CHICKPEA LANDRACES: A VALUABLE AND DIVERGENT SOURCE FOR DROUGHT TOLERANCE

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National Academy of Agricultural Science (NAAS) Rating : 3. 03

Chickpea Landraces: A Valuable and Divergent Source for Drought Tolerance

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ABSTRACT: *Chickpea incurs heavy yield losses due to terminal heat and drought as it is largely grown under rainfed restricted irrigated conditions on residual soil moisture. The narrow genetic base among cultivated chickpea accessions is limiting genetic improvement of chickpea through breeding efforts. Exploring the extent of natural variation among cultivated chickpea accessions for drought tolerance is important to develop pre-breeding and breeding strategies for chickpea. Thirty sevenlandracesrepresenting fivecountries and fourteen provinces obtained from ICARDA evaluated for theirRelative Water Content (RWC) and Membrane Stability Index (MSI) which are established physiological parameters for drought tolerance.Theanalysis intoRWC has indicated wide variability in the landraces for drought tolerance.RWC followed a similar pattern to MSI. The genotypes IG5856(Jordan) and IG5904 (Iraq) were having higher MSI and higher RWC indicating theirsuitability as donors for terminal drought tolerance.*

Keywords: *Chickpea, landraces, Relative Water Content, Membrane Stability Index, Drought*

INTRODUCTION

Chickpea (*Cicerarietinum*L.; Family: Fabaceae) is a self-pollinated, diploid (2n=16), cool season pulse crop with a genome size of ~738 Mb and an estimated 28,269 genes (Varshney *et al.*, 2013). It is widely grown in more than 50 countries representing all the continents (Upadhyay *et al.*, 2011). The region located between south-east Turkey and north-west of Iran and the neighbouring areas of Syria has been proposed to be the center of origin for the cultivated chickpea (*Cicerarietinum* L.) (van der Maesen, 1987; Talebi *et al.*, 2008). India and Ethiopia have been proposed as secondary centers of diversity of cultivated chickpea (Harlan, 1992). Drought is a major limiting factor for agricultural production in most parts of the world (Yu and Setter, 2003) and landraces are important genetic resources for crop improvement in dry areas (Pouresmaeila *et al.*, 2012). Landraces play an important resourceas pools of novel genes in crop breedingand may provide valuable sources of disease resistance, drought tolerance and other economically desirable attributes (Srivastava and Damania, 1989). Socollecting and characterizing landraces for various traits are primary steps in plant breeding programs (Sadeghzadeh *et al.*, 2009). It is an effective strategy to use genetically different varieties in order to minimize genetic vulnerability (Fatehi *et al.*, 2011). Depending on their geographical regions, landraces had specific genetic background that can be used in genetic research program (Harlan, 1975). Landraces are important genetic resources that improve gene pools of modern cultivars by introducing new alleles (Nevo and Payne, 1987). India is the world's major producer of chickpea. The annual production is around 7.58Mt, grown in the area of approximately 8.32 Mha, which is the world's 68% production of total chickpea and the average yield is approximately 912 kg/ha (FAOSTAT, 2012).Chickpea is grown mainlyin South-East Asian countries. Kabuli (white seeded) and desi (brown seeded) are two main types of cultivated chickpea, presenting two diverse gene pools (Nawroz and Hero, 2011). Earlier studies have indicated that the chickpea from Indian subcontinent had a narrow genetic pool (Bharadwaj *et al.*, 2011) which is limiting the genetic improvement of chickpea through conventional breeding efforts. Keeping in view of the

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above an investigation was planned with very divergent but cultivated pool of Kabuli chickpea landraces obtained from ICARDA and important released bold seeded Kabulilines of India to identify drought tolerant accessions based on RWC and MSI values.

MATERIALS AND METHODS

During *rabi* season 2011-12, 37 chickpea landraces from ICARDA were evaluated under both timely and late planting conditions (January sowing) (Table 1). The field experiments were conducted at the farm of Indian Agricultural Research Institute, New Delhi. The field experiments were carried out in a randomized block design with two replications. Each genotype was grown in four rows of 2m length with 45cm spacing between rows and 10cm within the rows. The established agronomic practices were followed during the crop season for proper crop growth. The crop was maintained free from weeds, diseases, and pest by applying appropriate plant protection methods. Observations were recorded on six parameters viz., Days to Flowering (DTF), Days to Maturity (DTM), 100 Seed Weight, Yield per plant (gm), Relative water content (RWC) and Membrane stability index (MSI) (Table 2).

RWC and MSI were calculated as below:

Relative water content (RWC): Three leaflets on top, middle and lower part of plant were taken for measuring relative water content RWC (%) was calculated at 50% poddingstage by the following formula given by Blum and Ebercon (1981).

RWC (%) = F_w-D_w/T_w-D_w x 100

Where, F_w= Fresh weight, T_w= Turgid weight, D_w= Dry weight.

Membrane stability index (MSI): Two gram fresh weight of leaf sample was taken to record membrane stability index at 50% flowering stage. MSI was calculated by the following formula given by Blum and Ebercon (1981).

MSI =(1- C_1/C_2) x 100

Where, C_1 = Electrical conductivity at 40°C for 30 minutes

C_2 = Electrical conductivity at 100°C for 10 minutes

Table 1
List of Landraces used for the RWC and MSIanalysis.

S.No	*Acc. No.*	*Latin Name*	*Origin*	*Province*
1	IG5839	Cicerarietinum	Jordan	Al Zarqa
2	IG5842	Cicerarietinum	Jordan	Al Zarqa
3	IG5843	Cicerarietinum	Jordan	Al Zarqa
4	IG5844	Cicerarietinum	Jordan	Amman
5	IG5844	Cicerarietinum	Jordan	Amman
6	IG5845	Cicerarietinum	Jordan	Amman
7	IG5852	Cicerarietinum	Jordan	Al Mafraq
8	IG5853	Cicerarietinum	Jordan	Al karak
9	IG5854	Cicerarietinum	Jordan	Al karak
10	IG5855	Cicerarietinum	Jordan	Al karak
11	IG5856	Cicerarietinum	Jordan	Ma'an
12	IG5857	Cicerarietinum	Jordan	Ma'an
13	IG5858	Cicerarietinum	Jordan	Al karak
14	IG5859	Cicerarietinum	Jordan	Al Balqa
15	IG5860	Cicerarietinum	Jordan	Al Balqa
16	IG5864	Cicerarietinum	Jordan	Irbid
17	IG5866	Cicerarietinum	Jordan	Irbid
18	IG5867	Cicerarietinum	Jordan	Irbid
19	IG5883	Cicerarietinum	Iraq	Ninawa
20	IG5884	Cicerarietinum	Iraq	Ninawa
21	IG5886	Cicerarietinum	Iraq	Ninawa
22	IG5887	Cicerarietinum	Iraq	Ninawa
23	IG5888	Cicerarietinum	Iraq	Ninawa
24	IG5889	Cicerarietinum	Iraq	Ninawa
25	IG5890	Cicerarietinum	Iraq	Ninawa
26	IG5891	Cicerarietinum	Iraq	Ninawa
27	IG5894	Cicerarietinum	Iraq	Arbil
28	IG5896	Cicerarietinum	Iraq	Arbil
29	IG5904	Cicerarietinum	Iraq	As Sulaymaniyah
30	IG5906	Cicerarietinum	Iraq	As Sulaymaniyah
31	IG5907	Cicerarietinum	Iraq	Baghdad
32	IG5908	Cicerarietinum	Iraq	Dahuk
33	IG5985	Cicerarietinum	Spain	Madrid
34	IG5990	Cicerarietinum	Greece	Thessalia
35	IG5993	Cicerarietinum	Greece	Thessalia
36	IG6000	Cicerarietinum	Tunisia	Tunisia
37	IG6002	Cicerarietinum	Tunisia	Tunisia

RESULTS AND DISCUSSION

The means, range, CV of the characters indicated presence of large amount of variability (Table 2) in the test landraces taken for study. Presence of such variability makes this set idealgroup to carry out selection to be used as parents in pre-breeding programme.

Days to flowering ranged from 76 days (IG5884) to 100 days (IG5887) with an average of 87 days while the Days to maturity ranged from 137 (IG5860) days to 144(IG5890) days with an average of 139 days. 100 seed weight ranged from 18 gm (IG5854, IG5855) to 44gm (IG5860).Yield for single plant ranged from 0.5 gm (IG5887) to 75 gm (IG5883) with the mean of 32 gm.

RWC and MSI of the 37landraceswereevaluated. The mean RWC was49.19 while it ranged from 38.13 (IG5889) to 80.74 (IG5856) and MSI ranged from 46.98

Table 2
Variability existing among the ICARDA landraces for various parameters

S.No	*Acc. No.*	*Days to Flowering*	*Days to Maturity*	*100 seed wt. (gm)*	*Yld/Plant (g)*	*RWC*	*MSI*
1	IG5839	80	138	22	8.33	39.12	47.03
2	IG5842	84	139	23	22.5	38.50	48.64
3	IG5843	78	138	19	15	39.91	48.50
4	IG5844a	83	139	22	27	53.18	69.76
5	IG5844b	88	139	26	50	51.68	67.12
6	IG5845	90	139	27	38.33	63.70	51.11
7	IG5852	82	138	27	32.5	38.50	49.62
8	IG5853	92	138	30	42.5	49.52	58.92
9	IG5854	88	141	18	16.67	39.30	49.12
10	IG5855	84	141	18	18.75	50.27	53.34
11	IG5856	80	138	22	22.5	80.73	72.84
12	IG5857	90	140	28	22.5	66.63	61.82
13	IG5858	96	140	23	35	38.25	49.58
14	IG5859	98	138	30	15	58.36	71.14
15	IG5860	96	137	44	24	58.18	46.98
16	IG5864	82	140	26	31.25	45.39	59.26
17	IG5866	77	143	26	40	38.85	47.30
18	IG5867	90	143	24	25	46.93	71.12
19	IG5883	88	140	33	75	54.86	63.14
20	IG5884	76	140	30	66.67	47.17	80.31
21	IG5886	98	139	23	20	39.67	47.56
22	IG5887	100	140	22	0.5	38.56	68.31
23	IG5888	86	140	28	45	38.76	49.57
24	IG5889	85	143	34	55	38.13	51.59
25	IG5890	84	144	26	40	57.03	77.01
26	IG5891	84	143	24	46.67	55.12	64.96
27	IG5894	85	139	25	48.75	41.91	73.26
28	IG5895	86	140	30	35	61.37	67.48
29	IG5896	96	141	37	42.5	59.01	74.14
30	IG5904	84	141	31	58.33	62.38	77.71
31	IG5906	84	140	28	10	54.35	50.73
32	IG5907	86	139	39	26.67	40.08	66.32
33	IG5908	84	138	25	37.5	44.70	48.70
34	IG5985	91	140	29	28.33	49.13	49.54
35	IG5990	90	139	31	30	39.64	47.25
36	IG5993	80	140	25	3.75	43.71	62.35
37	IG6000	96	141	31	30	57.67	63.61
MEAN		87.05	139.89	27.18	32.06	49.19	59.64
SD		6.24	1.67	5.56	16.77	10.3	10.8
VAR		38.99	2.82	30.99	281.25	106.11	116.84
CV		7.17	1.2	20.47	52.29	20.93	18.12
MAX.		100	144	44	75	80.73	80.31
MIN.		76	137	18	0.5	38.13	46.98

(IG5860) to 80.31 (IG5884) with a mean of 59.64. The accessionsIG5856 (Jordan) and IG5904 (Iraq) have been identified to be drought tolerant based on both RWC and MSI values (Fig. 1). All these accessions had high RWC. It is not absolute MSI but the difference in MSI of a line in normal sown conditions to that of MSI in stress conditions that is important. The lower the difference between them, the greater this line has tolerance to stress and can be used as a donor for that trait.The accessions IG5856 (Jordan) and IG5904 (Iraq)

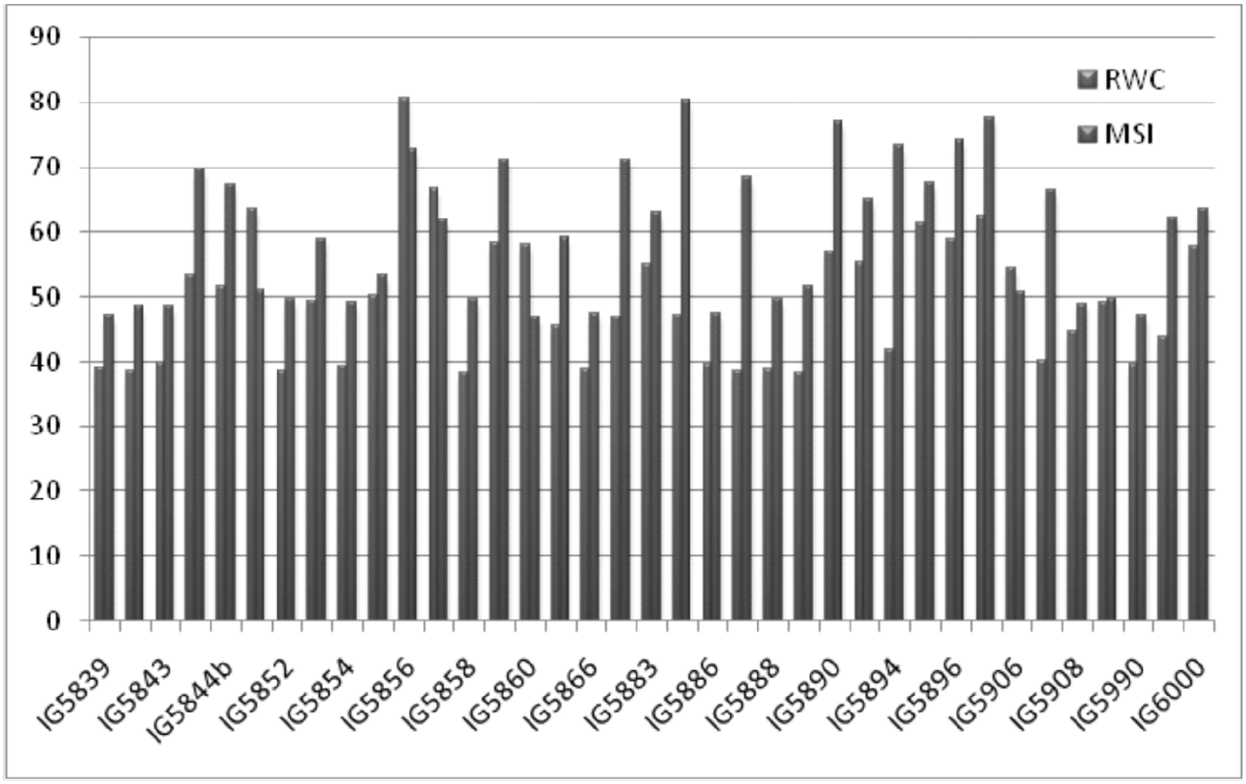

Figure 1: Evaluation of landraces for RWCand MSI analysis

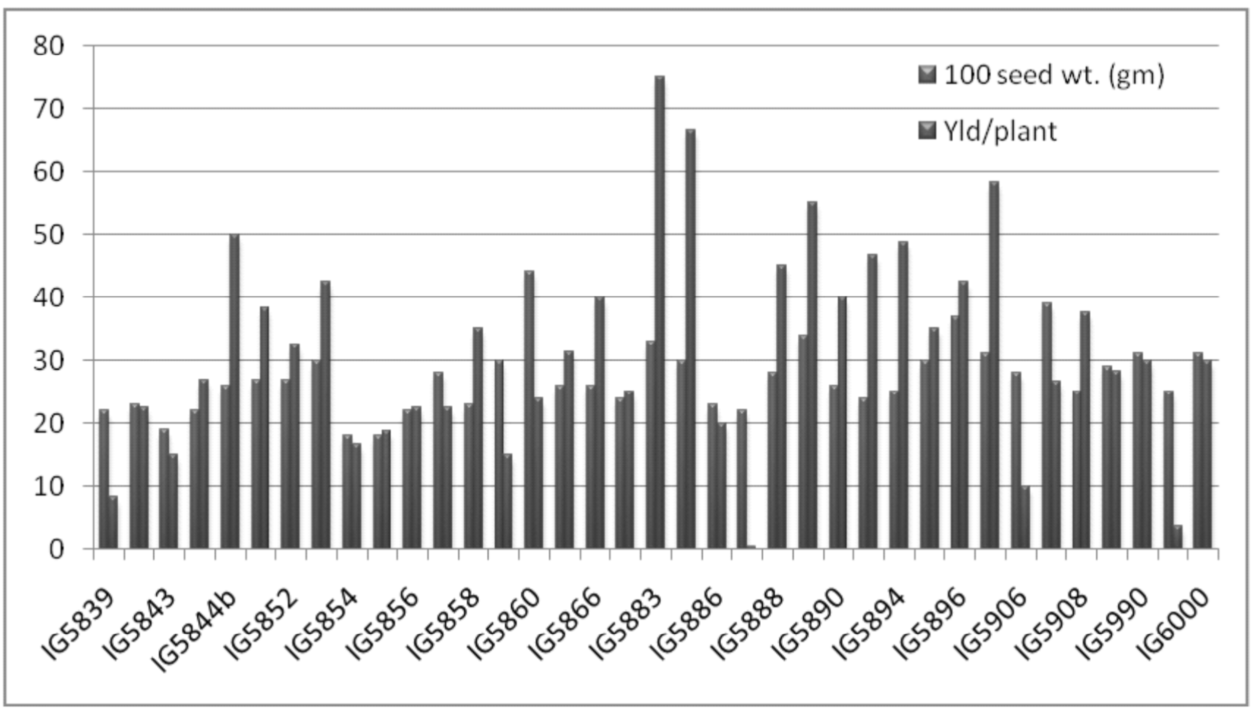

Figure 2: Variability for 100 seed weight and yield per plant among the landraces

not only had lower variation in MSI under normal sown and under late sown, they also were higher yielding and thus are promising indicating their suitability to be used as donors.

Chickpea grown under rain fed condition is approximately 90% worldwide, where drought is the major threat to chickpea production as they are grown after rainy season on residual soil moisture. The flowering or pods filling stage are most sensitive to drought (Khanna *et al.*,1987). This leads to severe yield losses from 30-100% depending on the genotype (Toker *et al.*, 1998).Though chickpea is grown as a rainfed crop, different genotypes perform differently under drought. Breeders can tap this variation for crop improvement. Attempts to measure drought parameters have been done by many workers (Bidinger *et al.*, 1982). The present investigation was therefore planned to findout the simple and precise field technique to detect genotypic differences in drought resistance based on membrane stability index and to identify important donors for this trait among the landraces.

It is necessary to investigate the variation for drought indicatory parameters in crops for their utilization (Ali *et al.*,2011; Dhanda *et al.*, 2004). In this study, the measurements of RWC and MSI as indices to identify drought tolerance indicated significant relation. Genotypes that had higher RWC and MSI were also drought tolerant with respect to their yield. Maximum variability was observed for seed yield per plant among all the studied characters. Direct selection for this trait may thus give an erroneous result. Selection therefore be based on character are stable like 100 seed weight however presence of large coefficient of variance, seed yield per plant indicates genotypic differences (Fig. 2). Coupled with drought tolerance parameters like RWC and MSI would aid in identifying drought tolerant genotypes which can be use as donors.

CONCLUSION

Chickpea landraces and the wild species are the repertoire of the genes which are tolerant to various abiotic and biotic stresses which are needed to be introgress into the cultivated chickpea varieties which are good at yield but susceptible to various stresses. For that we have to identify the landraces with resistance or tolerance to these stresses.

The present investigation clearly identifies the drought tolerant landraces viz., IG5856 (Jordan) and IG5904 (Iraq) based on yield *per se* and its significant stronger association with RWC and MSI, suggesting that these parameters to be considered while screening genotypes for drought tolerance.

ACKNOWLEDGEMENTS

Authors are greatly are greatlyacknowledgethe funding of Indian Agricultural Research Institute (ICAR) and Department of Agricultural Co-operation (DAC), Government of India, and all the partners in the DAC funded project 'Pre-breeding and genetic enhancement in breaking yield barriers in Kabulichickpea and lentil through ICAR – ICARDA collaboration'.

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