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Study on Physiological Growth indices for Drought Tolerance in Chickpea Varieties Preceded by Korra Cropping Sequence under Rainfed Conditions

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ABSTRACT

A field trial was conducted for two years at Agricultural Research Station farm, Darsi to assess the physiological growth indices for drought tolerance in chickpea varieties preceded by Korra cropping sequence under rainfed conditions of Prakasam district of Andhra Pradesh during 2018-19 and 2019-20. On the scrutiny of the data it was noticed that there was significant difference among treatments for soil moisture content, 50% flowering, TDM, CGR, SCMR, yield and yield components but no significant difference was observed in plant height and number of branches per plant in chickpea. The reduction in soil moisture was more compared to the cropping sequence of korra-chickpea. It might be due to absorption of moisture by korra from deeper layers of the soil. In the present study, all the chickpea entries recorded lower relative leaf water content (RLWC) at 70 DAS (pod development stage) as compared to 50 DAS (pod formation stage). The chickpea variety KAK-2 is found promising in maintaining higher RWC (68.8) at pod formation stage. The physiological indices, Crop Growth Rate (CGR) and SPAD chlorophyll meter reading (SCMR) recorded more at pod development stage when compared to that of flowering stage indicating the tolerance to drought at pod development stage. Though sole crop of chickpea recorded higher seed yield (927.5 kg/ha) in the cropping sequence of korra-chickpea, less reduction in soil moisture content and higher RWC in leaves of chickpea indicating its ability to withstand drought, which is beneficial to the dryland farmer. Among the sub treatments KAK-2 recorded highest seed yield (942.7 kg/ha) followed by NBeG 119 (903.8 kg/ha) with higher physiological indices.

Keywords: *Chickpea (Cicer arietinum L.), Physiological indices, Drought tolerance, Korra-Chickpea Cropping system*

Chickpea is generally thought to be a healthy vegetarian food for human beings and the most important feed for domestic animals in South Asia. India ranked first in terms of chickpea production and consumption in the world. About 65% of global area with 68 % of global production of chickpea is contributed by India (Amarenderreddy and Devrajmishra, 2010). In India, the area under chickpea is 8.2 million hectare with productivity of 895 kg/ha and production of 7.3 million tonnes. The selection of compatible crops is one of important consideration in deciding an economically viable and feasible cropping sequence. Korra (foxtail millet) is an important millet crop in India next to finger millet. In Andhra Pradesh, korra is also grown on sizeable area. Generally, the land will be kept fallow till the chickpea sowing is taken up. Of late, the importance of korra is recognized as diabetic food. It is rich in dietary fibre, minerals, micronutrients, protein, and has low glycemic index (GI). Unlike rice, foxtail millet releases glucose steadily without affecting the metabolism of the body. Korra followed by Chickpea is a prominent cropping sequence and popular among farming community especially in Prakasam District of Andhra Pradesh under rainfed conditions. The majority of the farmers adopt this system under resource constraint conditions. This system not only stabilized the chickpea production but also increased the cropping intensity. It has gained interest because of potential advantages it offers in yield through improved utilization of resources by the crops and particularly when a legume is grown in association with another crop in cropping sequence system, commonly a cereal or millet as the nitrogen nutrition of the associated crop may be improved by direct nitrogen transfer from the legume (Ranjeet Kaur *et.al*., 2016). Drought is the single most important abiotic constraint limiting the chickpea production. Moisture deficit affects seed germination and its establishment in the field, photosynthetic ability of the plants and osmotic behavior at cellular level. However, in prakasam district there is no tradition of taking crop prior to *rabi* chickpea To improve the economic status of the farmers and also to test the millet-chickpea cropping sequence in these areas the present study is proposed. Physiological processes associated with drought tolerance is pre-requisite especially when *rabi* chickpea crop is preceded by any millet crop. In general, species and genotypes vary in their capacity to tolerate drought. Therefore, the improved chickpea genotypes with better water use efficiency and high yield have to be identified for cultivation in drought prone areas, which in turn yield better and it will be a boon to improve the economic status of poor dryland farmers (Lalitha Kumari *et al.*, 2012). To achieve this, an understanding of physiological processes associated with drought tolerance is pre-requisite. Therefore, the study was undertaken with the objective to assess the morpho-physiological traits of chickpea. Under millet chickpea cropping sequence and also to identify the suitable chickpea entry for the system. Generally, the land will be kept fallow till the chickpea is sown.

MATERIALS AND METHODS

The field experiments on the assessment of physiological indices were conducted during two consecutive seasons of *Rabi* 2018-19 and 2019-20 at Agricultural Research Station, ANGR Agricultural University, Darsi, Prakasam District of AP. The soil of the experimental site was red sandy clay. The korra variety SiA 3088 is planted with a spacing of 25-30 cm (row to row), 8 – 10 cm (plant to plant). The recommended fertilizers are 40 kg Nitrogen, 20 kg P2 O 5 and 20 kg K2 O per ha. Soil test based fertilizers application is recommended. Applied entire quantity of P2 O 5 and half of Nitrogen at the time of sowing and remaining half of Nitrogen at 30 days after sowing. The fertilizer dose to chickpea was applied is 20-50-0 kg/ha NPK. The experiments were laid in split plot design with 2 main treatments (cropping sequence) *viz.*, M1 : No crop (fallow) in *kharif* followed by chickpea in *rabi*; M2 : Korra in *kharif* followed by chickpea in *rabi* and 6 sub treatments (varieties of chickpea) *viz.*, S1 JG 11; S2 NBeG 3; S3: NBeG 47 (desi types); S4: KAK-2; S5: NBeG 119 and S6: Phule G (kabuli types) replicated thrice. Soil samples were collected with the help of screw auger at 15-30 cm depth before sowing and after harvesting of each crop. Weights of soil samples before and after drying were taken. Soil samples were dried in hot air oven at 120^{0}C till samples were dried completely. The percentage of soil moisture content is calculated as follows

Soil moisture content (%) 4=

$$\frac{[\text{weight of wet soil - weight of oven dry soil}]}{\text{weight of oven dry soil}}$$

Table 1. Effect of cropping pattern with chickpea varieties on the soil moisture content, dry matter partitioning, yield attributes and seed yield

Treatment	Soil moisture content (%)		Plant height (cm)	No. of branches / pl	DMP at maturity (g)	pods/pl	100 Seed wt (g)	Seed Yield (kg/ha)
	Before the crop	After the crop						
M1 only chickpea	36.35	42.35	33.72	6.12	39.38	44.33	24.02	927.52
M2 Korra-chickpea cropping system	59.92	45.93	37.92	7.38	36.18	39.38	21.25	803.58
SEm ±	0.13	1.43	1.35	0.02	0.9	0.65	0.92	5.35
CD	0.84	N/A	N/A	N/A	N/A	4.28	N/A	35.05
CV	1.19	13.7	15.9	1.15	10.1	6.62	17.3	12.62
S1:JG-11	41.6	36	31.6	6.5	29.8	35.1	22.5	823.4
S2: NBeG 3	43.7	38.95	32.75	6.9	32.7	37.4	21.7	819.4
S3: NBeG 47	54.2	50.45	30.65	6.6	33.9	34.6	20.8	820.1
S4: KAK-2	48.3	43.95	41.9	6.9	42.5	51.2	23.9	942.7
S5: NBeG 119	51.3	47.5	38.35	6.8	44.7	43.7	24.1	903.8
S6: Phule G	49.7	48	39.65	6.8	43.1	49.15	22.8	883.9
SEm ±	1.075	2.248	1.591	0.189	1.644	1.39	1.029	26.576
CD	3.195	6.679	4.727	N/A	4.885	4.129	N/A	78.951
CV	5.3	12.5	10.9	6.9	10.7	8.1	11.1	7.5
Interaction								
M1S1	31.8	38.1	27.6	5.6	32.7	37.5	24.4	861.5
M1S2	34.8	41.9	32.6	6.7	31.3	43.5	23.9	874.6
M1S3	41.6	46.8	38.2	5.9	34	35.2	19	895.3
M1S4	43.6	43.6	36.4	6.2	45.3	57.1	28.5	997.8
M1S5	30.7	39.8	34.1	6.2	42.7	44.7	26.5	958.7
M1S6	35.6	43.9	33.4	6.1	50.3	48	21.8	977.2
M2S1	51.4	33.9	35.6	7.4	26.9	32.7	20.6	785.3
M2S2	52.6	36	32.9	7.1	34.1	31.3	19.5	764.2
M2S3	66.8	54.1	23.1	7.3	33.8	34	22.6	744.9
M2S4	53	44.3	47.4	7.6	39.7	45.3	19.3	887.6
M2S5	71.9	55.2	42.6	7.4	46.7	42.7	21.7	848.9
M2S6	63.8	52.1	45.9	7.5	35.9	50.3	23.8	790.6
SEm ±	0.314	3.492	3.3	0.044	2.194	1.599	2.261	13.104
CD	4.564	11.658	9.108	N/A	8.166	6.662	6.019	64.8

Table 2. Effect of cropping pattern with chickpea varieties on the physiological parameters.

Treatment	SCMR@ flowering	SCMR@ pod development	CGR 30DAS	CGR 50 DAS	CGR 70 DAS	RWC 30DAS	RWC 50DAS	RWC 70DAS
M1 only chickpea	31.7	44.8	2.29	3.7	3.11	71.5	73.4	64.7
M2 Korra-chickpea cropping system	34.9	40.7	2.71	3.5	2.89	43.8	49.8	61.3
SEm ±	1.18	0.14	16.8	12.9	13.1	46.7	1.05	1.21
CD	N/A	0.42	0.69	0.67	1.1	26.8	0.31	0.64
CV	9.6	6.4	7.8	8.41	5.22	4.71	2.9	3.71
S1:JG-11	34.5	40.1	2.37	3.16	2.61	58.6	61.7	54.8
S2: NBeG 3	31.9	36.7	2.64	3.24	2.59	52.4	56.4	50.4
S3: NBeG 47	30.7	38.2	2.91	3.08	2.64	49.1	52.9	43.7
S4: KAK-2	36.4	44.7	2.41	4.16	2.53	61.3	68.8	64.1
S5: NBeG 119	33.7	41.3	2.35	3.91	2.49	60.5	63.1	58.8
S6: Phule G	32.4	42.9	2.19	4.01	3.17	63.8	66.8	58.7
SEm ±	1.34	0.24	18.6	19.3	12.5	16.4	0.71	0.28
CD	N/A	0.43	0.72	0.83	1.64	21.5	0.06	13.7
CV	14.2	8.6	11.7	12.7	14.9	24.8	26.3	24.1
Interaction								
M1S1	28.5	36.5	2.16	2.98	2.53	56.5	53.8	52.7
M1S2	31.5	37.2	1.98	3.07	2.49	53.7	62.7	46.9
M1S3	26.4	41.9	2.35	3.16	2.38	61.8	59.4	51.6
M1S4	30.8	37.2	2.17	3.83	2.19	58.7	61.7	49.3
M1S5	27.3	44.2	2.09	2.96	3.04	59.4	59.3	48.2
M1S6	28.2	32.9	2.27	3.11	3.16	56.6	58.4	50.8
M2S1	29.1	37.7	1.67	2.76	2.75	61.9	57.3	51.9
M2S2	30.5	40.8	1.83	2.84	2.98	60.8	64.2	50.5
M2S3	24.6	42.1	1.94	3.91	2.49	61.7	59.7	52.7
M2S4	20.8	36.8	1.56	3.08	2.58	59.6	56.2	56.1
M2S5	32.3	32.9	2.08	4.28	2.17	61.4	61.7	52.8
M2S6	28.1	31.4	2.11	2.99	2.93	58.9	59.8	49.6
SEm ±	0.18	0.34	19.4	18.2	16.7	17.4	29.4	26.1
CD	N/A	N/A	17.3	8.4	1.9	23.7	0.21	0.84

The relative leaf water content (RLWC) was determined according to the modified method of Bars and Wetherley (1962) at 30, 50 and 70 days after sowing of chickpea. The index of total chlorophyll content (SCMR) of randomly selected leaves was recorded by using the instrument SPAD meter at 50% flowering and pod development stages of chickpea crop. The observations of plant height, dry matter production, test weight, yield components and yield along with Crop Growth Rate (CGR) at regular interval were recorded.

RESULTS AND DISCUSSION

Perusal of data pertaining to the pooled analysis of two seasons of the experiments revealed that no significant differences among the treatments in plant height and number of branches (Table 1) and significant difference is observed among SCMR readings at flowering stage (Table 2). In case of soil moisture content, the sole crop of chickpea recorded more soil moisture reduction than the cropping sequence of korra-chickpea. It might be due to absorption of moisture by korra from the deeper layers of the soil. On the scrutiny of data pertaining to the physiological indices it was noticed that the relative leaf water content (RLWC) was relatively low at 70 DAS (pod development stage) as compared to 50 DAS (pod formation stage). The higher RLWC (68.8) was found in the chickpea variety KAK-2 reflecting its tolerance to drought at pod formation stage. The physiological indices Crop Growth Rate (CGR) and SPAD chlorophyll meter reading (SCMR) recorded more at pod development stage when compared to that of flowering stage indicating the tolerance to drought at pod development stage. These results were in accordance with the findings of Talebi *et al.*(2013).

Dry matter production

The physiological processes result into a net balance and accumulation of dry matter and hence, the biological productivity of plant is judged from their actual ability to produce and accumulate dry matter. In the present experiment, the total dry matter production at maturity presented (Table 1) significantly higher dry matter production was recorded due to sole crop of chickpea (31.5g/plant) compared to the chickpea under korra-chickpea cropping system (25.6 g/plant). Among the sub treatments, the chickpea variety *viz.*, NBeG 119 recorded higher dry matter production (44.7 g/plant) and this might be due to higher RWC and SCMR values and these results are in accordance with Ulemale *et.al.*, 2013.

Seed yield

The generative growth and sink capacity relates with final produce of the plant. Though sole crop of chickpea yielded high seed yield (927.5 kg/ha), korra followed by chickpea crop obtained highest relative water content with less reduction in soil moisture content indicating its ability to withstand the drought which is beneficial to the dryland farmer. Among sub treatments KAK-2 recorded highest seed yield (942.7 kg/ha) followed by NBeG 119 (903.8 kg/ha).

CONCLUSION

The physiological changes observed could be the result of deleterious effect of water deficit on important metabolic processes as well as responses of various defense mechanisms by the plant under drought stress. In this study, it is explained the response of chickpea varieties for cropping sequence under receding soil moisture content in terms of physiological indices to tolerance to drought. It is noticed that, desi variety (JG-11) and kabuli variety (KAK-2) possessing higher relative leaf water content (RLWC) along with SCMR readings may be permitted to use as selection criteria for chickpea crop improvement. These results are in agreement with Sairam and Saxena (2000).

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