IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
Volume 8 | Issue 2 | July, 2013 | 258-261

RESEARCH ARTICLE

Studies on morpho-physiological parameters in chickpea

■ SANTOSH BHATNAGAR AND P.K. SINGH

SUMMARY

Ten genetically diverse parents of chickpea were crossed in half diallel fashion to study the morpho- physiological parameters during four growth stages in a field experiment conducted at Indian Institute of Pulses Research, Kanpur. Wide variation was observed among all the parameters during all the four growth stages.Highest yielding parents (K850, JG62 and N59) and hybrids (ICC10035 x K850, ICC987 x K850 and ICC 4914 x JG62) were relatively short statured and exhibited greater initial growth leading to higher leaf area index, greater root length and weight. Dry matter production and crop growth rate were slow during early vegetative phase in all the parents as well as hybrids and increase progressively as the duration/ temperature advanced. A comparison of relative growth rates in parents and hybrids indicated more rapid RGR in early part of season implying faster rate of leaf development and profuse branching which are instrumental in producing better photosynthetic apparatus in hybrids before pod formation.

Key Words : Chickpea, Growth stages, Morpho-physiological parameters

How to cite this article : Bhatnagar, Santosh and Singh, P.K. (2013). Studies on morpho-physiological parameters in chickpea. *Internat. J. Plant Sci.*, **8** (2) : 258-261.

Article chronicle : Received : 14.09.2012; **Revised :** 08.02.2013; **Accepted :** 15.03.2013

Chickpea (*Cicer arietinum* L.) occupied a very important position in rainfed farming system both for meeting dietary need owing to high protein content, high protein efficiency rate and resorting soil fertility. Reasons for lower productivity in pulses are related to poor plant type and inferior sources- sink relationship. Growth and yield are functions of a large number of metabolic processes which are affected by environmental and genetic factors. Information about growth patterns not only tell us how plant accumulate dry matter, but also reveals the events which can make a plant more or less productive singly or in population. Much can be done to improve the chickpea productivity through modifications of plant structures and physiological processes. Furthermore, growth parameters like optimum leaf area index and crop growth rate at flowering stage have been identified as the major determinants of yield (Sun *et al*., 1999). Combinations of these growth parameters can explain yields in much better way than any individual growth variable. That is why the present investigation was conducted to determine morpho-physiological growth parameters and their relation to yield and also to suggest appropriate breeding strategy for enhancement in grain yield of chickpea.

MEMBERS OF THE RESEARCH FORUM

Author to be contacted :
P.K. SINGH, C.S. Azad University of Agriculture and Technology, KANPUR (U.P.) INDIA
Email: pk_singh65@yahoo.com

Address of the Co-authors:
SANTOSH BHATNAGAR, A.N.D. College, C.S.J.M. University, KANPUR (U.P.) INDIA

MATERIAL AND METHODS

The basic experimental materials were comprised of ten diverse genotypes of chickpea collected from different geographic regions of the chickpea growing countries and were crossed in diallel fashion excluding reciprocals. The resultant $45F_1S$ along with parents were evaluated in RBD with three replications at Indian Institute Pulses Research, Kanpur. The plot size was single row of 3m length with row to row distance of 30cm. Growth analysis was performed at monthly intervals on five randomly selected plants from parents and FIS. The plants were dug out carefully up to 60 cm in order to recover as much of the root portion as possible and were processed (dried at 80 ^{0}C) for recording different growth parameters (Table A). The crop growth rate and relative growth rate were calculated using the formula given by Blackman and Black (1955).

Table A : Mean values of growth parameters at five different growth stages in 10 parents and 45 hybrids of chickpea

Parameters	Parents/F_1s	Days after sowing				
		30	60	90	120	150
Plant height (cm)	Parents	12.99	27.01	45.18	58.42	65.78
	CD	1.32	1.96	4.58	4.82	6.03
	F_1s	12.70	28.67	44.99	57.33	62.84
	CD	1.07	1.98	3.32	4.78	5.26
Number of primary branches	Parents	1.34	2.66	3.84	6.05	8.72
	CD	0.15	0.17	0.33	0.51	0.72
	F_1S	1.92	3.66	5.60	8.18	10.92
	CD	0.11	0.38	0.49	0.69	1.03
Number of secondary branches	Parents	2.28	4.91	7.74	10.15	14.12
	CD	0.22	0.42	0.60	0.76	1.53
	F_1S	1.52	5.72	9.72	15.16	20.47
	CD	0.15	0.47	0.81	1.26	1.70
Pod number	Parents	~	~	2.05	22.69	93.99
	CD	~	~	0.34	3.78	15.66
	F_1S	~	~	4.49	32.12	155.17
	CD	-	-	0.74	5.03	12.92
Pod weight (g)	Parents	~	~	0.92	11.58	37.14
	CD	~	~	0.14	1.56	6.19
	F_1S	~	~	2.01	14.23	55.54
	CD	~	~	0.29	2.02	8.53
Root length (cm)	Parents	5.38	10.70	15.85	22.54	30.50
	CD	0.62	1.53	1.89	NS	NS
	F_1S	6.10	11.88	16.51	23.66	31.93
	CD	0.53	1.05	2.13	NS	NS
Root weight (g)	Parents	0.60	1.01	1.53	2.36	3.30
	CD	0.05	0.09	0.12	NS	NS
	F_1S	0.74	1.08	1.70	2.68	3.61
	CD	0.06	0.09	0.14	0.22	NS
Dry matter (leaves+ stem)	Parents	1.07	2.32	11.53	19.20	26.67
production (g/plant/day)	CD	NS	0.19	0.95	1.53	2.22
	F_1S	1.34	2.69	13.62	22.26	30.48
	CD	0.10	0.15	1.10	1.77	2.41
Dry matter (leaves+pods+stem)	Parents	1.07	2.32	12.45	30.67	63.81
production (g/plant/day)	CD	NS	0.19	1.03	2.23	4.27
	F_1S	1.34	2.69	15.63	36.49	86.14
	CD	0.10	0.15	1.30	2.61	5.01
Relative growth (leaves + stem) rate	Parents		0.03	0.044	0.017	0.011
(g/plant/day)	CD		0.003	0.004	0.001	0.006
	F_1S		0.023	0.055	0.016	0.010
	CD		0.001	0.002	0.001	0.001
Relative growth (leaves+ stem + pod) rate	Parents		0.029	0.05	0.03	0.024
(g/ plant/day)	CD		0.001	0.002	0.001	0.001
	F_1S		0.003	0.058	0.030	0.029
	CD		0.002	0.006	0.001	0.001
Crop growth (leaves +stem)rate (g/plant/day)	Parents		0.042	0.0307	0.259	0.249
	CD		0.004	0.038	0.024	0.025
	F_1S		0.045	0.364	0.288	0.274
	CD		0.006	0.028	0.019	0.024
Crop growth (leaves + stem +pod) rate	Parents		0.042	0.338	0.599	1.101
(g/plant/day)	CD		0.003	0.034	0.062	0.112
	F_1S		0.045	0.446	0.690	0.112.
	CD		0.009	0.092	0.124	0.37

RESULTS AND DISCUSSION

Pulses continue to occupy a very important position in rainfed farming owing to meeting dietary needs of the people and for resorting soil fertility. Reasons for lower productivity in pulses compared to cereals are related to poor plant type and inferior source-sink relationship.The results presented in Table 1 revealed that parental plant height ranged from 10.16 cm (ICC 6148) to 15.28 cm (ICC 10035) at 30 days after sowing and the rate of extension was found in the same order. In the hybrids greater initial plant height was observed even in crosses with shortest parent (ICC1073) possibly due to hybrid vigour of seedling at initial stage (30 days) relative to parents. This persisted to some extent up to 90 days however, at 120 and 150 days of sampling, plant height in F_1S were lower than the corresponding taller parents of the crosses. An interesting feature of relationship between plant height and yield was that all the three top yielding hybrids were shorter in stature than lowest yielding three hybrids confirming the views of Donald (1968) and Asana (1968) on crop ideotype concept. The data on primary and secondary branches indicated that strain IC 5033 was conspicuous in having the highest number of primary branches among the parents.

The maximum gain in branching occurred during 91-150 days growth indicating excessive vegetative growth during reproductive phase. Pandey and Saxena (1974) reported an efficient genotype in chickpea will be one which stops vegetative growth with the onset of reproductive growth and would therefore, be more efficient producer of economic yield. Parent IC 10035 had the lowest number of primary and secondary branches and was also the lowest yielder which prove that an appropriate photosynthetic apparatus is must to create source site. The highest yielding cross IC 10035 x K 850 produced 7.47 branches during 61-90 days in contrast to 3.34 branches in low yielding cross N59x JG62 suggesting that active and faster growth rate prior to the start of reproductive phase and slower growth during active reproductive phase made cross IC 10035 x K850 more efficient producer of economic yield.

Parents K850, N59 and JG62 were the top scorers at 150 DAS whereas, IC1073, ICC5033 and IC10035 were lowest for both pod number and pod weight in that order. Because of fewer secondary branches ICC10035 had the lowest number of pods but due to larger seed size, its pod weight was only marginally lower (19%). Top ranking hybrids had more than twice the pod number as well as pod weight in comparision to lowest ranking hybrids. Another interesting feature about late flowering parent K850 was that it did not form pods during 61-90 days DAS but in crosses with the other parents wherever used as male parent, it was instrumental in inducing early flowering (61-90 DAS) and pod formation. Kumari and Sinha (1972) reported that pods in chickpea are capable of photosynthesis. It is therefore, suggested to select the genotypes in which fruits come out of the plant canopy earlier.

Four parents K850, N59, JG62 and ICC4194 showed somewhat greater root length at 150 DAS and similar pattern was observed in F_1S. With regard to root weight little variation at all the five developmental stages were observed in both parents and hybrids. Deeper roots in parents K850, N59 and JG62 might be responsible for the extraction of moisture and nutrients from deeper soil profile resulting in early flowering in all the hybrids wherever, those parents were used as male parent.

Table 1: Relationship between grain yield and some economic characters in three highest and lowest yielding parents and crosses in chickpea

Sr.No. #	Parents/ crosses	Grain yield (g/plant)	1000-grain weight (g)	Biomass weight (g)	Per day productivity (g/plant)	Harvest index	Days to flowering	Reproductive phase (days)
Parents								
1.	K850	34.65	291.43	76.75	0.22	52.65	77.98	77.15
2.	N59	26.72	237.49	73.59	0.20	43.27	63.27	67.70
3.	JG62	24.60	198.58	72.48	0.17	48.32	68.80	69.38
4.	ICC10035	9.78	217.59	53.24	0.06	40.60	75.43	76.18
5.	ICC5033	16.85	224.53	57.79	0.10	42.88	80.15	80.88
6.	ICC1073	18.23	144.60	57.90	0.11	45.67	77.03	77.01
Crosses								
1.	ICC10035 x K850	69.70	268.63	115.04	0.45	53.25	66.23	86.13
2.	ICC987 x K850	64.83	258.58	113.44	0.41	51.81	68.69	88.08
3.	ICC4914 x JG62	61.55	235.49	114.04	0.45	49.84	68.21	68.05
4.	ICC5033 x ICC987	22.61	272.51	63.74	0.15	53.70	74.11	72.90
5.	N59 x JG62	22.70	228.57	72.51	0.17	52.68	73.76	59.48
6.	ICC4914 x ICC5033	22.82	228.62	71.39	0.14	45.86	76.61	75.84

1, 2, 3 – Three highest yielding parents and crosses. 4, 5, 6 –Three lowest yielding parents and crosses

Total dry matter production in top ranking parents K850 (76.75g), N59 (73.59 g) and JG62 (72.48g) was appreciably higher than lowest ranking parents ICC 1073 (57.90g), ICC5033 (57.79g) and ICC10035 (5 3.24g) and similar trend was observed in case of three top ranking hybrids and three bottom ranking hybrids. However, the three best hybrids exceeded three best parents by a margin of 50 per cent in total dry matter production exihibiting physiological heterosis for this trait. Association between biomass and grain yield was also observed in this set of materials. The dry matter production was very slow up to 60 days in all the parents and hybrids due to prevalence of low temperature.

The relative growth rate (RGR) was moderate during early vegetative period (31-60days) in all the parents, highest during 61-90 days and it declined with the advancement of crop age (Table1). The three highest yielding parents showed lower RGR than low yielding parents (ICC 5033 and ICC 1073) at 91-120 days which is due to low leaf area ratio and high net assimilation rate in high yielding parents as reported earlier by Deshmukh and Bhapkar (1981) and Srivastava and Tiwari (1981). Similar pattern was discerned in hybrids for RGR under present investigation.

Parents ICC6148 and K850 recorded highest value for crop growth rate(CGR) whereas,JG62 has the lowest value. The hybrids were superior to parents in CGR at all the four growth stages reflecting better growth of leaves and stems in hybrids.CGR superiority in hybrids was maximum at pod formation stage (61-90 DAS). This rapid increase in CGR after pod filling stage resulted in increased accumulation of dry matter in the reproductive parts of the hybrids. Pandey and Saxena (1974) also reported positive and significant correlation of CGR with grain yield especially during pod formation stage.

Based on present findings, it may be suggested that the development of plant type concept in chickpea should be based on growth parameters like greater dry matter production, longer reproductive phase, better root system, greater pod number with more secondary branches, dwarf plant height and physiological parameters like greater crop growth rate during pod formation stage and lower relative growth during pod formation stage. Further studies on the contributions of leaf area index, leaf area ratio, net assimilation rate and quantification of photosynthates produced by pod wall are suggested to develop more efficient yielder genotypes of chickpea.

REFERENCES

Asana, R.D. (1968). In quest of yield. *Indian J. Plant Physio*., **11**:1-10.

Blackman, G.E. and Black, J.H. (1955). Physiological and ecological studies in the analysis of plant environment: an analysis of the effect of seasonal variation in daily light and temperature on growth of *Helianthus annus* in the vegetative phase. *Ann. Bot*., **19**:527-548.

Deshmukh, R.B. and Bhapkar, D.G. (1981). Heterosis and combining ability for harvest index and agronomic characters in chickpea. *Legume Res*., **4**:19-22.

Donald, C.M. (1968). The breeding of crop ideotypes. *Euphytica*, **17**:385-403.

Kumari, P.S. and Sinha, S.K. (1972).Variation in chloroplasts and photosynthetic rate in cultivars of Bengal gram (*Cicer arietinum* L.).*Photosynthetica*, **6**: 189-194.

Pandey, R.K. and Saxena, M.C. (1974). Morpho-physiological consideration in the development of efficient plant types of arhar and gram. *Indian J.Genet*., **34**:1012-1015.

Srivastava, S.K. and Tiwari, D.K. (1981). Correlation of physiological growth parameters of productivity in chickpea. *JNKV Res. J*., **15**:75-77.

Sun, Y.F., Liang, J.M., Ye, J. and Zhu, W.Y. (1999). Cultivation of super- high yielding rice plants. *China Rice*, **5**:38-39.