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Spad Meter Reading and Relative Water Content Effected by Water Stress in Green Gram Genotypes (*Vigna radiate.* L)

B. Rambabu*, V. Padma*, Ramesh Thatikunta* and N. Sunil**

ABSTRACT: *Water stress is one of several environmental factors greatly limiting crop production. In order to study the effect of water stress on green gram (*Vigna radiata *L.) Wilczek, an experiment was laid out in split plot design with three irrigation levels as main treatments (T1, T2 and T3) and five genotypes as sub treatments at College of Agriculture, Rajendranagar, Hyderabad. Among treatments, T1 was irrigated control, irrigated throughout the growth period, while T2 and T3 were water stress treatments, where T2 was irrigated at flowering stage and T3 was irrigated at flowering and pod filling stages. The experiment was replicated thrice and observations were recorded at three stages* viz., *stage 1 (maximum vegetative stage) and stage 2 (5 days after irrigation at flowering) and stage 3 (5 days after irrigation at pod filling). The present study revealed that water stress significantly effected the SPAD meter reading and relative water content of green gram genotypes. The parameters ((SPAD meter reading (r = 0.945) and relative water content (r = 0.905)) taken under study were significantly and positively correlated with seed yield. During water stress, among the genotypes studied WGG 37 and WGG 42 recorded high SPAD meter reading and relative water content respectively and for both parameters least recorded by the genotype MGG 347. While recovery stages (47 and 65 DAS) WGG 42 genotype recorded high SPAD meter reading and relative water content (RWC). Highest seed yield was recorded by the genotype WGG 37 (1058.71 Kg ha^{-1}), followed by WGG 42 (1052.22 Kg ha^{-1}), while lowest seed yield was recorded in MGG 348 (951.42 Kg ha^{-1}).*

Key words*: Green gram, Spad meter reading, Relative water content and yield.*

INTRODUCTION

Pulses play an important role in meeting our dietary requirement of protein. India is the largest producer of pulses in the world. Among pulses green gram *(Vigna radiata* L.) is major legume crop of Asia. The total area under green gram cultivation in India is 1.96 million ha and production is 1.48 million tonnes (Anonymous, 2013). In A.P green gram is cultivated in 2, 83, 464 ha area with a production of 1, 63, 419 tonnes (Anonymous, 2012).

Green gram is an important short-duration legume crop with wide adaptability and low input requirement. It also plays a vital role in sustainable agriculture, while it is cultivated as mixed crop, inter crop, rotational crop to improve nitrogen status of soil or to break the disease or pest cycles (Jaiwal *et al.*, 2001). The cultivation of green gram also results in the production of large quantity of nutritious green fodder for livestock.

Green gram is a cheap source of vegetable protein (20-25%), and is an important source of high quality protein in the cereal-based diet (Khattak *et al.*, 2001). Pods and sprouts of mungbean are also consumed as a vegetable and are a rich source of vitamins and minerals (Somta *et al*., 2008).

The major factor limiting the crop yield is the amount of moisture available to the crop during the growing season. The sensitive crop growth stages need to be identified for the new genotypes. Drought distributed widely across the world over in 1.2 billion hectare area in rainfed agricultural land (Kijne, 2006), decreases crop yield up to 45% (Lalinia *et al*., 2012). In India, about 68% of net sown area (140 million hectares) is reported to be vulnerable to drought conditions.

Mungbean when cultivated in post rainy season faces water stress at various stages of crop growth. Hence, upon identification of sensitive stage for water

* Department of Crop Physiology, College of Agriculture, Prof. Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-500030, India.

** Department of Genetics and Plant Breeding, Winter Nursery Center, Indian Institute of Maize Research, Rajendranagar, Hyderabad-500030, India.

stress assured or limited irrigation facilities can be given at any of the stages. Besides identification of the genotypes which are tolerant to water stress crop growth facilitates improvement in yield and their utilization in breeding programme for crop improvement.

Materials and methods

Five green gram genotypes were used in the present study. The seed of two green gram cultivars WGG 37 and WGG 42 were obtained from RARS, Warangal and of MGG 295, MGG 347 and MGG 348 were obtained from RARS, Madhira. Crop was sown in Rabi, 2013-14 with a spacing of 30x10cm. Adequate space was provided between plots so that irrigation water could be diverted to desired treatments. This experiment laid out in split plot design with treatments T1 was the irrigated control, T2 irrigated only at flowering and T3 irrigated at flowering and pod filling stages. Seed yield was calculated from net plot. SPAD meter reading and relative water content estimated by following instruments and procedures.

SPAD METER READING

The SPAD (Soil Plant Analytical Development) chlorophyll meter readings (SPAD 502; Minolta Company Ltd) measures the greenness or relative chlorophyll content of leaves. SCMR reading was taken at maximum vegetative stage, flowering stage and pod filling stage. The third leaf from top was used for measuring SCMR, which was taken midway between the leaf base and tip. The readings were taken between 10.00 and 12.00 hours of the day. Thirty readings were taken from five tagged plants in each plot and the mean was reported as per plant value.

Relative water content

Relative water content was estimated following the procedure of Barrs and Weatherly (1962). At the stage of imposing drought leaf discs from third fully expanded leaf from the top were collected and 0.5 g of leaf discs were taken (fresh weight). The weighed leaf discs were floated in a petridish containing distilled water for three hours and subsequently blotted gently and weighed again, which was referred to as the turgid weight. After taking turgid weight, the leaf discs were oven dried at 80°C for 48 hours and dry weight was recorded. The RWC was calculated by using the following formula and expressed in percentage.

$$\text{Relative water content (\%)} = \frac{\text{Fresh weight (g)} - \text{dry weight (g)}}{\text{Turgid weight (g)} - \text{dry weight (g)}} \times 100$$

RESULTS AND DISCUSSION

SPAD meter reading

The data on the effect of water stress on SPAD chlorophyll meter reading is given in Table 1 and Figures (1, 2 and 3), revealed that SCMR values increased up to flowering, and decreased at pod filling stage. Among the irrigation treatments T1 (irrigated control) recorded highest SCMR values (43.72, 49.11 and 39.85) at stage 1, stage 2 and stage 3 respectively. The difference in SPAD values were statistically significant during stage 1 and 2. But in stage 3, the SPAD values were non significant in different irrigation treatments. The SPAD values of T2 and T3 treatment were on par even in stage 1 and stage 2 only that the irrigation control (T1) maintained superiority during these 2 stages. Under moisture stress conditions significant and positive relationship was observed between seed yield and SCMR in black gram and green gram (Sudhakar *et al.*, 2006). Water stress, at vegetative stage decreased SCMR by 24.88 per cent, while at stage 2 by 7.47 per cent and stage 3 by 12.07 percent compared to irrigated control.

Table 1
SPAD meter reading of Green gram genotypes at different irrigation treatments

	30 DAS				*47 DAS*				*65 DAS*			
Genotypes	*T1*	*T2*	*T3*	*Mean*	*T1*	*T2*	*T3*	*Mean*	*T1*	*T2*	*T3*	*Mean*
MGG 295	43.23	32.10	32.00	**35.78**	49.10	45.87	45.90	**46.95**	39.65	31.60	35.03	**35.42**
MGG 347	42.97	31.90	31.55	**35.47**	48.85	44.79	44.55	**46.06**	39.67	29.98	34.88	**34.84**
MGG348	42.85	32.15	32.16	**35.72**	48.25	44.50	44.30	**45.69**	39.24	30.25	34.71	**34.73**
WGG 37	43.88	33.40	33.56	**36.95**	49.24	45.30	45.45	**46.66**	40.20	32.33	35.10	**35.88**
WGG 42	45.68	34.65	35.30	**35.54**	50.10	46.75	46.64	**47.83**	40.49	33.25	35.50	**36.41**
Mean	43.72	32.84	32.91	36.49	49.11	45.44	45.37	46.63	39.85	31.48	35.04	35.45
C.D (p=0.05)(T)		6.247				2.729				NS		
C.D(p=0.05)(G)		NS				NS				NS		
TXG		NS				NS				NS		

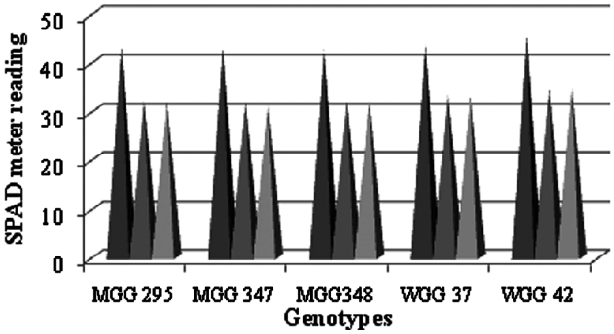

Figure 1: SPAD meter reading of Green gram genotypes at 30 DAS

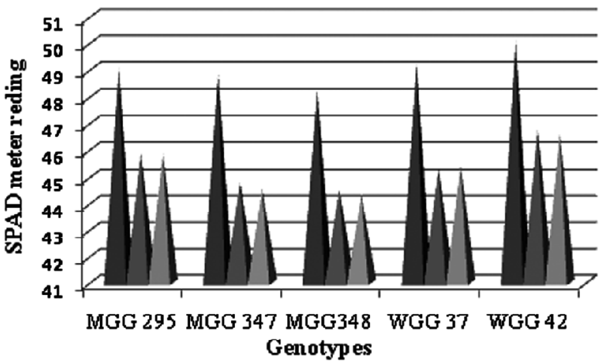

Figure 2: SPAD meter reading of Green gram genotypes at 47 DAS.

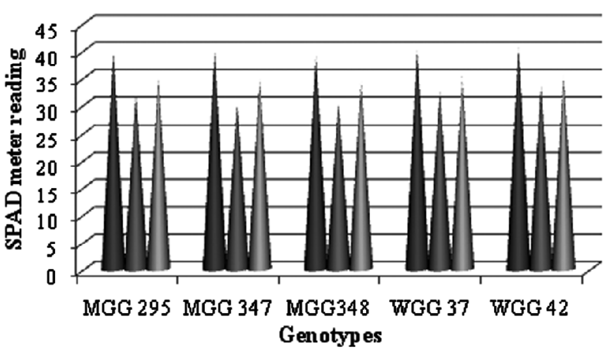

Figure 3: SPAD meter reading of Green gram genotypes at 65 DAS

The SCMR values recorded by the green gram genotypes at all the 3 stages were on par with each other, which indicated that there was no variation in genotypes with respect to this parameter. The interaction between the genotypes and treatments was also not significant at all the 3 stages. There was positive and significant correlation between SCMR values and seed yield at maximum vegetative stage i.e., stage 1.

Relative water content (RWC)

The results of this experiment revealed that water stress effect on relative water content increased continuously up to flowering, then after decreased shown in Table 2 and depicted in Figures (4, 5 and 6). Significant differences were observed among irrigation treatments at stage 1 and stage 2. At maximum vegetative stage the relative water content in treatments T2 (28.42 per cent) and T3 (28.80 per cent), was significantly less compared to irrigated control (46.25 per cent). During stage 2 (47 DAS), the RWC recorded was high and statistically significant compared to irrigated control (74.40 percent). T2 (69.89 per cent) and T3 (69.97 per cent), however difference were non significant at stage 3 (i.e., pod filling stage). Water stress at vegetative stage decreased the relative

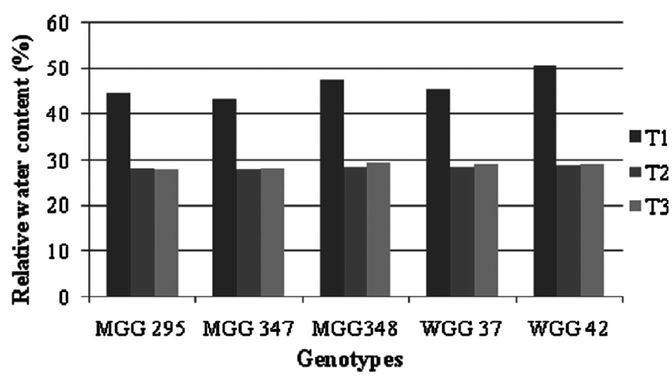

Figure 4: Relative water content of Green gram genotypes at 30 DAS

Table 2
Relative water content of Green gram genotypes at different irrigation treatments

	30 DAS				*47 DAS*				*65 DAS*			
Genotypes	*T1*	*T2*	*T3*	*Mean*	*T1*	*T2*	*T3*	*Mean*	*T1*	*T2*	*T3*	*Mean*
MGG 295	44.50	28.20	27.90	**33.54**	71.98	65.70	65.14	**67.60**	62.30	57.15	60.55	**60.00**
MGG 347	43.18	27.84	28.25	**33.09**	71.50	64.25	63.96	**66.57**	62.06	56.55	59.92	**59.51**
MGG348	47.37	28.60	29.47	**35.15**	76.15	70.18	71.15	**72.49**	63.10	58.35	61.87	**60.10**
WGG 37	45.50	28.65	29.31	**34.49**	72.18	74.24	75.00	**73.80**	62.95	57.65	60.89	**60.49**
WGG 42	50.72	28.79	29.10	**36.02**	80.18	75.10	74.60	**76.63**	63.40	58.93	62.18	**61.50**
Mean	46.25	28.42	28.80	34.49	74.40	69.89	69.97	71.42	62.76	57.73	61.08	60.52
C.D (p=0.05)(T)		1.606				3.706				NS		
C.D(p=0.05)(G)		NS				4.306				NS		
TXG		NS				NS				NS		

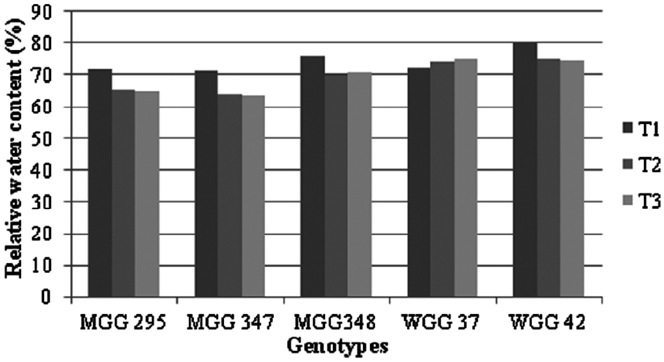

Figure 5: Relative water content of Green gram genotypes at 47 DAS

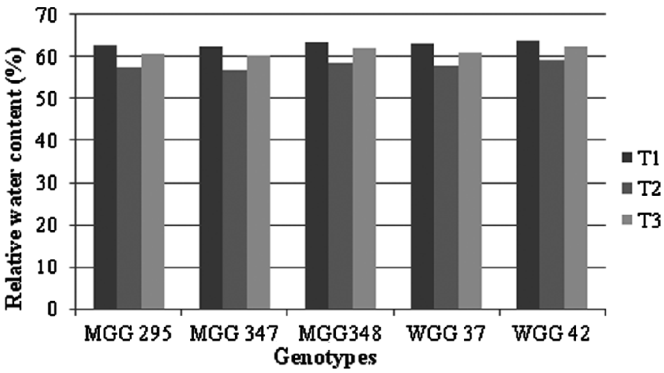

Figure 6: Relative water content of Green gram genotypes at 65 DAS

water content by 38.55 per cent, while at flowering stage (stage 2) by 6.06 per cent and at pod filling stage (stage 3) by 2.67 per cent compared to irrigated control.

Among the genotypes, WGG 42 recorded highest relative water content of 36.02, 76.63 and 61.50 per cent at stage 1, 2 and 3, respectively. This genotype is followed by WGG 37 (34.49, 73.80 and 60.49 per cent) and least was recorded in MGG 347 (33.09, 65.57 and 59.51 per cent) at 30, 47 and 65 DAS, respectively. However, the differences between the genotypes were significant only at 47 DAS. Relative water content (RWC) represents the water status of the plant and it has great affect on grain yield. In the present study relative water content increased up to flowering, and decreased thereafter. It was reported that in mungbean genotypes, drought stress decreased leaf water status, which in return decreased the final yield (Kumar and Sharma, 2009). At stage 2 and 3, correlation ($r = 0.905$) between relative water content and seed yield was positive and significant.

Seed yield (Kg ha^{-1})

The collected data from experimental field revealed that water stress greatly effected seed yield in the water stress treatments (T2 and T3) compared to the irrigated control (T1) shown in Table 3. Water stress decreased seed yield significantly in both water stress treatments i.e., T2 (937.87 Kg ha^{-1}) and T3 (954.46 Kg ha^{-1}) compared to irrigated control (1150.20 Kg ha^{-1}). While the water stress treatments (T2 and T3) are on par with one another. Data on seed yield revealed that water stress decreased the seed yield by 18.46 per cent in T2 and by 17.01 per cent in T3 over irrigated control. Mahdi *et al*., (2013) also reported that mungbean seed yield was affected by 51%, when water stress was imposed from blooming stage to complete maturity stage and 85.5% when water stress was imposed at seed filling period compared to control. Among the genotypes studied MGG 37 (1058.71 Kg ha^{-1}) recorded high seed yield compared to other genotypes in this experiment and least seed yield recorded by MGG 348 (951.42 Kg ha^{-1}). Significant differences were not recorded among the genotypes with respect to seed yield. The interaction between genotypes and treatments was also non significant.

Table 3
Seed yield (Kg ha^{-1}) of Green gram genotypes with different Irrigation treatments

Genotypes	*T1*	*T2*	*T3*	*Mean*
MGG 295	1173.62	966.12	976.58	**1038.77**
MGG 347	1100.86	896.68	911.73	**969.75**
MGG 348	1085.58	876.70	891.97	**951.42**
WGG 37	1200.73	976.08	999.32	**1058.71**
WGG 42	1190.22	973.76	992.68	**1052.22**
Mean	1150.20	937.87	954.46	1014.18
C.D (p=0.05) (T)		78.443		
C.D (p=0.05) (G)		NS		
TXG		NS		

CONCLUSION

In this present experiment, the results conclude that all the genotypes taken under study were significantly effected by water stress in terms of SPAD chlorophyll meter reading and relative water content (RWC) which ultimately reduced the seed yield. Relative water content and SPAD chlorophyll meter reading recorded low by all the genotypes in all the three treatments (T1, T2 and T3) at 30DAS because water stress maintained up to this stage, while at recovery stages (47 and 65 DAS), plants recovered from water stress and recorded high relative water content and SPAD chlorophyll meter reading. Among the genotypes studied WGG 37 recorded high SPAD meter reading and seed yield (1058.71 Kg ha^{-1}) and the genotype WGG 42 recorded high relative water content and second high seed yield (1052.22 Kg ha^{-1}), while least seed yield recorded by MGG 348 (951.42 Kg ha^{-1}).

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