Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 7 [4] March 2018 : 43-49

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Screening of Blackgram genotypes for total dry matter and Yield components under imposition of Moisture stress

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ABSTRACT
A field experiment was conducted at the experimental field twelve Mungbean (Vigna radiata L.) genotypes under water stress condition. A wide diversity among the genotypes in their physio-morphological characters including yield was recorded. Genotypes varied from genotypes TBG-104, KU-12-13 plant height was not affected during moisture stress condition in both the years and maintained higher nodule number in irrigated control as well as moisture condition. TBG-104, KU-12-13, KU-12-37, LBG-623 recorded significantly higher leaf area, total plant drymatter and partioning under both irrigated as well as stress conditions, which denotes the ability of these genotypes in sustaining the photosynthesising area and accumulation of photosynthates in stem. Whereas NDU-12-300 recorded lowest total dry matter during rabi 2015-16 and rabi 2016-17
Key words :*Mungbean, dry matter and yield*

Received 12.11.2017 Revised 12.12.2017 Accepted 24.02.2018

INTRODUCTION

Drought stress is considered to be a moderate loss of water, which leads to stomatal closure and limitation of gas exchange. Desiccation is much more extensive loss of water, which can potentially lead to gross disruption of metabolism and cell structure and eventually to the cessation of enzyme catalyzed reactions [8]. Drought stress is characterized by reduction of water content, diminished leaf water potential and turgor loss, closure of stomata and decrease in cell enlargement and growth. Severe water stress may result in the arrest of photosynthesis, disturbance of metabolism and finally the death of plant .When plants are subjected to various abiotic stresses, some relative oxygen species (ROS) produced. These ROSs may initiate destructive oxidative processes. However, antioxidant enzymes as Superoxide dismutase (SOD), catalase and peroxidase play a key role in scavenging those activated species. Modulation of the activity of these enzymes may be an important factor in the tolerance of various plants to environmental stress. The relation between drought stress and enzymatic antioxidant systems has been studied in some plant species [12].

However, production of blackgram is adversely affected by various environmental stress factors, especially drought that reduce yield [10]. Soil moisture stress is a major hazard for successful crop production throughout the world. It reduces the productivity by delay or prevention of crop establishment, destruction of established crop, predisposition of crop to insects and diseases, alteration of physiological and biochemical metabolism in plant and quality of grain. However, species and genotypes vary in their capacity to tolerate water stress

MATERIALS AND METHODS

The experiment was laid out in a split plot design with two main treatments, twelve sub treatments and replicated thrice. Main Treatments: 2: i) Irrigated (control) ii) Impose moisture stress at 60-80 DAS, Sub Treatments (12 Genotypes) KU -12-55, LBG-623, LBG-680, NDU-12-300, LBG-685, KU-12-14, LBG-645, KU-12-37, TBG-104, KU-12-33, LBG-752 and LBG-20. Following parameters are recorded every 15 days interval in both rabi 2015-16 and rabi 2016-17.

Dry matter (g plant^{-1})

The dry weights of oven dried stems, leaves, roots and pods were recorded and expressed as g plant^{-1}. Similarly total dry matter was computed and expressed as g plant^{-1}.

Pod yield (g plamt^{-1})

Weight of pods from the plants harvested per m2 in each plot was recorded and average weight of pods m^{-2} was calculated and expressed as pod yield in g plant^{-1}.

Seed yield (kg ha^{-1})

Weight of seeds from the plants harvested per m2 in each plot was recorded and average weight m^{-2} was calculated and expressed as seed yield in kg ha^{-1}

Harvest index

Harvest index (%) was expressed as the ratio of seed yield to biological yield and following formula given by Donald (1962).

$$\text{Harvest Index (HI)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

RESULTS AND DISCUSSION

Total drymatter data indicated that irrespective of the treatments, there was a two-three fold increase in total plant dry weight between 15-60 DAS and thereafter it was decreased relatively as the crop reached maturity, during both the years of testing (Table 1 and 2). Significant differences were observed among treatments and genotypes from 30 DAS to 75 DAS in both years. However interaction effects of treatments and genotypes were non significant. Similar significant differences between genotypes under irrigated as well as moisture stress conditions was also reported in chickpea [4], blackgram [11] and pigeonpea [13].

Mean total plant dry matter significantly decreased due to moisture stress from 45 to 60 DAS in moisture stress treatment compared to irrigated treatment in both years. The extent of decrease was 29.4 and 13.4 percent at 45 DAS, 32.6 and 32.8 percent at 60 DAS and 32.9 and 33.5 percent at 75 DAS in rabi 2015-16 and 2016-17 seasons respectively compared to irrigated treatments. Similar results were reported in groundnut [14] and mungbean [15].

Table -1: Evaluation of blackgram genotypes for total drymatter (g plant^{-1}) under imposed moisture stress condition during *rabi* 2015-16

	15 DAS			**30DAS**			**45 DAS**			**60 DAS**			**75 DAS**		
Genotypes	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**
KU-12-55	0.30	0.30	**0.30**	2.55	2.63	**2.59**	5.40	3.91	**4.66**	11.63	6.04	**8.84**	12.95	8.06	**10.51**
LBG-623	0.43	0.43	**0.43**	2.92	3.36	**3.14**	6.58	7.14	**6.86**	12.85	9.77	**11.31**	17.28	12.12	**14.70**
LBG-680	0.42	0.42	**0.42**	2.27	2.51	**2.39**	8.33	5.83	**7.08**	17.57	9.04	**13.31**	17.83	10.17	**14.00**

NDU-12-300	LBG-685	KU-12-14	LBG-645	KU-12-37	TBG-104	KU-12-13	LBG-752	LBG-20	Mean		SE m ±	CD (P=0.05)
0.30	0.30	0.34	0.42	0.36	0.38	0.40	0.43	0.42	**0.38**	**T**	0.001	N.S
0.31	0.31	0.34	0.34	0.39	0.41	0.40	0.43	0.44	**0.38**	**G**	0.002	0.005
0.30	**0.31**	**0.34**	**0.38**	**0.37**	**0.40**	**0.40**	**0.43**	**0.43**		**T × G**	0.002	0.007
3.14	2.39	2.33	2.33	2.68	2.55	2.79	3.34	3.02	**2.69**	**T**	0.002	0.015
3.57	2.93	2.84	2.45	2.80	2.84	3.06	3.34	4.01	**3.03**	**G**	0.127	0.363
3.35	**2.66**	**2.59**	**2.39**	**2.74**	**2.70**	**2.93**	**3.34**	**3.51**		**T × G**	0.008	N.S
4.44	6.52	6.62	5.75	7.58	9.99	10.18	8.38	8.18	**7.33**	**T**	0.022	0.140
4.01	6.56	6.14	6.45	7.32	10.38	10.05	5.22	5.78	**6.57**	**G**	0.316	0.902
4.23	**6.54**	**6.38**	**6.10**	**7.45**	**10.18**	**10.12**	**6.80**	**6.98**		**T × G**	0.078	1.27
11.15	13.46	12.93	12.86	18.75	18.35	18.83	14.64	16.01	**14.92**	**T**	0.052	0.324
6.82	10.18	8.91	9.96	12.80	13.91	13.80	9.41	9.89	**10.05**	**G**	0.569	1.623
8.99	**11.82**	**10.92**	**11.41**	**15.78**	**16.13**	**16.32**	**12.02**	**12.95**		**T × G**	0.182	N.S
14.03	13.67	14.23	15.02	19.50	19.46	19.79	15.00	16.74	**16.29**	**T**	0.061	0.379
7.20	10.62	9.01	10.00	12.97	16.40	15.48	9.51	10.00	**10.96**	**G**	0.622	1.773
10.62	**12.15**	**11.62**	**12.51**	**16.23**	**17.93**	**17.64**	**12.26**	**13.37**		**T × G**	0.213	N.S

M_0: Irrigated (control), M_1: Moisture stress

Table- 2: Evaluation of blackgram genotypes for total drymatter (g plant^{-1})under imposed moisture stress condition during *rabi* 2016-17

	15 DAS			**30DAS**			**45 DAS**			**60 DAS**			**75 DAS**		
Genotypes	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**
KU-12-55	0.26	0.29	**0.28**	2.21	2.23	**2.22**	5.53	4.66	**5.10**	11.07	5.54	**8.31**	11.10	7.77	**9.44**
LBG-623	0.42	0.44	**0.43**	2.98	3.00	**2.99**	5.20	7.04	**6.12**	12.27	9.17	**10.72**	16.43	11.09	**13.76**
LBG-680	0.40	0.41	**0.41**	2.10	2.42	**2.26**	8.62	5.27	**6.95**	16.79	8.69	**12.74**	17.00	9.71	**13.36**
NDU-12-300	0.30	0.31	**0.30**	2.76	2.95	**2.86**	4.14	3.80	**3.97**	10.55	6.00	**8.28**	13.47	6.75	**10.11**
LBG-685	0.33	0.34	**0.34**	2.52	2.63	**2.58**	5.86	6.18	**6.02**	12.71	9.38	**11.05**	13.08	9.46	**11.27**
KU-12-14	0.37	0.37	**0.37**	2.31	2.41	**2.36**	6.07	5.58	**5.83**	11.46	8.45	**9.96**	13.61	8.57	**11.09**
LBG-645	0.39	0.40	**0.40**	2.25	2.22	**2.24**	5.68	6.13	**5.91**	12.01	8.81	**10.41**	14.28	9.08	**11.68**
KU-12-37	0.36	0.39	**0.37**	2.62	2.76	**2.69**	6.87	6.90	**6.89**	14.94	10.46	**12.70**	17.64	11.83	**14.74**
TBG-104	0.33	0.38	**0.35**	2.27	2.68	**2.48**	9.65	9.77	**9.71**	16.80	13.11	**14.96**	18.80	15.77	**17.29**
KU-12-13	0.38	0.35	**0.37**	3.19	3.28	**3.24**	9.78	9.84	**9.81**	16.57	13.25	**14.91**	19.05	14.79	**16.92**
LBG-752	0.38	0.35	**0.37**	3.21	3.00	**3.11**	8.02	4.99	**6.51**	13.70	8.73	**11.22**	14.22	8.79	**11.51**
LBG-20	0.38	0.41	**0.39**	2.98	3.77	**3.38**	7.66	5.55	**6.61**	15.56	9.17	**12.37**	16.15	9.26	**12.71**

Mean		SE m ±	CD (P=0.05)
0.36	T	0.0001	0.001
0.37	G	0.002	0.005
	T × G	0.0001	0.007
2.62	T	0.002	0.016
2.78	G	0.008	0.022
	T × G	0.008	0.033
6.92	T	0.024	0.150
6.31	G	0.305	0.869
	T × G	0.084	1.23
13.70	T	0.062	0.38
9.23	G	0.52	1.50
	T × G	0.21	2.14
15.40	T	0.06	0.37
10.24	G	0.58	1.67
	T × G	0.21	N.S

M_0: Irrigated (control), M_1: Moisture stress

Pod yield as affected by moisture stress treatment at pod formation to pod filling (i.e 40-60 DAS) among blackgram genotypes was recorded in rabi 2015-16 and rabi 2016-17 were presented in Table 3 and 4, treatments, genotypes and their interactions were significantly varied for pod yields (kg/ha). Moisture stress was imposed at 40-60 DAS significantly reduced pod yields compared to irrigated control. 27.0 per cent & 29.0 per cent during rabi 2016 and rabi 2017 respectively. Similar results also found in blackgram (Naresh et al , 2013)

Among the genotypes tested under irrigated control conditions LBG-680 recorded higher pod yields during rabi 2015-16 (2410.79 kg/ha) and rabi 2016-17 (2165.36 kg/ha) followed by LBG-645, KU-12-55. However moisture stress was imposed at grain filling stage the genotypes TBG-104, KU-12-13 and KU-12-55 recorded higher pod yield. It is interesting to note in these genotypes per reduction in pod yield due to moisture stress is also minute 6.16 to 25.6 per cent compared other genotypes. Thus results confirm that due to higher drought tolerance ability of TBG-104, KU-12-13 and KU-12-55 maintained higher growth, drymatter accumulation and partitioning to sink.

In seed yield significant differences were noticed between moisture stress treatments, genotypes and their interactions in both the years. Similar significant results were found in pulses [1, 2] and blackgram [7]. Similar to pod yields, seed yield also followed the same trend. LBG-680 and LBG-645 recorded higher seed yield under irrigated control, but yields were drastically reduced 34.3 to 54.5 per cent when moisture stress was imposed at from critical growth stage i.e pod filling to pod maturity. Whereas TBG-104, KU-12-13 and KU-12-55 recorded higher seed yield after exposing to moisture stress, as these genotypes maintain higher water mining root traits, tissue water content, high WUE, osmoregulation, higher CGR and NAR and dry matter accumulation and its partitioning to seed growth.

Harvest index is one of the major component for higher grain yields. Significant differences were noticed between moisture stress treatments, genotypes only. Due to imposition of moisture stress at pod formation stage to pod filling stage, i.e. from 40-60 DAS mean harvest index was significantly decreased (7.91 & 9.47 per cent) compared to irrigated control, which indicated that moisture stress affected partitioning of photosynthates. Significant results were found in mungbean [5, 6].

Table- 3: Evaluation of blackgram genotypes for yield components under imposed moisture stress condition during *rabi* 2015-16

	Harvest Index			Pod yield (kg ha^{-1})			Seed yield (kg ha^{-1})		
Genotype	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**
KU-12-55	31.25	29.01	**30.13**	1913.31	1658.25	**1785.78**	1015.35	862.00	**938.67**
LBG-623	31.15	30.97	**31.06**	1032.63	845.63	**939.13**	640.69	494.72	**567.70**
LBG-680	31.60	27.73	**29.66**	2410.79	1210.01	**1810.40**	1308.20	595.16	**951.68**
NDU-12-300	31.15	31.22	**31.18**	645.56	321.75	**483.66**	444.40	185.87	**315.14**
LBG-685	27.85	25.81	**26.83**	835.99	618.75	**727.37**	498.54	352.28	**425.41**
KU-12-14	31.79	31.04	**31.41**	2436.47	880.00	**1658.24**	1244.48	485.38	**864.93**
LBG-645	29.25	28.90	**29.07**	1135.75	772.06	**953.91**	686.10	450.35	**568.23**

KU-12-37	30.29	26.71	**28.50**	1684.38	1512.50	**1598.44**	891.42	630.55	**760.99**
TBG-104	32.63	32.50	**32.56**	1650.69	1548.88	**1599.78**	1018.69	959.49	**989.09**
KU-12-13	31.99	31.12	**31.56**	1952.50	1452.00	**1702.25**	1142.67	855.94	**999.31**
LBG-752	32.04	24.68	**28.36**	1400.44	1282.88	**1341.66**	836.11	525.77	**680.94**
LBG-20	33.66	25.29	**29.47**	1408.00	1392.19	**1400.09**	842.91	543.19	**693.05**
Mean	**31.22**	**28.75**		**1542.21**	**1124.57**		**880.80**	**578.39**	
	T	**G**	**T × G**	**T**	**G**	**T × G**	**T**	**G**	**T × G**
SE m ±	0.03	1.36	0.12	2.41	68.91	8.35	2.74	37.46	9.49
CD (P=0.05)	0.21	N.S	N.S	14.88	196.47	278.07	16.90	106.79	151.54

M_0: Irrigated (control), M_1: Moisture stres

Table -4: Evaluation of blackgram genotypes for yield components under imposed moisture stress condition during *rabi* 2016-17

	Harvest Index			**Pod yield (kg ha^{-1})**			**Seed yield (kg ha^{-1})**		
Genotype	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**	**M_0**	**M_1**	**Mean**
KU-12-55	27.30	26.46	**26.88**	1827.62	1557.60	**1692.61**	798.44	621.35	**709.89**
LBG-623	31.36	29.88	**30.62**	943.14	703.54	**823.34**	619.22	423.08	**521.15**
LBG-680	32.36	31.32	**31.84**	2165.63	1075.33	**1620.48**	1225.56	637.54	**931.55**
NDU-12-300	31.92	29.34	**30.63**	579.58	226.42	**403.00**	407.43	158.69	**283.06**
LBG-685	27.66	27.23	**27.45**	751.93	493.87	**622.90**	462.35	320.16	**391.26**
KU-12-14	34.46	26.15	**30.30**	2065.08	826.42	**1445.75**	1144.83	430.98	**787.91**
LBG-645	28.15	26.18	**27.17**	1027.58	662.93	**845.25**	593.81	344.85	**469.33**
KU-12-37	31.23	27.64	**29.44**	1621.60	1399.06	**1510.33**	839.46	580.49	**709.97**
TBG-104	33.42	33.24	**33.33**	1473.82	1443.52	**1458.67**	850.25	822.92	**836.58**
KU-12-13	30.86	30.45	**30.66**	1863.61	1396.54	**1630.08**	1029.29	793.88	**911.58**
LBG-752	31.86	24.26	**28.06**	1227.81	1062.19	**1145.00**	725.09	421.80	**573.45**
LBG-20	32.80	25.90	**29.35**	1237.79	1057.32	**1147.55**	717.30	414.34	**565.82**
Mean	**31.12**	**28.17**		**1398.77**	**992.06**		**784.42**	**497.51**	
	T	**G**	**T × G**	**T**	**G**	**T × G**	**T**	**G**	**T × G**
SE m ±	0.053	1.3.4	0.18	3.17	62.31	18.99	2.70	33.46	9.38
CD (P=0.05)	0.32	3.82	N.S	19.58	177.66	251.66	16.70	95.41	135.49

M_0: Irrigated (control), M_1: Moisture stres

CONCLUSION

Among the genotypes TBG-104 recorded highest harvest index, seed & pod yield and dry matter followed by KU-12-13 compared to other genotypes. LBG-623, KU-12-14, LBG-645, and KU-12-55 recorded moderate harvest index, whereas, LBG 685 recorded lowest values in both the seasons.

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CITATION OF THE ARTICLE

Y. Yohan, P. Sudhakar, V.Umamahesh, D. Mohan Reddy and V. Sumathi. Screening of Blackgram genotypes for total dry matter and Yield components under imposition of Moisture stress. Bull. Env. Pharmacol. Life Sci., Vol 7 [4] March 2018 : 43-49