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Effect of Various Morphological Traits on Chickpea Yield Under Drought and Normal Field Conditions

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Abstract
Ten chickpea genotypes were evaluated for various morphological traits and yield under drought and normal field conditions. Genotype CM 2 produced more pods per plant, more elliptic index of leaf and more grain yield per plant under both conditions. Multiple correlation and regression analysis revealed that under normal conditions over all 92 percent variability in yield was accounted for by the plant height, secondary branches, pods per plant and elliptic index of leaf. While under drought conditions 96 percent variability in yield was accounted for by plant height, primary and secondary branches and pods per plant. Yield had high dependence upon plant height, secondary branches and pods per plant both under drought and normal field conditions.

Introduction
Chickpea (*Cicer arietinum* L.) is the most important grain legume crop of Pakistan and serve as a major source of vegetable protein in the daily diet of majority of the population. It is grown on about 1.1 million hectares with an annual production of about 0.60 million tones (Anonymous, 1996) yield of 0.55 t ha^{-1} is extremely low. Crop yield is a complex character and depends upon the interaction of several component characters. The knowledge of association of yield and its components is of immense value to breeders and forms a basis for selection. It is well known that different components of yield very often exhibit considerable degree of association among themselves and with yield. Mishra *et al*. (1988) concluded that grain yield in chickpea had positive association with plant spread, primary branches per plant, reproductive branches per plant, pods per plant, biological yield and harvest index. Singh (1977), reported that grain yield per plant was correlated with primary branches, pods per plant and seeds per pod but negatively correlated with days of flower and plant height. A combination of three variables, viz. plant height, number of branches and pods per plant was found better than other combinations of characters for the improvement of seed yield (Jain *et al*., 1991). Singh *et al*. (1991), concluded that in drought prone environments, a variation upto 75 percent in yield per plant was accounted for by the time to 50 percent flowering, time to maturity and 100 seed weight. Under drought free environments, 39 percent variation in yield was accounted for by these traits.

This study was conducted to examine the best character combination in chickpea through the techniques of multiple correlation and regression under drought and normal field conditions.

Materials and Methods
The experiment was carried out under semi-controlled moisture conditions in the research area of the Department of Crop Physiology at Postgraduates Agricultural Research Station (PARS), University of Agriculture, Faisalabad, Pakistan. Seeds of ten chickpea genotypes namely CM 1, CM 2, CM 72, CM 88, CM 1918, C 44, K 850, C 727, Thal White and 86135, were used for these studies. Split-plot design was employed keeping moisture levels in main plots and genotypes in subplots. The subplot size was 1.5 x 0.3 m with three replications. Recommended cultural practices were followed for seed bed preparation. Before sowing urea at 20 kg N ha^{-1} and single superphosphate at 22 kg P ha^{-1} were thoroughly mixed in the soil. Seed were dibbled in soil at a depth of 2.5 cm the area around the experiment was also sown to on-experimental chickpea. Thinning was done two weeks after seeding and twenty uniform seedlings were retained in each subplot.

The irrigation was applied uniformly to all plots 45 days after sowing for crop establishment. Thereafter non-stressed control was given two more irrigations i.e. first 90 days after sowing and second 135 days after sowing. No irrigation was given to stressed chickpeas after the first irrigation. The plants were individually harvested at the ground level and data were recorded on plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, harvest index, elliptic index of leaf, hundred seed weight and seed yield per plant.

The data subjected to analysis of variance and LSD test using the standard method of Steel and Torrie (1980). The multiple correlation and regression analysis and selection of best regression equation for the stress and non-stress population was done through backward elimination procedure described by Draper and Smith (1966).

Results and Discussion
The performance of ten chickpea genotypes was studied under normal and drought conditions (Table 1). As the moisture stress was applied at flowering stage when plants had already attained their maximum vegetative growth, so there were no differences in plant height and number of branches (primary and secondary) under drought and normal field conditions. However the varietal differences were quite obvious. Variety CM 2 gave the maximum number of pods per plant (87.20 and 126.97) and maximum yield per plot

(18.97 g and 28.8 g) both under drought and normal field conditions respectively. It also gave maximum elliptic index of leaf under normal conditions (91.94) but under drought it showed more reduction (71.81) than C 44 (78.97). K 850 exhibited maximum harvest index (28.07 and 32.96%) both under drought and normal field conditions respectively. CM 2 proved superior to the other nine genotypes in most of the characters studied. The superiority of CM 2 may be attributed to its higher number of pods per plant and more yield per plant. Multiple correlation and regression analysis among various morphological traits was also performed for their significance and level of contribution in yield per plant. It is clear from the results (Table 2 and 3) that when the screening of the contributing traits for seed yield was restricted to a set of four variables over all 92 percent variability in yield was accounted for by the plant height, number of secondary branches, pods per plant elliptic index of leaf under normal field conditions. While under drought conditions over all 96% variability in yield was accounted for by plant height, number of primary and secondary branches and pods per plant. Yield had high dependence upon plant height, number of secondary branches and pods per plant both under normal and stress conditions.

Table 1: Average performance of various morphological traits in chickpea under moisture stress conditions

Varieties		Plant height (cm)	No. of primary braches	No. of secondary branches	Pods/Plant
CM 1		76.30*	3.97	18.53	89.87
		74.70**	3.93	18.63	81.87
CM 2		92.20	5.83	23.00	126.97
		88.17	5.97	23.13	87.20
CM 88		91.07	5.07	16.13	64.23
		93.70	5.07	16.03	52.60
CM 72		72.17	6.77	15.90	68.30
		72.43	7.00	15.85	58.43
CM 1918		77.40	4.57	12.73	68.37
		75.93	4.50	12.77	46.17
C 44		75.93	7.13	14.37	85.07
		75.03	6.93	14.27	48.63
K 850		65.17	4.80	14.87	93.83
		64.73	4.80	15.17	80.03
C 727		71.43	7.13	15.77	67.90
		71.40	7.07	15.90	53.80
Thal White		65.93	4.27	14.33	101.07
		63.20	4.17	14.27	72.57
86135		62.57	3.67	13.20	94.50
		62.23	3.60	13.20	75.17
LSD 5%	a	5.51	0.74	1.38	5.59
	b	5.98	0.94	1.47	5.32
1%	a	7.55	1.01	1.89	7.66
	b	8.19	1.28	2.01	7.29

* = Under normal field conditions; ** = Under moisture stress conditions

Table 2: Multiple correlation and regression analysis of various morphological traits of ten chickpea genotypes under normal field conditions

Multiple Correlation (RI = 0.956

Coefficient of Determination (R^2) = 0.915

Multiple Linear Regression Equation

$Y = -9.3156 + 0.1747X_1 - 0.6595X_2 + 0.2158X_3** + 0.1272X_4**$

*,** = Significant at 5 and 1% levels respectively

Y = Yield per plant; X_1 = Plant height; X_2 = No. of secondary branches; X_3 = Pods per plant; X_4 = Elliptic index of leaf

Partial Regression Coefficients and their significance

Variable	Regression co-efficient	Standard error	Standard partial regression coefficient	S.E of standard partial regression coefficient	Student t value	Probability
Plant height	0.1747	0.0655	0.7281	0.2729	2.668	0.026
Sec.	-0.6595	0.2676	-0.8596	0.3488	-2.465	0.036
Pods/plant	0.2158	0.0432	1.4179	0.2836	4.999	0.001
Elliptic index of leaf	0.1272	0.0284	0.6701	0.1497	4.477	0.002

Table 3: Multiple correlation and regression analysis of various morphological traits of ten chickpea varieties under stress conditions

Multiple Correlation (R) = 0.097
Coefficient of Determination (R^2) = 0.956
Multiple Linear Regression Equation
$Y = -9.7964 + 0.1769X_1 + 1.6787X_2 - 1.3344X_3** + 0.3441X_4**$
*, ** = Significant at 5% and 1% levels respectively
Y = Yield per plant; X_1 = Plant height; X_2 = Primary branches; X_3 = Secondary branches; X_4 = Pods per plant

Partial Regression Coefficients and their significance

Variable	Regression co-efficient	Standard error	Standard partial regression coefficient	Standard error of partial regression coefficient	Student t value	Probability
Plant height	0.1769	0.0693	0.3688	0.1445	2.552	0.031
Primary branch	1.6787	0.3916	0.4554	0.1062	4.287	0.002
Sec. branches	-1.3344	0.2986	-0.8253	0.1847	-4.469	0.002
Pods/plant	0.3441	0.0357	1.3984	0.1451	9.635	0.0000

Analysis of Variance

S.O.V.	D.F.	S.S	M.S	F. value	Probability
Regression	4	201.4235	50.3559	27.07	0.001
Residual	5	9.3019	1.8604		
Total	9	210.7255			

Results also showed that the regression of yield on secondary branches and pods per plant was highly significant both under normal and stress conditions. This indicates the importance of these two traits in determining the yield. The regression of yield on elliptic index of leaf was significant under normal conditions while it had no effect under stress conditions and instead the regression of yield on primary branches became highly significant. This indicated that elliptic index of leaf may not be a useful indication of yield under stress conditions and the primary branches assume more importance under these conditions. The findings of this study are almost consistent with the results obtained by Jain *et al*. (1991) who reported that a combination of three characters, viz. plant height, number of branches and pods per plant was superior to others and its relative contribution towards seed yield was 94 and 97 percent in two years under normal field conditions and 50-97 percent under drought. Our results contradicted with those of Singh *et al*. (1991) who concluded that under normal field conditions 75% of the variation in yield was because of time to 50% flowering, time to maturity and 100 seed weight. While 39 percent flowering, time to maturity and 100 seed weight. While 39 percent of the total variation in yield was because of these three traits under drought. These findings did not agree to Haq (1990). He found that 99.1 percent variability in yield was accounted for by the number of pods per plant, seeds per pod and 100 seed weight in control and 96.3 and 93.7 percent variability in yield was accounted for by pods per plant, seeds per pod and 100 seed mass in two sets of mutated populations respectively. The difference in findings might be due to different material utilized and the environments under which the studies were undertaken.

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