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Performance of Greengram Genotypes for Morpho-physiological and yield Traits

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ABSTRACT: A field experiment with five genotypes of green gram (*Vigna radiata* (L.) R. Wilczek) was conducted during *rabi* 2021 for understanding their variation in morphological, phenological, physiological, biomass and yield parameters prior to moisture stress experiments. Plant height was highest in genotype MGG-351(52 cm) followed by MGG-385 (48cm). Days to 50% flowering (40 days) and days to maturity (73 days) were highest in genotype MGG-385 compared with other genotypes. Genotypes WGG-42 and MGG-385 recorded higher photosynthetic rate of 27.25 and 27.03 µmol CO_2 $m^{-2}s^{-1}$. The water-holding capacity of excised leaves among the genotypes ranged between 71.1% to 73.0%. A significant genotypic variation was observed for total biomass, seed yield, pod number, pod weight, clusters/plant, pods/cluster, pods/plant, seeds/pod and hundred seed weight. Genotypes MGG-385 (11.90 g/pl) and MGG-351(11.8 g/pl) produced significantly higher seed yield than WGG-37(10.6 g/pl), WGG-42 (10.4 g/pl) and MGG-295 (9.7 g/pl).

Keywords: Greengram, chlorophyll, photosynthesis, ELWRC, yield.

INTRODUCTION

Green gram (*Vigna radiata* L. Wilczek) is the third most important pulse crop after chickpea and pigeon pea. It is one of the major short-duration pulse crops with wider adaptability and is commonly grown pulse crop as sole crop and also as inter-crop in *kharif*, *rabi* and summer seasons in Telangana and Andhra Pradesh. Despite being an economically important crop, the overall production of mung bean is low due to abiotic and biotic stresses. Drought is the most important limiting factor for mung bean production and causes major crop yield losses worldwide. Assessment of ELWRC has shown promise for characterizing drought resistance. Following excision, stomata close and after 20 to 30 minute the rate of water loss enters a linear phase that lasts for several hours (McCaig and Romagosa 1991). During this phase the water is lost from incompletely closed stomata. This trait also influences the recovery of plant from stress and consequently affects yield and yield stability. If water retention capacity of genotypes is increased, the yield of rainfed crop could be increased or at least stabilized. Photosynthetic rate has generally been considered to be the major factor affecting the biomass production in crop plants. Photosynthetic rate largely depends on stomatal aperture because the entry of CO_2 for photosynthesis takes place through stomatal pores (Cornic and Briantains 1991). Genotypic variation for photosynthesis, stomatal conductance and yield in blackgram and greengram was reported by Baroowa *et al.* (2015).

Therefore, it was considered worthwhile to study genotypic variation in morphological, phenological, physiological, biomass and yield parameters of the selected genotypes for further conducting moisture stress experiments.

MATERIALS AND METHODS

A field experiment using 5 genotypes of green gram *viz.*, MGG-295, MGG-351, MGG-385, WGG-37 and WGG-42 was conducted in randomized block design, with three replications at experimental farm, Central Research Institute for Dryland Agriculture, Hyderabad, during *Rabi* season, 2021. The seed material was obtained from Regional Agricultural Research Station (RARS), Lam, Guntur, A.P. and

RARS, Warangal, Telangana. Genotypes MGG-295 and WGG-37 were released in year 1995. MGG-351 and WGG-42 were released in year 2016. Genotype MGG-385 was released in year 2021. Each genotype was grown in three rows of 4m length with plant-to-plant and row-to-row spacings of 15 and 30 cm, respectively. One border row was planted on both sides for each replication. The seeds were pretreated with Rhizobium inoculants and sowed. Standard agronomic practices and plant protection measures were adopted as and when required.

Net photosynthetic rate (P_N), stomatal conductance (g_s) and transpiration rate (T_r) were measured with a portable photosynthesis system (LI-6400, LI-COR) at flowering stage on a fully expanded young leaf of the three plants for each genotype. Photosynthetic measurements were performed at between 10:00 and 11:00 hours, with irradiance set 1200 μmol $m^{-2}s^{-1}$ and CO_2 partial pressure of 400 ppm. Water use efficiency (WUE) was calculated as the ratio of P_N and T_r using the formula WUE= P_N/T_r. The total chlorophyll content in leaf tissue was estimated by non-maceration method using Dimethyl Sulphoxide as suggested by Hiscox and Israelstam (1979). Total chlorophyll (Tchlo) content was estimated according to the method of Arnon (1949).

Excised leaf water retention capacity (ELWRC) curves were drawn to record the moisture percent actually retained by the leaf after it was excised from the plant according to Rao *et al.* (1998). At 40 days after sowing, fully expanded leaves from three plants of each genotype were selected for ELWRC study. The leaves were excised at the base excluding the petioles and immediately transferred to the laboratory to record their fresh weights. The room temperature during the study varied from 28 to 30°C. The water retention capacity of leaves after excision was measured by recording the weights of the leaves at different time intervals. The weight loss of the leaves was recorded at regular intervals (30-35 minutes) up to 270 min. ELWRC was calculated based on the percentage of weight loss of leaves from initial weight over a period of time.

The phenological observations of days to 50% flowering and days to maturity of individual genotype were recorded on whole plot basis. At maturity, five plants of each genotype from each replication were used to determine above ground dry matter accumulation and seed yield. Plants were cut off at the base of the stems. The biomass of leaves and stem was measured after drying them in hot air oven at 55^{o}C till constant weights were attained. The data on yield parameters such as number of clusters per plant, pod number, pod weight, seed weight and hundred seed weight were recorded. Mean values of five plants were used for statistical analysis.

RESULTS AND DISCUSSION

Chlorophyll is a vital component of photosynthesis and this photosynthesis is carried mostly by the leaves. Total chlorophyll content ranged from 1.79 mg/g. (MGG-295) to 1.93 mg/g fresh weight (MGG-385). Higher chlorophyll content and photosynthetic rate was observed in MGG-385 and WGG-42. Photosynthetic rate, stomatal conductance and transpiration rate varied among the genotypes though the differences were non-significant (Table 1). The photosynthetic rate was highest in WGG-42 (27.25 μmol CO_2 $m^{-2}s^{-1}$) and MGG-385 (27.03 μmol CO_2 $m^{-2}s^{-1}$) was lowest in MGG-295 (24.4 μmol CO_2 $m^{-2}s^{-1}$). The range for stomatal conductance was 0.493 mol $m^{-2}s^{-1}$ (WGG-42) to 0.593 mol $m^{-2}s^{-1}$ (MGG-351). Lolesh *et al*. (2018) reported variations in photosynthetic rate and stomatal conductance in green gram genotypes. Photosynthesis is the key to dry matter production and increasing the photosynthetic efficiency is the most efficient way of increasing productivity (Gupta, 1994). Transpiration rate varied from 7.02 mmol H_2O $m^{-2}s^{-1}$ (WGG-42) to 7.53 mmol H_2O $m^{-2}s^{-1}$ (MGG-295). With increased P_N and decreased T_r the WUE improved in genotypes MGG-385 (3.86 μmol CO_2 mmol H_2O^{-1}) and WGG-42 (3.79 μmol CO_2 mmol H_2O^{-1}) compared to other genotypes.

The water holding capacity of excised leaves among the green gram genotypes was revealed by ELWRC (Fig. 1). All the genotypes retained similar water content of 71.1% to 73.0% after excision from the plant. The values of ELWRC were highest in genotype WGG-42 (73.0%) followed by WGG-37 (72.7%), MGG-295 (71.9%), MGG-385 (71.5%) and MGG-351 (71.1%). The ELWRC could be attributed to the quick stomatal response to excision (Maheswari *et al.,* 2017) and retaining more moisture for longer periods. Excised leaf water retention capability to screen for drought tolerance under non-stressed conditions was reported by Rao *et al.* (1998).

The days to 50% flowering were lowest in WGG -42 (33.5 days) followed by MGG-295 (35.5 days), WGG-37 (36 days), MGG-351 (37.5 days) and highest in MGG-385 (40 days). Though the flowering pattern is a genetic character of a plant, it can be modified by environmental factors and is a relatively important factor from the point of seed yield. Similarly, days to maturity varied from 63.5 days (WGG-42) to 73 days (MGG-385). Yadav *et al*., 2017) also reported genotypic variation in days to 50% flowering and maturity. Days to maturity have a direct effect on seed yield per plant and genotypes with more days to maturity gave higher seed yield per plant as reported in wheat (Anwar *et al*., 2009).

Dry matter production largely depends on the size of the photosynthetic apparatus and its efficiency. Vegetative biomass which includes the stem and leaf biomass was highest in MGG-351 (20.64 g/pl) and significantly superior over all other genotypes. Similarly, reproductive biomass *i.e.* the pod biomass was highest in MGG-385 (14.80 g/pl) and significantly superior over other genotypes. Total biomass was observed to be maximum in the genotype MGG-351 (34.3 g/pl) and was significantly superior over MGG-295 (29.7 g/pl), MGG-385 (29.5), WGG-37 (29.1g/pl) and WGG-42 (23.7g/pl).

Pod number per plant varied from 21 to 38 with the maximum number of pods recorded in MGG-351 (38) followed by MGG-385 (34), WGG-37 (31.7) and

MGG-295 (30.7) and the least in WGG-42 (21). Significant variation in pod number per plant has been recorded earlier by Lolesh *et al*. (2018).

Seed yield was observed to be maximum in the genotypes MGG-385 (11.9 g/pl) and MGG-351 (11.8 g/pl) and was significantly superior over WGG-37 (10.6 g/pl), WGG-42 (10.4 g/pl) and MGG-295 (9.7 g/pl). Higher seed yield in MGG-385 and MGG-351 was due to a significantly higher number of clusters/plants, pods/plant and pod weight compared to other genotypes. Bangar *et al*. (2019) also reported genotypic variation in the number of clusters per plant, number of pods per cluster, number of pods per plant and seed yield. Uprety *et al.* (1979) demonstrated that grain yield was controlled not only by total dry matter production but also by the distribution of photosynthates inside the plant in cowpea.

Harvest index can be defined as the physiological efficiency and ability of a crop for converting dry matter into economic yield (Sharifi *et al*., 2009). Harvest index was highest in WGG-42 (42.64%) and MGG-385 (40.32%) and significantly superior over WGG-37 (35.9%), MGG-351 (34.43%) and MGG-295 (32.6%). Hundred seed weight was also highest in WGG-42 (5.1g) and significantly superior over other genotypes. Seeds per pod were also highest in WGG-42 (11.3) compared to other genotypes. Kumar *et al.* (2013) reported variation in harvest index and hundred seed weight.

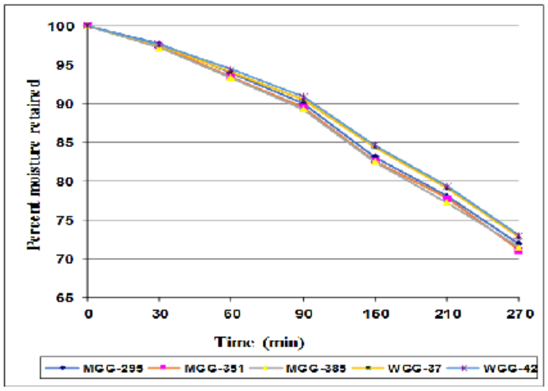

Fig. 1. Excised leaf water retention capacity of the green gram genotypes.

Table 1: Performance of morphological, phenological, physiological and yield parameters of green gram genotypes.

Genotypes **Parameters**	**MGG-295**	**MGG-351**	**MGG-385**	**WGG-37**	**WGG-42**	**Mean**	**LSD (0.05)**	**LSD (0.01)**
Morphological								
Plant height (cm)	44	52	48	46	39	**45.8**	3.43	4.727
Phenological								
Days to 50% flowering	35.5	37.5	40	36	33.5	**36.5**	0.947	NS
Days to maturity	68.5	69	73	67.5	63.5	**67.9**	1.358	NS
Physiological								
Total Chlorophyll (mg/g f.wt.)	1.79	1.81	1.93	1.85	1.89	**1.85**	NS	NS
P_N [µmol CO_2 $m^{-2}s^{-1}$]	**24.38**	25.70	27.03	25.86	27.25	**26.04**	NS	NS
g_s [mol m^{-2} s^{-1}]	0.569	0.593	0.5	0.569	0.493	**0.545**	NS	NS
Tr [mmol H_2O $m^{-2}s^{-1}$]	7.528	7.434	7.07	7.78	7.018	**7.366**	NS	NS
WUE [µmol CO_2 mmol H_2O^{-1}]	3.238	3.554	3.862	3.322	3.794	**3.554**	0.253	NS
Biomass (g/pl)								
Vegetative biomass (g)	18.05	20.64	14.7	16.71	11.5	**16.32**	1.348	1.857
Reproductive biomass (g)	11.68	13.68	14.80	12.34	12.17	**12.94**	0.972	1.34
Total biomass (g)	29.73	34.32	29.50	29.05	23.67	**29.69**	1.788	2.464
Yield parameters/pl								
Clusters/plant	8.1	10.1	11	8.5	7	**8.93**	1.229	1.693
Pods/cluster	3.8	3.7	3.1	3.7	3	**3.456**	0.343	0.472
Pods/plant	30.7	38	34	31.7	21	**31.076**	3.861	5.321
Seeds/pod	9.7	9.8	10	10.4	11.3	**10.24**	NS	NS
Pod weight (g)	11.68	13.68	14.80	12.34	12.17	**12.94**	0.972	1.34
Hundred seed weight (g)	3.85	3.9	3.5	3.75	5.1	**3.992**	0.279	0.385
Seed yield (g)	9.7	11.8	11.9	10.7	10.4	**10.78**	0.655	0.903
Harvest Index (%)	32.60	34.43	40.32	35.93	42.64	**37.18**	2.105	2.901

P_N= Photosynthetic rate, g_s= stomatal conductance, Tr= Transpiration rate, WUE= Water use efficiency f. wt.= fresh weight

CONCLUSION

It can be concluded that morpho-physiological and yield traits like higher total chlorophyll content, photosynthetic rate, water use efficiency, pod weight, harvest index and more days to maturity (73 days) to be major contributing factors for higher yield performance in genotype MGG-385. Genotype MGG-295 had higher vegetative biomass and lower harvest index. Genotype WGG-42 with less crop duration of 63.5 days has highest number of seeds per pod, hundred seed weight, harvest index and ELWRC. Increased yields in the recently released varieties (MGG-385, WGG-42) is largely attributable to improved partitioning of biomass to grain *i.e.* higher harvest index and physiological superiority.

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Conflict of Interest. None.

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