Electronic Journal of Plant Breeding, 5(2): 260-267 (June 2014)
ISSN 0975-928X

Research Note

Selection strategies to assess the promising kabuli chickpea promising lines under normal and heat stress environments

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(Received: 14 Mar 2014; Accepted: 08 Apr 2014)

Abstract
The present study was carried out with 12 promising kabuli chickpea lines sown normal sown and late sown environments. High PCV and GCV was accounted for the traits seed yield per plant, number of effective pods per plant, number of total pods per plant, seed size and harvest index in timely and late sown environments. Flower initiation (days) and 50 % flowering (days) noted for high heritability along with high genetic advance as percentage of mean. Positive and significant correlation of seed yield per plant was found with harvest index, number of total pods per plant, number of effective pods per plant, seed size and biological yield per plant under both conditions. Path coefficient analysis revealed that highest direct effect on seed yield was contributed by number of effective pods per plant. Based on minimum yield reduction percentage KAK 2, JGK 2, ICCV 07311 and ICCV 06301 have been identified as heat tolerant lines. The potential for indirect selection for heat stress tolerance using these associated characters may be useful to the breeder to formulate appropriate breeding plans for selection of the genotype which tolerate high temperature conditions.

Keywords: Kabuli Chickpea, correlation, heat Tolerance, path Coefficient

Chickpea (*Cicer arietinum* L.) family Leguminosae, is a self pollinated diploid (2n = 2x = 16) food legume originated in Turkey. In India, the total area under chickpea is 9.01 m ha with 7.58 m t production. Total area in M.P. reached 3.04 m ha with 3.29 m t production with productivity of 1082 kg/ha (FAOSTAT 2013-14). In India chickpea have been exposed to high temperature stress in the growing season, mainly in reproductive phase. Chickpea production mostly occurs in residual soil moisture under rainfed conditions, where terminal drought and heat stresses are major limitations to chickpea grain yield (Summerfield *et al.,* 1990). The expansion of irrigated agriculture in northern India has led to the replacement of chickpea with wheat. As a result, area under chickpea has reduced from 3.2 to 1.0 m ha in Punjab, Haryana and Uttar Pradesh, while it increased from 2.6 to 4.3 m ha in central and southern states (Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka) (IIPR, AICRP on Chickpea). Breeding efforts have contributed to improve yield potential regional adaptation through resistance to stresses, plant type and seed characteristics. Heat stress is major problem to chickpea production under warm environments. Changes in seasonal temperature affect the grain yield, mainly through phenological development processes. Winter crops like chickpea are highly vulnerable to high temperature during the reproductive stages. Chickpea growing season under rainfed conditions ranges from late-September to late-October, however there is a wide range in time of sowing under irrigated conditions that extends to the second fortnight of December. Grain yield reduction was observed at high temperature (≥35˚C) during flowering and pod development (Wang *et al.,* 2006) linked to reduced pollen viability. Irrigated chickpea in late sown conditions suffers heavy yield losses due to heat stress at the reproductive stage. Reproductive stages (flowering and podding) in chickpea are susceptible to changes in external environment and heat stress (Summerfield *et al.,* 1984; Wang *et al.,* 2006; Krishnamurthy *et al.,* 2011). Hence the present investigation was taken to assess the effect of sowing on the selection indices of kabuli chickpea.

The experimental material consisted of 12 high yielding promising kabuli chickpea lines. The lines were sown on 22nd Nov 2009 (timely sown) and 2nd Feb 2010 (late sown). In timely sown conditions the maximum and minimum temperature from sowing to flowering was 25.2^{0}C and 8.3^{0}C and from flowering to maturity maximum and minimum temperature was 28.1^{0}C and 11.26^{0}C (Table 1). In late sown conditions the maximum and minimum temp from sowing to flowering was 30.2^{0}C and 12.1^{0}C and from flowering to maturity maximum and minimum temperature was 39.4^{0}C and 20.3^{0}C (Table 1). The experiment was laid out in a randomized complete block design with two replications during Rabi 2009-10 under All India Coordinated Research Project on Chickpea, in the experimental field of Seed Breeding Farm, JNKVV Jabalpur (M.P). Size of each plot was kept 4.0 x 0.90 m, with 2 rows of 4 m length. Row to row distance 45 cm and plant to plant spacing was 10 cm. Observations were recorded on 14 quantitative traits including four phenological traits. Statistical methods viz., Genetic variability (PCV, GCV), heritability, genetic advance, correlation analysis and path coefficient analysis were estimated as per the standard procedure.

Results and discussion

PCV and GCV**:** Estimates of various parameters for assessment of genetic variability (Table 2) *viz,* mean, range of variability, heritability, genetic advance and coefficient of variation were analyzed for the traits which are directly affecting the seed yield. A relative study on comparison of magnitude of PCV and GCV for different traits in case of timely and late sown kabuli chickpea interprets that the highest magnitude of phenotypic and genotypic coefficient of variation in normal sown kabuli chickpea (Table 2) was recorded for characters seed yield per plant followed by number of effective pods per plant, number of total pods per plant, seed size and harvest index (Singh *et al.*, 2001). The traits number of seeds per pod and biological yield was having moderate coefficient of variation.

Heritability and Genetic Advance**:** In timely sown and late sown kabuli lines (Table 2) flower initiation (days) and 50 % flower (days) has recorded high heritability along with high genetic advance as percentage of mean, moderate heritability with genetic advance in 100 seed weight, seed yield per plant in case of timely sown kabuli chickpea. It indicates that most likely the heritability is due to additive gene effects contributing these traits. Therefore direct selection is based on these phonological traits may be rewarding. These findings are in conformity with Babbar and Patel (2005) Krishnamurty *et al.* (2011) and Summerfield *et al.* (1984).

Correlation Coefficient**:** Genotypic correlation coefficient of seed yield per plant was studied with different yield contributing characters. In case of timely sown kabuli chickpea genotypes (Table 3) seed yield per plant showed positive and significant correlation with maturity (days), harvest index, number of secondary branches, plant height number of total, number of effective pods, seed size and biological yield per plant (Singh et al. 1999). Positive and significant mutual relationship have shown by phenological traits viz. flowering (days), 50% flowering (days), maturity (days) with number of primary number of secondary branches, plant height, number of total, number of effective pods per plant, number of seeds per pod, harvest index and biological yield per plant. While maturity (days) had positive association with plant height, seeds per pod and number of secondary branches. These findings expressed that high yielding lines are early maturing, has tall plant, more number of effective pods, more seed size and biomass of the plant but late maturing genotype has less seeds per pod.

In case of late sown kabuli lines (Table 3) seed yield per plant exhibited positive correlation with harvest index, biological yield, number of total, number of effective pods per plant, number of primary and secondary branches per plant, plant height, number of seeds per pod and seed size. The phenological traits *viz;* flower initiation (days), 50% flowering (days), pod initiation (days) had shown positive correlation with number of total and effective pods per plant, number of seeds per pod, seed size (Arshad *et al.,* 2004) whereas the trait maturity (days) has shown positive correlation with number of effective pods per plant and number of seeds per pod. According to these findings the lines with late flowering and maturity have more pods and more seeds per pod. It clearly indicates that early maturing lines are not exposed to higher temperature and will be less affected. Positive and significant correlation of seed yield per plant with effective pods per plant and seeds size should be considered in selection of heat tolerant genotypes (Saleem *et al.,* 2002).

Path coefficient analysis: Genotypic path analysis of different traits contributing to seed yield in timely sown kabuli lines showed (Table.4) that highest direct effect on seed yield per plant is expressed by 50% flowering (days), number of effective pods per plant, seeds per pod and plant height (Bakhsh *et al.,*1995), while maximum positive indirect effect on seed yield per plant was shown via flower initiation (days), harvest index and biological yield, attention should be given to these characters. The highest positive direct effect on seed yield per plant in case of late sown kabuli lines is shown by number of effective pods per plant, harvest index, biological yield and flower initiation (days) (Farshadfar and Farshadfar, 2008).

While, the maximum indirect effect is observed through plant height, number of total pods per plant and secondary branches.

Yield reduction percentage**:** Minimum yield reduction percentage (Table 5) was reported for lines KAK 2 (2.5 %) and JGK 2 (17.0%) followed by ICCV 07311 (27.2%), ICCV 06301 (34.7%). These lines found most promising in both the conditions (Table 6). Therefore, these lines are recommended for sowing in timely as well as late sown conditions (Devasirvatham *et al.,* 2010).

The present study conducted under high temperature conditions indicated that number of effective pods per plant, biological yield and harvest index had the maximum contribution in determining seed yield under heat stress in kabuli chickpea (Yadav *et al.,* 2001) Breeding strategies for improvement of yield potential in normal and late sown chickpea would aim on selection of plants having higher number of effective pods, high biological yield, more number of branches and harvest index along with earliness.

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Table 1. Day Temperature from sowing to maturity of timely (2009) and late (2010) sown kabuli lines

Day	Date	Max Tem p^{0}C	Min Temp^{0}C	Day	Date	Max Tem p^{0}C	Min Tem p^{0}C	Day	Date	Max Tem p^{0}C	Min Tem p^{0}C	Day	Date	Max Tem p^{0}C	Min Tem p^{0}C	Day	Date	Max Temp ^{0}C	Min Tem p^{0}C	Day	Date	Max Temp ^{0}C	Min Tem p^{0}C
Timely Sown:22nd Nov 2009												Late Sown : 2nd Feb 2010											
Month: November				Month: December				Month: January				Month: February				Month: March				Month: April			
1	22	23.3	6	10	1	26	6.9	41	1	20.2	3.5	72	1	27	11.5	100	1	31.7	12.2	132	1	38.9	23.6
2	23	24.2	6.8	11	2	27.2	6.4	42	2	21.2	2.9	73	2	28.2	13.4	101	2	34.7	12.9	133	2	37.6	18.7
3	24	25.2	6.7	12	3	27.2	7.4	43	3	22.7	3.9	74	3	22.7	12	102	3	34.8	13.7	134	3	38.5	23.9
4	25	25.7	7	13	4	27	7.2	45	5	22.6	4.5	75	4	26.2	12.4	103	4	33.2	14.5	135	4	38.2	19.1
5	26	27	7.8	14	5	26.2	8.4	46	6	19.8	2.5	76	5	25.2	7.6	104	5	33.2	20.1	136	5	38.2	16.9
6	27	27.2	7.9	15	6	26.2	8.4	47	7	20.8	2.8	77	6	25.7	6.6	105	6	33.2	15.5	137	6	38.4	17.1
7	28	27.6	7.9	16	7	28.2	9.9	48	8	21.2	2.5	78	7	28.7	9	**106**	**7**	**33.2**	**14**	138	7	39.7	17.1
8	29	26.8	7.4	17	8	29.2	13.9	49	9	23.2	4.4	79	8	31.7	9	107	8	30.2	13.6	139	8	40	18.1
9	30	25.8	7.9	18	9	29.2	12.5	**50**	**10**	**23.7**	**6.9**	80	9	31.2	9	108	9	30.8	12.1	140	9	40.2	18
				19	10	28.5	12.8	51	11	24.2	7.4	81	10	31.2	9	109	**10**	31.2	13.1	141	10	41.4	23.2
				20	12	28.8	13.8	52	12	24.2	9.5	82	11	32	16	110	11	32.2	17.1	142	11	40.8	21.1
				21	12	28.2	11	53	13	24.2	16	83	12	32.5	14	111	12	32.2	16.5	143	12	41.4	24.6
				22	13	28.2	10.4	54	14	24.6	13	84	13	32.5	13.6	112	13	32.7	18	144	13	41.2	23.1
				23	14	27.2	11.4	55	15	20.2	8.6	85	14	32.7	13.5	113	14	34.8	13.3	145	14	40.2	20.6
				24	15	27.2	12	56	16	17.2	7	86	15	32.7	14.5	114	15	36.2	14.1	146	15	41.2	18.6
				25	16	28.8	11.3	57	17	20.2	8	87	16	31.7	12.6	115	16	37.2	16.1	147	16	42.6	24.6
				26	17	29.2	13.5	58	18	21.8	7.2	88	17	28.7	18.5	116	17	37.2	15.1	148	17	43.4	20.6
				27	18	24.2	13.9	59	19	21.2	6.3	89	18	28.6	13	**117**	**18**	**37.8**	**15.6**	149	18	44.2	25.7
				28	19	25.7	11.4	60	20	21.7	7	90	19	27.2	9.1	118	19	36.2	15.3	150	19	44	27.6
				29	20	25.8	10.4	61	21	23.2	6.8	91	20	26.2	7.5	119	20	36.7	15.1	151	20	41.7	28
				30	21	25.7	9.6	62	22	23.2	7.8	92	21	27.4	6.6	121	21	37.2	15.1	152	21	40.4	28.1
				31	22	23	5.4	63	23	23.8	7.4	93	22	28.2	8.4	122	22	39.2	15.1	153	22	41.2	21.6
				32	23	21.4	4.9	64	24	25.2	7.6	94	23	28.7	9.2	123	23	40.7	18	154	23	40.7	23
				33	24	23.4	5.9	65	25	26.2	10	95	24	30	12.6	124	24	40.2	18.1	155	24	41.2	21.1
				34	25	25.4	7.8	66	26	25.4	8.8	96	25	31.2	15.6	125	25	39.6	17.2	156	25	40.2	23.2
				35	26	24.2	7.8	67	27	24.7	9.3	97	26	30.2	11.1	126	26	38.9	20.6	157	26	41.2	20.8
				36	27	25	7.4	68	28	24.8	9.8	98	27	30.2	11.1	127	27	39.2	21.7	158	27	41.9	23.2
				37	28	25.8	7.9	69	29	25.2	9.6	99	28	30.5	10.5	128	28	38.7	17.6	159	28	42.7	25
				38	29	25.4	8.9	70	30	26.2	11.4					129	29	39.2	19.2	160	29	42.4	26.2
				39	30	27	12.4	71	31	27.2	12.2					130	30	40.2	24.5	**161**	**30**	**42.7**	**28.7**
				40	**31**	**21.4**	**10.8**									131	31	39.7	21.3				

Max ^{o}C : Maximum day temperature Min^o C : Minimum day temperature
31st Dec 2009: Flower initiation (days) : Timely sown kabuli lines, 10th March 2010: Flower initiation (days) : Late sown kabuli lines
7th March2010 : Maturity (days) : Timely sown kabuli lines, 16th April 2010 : Maturity (days) in Late sown kabuli lines
18 March 2010 : Harvesting of Timely sown kabuli lines, 30 April 2010 : Harvesting of Late sown kabuli lines

Table 2. Genetic factor of variation for yield and its traits

Traits		Grand mean	Range		Coefficient of variation		h^2 (B) %	GA as % of mean
			Min.	Max.	PCV (%)	GCV (%)		
Flower initiation (days)	TS	50.0	41.0	63.5	16.31	15.54	90.8	40.50
	LS	39.3	36.0	48.0	8.69	7.88	82.2	34.72
50% flowering (days)	TS	55.5	47.0	67.5	14.02	13.39	91.2	46.35
	LS	43.6	39.5	52.5	8.33	7.03	71.2	42.23
Pod initiation (days)	TS	79.5	74.5	84.0	5.79	1.69	8.5	1.02
	LS	49.4	46.0	58.0	6.92	5.85	71.4	10.18
Maturity (days)	TS	110.5	106.5	113.5	3.03	1.01	11.2	0.70
	LS	79.6	73.5	83.0	5.90	2.32	15.5	1.88
Plant height (cm)	TS	48.6	40.2	58.2	13.33	8.60	40.4	11.27
	LS	26.7	21.0	33.2	17.47	5.04	0.83	2.99
Primary Branches	TS	3.27	2.80	5.4	36.43	20.79	-32.5	-24.43
	LS	2.3	2.0	2.6	11.29	6.06	28.8	6.70
Secondary Branches	TS	8.76	7.1	11.6	20.17	8.08	16.0	6.66
	LS	6.0	5.1	8.0	19.57	7.48	14.6	5.89
Total pods	TS	57.4	32.7	84.4	40.20	20.03	23.9	21.97
	LS	20.9	10.8	38.0	48.25	22.81	22.3	22.22
Effective pods	TS	43.6	21.3	69.0	47.19	23.99	41.8	38.53
	LS	16.0	7.6	35.0	60.61	33.72	40.9	29.65
Seeds/pods	TS	1.22	0.5	1.6	27.05	17.67	42.6	30.77
	LS	1.3	0.65	1.8	39.70	2.78	40.4	29.40
Bio. Yield (g)	TS	37.6	30.0	45.0	42.90	21.60	46.4	19.91
	LS	18.2	10.0	27.5	43.06	24.96	22.0	10.70
Seed size (g)	TS	28.7	20.0	37.0	39.90	20.01	52.8	26.28
	LS	28.2	19.8	37.3	57.59	23.99	50.1	21.10
Seed Yield (g)	TS	47.2	10.9	98.1	60.12	49.31	51.7	49.45
	LS	4.0	1.3	8.6	61.19	21.13	61.9	35.03
Harvest Index (%)	TS	37.7	26.1	54.3	28.81	20.72	55.6	14.63
	LS	20.8	7.9	40.2	52.32	21.45	16.8	18.11

TS- Timely sown, LS-Late Sown

Table 3. Correlation study of yield and its traits of timely sown (above diagonal) and late sown (below diagonal) kabuli chickpea lines

Traits	Flower initiation (days)	50% flowering (days)	Pod Initiation (days)	Maturity (days)	Plant Height (cm)	Primary branches	Secondary Branches	Total pods	Effec. pods	Seeds/ pod	Bio. Yield (g)	Seed size (g)	Harvest Index (%)	Seed yield (g)
Flower initiation (days)	1.0000	0.9883**	0.2811	0.3819	0.2491	0.2625	0.3437	0.3894	0.4514*	0.0140	0.2362	-0.1764	0.3966	-0.1293
50% flowering (days)	0.9167**	1.0000	0.2978	0.4617*	0.3043	0.3009	0.3790	0.4230*	0.4817*	0.0905	0.3274	-0.1759	0.4481	-0.0926
Pod Initiation (days)	0.9459**	0.8926**	1.0000	0.0865	0.4473*	-0.2253	0.0781	-0.1230	-0.0629	0.0322	-0.0588	-0.1486	-0.2554	-0.1178
Maturity (days)	0.5891**	0.4660*	0.6186**	1.0000	0.2213	0.1992	0.5074*	0.3826	0.3983	0.2346	0.6212**	-0.1342	0.3253	0.0976
Plant Height (cm)	0.3650	0.4014*	-0.3371	-0.4390	1.0000	0.1883	0.4953*	0.2210	0.2534	-0.1658	0.4210*	0.4817*	0.2564	0.3948
Primary branches	0.5634**	-0.6105	-0.5496	-0.2552	0.5864*	1.0000	0.1111	0.4691*	0.4495*	0.1007	0.4329*	0.0769	0.4131*	-0.0312
Secondary Branches	-0.2148	0.1948	-0.0326	0.4146*	0.1146	0.5920**	1.0000	0.3874	0.4036	0.1108	0.4447*	0.0419	0.4422*	0.2773
Total pods	0.1312	0.1618	0.0399	-0.0187	0.0044	0.1404	0.3473	1.0000	0.9821**	-0.2241	0.6487**	-0.0870	0.7464**	0.1125
Effective pods	0.5130**	0.2441	0.2402	-0.0088	-0.0794	-0.0248	0.2842	0.9708**	1.0000	-0.2357	0.6146**	-0.1231	0.7246**	0.4328*
Seed/Pods	0.0551	0.0014	0.1458	0.0161	0.2154	0.1176	0.1009	0.0088	0.1282	1.0000	0.0140	0.3538	0.2423	-0.0518
Bio Yield (g)	-0.0888	-0.0660	0.1352	0.1877	0.1616	0.2811	0.3245	0.2568	0.1943	0.1458	1.0000	0.1848	0.4667*	0.4924*
Seed size	0.0285	0.0581	0.0304	-0.2054	-0.1885	0.1101	0.0466	0.2289	0.1494	-0.0218	0.3053	1.0000	0.4287*	0.4637*
Harvest Index (%)	0.5661**	-0.3111	-0.3343	-0.3286	0.2425	0.5008**	0.4246*	0.4244*	0.3671	0.0384	0.3841	0.0620	1.0000	0.1537
Seed Yield (g)	-0.3256	-0.2932	-0.3253	-0.4310	0.3346	0.4524*	0.3931	0.4837*	0.4614*	0.2584	0.6031**	0.0467	0.8458***	1.0000

TS- Timely sown, LS-Late Sown

Table 4. Path coefficient analysis of timely and late sown kabuli chickpea lines

Traits		Flower initiation (days)	50% flowering (days)	Pod Initiation (days)	Maturity (days)	Plant Height (cm)	Primary branches	Secondary Branches	Total Pods	Effec. Pods	Seeds/ pod	Bio. Yield (g)	Seed size (g)	Harvest Index (%)
Flower initiation	TS	1.6432	1.6239	0.4619	0.6276	0.4094	0.4313	0.5647	0.6398	0.7418	0.0230	0.3882	-0.2898	0.6517
(days)	LS	-0.6870	-0.6297	-0.6498	-0.4047	0.2507	0.3871	0.1475	-0.0901	-0.1463	-0.0379	0.0610	-0.0196	0.1828
50% flowering	TS	2.0749	-2.0996	-0.6252	0.9694	-0.6389	-0.6318	-0.7957	-0.8881	-1.0113	-0.1900	0.6874	0.3694	0.9407
(days)	LS	0.2439	0.2661	0.2375	0.1240	-0.1068	-0.1624	-0.0518	0.0430	0.0649	0.0004	-0.0176	0.0154	-0.0828
Pod initiation	TS	-0.0123	0.0131	-0.0439	-0.0038	-0.0065	0.0099	-0.0034	0.0054	0.0028	-0.0014	0.0024	0.0065	0.0112
(days)	LS	0.2734	0.1636	0.1833	0.1134	-0.0618	-0.1008	-0.0507	0.0283	0.0440	0.0267	-0.0248	0.0056	-0.0613
Maturity (days)	TS	-0.0758	0.0917	0.0172	-0.1986	0.0439	-0.0395	-0.1007	-0.0760	0.0791	-0.0466	0.1233	0.0266	-0.0646
	LS	0.0604	0.0478	0.0635	0.1026	0.0450	-0.0262	-0.0121	-0.0070	-0.0001	0.0017	-0.0398	-0.0211	-0.0337
Plant Height	TS	0.0850	0.1038	0.0503	0.0755	0.3412	0.0642	0.1690	0.0754	0.0865	-0.0566	0.1436	0.1643	0.0875
(cm)	LS	-0.0551	0.0606	-0.0509	-0.0662	0.1509	0.1885	0.0173	-0.0082	-0.0120	0.0325	0.0244	-0.0284	0.0366
Primary	TS	-0.0564	-0.0646	0.0484	-0.0428	-0.0404	-02148	0.0239	-0.1008	-0.0965	-0.0216	0.0930	0.0165	0.0887
branches	LS	0.0946	0.1025	0.0923	0.0429	-0.0985	0.1679	-0.0994	-0.0236	-0.0042	-0.0198	-0.0472	-0.0185	-0.0841
Secondary	TS	0.0047	0.0051	0.0011	0.0069	0.0067	0.0015	0.0316	0.0053	0.0055	0.00015	0.0060	0.0006	0.0060
Branches	LS	0.0051	0.0046	0.0066	0.0028	0.0027	-0.0141	-0.0238	0.0083	-0.0068	-0.0024	-0.0077	-0.0011	-0.0101
Total pods	TS	-0.8713	-0.9465	0.2753	-0.8562	-0.4946	-1.0498	-08668	-2.2377	2.1976	0.5014	1.4516	0.1946	-1.6703
	LS	-0.0211	-0.0260	-0.0248	0.0109	0.0088	-0.0226	-0.0558	-0.1607	-0.1560	-0.0014	-0.0413	-0.0368	-0.0682
Effective Pods	TS	0.7027	0.7498	-0.0978	0.6201	0.3944	0.6997	0.6283	1.5287	1.5567	-0.3669	0.9567	-0.1917	1.1280
	LS	0.0726	0.0831	-0.0818	-0.0003	-0.0270	0.0085	0.0968	0.3307	0.3407	0.0437	0.0662	0.0509	0.1250
Seeds/pods	TS	-0.0017	-0.0113	-0.0040	-0.0292	0.0206	-0.0125	-0.0138	0.0279	0.0293	-0.1245	0.0017	0.0441	0.0302
	LS	0.0075	0.0002	-0.0197	0.0022	0.0291	0.0159	-0.0136	0.0012	0.0173	0.1352	0.0197	-0.0029	0.0052
Bio. Yield (g)	TS	0.2420	0.3353	-0.0571	0.6362	0.4312	0.4434	0.4554	0.6644	0.6295	-0.0144	1.0242	0.1893	0.4780
	LS	-0.0315	-0.0234	-0.0480	-0.1377	0.0574	0.0998	0.1152	0.0912	0.0690	0.0518	0.3551	0.1084	0.1364
Seed size (g)	TS	0.0501	0.0499	0.0422	0.0381	-0.1367	0.0218	-0.0119	0.0247	0.0350	0.1004	-0.0525	-0.2838	-0.0082
	LS	-0.0014	-0.0028	-0.0015	0.0100	0.0092	-0.0054	-0.0023	0.0112	0.0073	0.0011	0.0149	-0.0488	-0.0030
Harvest Index	TS	0.2356	0.2661	-0.1517	0.1932	0.1523	0.2453	0.2626	0.4433	0.4304	0.1439	02772	0.0171	0.5940
(%)	LS	-0.1871	-0.2350	-0.2350	-0.2310	0.1705	0.3520	0.2985	0.2983	0.2581	0.0270	0.2700	0.0436	0.7030

TS- Timely sown, LS-Late Sown

Table 5. Average of different traits under timely and late sown conditions in kabuli chickpea lines

Entries	Maturity (days)		No. of total pods		No. of Effective pods		Seed size (g)		Biological yield per plant (g)		Seed yield per plant (g)		Seed Yield reduction (%)
	Timely	Late	Timely	Late	Timely	Late	Timely	Late	Timely	Late	Timely	Late	
ICCV2	113	78	62.8	16.6	47.5	11.5	20.0	37.1	40.0	10.0	13.8	2.4	82.6
ICCV06301	**108**	**77**	**59.6**	**38.6**	**38.4**	**27.6**	**30.4**	**30.1**	36.0	**27.5**	**14.7**	**9.6**	**34.7**
ICCV06302	109	78	32.7	22.3	21.3	16.7	32.8	24.9	**30.5**	15.5	10.9	4.3	60.6
ICCV06306	111	83	74.0	16.0	57.9	12.5	33.1	19.9	40.5	20.0	22.9	3.6	84.3
ICCV07311	**110**	**74**	**65.0**	**38.6**	**50.4**	**43.3**	**31.0**	**28.9**	34.5	**15.5**	**55.5**	**40.4**	**27.2**
ICCV07313	114	73	42.1	16.6	32.1	10.0	26.4	20.2	**39.0**	17.0	72.8	3.2	95.6
IPC16216	113	85	84.4	38.0	69.0	35.0	20.1	20.0	42.5	16.5	22.6	3.0	86.7
JGK1	109	82	62.3	15.1	46.9	12.1	28.2	20.3	45.0	15.0	98.1	4.4	95.5
JGK2	**107**	**81**	**70.6**	**51.6**	**59.7**	**48.5**	**29.5**	**22.5**	37.5	**15.0**	**48.1**	**39.9**	**17.0**
KAK2	**106**	**79**	**61.9**	**44.6**	**52.0**	**48.6**	**27.3**	**22.6**	**30.0**	**25.0**	**60.2**	**58.7**	**2.5**
LBeG-11	110	82	42.0	10.8	31.8	7.6	37.0	20.2	**37.0**	16.5	64.8	1.3	98.0
Vihar	113	80	62.4	19.1	49.2	10.9	29.1	27.9	39.5	25.5	72.3	3.9	94.6