

## Attributes of Seed Yield in Relation to Seed Size in Chickpea (*Cicer arietinum* L.)

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The present study was carried out to determine the component characters of seed yield in relation to seed size in chickpea. Fifty-three genotypes of diverse origin were grouped based on seed size as small (G I), medium (G II) and bold (G III). Significant differences were found among seed groups and genotypes. Multiple regression analysis indicated that pods per plant was found to be major contributor of seed yield among all the groups of chickpea. Days to flowering in medium seeds and days to maturity in bold seeds had shown their substantial contribution towards seed yield. Path analysis indicated that pods per plant had the highest positive direct effect on seed yield but its effect was diluted with increase in seed size. Negative indirect effect of seed weight in large seed group indicated that breeding for much larger seeds may not be helpful in increasing its productivity and greater attention should be paid on medium bold seeds. Based on *per se* performance superior genotypes like BGD 116 and BGD 115 for high number of pods, seed yield and bold seed size; H 95-25 and BGM 528 for high number of pod; Vijay, JG 74 and RSG 964 for early flowering could be considered in chickpea breeding programme

**Key Words: Chickpea, Correlation, Path Analysis, Seed Size, Seed Yield**

The seed yield being a complex and variable entity, is attributed to various traits. Direct selection for yield *per se* may not be very effective and it is also true that interdependency of contributing traits may affect the selection criterion. In crop like chickpea not only seed yield but seed size is also equally important in determining the value of the produce. In view of this the present study was carried out to determine the component characters of seed yield in relation to seed size in chickpea.

### Materials and Methods

Fifty-three genotypes of diverse origin were grown in randomized complete block design with three replications during winter 2001-02 at Research Farm, I.G.A.U., Raipur. Each genotype was represented by 4 rows 4 m long, 30 cm apart with intra-row spacing of 10 cm. Basal application of 20 kg N and 50 kg P<sub>2</sub>O<sub>5</sub> per hectare

was applied at the time of sowing. Recommended package of practices was adopted to raise a good crop. Crop was sprayed twice with monocrotophos 36 EC @ 1 litre per ha. Observations were recorded on five competitive plants for plant height (cm), primary branches, pods, seed yield (g) and 100-seed weight (g). Days to first flower and maturity were recorded on plot basis. Based on test weight (100-seed weight) genotypes were grouped as small (G I), medium (G II) and bold (G III) and data were analysed using Balanced Group Design (Gomez and Gomez, 1976).

### Results and Discussion

Analysis of variance (Table 1) revealed significant differences among seed groups and genotypes. A wide range of variation was observed for all the traits studied (Table 2); 44-70 for days to first flower; 97-118 for days to maturity; 39.4 – 59.4 cm for plant height;

Table 1. Analysis of variance for different characters in three seed groups of chickpea

Group	Sources of variation	d.f.	Mean Squares							
			Days to first flower	Days to maturity	Plant height	Primary branches plant <sup>-1</sup>	Pods plant <sup>-1</sup>	Seeds pod <sup>-1</sup>	100-seed weight	Seed yield
I	Replication	2	5.500	5.031	0.047	0.025	0.051	0.019	0.084	0.052
	Genotype	21	92.545**	69.616**	60.129**	0.323**	515.567**	0.098**	7.547**	15.517**
	Error	42	0.357	0.427	0.001	0.0001	0.0005	0.0001	0.018	0.003
II	Replication	2	1.313	1.313	0.039	0.013	0.016	0.009	0.048	0.060
	Genotype	18	104.632**	27.351**	73.896**	21.524**	288.181**	0.057**	6.753**	15.166**
	Error	36	0.316	0.316	0.001	0.0001	0.001	0.0003	0.012	0.0004
III	Replication	2	0.336	0.328	0.020	0.008	0.016	0.011	2.797	0.022
	Genotype	11	38.432**	46.977**	53.195**	19.529**	513.466**	0.035**	5.814**	48.109**
	Error	22	0.151	0.152	0.001	0.028	0.0001	0.00005	2.731	0.0003

**Table 2. Estimates of genetic parameters for different traits in chickpea**

Characters	Mean	Range		GCV (%)	$r_g$ with seed yield
		Min.	Max.		
Days to first flower	58.88	44.00	70.00	9.07	0.556**
Days to maturity	104.21	97.00	118.00	3.97	-0.153
Plant height (cm)	49.67	39.40	59.40	9.76	0.210
Primary branches plant <sup>-1</sup>	2.70	2.00	3.53	10.72	0.418**
Pods plant <sup>-1</sup>	41.64	18.00	83.67	28.41	0.750**
Seeds pod <sup>-1</sup>	1.39	1.03	1.78	12.82	-0.332**
100-seed weight (g)	20.36	13.19	31.50	24.15	0.577**
Seed yield plant <sup>-1</sup> (g)	9.72	4.96	18.60	33.55	-

2-3.53 for number of primary branches; 18-84 for pods per plant; 1.03-1.78 for seeds per pod; 4.96-18.60 g for seed yield per plant and 13.19-31.50 g for 100-seed weight. Relatively high estimates of genotypic coefficient of variation (GCV) for seed yield (33.55%), pods per plant (28.41%) and 100-seed weight (24.15%) would offer better opportunities for genetic improvement of these traits. Other traits exhibited moderate to low GCV.

#### Relative Contribution of Attributes

Multiple Regression Analysis (MRA) presented in (Table 3) showed differential contribution of attributes towards seed yield in different seed groups. Moreover, pods per plant, invariably was found to be major contributor of seed yield in chickpea. Its relative contribution was 94.71, 63.79 and 95.46 per cent in small, medium and bold seeds, respectively. The next important contributor

**Table 3. Relative contribution of individual yield components towards seed yield**

Characters	I	II	III
Days to first flower	-0.386	11.981	-2.343
Days to maturity	0.376	1.945	4.059
Plant height	0.161	2.800	0.005
Primary branches plant <sup>-1</sup>	1.050	2.877	2.023
Pods plant <sup>-1</sup>	94.714	63.788	95.457
Seeds pod <sup>-1</sup>	-2.929	-0.031	-1.051
100-seed weight	7.014	16.640	1.850
Total	100.000	100.000	100.000

**Table 4. Genotypic path coefficients in group I**

Characters	Days to first flower	Days to maturity	Plant height	Primary branches plant <sup>-1</sup>	Pods plant <sup>-1</sup>	Seeds pod <sup>-1</sup>	100-seed weight	$r_{yi}$
Days to first flower	-0.005	-0.007	0.000	0.003	0.605	-0.056	0.019	0.560**
Days to maturity	-0.001	-0.033	-0.001	0.009	-0.076	0.014	-0.022	-0.011
Plant height	0.000	-0.004	-0.005	-0.004	-0.324	0.051	-0.030	-0.316
Primary branches plant <sup>-1</sup>	0.000	-0.008	0.001	0.036	0.196	-0.015	0.075	0.285
Pods plant <sup>-1</sup>	-0.003	0.003	0.002	0.007	0.989	-0.083	0.000	0.914**
Seeds pod <sup>-1</sup>	0.001	-0.002	-0.001	-0.002	-0.304	0.268	-0.070	-0.109
100-seed weight	0.000	0.003	0.001	0.009	0.000	-0.065	0.288	0.235

Residual effect = 0.045

was seed mass especially in small (7.01%) and medium seed groups (16.64%). This was further confirmed by average yield of the genotypes obtained in each group, which clearly indicated that 15.09 and 13.21 per cent of the genotypes had seed yield above 10 gm per plant in G III and G II while only 3.77 per cent genotypes obtained this level in small seed group. Days to flowering in medium seeds and days to maturity in bold seeds had shown their substantial contribution and hence, they should be considered in selection scheme. Therefore, emphasis on genotypes with faster plant growth, early flowering and early maturity should be given. Kulkarni (2000) also reported the highest contribution of pods per plant followed by seed weight and days to flowering in rainfed chickpea.

Correlation and path analysis further confirmed the results of MRA. Significant positive association with pods per plant and days to flowering was observed in G I (Table 4). Similarly, pods per plant, days to flowering and 100-seed weight in G II and pods per plant and primary branches in G III had significant positive association with seed yield (Table 5 & 6). These findings are in agreement with the findings of Gowda and Pandya (1975) and Sarvaliya and Goyal (1994). Days to maturity had significant negative association with seed yield, emphasizing the significance of early maturity in semi-arid tropics. Setty *et al.* (1977) and Islam and Begum (1985) had also reported similar association in chickpea.

Path coefficient analysis further confirmed the results, indicating variable effects of different attributes in different seed groups (Tables 4, 5 & 6). However, pods per plant invariably had highest positive direct effect on seed yield but its effect was diluted with increase in seed size. It was highest in G I and the lowest in G III. Other important attributes were seed mass and seeds per pod in G I and II; primary branches and seeds per pod in group III. The results gave clear

Table 5. Genotypic path coefficients in group II

Characters	Days to first flower	Days to maturity	Plant height	Primary branches plant <sup>-1</sup>	Pods plant <sup>-1</sup>	Seeds pod <sup>-1</sup>	100-seed weight	r <sub>yi</sub>
Days to first flower	0.182	0.010	0.044	0.001	0.296	0.004	0.107	0.644**
Days to maturity	-0.082	-0.022	-0.033	-0.006	-0.415	-0.004	-0.025	-0.588**
Plant height	0.081	0.007	0.099	-0.017	0.045	0.047	0.008	0.269
Primary branches plant <sup>-1</sup>	0.003	0.002	-0.026	0.065	0.325	-0.022	0.082	0.429
Pods plant <sup>-1</sup>	0.078	0.013	0.006	0.030	0.691	-0.005	0.071	0.885**
Seeds pod <sup>-1</sup>	0.005	0.001	0.031	-0.010	-0.021	0.149	-0.160	-0.005
100-seed weight	0.059	0.002	0.002	0.016	0.147	-0.072	0.330	0.485*

Residual effect = 0.044

Table 6. Genotypic path coefficients in group III

Characters	Days to first flower	Days to maturity	Plant height	Primary branches plant <sup>-1</sup>	Pods plant <sup>-1</sup>	Seeds pod <sup>-1</sup>	100-seed weight	r <sub>yi</sub>
Days to first flower	0.066	0.084	-0.004	0.045	0.315	-0.059	0.048	0.495
Days to maturity	-0.019	-0.302	0.003	-0.032	-0.300	0.001	0.045	-0.603**
Plant height	-0.010	-0.035	0.029	-0.043	-0.010	0.034	0.031	0.003
Primary branches plant <sup>-1</sup>	0.007	0.022	-0.003	0.446	0.347	0.003	-0.146	0.706**
Pods plant <sup>-1</sup>	0.039	0.171	-0.001	0.292	0.530	-0.033	-0.027	0.971**
Seeds pod <sup>-1</sup>	-0.034	-0.003	0.009	0.013	-0.153	0.114	-0.091	-0.145
100-seed weight	-0.021	0.092	-0.007	0.347	0.096	0.069	-0.149	0.427

Residual effect = 0.039

indication that number of seeds and seed mass are the sole entities of seed yield but their contribution was hidden in group III as evidenced by its negative and negligible direct effect and non-significant positive association with seed yield. Secondly, number of seeds per pod was decreasing with increase in seed size. Hence, this should be kept in mind while formulating breeding programme for larger seeds in chickpea. In accordance to the present findings earlier workers Gowda (1972), Chand *et al.* (1975), Singh and Paroda (1986) and Dasgupta *et al.* (1992) have also reported the highest contribution of these traits in chickpea. The results further indicated that days to flowering and primary branches had indirect contribution through pods per plant. However, negative indirect effect of plant height through pods per plant indicated that increase in plant height may not be helpful in increasing seed yield in chickpea.

It is evident from the present findings that genetic relationship and relative contribution of the attributes changed little in relation to seed size. In general, higher number of effective pods with high seed mass should be included in the selection criterion for maximization of seed yield in chickpea. Katiyar (1981) had also suggested similar selection scheme for betterment of seed yield in this crop. Negative indirect effect of seed weight in G III indicates that breeding for much larger seeds may not be helpful in increasing its productivity. Hence, much attention should be paid on medium bold seeds. Days to flowering and maturity can not be ignored in sub-tropical climate, which directly influence the pod setting and proper seed development. Hence, emphasis should be on fast growing genotypes with early in flowering and maturity.

Table 7. Mean performance of seed yield and its components with source of material

Group I									
Genotype	Source	D/F	D/M	Plant height (cm)	Primary branches plant <sup>-1</sup>	Pods plant <sup>-1</sup>	Seeds pod <sup>-1</sup>	100-seed weight (g)	Seed yield (g)
H 95-122	Haryana	57	98	49.80	2.20	44.32	1.48	13.43	7.84
PBG-78	Punjab	58	107	52.50	2.13	34.67	1.59	13.24	5.58
CSJD-901	Rajasthan	53	99	43.87	2.40	31.67	1.41	13.55	4.96
GCP 9504	Rajasthan	57	106	46.27	2.40	38.00	1.57	13.59	6.72
C-235	Punjab	61	105	49.13	2.47	48.00	1.56	13.86	7.42
CSJD-869	Rajasthan	55	103	48.20	2.47	32.67	1.40	13.92	5.31
Phule G-95007	Maharashtra	54	108	53.87	2.80	43.00	1.18	13.90	6.42

FG-559	Punjab	57	105	51.67	2.67	39.33	1.78	14.22	9.29
ICCV-97017	Andhra Pradesh	52	103	49.53	2.87	46.67	1.70	14.26	8.55
FG-712	Punjab	58	102	55.00	2.60	35.00	1.77	14.82	6.96
IG-338	Madhya Pradesh	53	102	44.53	2.53	39.00	1.68	14.83	8.73
H 95-25	Haryana	70	102	44.33	3.13	83.67	1.34	15.47	14.79
ICCV-97001	Andhra Pradesh	62	103	46.80	2.80	37.00	1.65	15.51	7.42
ICCV-97031	Andhra Pradesh	49	108	39.40	2.47	51.67	1.60	15.78	9.70
PG 97-6	Uttar Pradesh	52	98	58.07	2.60	34.67	1.65	16.42	7.49
H 95-37	Haryana	69	104	44.13	2.80	68.67	1.30	16.64	12.33
ICCV-93118	Andhra Pradesh	61	109	51.73	2.73	45.00	1.30	16.76	8.60
BGD-112	Karnataka	63	118	52.93	2.67	26.33	1.61	16.83	5.97
RSG-964	Rajasthan	53	98	44.20	2.47	33.67	1.57	17.12	7.34
Vijay (C)	Maharashtra	49	105	44.67	3.53	26.33	1.37	17.17	5.72
JG-74 (C)	Madhya Pradesh	57	97	47.87	2.00	42.00	1.14	18.04	7.94
GCP-9516	Rajasthan	56	99	49.53	2.67	36.67	1.56	18.18	8.26
mean		57.09	103.60	48.55	2.61	41.73	1.51	15.34	7.88
S.Ed		0.488	0.534	0.001	0.008	0.018	0.009	0.108	0.041
CV %		1.047	0.631	0.001	0.393	0.053	0.782	0.863	0.637
CD <sub>5%</sub>		0.956	1.047	0.002	0.016	0.035	0.018	0.212	0.08

**Group II**

Genotype	Source	D/F	D/M	Plant height (cm)	Primary branches plant <sup>-1</sup>	Pods plant <sup>-1</sup>	Seeds pod <sup>-1</sup>	100-seed weight (g)	Seed yield (g)
ICCV-97033	Andhra Pradesh	62	107	47.07	2.33	27.00	1.42	19.31	7.30
H 95-30	Haryana	67	102	48.73	2.73	56.33	1.60	19.36	12.19
BGD-109	Karnataka	56	105	49.13	2.47	46.33	1.37	19.47	8.52
GL-96047	Punjab	64	101	55.27	2.87	35.33	1.44	19.64	8.43
Phule G-93009	Maharashtra	52	107	51.80	2.47	30.33	1.48	19.66	7.08
ICCV-97038	Andhra Pradesh	44	106	40.47	3.33	44.33	1.40	20.02	8.96
ICCV-97016	Andhra Pradesh	58	109	49.07	3.00	36.33	1.14	20.10	7.99
GL-96004	Punjab	66	101	52.80	3.00	50.67	1.50	20.14	11.98
ICCV-97024	Andhra Pradesh	55	105	50.40	2.53	27.67	1.49	20.36	6.89
ICCV-97039	Andhra Pradesh	54	104	44.33	2.60	38.33	1.24	20.59	8.20
BG-391 (C)	New Delhi	65	102	50.07	2.67	50.00	1.30	21.86	12.28
ICCV-97030	Andhra Pradesh	59	103	42.93	2.93	53.33	1.25	21.84	11.45
CG-938	Chhattisgarh	59	102	39.80	2.87	35.33	1.11	22.12	8.14
GNG-1275	Rajasthan	64	104	53.13	2.87	47.33	1.19	22.60	11.01
RSG-966	Rajasthan	59	103	55.00	2.33	35.67	1.23	22.89	9.59
ICCV-97034	Andhra Pradesh	61	112	43.53	3.87	31.00	1.35	22.97	8.87
IPC 96-27	Uttar Pradesh	63	103	57.00	2.93	44.67	1.49	22.98	12.63
BGM-528	New Delhi	68	100	55.67	3.07	60.33	1.21	23.21	14.93
JSC-3 (C)	Madhya Pradesh	62	106	45.87	2.93	42.00	1.34	23.23	9.93
mean		59.895	104.316	48.793	2.779	41.701	1.345	21.177	9.809
S.Ed.		0.488	0.459	0.009	0.010	0.027	0.013	0.088	0.015
CV %		1.047	0.539	0.025	0.451	0.079	0.222	0.507	0.193
CD <sub>5%</sub>		0.956	0.899	0.018	0.019	0.005	0.025	0.172	0.029

**Group III**

Genotype	Source	D/F	D/M	Plant height (cm)	Primary branches plant <sup>-1</sup>	Pods plant <sup>-1</sup>	Seeds pod <sup>-1</sup>	100-seed weight (g)	Seed yield (g)
BGD-72 (C)	Karnataka	63	104	50.13	2.40	46.00	1.23	23.82	12.25
GNG-469	Rajasthan	61	102	55.07	2.60	45.00	1.19	24.07	11.36
ICCV-97032	Andhra Pradesh	56	110	47.87	3.00	34.00	1.41	27.48	9.94
IPC 97-1	Uttar Pradesh	63	111	59.20	2.47	34.00	1.41	24.25	9.16
BGM-524	New Delhi	59	110	54.93	3.00	50.33	1.19	24.58	14.49
ICCV-95138	Andhra Pradesh	57	106	48.33	2.20	18.00	1.29	25.05	5.56
BG-256 (C)	New Delhi	63	103	50.07	2.73	49.33	1.28	25.33	13.92
BGD-115	Karnataka	66	101	52.13	2.93	59.67	1.27	25.71	18.01
IPC 96-46	Uttar Pradesh	58	109	59.40	2.53	26.33	1.30	25.81	8.03
BGD-116	Karnataka	65	103	51.60	2.80	62.67	1.17	26.91	18.60
KGDB-1178	Uttar Pradesh	64	105	49.13	2.87	41.67	1.27	27.39	12.54
KGDM-1181	Uttar Pradesh	56	99	58.00	2.80	49.67	1.54	27.63	16.46
mean		60.920	105.300	52.988	2.694	43.056	1.296	25.670	12.526
S.Ed.		0.320	0.320	0.030	0.137	0.001	0.006	1.349	0.014
CV %		0.640	0.370	0.071	6.209	0.001	0.572	6.438	0.141
CD <sub>5%</sub>		-	-	-	-	-	-	-	-

Based on *per se* performance superior genotypes like BGD-116 and BGD-115 for high number of pods, seed yield and bold seed size; H 95-25 and BGM-528 for high number of pods; Vijay, JG-74, RSG-964 for early flowering could be considered in chickpea improvement programme.

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