achieved have been less. Keeping in view the importance of these stresses, development of mungbean genotypes, which can retain maximum number of flowers and produce productive pods during high temperature (>40°C) and tolerate drought are essential to increase mungbean production in the country.

The success of selection in self-pollinated crops depends on the extent to which breeders can fix transgressive segregation in early generations as high heterotic crosses would result in more productive transgressive segregants in later generations as pointed by Arunachalam *et al*. (1981).Transgressive segregants can be predicted and observed within progenies of an early segregating generation. Transgressive segregation may be used as a positive tool in plant breeding where segregants in F_2 or later generation exceed either of the two parents of the cross in one or more characters which occurs due to the accumulation of favorable genes from both the parents.

MATERIALS AND METHODS

The present experiment was carried out at dry land farm of Sri Venkateswara Agricultural College, Tirupati, situated at an altitude of 182.9 m. above mean sea level, 32.27°N latitude and 79.36°E longitude, situated geographically in Southern Agro Climatic Zone of AndhraPradesh, India. The F_1s of three superior crosses selected based on their yield, WUE and heat stress tolerance related attributes *viz.*, ML 267×LGG 528, MGG 390×LM 95 and LM 95×EC 362096 and their five parents *viz.*, ML 267, LGG 528, MGG 390, LM 95 and EC 362096 were sown at dry land farm, S.V. Agricultural College, Tirupati during *kharif,* 2017. The F_2 seed was harvested from selfed F_1 population.

The experimental material consisted of F_2 populations of three crosses *viz.,* ML 267×LGG 528, MGG 390×LM 95 and LM 95×EC 362096 were grown at the dry land farm, S.V. Agricultural College, Tirupati during *rabi,* 2017 in compact family block design with two replications. F_2 populations were raised in 10 rows of three meter length following a spacing of 30 cm between the rows and 10 cm between the plants within a row. As a basal dressing, fertilizers *viz.,* urea and single super phosphate to supply 20 kg N and 40 kg $P_2O_5 ha^{-1}$ were applied respectively to experimental plots. Thinning was done to leave single seedling per hill after 15 days of sowing. Irrigation, weeding and plant protection measures were taken up as and when needed during the crop growth period, as per the standard recommended package of practices to raise a good and healthy crop.

Observations were recorded on 80 randomly chosen competitive plants from each genotype in each replication for all the characters. The values of 80 competitive plants were averaged and expressed as mean of the respective characters. In the present study, transgressive segregants were identified by finding the number of plants exceeding mean value of the higher parent or lagging behind the mean value of the lower parent by critical difference at 5 per cent level. The data recorded on 160 individual plants for each cross was used for calculating the transgressive segregants.

RESULTS AND DISCUSSION

In self-pollinated crops like mung bean the success of selection depends on the extent to which breeders can fix transgressive segregation in early generations. Transgressive segregation refers to appearance of individuals, in the progeny from a hybrid, which exceed either of the two parents of the hybrid with respect to one or more characters. Such plants are produced by accumulation of favourable genes from both the parents as a consequence of segregation and recombination. Success in obtaining the desired transgressive segregants depends on obtaining genetic recombination between both linked and unlinked alleles (Briggs and Allard, 1953). Hence, an attempt was made to identify the transgressive segregants in F_2 generation in the desired direction for different traits in the three crosses and the results were presented in Table 1. Transgressive segregants in desirable direction for different traits were identified by finding the number of plants exceeding the value of the higher parent or lagging behind the value of the lower parent by critical difference at 5 per cent level.

The frequency of transgressive segregants varied in the three crosses for different characters. A good number of transgressive segregants in desirable direction were observed for plant height, number of pods per cluster, harvest index, SLA, SLW and relative injury in the cross ML 267 x LGG 528: for plant height, number of branches per plant, SCMR, SLA, SLW and relative injury in the cross MGG 390 x LM 95 and for plant height, number of pods per cluster, number of pods per plant SCMR, SLA, SLW, relative injury and seed yield in the cross LM 95 x EC 362096. These transgressive segregants should be maintained and forwarded to further generation till they reach nearly homozygous condition and the most promising one can be used for the development of better genotype.

More number of transgressive segregants for seed yield were observed in the cross LM-95 x EC 362096 (19.38%) followed by the cross ML 267 x LGG 528 (13.13%) and MGG 390 x LM 95 (9.38%). Transgressive individuals with values exceeding the better parent in desired direction were observed in three crosses for seed yield and water use efficiency traits *viz*., SCMR, SLA, SLW and relative injury. Transgressive segregants with more pods and bearing more clusters have direct contribution towards yield. Transgressive segregants for seed yield and other traits were earlier reported Uma and Salimath (2004) in cowpea, Shivkumar *et al.* (2013) in chickpea, Singh *et al.* (2016) in mungbean and Shilpa *et al.* (2020) in blackgram. This indicates that the parents possess different alleles and genes governing respective characters from which it could be inferred that there is a lot of scope to bring in beneficial alleles into a single genotype through rigorous selection and handling of these segregants to arrive at desirable plant types with higher seed yield and water use efficiency through selection in later generations.

The most promising transgressive segregants for seed yield and at least one water use efficiency trait in desired direction *viz*.; individual plant numbers 33, 35, 40, 72, 86, 96, 99, 106, 108, 116 in cross ML 267 x LGG 528; 8, 25, 26, 65, 70, 71, 95, 105, 113, 135, 151 in cross MGG 390 x LM 95; and 30, 38, 45, 48, 66, 74, 75, 76, 92, 95, 110, 115, 125, 128, 132, 141, 154 in cross LM 95 x EC 362096 needs further evaluation which may prove their immense value.

Apart from the frequency of transgressants, it will be of great interest to examine the intensities of the characters expression achieved in the transgressants in each of the crosses. This will provide an insight into the extended limits and intensities of desired characters expression achieved by transgressive breeding. From this investigation, it can be suggested that the most promising transgressive segregants listed in (Table 1) need to be evaluated further. If they confirm their superiority in further generations may

Table 1: Transgressive segregants for different traits in desired direction in F_2 generation of three crosses of mungbean.

Character	Number of transgressive segregants		
	ML 267 × LGG 528	MGG 390 × LM 95	LM 95 × EC 362096
Days to 50% flowering	3(1.88%)	5(3.13%)	4(2.50%)
Days to maturity	13(8.13%)	0(0.00%)	1(0.63%)
Plant height (cm)	75(46.88%)	81(50.63%)	36(22.50%)
Number of branches per plant	0(0.00%)	47(29.38%)	5(3.13%)
Number of clusters per plant	13(8.13%)	29(18.13%)	25(15.63%)
Number of pods per cluster	39(24.38%)	10(6.25%)	65(40.63%)
Number of pods per plant	21(13.13%)	24(15.00%)	52(32.50%)
100-seed weight (g)	25(15.63%)	30(18.75%)	2(1.25%)
Harvest index (%)	38(23.75%)	22(13.75%)	21(13.13%)
SPAD chlorophyll meter reading	8(5.00%)	55(34.38%)	34(21.25%)
Specific leaf area (cm^2g^{-1})	57(35.63%)	36(22.50%)	36(22.50%)
Specific leaf weight (g cm^{-2})	62(38.75%)	34(21.25%)	30(18.75%)
Relative injury (%)	55(34.38%)	65(40.63%)	52(32.50%)
Seed yield per plant (g)	21(13.13%)	15(9.38%)	31(19.38%)
Number of plants showing transgressive segregation for yield and at least one water use efficiency trait in desired direction	10	11	17
Promising transgressive segregants for seed yield and at least one water use efficiency trait in desired direction	33, 35, 40, 72, 86, 96, 99, 106, 108, 116	8, 25, 26, 65, 70, 71, 95, 105, 113, 135, 151	30, 38, 45, 48, 66, 74, 75,76, 92, 95, 110, 115, 125, 128, 132, 141, 154

be considered for multi-location evaluation for release as a variety or may be used as a parent in future breeding programme.

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