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Physiological Traits Associated with Seed Yield in Chickpea (*Cicer arietinum* L.) Genotypes under Different Environmental Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during Rabi, 2019-20 at Sehore, Madhya Pradesh to investigate the association of yield and its related components of physiological traits in Chickpea under three sown environments. Seed yield per plant was showed significant positive association with LA & LAI at 60 days after sowing in E-I, CGR in E-III. This suggested that attributes might be utilized primarily for selection of high yielding genotypes, with yield contributing characters potentially playing a key role as selection parameters for isolating a high yield in eligible genotypes.

Keywords: Chickpea; correlation; seed yield.

1. INTRODUCTION

The chickpea, (*Cicer arietinum* L.) is a significant pulse legume that is grown and eaten all over the world. The world's biggest producer and consumer of chickpeas is India. It is abundant in linoleic and oleic acid, two essential unsaturated fatty acids for nutrition. Important sterols found in chickpea oil include stigma, campesterol, and b-sitosterol. Chickpea seeds also include calcium, magnesium, phosphorus, and especially potassium. Important vitamins like riboflavin, niacin, thiamin, folate, and the precursor of vitamin A, -carotene, can all be found in chickpeas. High temperatures have an impact on the physiological processes, growth, and development of the crop. Heat stress shortens the duration of plant developmental stages and the carbon assimilation process within the plant, resulting in low biomass production and reduced source-sink activity in most crops [1]. Heat stress also affects crop growth and development by altering the morpho-anatomical, physiological, and biochemical makeup of most crops [2]. The most sensitive genotype of chickpeas had reduced chlorophyll content and symptoms of chlorosis leaves at 40/30°C. Heat waves are frequently encountered when growing chickpea, which has an impact on crop growth and productivity [3]. After harvesting rice, early potatoes, or cotton, there is considerable potential for late planting of chickpea in North India. In such cases, the crop must be planted up until the end of December or the beginning of January. Low temperatures are seen during sowing time for this late-planted chickpea crop, and high temperatures are experienced at the conclusion of the growing season. Poor and slow vegetative development is caused by low temperatures at the beginning of crop growth, whereas forced maturation and problems are caused by high temperatures towards the end of cropping season. For these reasons, present study was undertaken to assess the associations for seed yield and related physiological traits in chickpea in three sown conditions.

2. MATERIALS AND METHODS

The research was conducted at the Rafi Ahmed Kidwai College of Agriculture, Sehore, in three environments (normal November 28, 2019, mid-late December 28, 2019, and very late January 28, 2020) to correlate excessive heat stress with pollination time, reproductive time, and grain filling period (Madhya Pradesh). The minimum and maximum temperatures of the atmosphere ranged from 7.4°C in November and 45.0°C in April. Under the All India Coordinated Research Project on Chickpea, the experiment was set up in Rabi 2019–20 with two replications and a randomized complete block design. Two rows of each genotype, measuring 3 m each, were sowed. The row to row spacing distance was kept 30 cm and plant to plant spacing was 30 x 10 cm. The recommended packages of practices were followed to raise a healthy crop. Data were accumulated on Leaf Area (LA) and Leaf Area Index (LAI) at 45 days, LA and LAI at 60 days, Total Dry Matter (TDM) at 45 days, TDM at 60 days, Crop growth rate (CGR), Net assimilation rate (NAR), Chlorophyll index (SPAD) were recorded each of three environments. These were estimated from five randomly selected plants. The genotypes were organized in randomized complete block design with two replications. According to, Miller et al. [4] were computed utilizing variance and co-variance of phenotypic correlation coefficients among characters.

3. RESULTS AND DISCUSSION

The values of correlation coefficient for seed yield per plant with physiological traits were given in Tables 1, 2, 3 for each environment, separately. In the current investigation, a correlation between physiological traits and seed

Table 1. Correlation coefficient analysis among physiological traits and seed yield in Environmental-1

Traits	LA at 45 DAS	LA at 60 DAS	LAI at 45 DAS	LAI at 60 DAS	TDM at 45 DAS	TDM at 60 DAS	NAR	CGR	Chlorophyll Index	Seed yield per plant
LA at 45 DAS	1									
LA at 60 DAS	0.476*	1								
LAI at 45 DAS	0.999**	0.475*	1							
LAI at 60 DAS	0.476*	0.999**	0.475*	1						
TDM at 45 DAS	0.746**	0.648**	0.746**	0.647**	1					
TDM at 60 DAS	0.432*	0.660**	0.432*	0.660**	0.632**	1				
NAR	0.468*	0.073	0.467*	0.072	0.534**	-0.293	1			
CGR	0.253	0.556**	0.253	0.556**	0.400*	0.963**	-0.532**	1		
Chlorophyll index	0.272	0.347	0.274	0.346	0.249	0.389	-0.026	0.374	1	
Seed Yield per Plant (g)	0.172	-0.05	0.173	-0.049	0.252	0.001	0.286	-0.087	0.079	1

*Note * and** significant at 5% and 1% level of probability, respectively*

(DAS- Days after sowing, LA - leaf area, LAI- leaf area index, TDM- Total dry matter, CGR- crop growth rate, NAR-Net assimilation rate, SPAD- Soil Plant Analysis Development)

Table 2. Correlation coefficient analysis among physiological traits and seed yield in Environmental-II

Traits	LA at 45 DAS	LA at 60 DAS	LAI at 45 DAS	LAI at 60 DAS	TDM at 45 DAS	TDM at 60 DAS	NAR	CGR	Chlorophyll index	Seed Yield per Plant (g)
LA at 45 DAS	1									
LA at 60 DAS	0.493*	1								
LAI at 45 DAS	0.999**	0.491*	1							
LAI at 60 DAS	0.493*	0.999**	0.491*	1						
TDM at 45 DAS	0.489*	0.595**	0.486*	0.595**	1					
TDM at 60 DAS	0.549**	0.483*	0.548**	0.482*	0.755**	1				
NAR	0.176	-0.558**	0.177	-0.558**	-0.246	0.091	1			
CGR	0.515**	0.402*	0.514**	0.402*	0.607**	0.979**	0.185	1		
Chlorophyll index	-0.066	0.069	-0.064	0.069	0.375	0.191	0.062	0.117	1	
Seed Yield per Plant (g)	0.295	0.475**	0.289	0.477*	0.384	0.213	-0.181	0.14	-0.038	1

*Note * and** significant at 5% and 1% level of probability, respectively*

(DAS- Days after sowing, LA - leaf area, LAI- leaf area index, TDM- Total dry matter, CGR- crop growth rate, NAR-Net assimilation rate, SPAD- Soil Plant Analysis Development)

Table 3. Correlation coefficient analysis among physiological traits and seed yield in Environmental-III

Traits	LA at 45 DAS	LA at 60 DAS	LAI at 45 DAS	LAI at 60 DAS	TDM at 45 DAS	TDM at 60 DAS	NAR	CGR	Chlorophyll index	Seed Yield per plant (g)
LA at 45 DAS	1									
LA at 60 DAS	0.810**	1								
LAI at 45 DAS	0.999**	0.811**	1							
LAI at 60 DAS	0.810**	0.999**	0.810**	1						
TDM at 45 DAS	0.415*	0.517**	0.415*	0.517**	1					
TDM at 60 DAS	0.321	0.513**	0.321	0.513**	0.239	1				
NAR	-0.296	-0.598**	-0.297	-0.598**	-0.481*	0.148	1			
CGR	0.126	0.27	0.125	0.271	-0.232	0.888**	0.375	1		
Chlorophyll index	0.364	0.012	0.363	0.011	-0.151	-0.29	-0.017	-0.22	1	
Seed Yield per Plant (g)	-0.054	0.023	-0.054	0.024	-0.34	0.277	0.063	0.437*	-0.067	1

*Note * and** significant at 5% and 1% level of probability, respectively*

(DAS- Days after sowing, LA - leaf area, LAI- leaf area index, TDM- Total dry matter, CGR- crop growth rate, NAR-Net assimilation rate, SPAD- Soil Plant Analysis Development)

yield was recorded separately in each of the three environmental conditions. The seed yield per plant was highly influenced by physiological traits of the plants, but different environmental conditions plant was not similar interrelationship due to environment fluctuations. Seed yield per plant was showed significant positive association with LA & LAI at 60 days after sowing in E-I, CGR except in E-I & E-II. This suggested that attributes might be utilized primarily for selection of high yielding genotypes, with yield contributing characters potentially playing a key role as selection parameters for isolating a high yield in eligible genotypes. In E-I, E-II, and E-III settings, inter correlations between physiological traits showed a similar statistically significant trend because environmental factors including temperature, humidity, and daylight hours had no influence on the transmission of these traits.

The positive and significant association was noticed between LA and LAI at 45 DAS with LA & LAI at 60 DAS, total dry matter at 45 days after sowing & 60 DAS. LA and LAI at 60 DAS with LA & LAI at 45 DAS, total dry matter at 45 & 60 days after sowing. TDM at 45 days after sowing with LA & LAI at 45 & 60 days after sowing. TDM at 60 days after sowing with LA & LAI at 45 & 60 days after sowing, crop growth rate. Inter-correlations among the traits and with seed yield did not follow similar significant trend of most of the traits in all the environmental conditions because the environmental factors viz., temperature, humidity, sunshine hours, had much influenced in transmission of these traits. The dissimilar positive significant trend was reported between LA and LAI at 45 DAS with CGR in E-I, NAR in E-II, chlorophyll index in E-III. LA and LAI at 60 DAS with seed yield per plant except in E-II & III, CGR except in E-III. TDM at 45 days after sowing with total dry matter at 60 DAS in E-I&E-II, CGR in E-I&E-II, NAR in E-II, Chlorophyll index in E-I, seed yield in E-I. TDM at 60 DAS with Crop growth rate except in E-II & E-III, total dry matter at 45 DAS in E-I & E-II, chlorophyll index in E-II. NAR with LA and LAI at 45 DAS in E-II, total dry matter at 45 DAS in E-II, CGR in E-III. CGR with total dry matter at 60 DAS except in E-II, LA & LAI at 45 days after sowing & 60 DAS in E-I, total dry matter at 45 days after sowing in E-I & E-II, LA & LAI at 60 DAS in E-II, seed yield in E-III. Chlorophyll index with total dry matter at 45 DAS except in E-II & E-III, total dry matter at 60DAS in E-II, CGR in E-II. The above results were in agreement with findings of Singh et al. [5] for chlorophyll content was highest in early sowing in temperature tolerance in chickpea, Singh et al. [6] and MART [7] for chlorophyll content was closely associated with NAR and LAI under different planting dates in chickpea, Singh et al. [8] and Tiwari et al. [9] for seed yield was positive correlated with LAI, total chlorophyll content, CGR for heat tolerance in chickpea [10].

4. CONCLUSIONS

To present study, seed yields per plant was significant positive correlated with leaf area and leaf area index at 60 days in E-I, crop growth rate in E-III. This indicated that yield contributing characters could play a significant role as selection parameters for provides a high yield.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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