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Selection indices for higher seed yield in rainfed and irrigated chickpea (*Cicer arietinum* L.)

SHUDHANSHU PANDEY, DEVENDRA PAYASI, S.K. NAIR AND R.L. PANDEY

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SUMMARY

Thirty genotypes of chickpea (*Cicer arietinum* L.) including two standard checks were laid out in randomized block design with three replications in both rainfed and irrigated situations separately, during winter 2001. Selection indices based on discriminent function was used to determine the phenotypic worth of different component characters. The selection indices clearly indicated that selection criterion for higher seed yield under rainfed and irrigated condition may be similar. Higher number of pods per plant had shown the highest relative efficiency over straight selection for seed yield. For higher selection efficiency a character combination of pods per plant, seed yield per plant and days to flowering/days to maturity had considerable genetic gain over straight selection. Days to 50 per cent flowering under rainfed and days to maturity under irrigated condition were found important trait.

Key words : Selection indices, Chickpea, Relative efficiency, Genetic advance

Chickpea (*Cicer arietinum* L.) is a native of Indian subcontinent and Central Asia. On global basis it is the third important pulse crop with an area of 9.5 million hectare with production of 8.5 million tonnes and its productivity 700 kg ha^{-1} (Kharakwal, 2002). India has a distinction of being world's largest producer of chickpea and contributes 67 per cent in area and 70 per cent of corresponding production. Amaizongly, its productivity is only 806 kg ha^{-1} (Ali and Kumar, 2001). The reason being it is cultivated under biotic and abiotic stresses, notably more than 80 per cent the crop is grown under rainfed conditions. In Chhattisgarh state cultivation of chickpea is limited. Chickpea genotypes generally show differential response to stress and non-stress conditions. Moisture stress constitutes the major production constraint in stabilizing the chickpea production. Hence, it is imperative to initiate systematic breeding programme to develop varieties suitable for rainfed and irrigated condition separately in Chhattisgarh. In view of the above, the present study was an attempt to develop suitable selection indices based on component approach for maximization of seed yield.

MATERIALS AND METHODS

The experimental material comprised of 30 genotypes including annigeri-1 and ICC-4958 as standard checks. The experiment was laid out in a randomized complete block design with three replications under two conditions *viz.,.*, rainfed (stress) and irrigated (non-stress) separately. Each genotype was planted in two rows of four meter long and 30 cm apart. A light irrigation was applied to both experiments to ensure uniform seed germination and better establishment of seedlings. An additional irrigation was applied at 40 days after sowing to one set of experiment called as irrigated (non-stress). Other agronomical practices were adopted uniformly in both sets of experiment. Observations on plant and seed characters were recorded on five competitive plants randomly selected at appropriate stage. The characters observed were: days to 50 per cent flowering, plant height, primary branches plant^{-1}, secondary branches plant^{-1}, pod bearing length, days to maturity, pods plant^{-1}, seeds pod^{-1}, biological yield plant^{-1}, seed yield plant^{-1} and 100 seed weight. The selection indices were constructed by solving the equations suggested by Robinson *et al.* (1951).

The indices were developed individually for each component character as well as yield plant^{-1}, in combination with two or more characters along with seed yield plant^{-1}. The expected genetic advance of these indices was expressed as per cent of genetic advance obtained from the selection of yield only.

RESULTS AND DISCUSSION

Seed yield is a complex entity associated with many contributing traits, which are interrelated among themselves. The interdependency of contributing traits affects the selection criteria. Selection indices based on

Correspondence to:
DEVENDRA PAYASI, Barwale Foundation, HYDERABAD (A.P.) INDIA
Authors' affiliations:
SHUDHANSHU PANDEY, S.K. NAIR AND R.L. PANDEY, Indira Gandhi Krishi Vishwa Vidyalaya, RAIPUR (C.G.) INDIA

Table 1 : Discriminate function for seed yield and their expected genetic gain (%) over straight selection in chickpea under rainfed situation

Sr. No.	Function	Bi values	Expected genetic advance	Expected gain (%) over straight selection
1.	b_1x_1	0.93	7.99	43.31
2.	b_2x_2	0.67	5.22	28.29
3.	b_3x_3	0.42	0.49	2.66
4.	b_4x_4	0.12	0.30	1.63
5.	b_5x_5	0.70	3.37	18.27
6.	b_6x_6	0.88	7.61	41.25
7.	b_7x_7	0.97	31.40	170.19
8.	b_8x_8	0.94	0.47	2.55
9.	b_9x_9	0.99	13.44	72.80
10.	$b_{10}x_{10}$	0.94	5.42	100
11.	$b_7x_7+ b_1x_1$	0.98, 0.95	32.19	174.47
12.	$b_7x_7+ b_2x_2$	0.97, 0.64	31.80	172.36
13.	$b_7x_7+ b_3x_3$	0.97,0.11	31.33	169.81
14.	$b_7x_7+ b_4x_4$	0.98,-0.05	31.60	171.27
15.	$b_7x_7+ b_5x_5$	0.97,0.68	31.24	169.32
16.	$b_7x_7+ b_6x_6$	0.97,0.88	31.49	170.68
17.	$b_7x_7+ b_8x_8$	0.98,0.79	31.45	170.46
18.	$b_7x_7+ b_9x_9$	0.97,0.98	29.86	161.84
19.	$b_7x_7+ b_{10}x_{10}$	0.99,0.83	34.88	189.05
20.	$b_7x_7+ b_{10}x_{10}+b_1x_1$	0.99,0.89,0.96	35.61	193.01
21.	$b_7x_7+ b_{10}x_{10}+b_2x_2$	0.98,0.91,0.65	35.47	192.25
22.	$b_7x_7+ b_{10}x_{10}+b_3x_3$	0.98,0.88,0.27	34.86	188.94
23.	$b_7x_7+ b_{10}x_{10}+b_4x_4$	0.98,1.01,-0.18	35.27	191.16
24.	$b_7x_7+ b_{10}x_{10}+b_5x_5$	0.98,0.92,0.71	34.87	188.99
25.	$b_7x_7+ b_{10}x_{10}+b_6x_6$	0.98,0.85,0.89	34.95	189.43
26.	$b_7x_7+ b_{10}x_{10}+b_8x_8$	0.99,0.83,0.50	34.93	189.32
27.	$b_7x_7+ b_{10}x_{10}+b_9x_9$	1.02,0.67,1.07	34.47	186.83
28.	$b_7x_7+ b_{10}x_{10}+b_1x_1 + b_2x_2$	0.98,0.93,1.01,0.64	36.47	197.67
29.	$b_7x_7+ b_{10}x_{10}+b_1x_1 + b_3x_3$	0.98,0.89,0.95,0.44	35.56	192.74
30.	$b_7x_7+ b_{10}x_{10}+b_1x_1 + b_4x_4$	0.98,0.99,0.98,0.05	36.01	195.17
31.	$b_7x_7+ b_{10}x_{10}+b_1x_1 + b_5x_5$	0.97,0.95,0.98,0.67	35.76	193.82
32.	$b_7x_7+ b_{10}x_{10}+b_1x_1 + b_6x_6$	0.98,0.88,1.08,0.80	37.07	200.92
33.	$b_7x_7+ b_{10}x_{10}+b_1x_1 + b_8x_8$	0.99,0.85,0.95,0.32	35.62	193.06
34.	$b_7x_7+ b_{10}x_{10}+b_1x_1 + b_9x_9$	1.02,0.68,0.94,1.08	35.79	193.98
35.	$b_7x_7+ b_{10}x_{10}+ b_1x_1 + b_6x_6 + b_2x_2$	0.97,0.96,1.12,0.81,0.65	38.13	206.66
36.	$b_7x_7+ b_{10}x_{10}+ b_1x_1 + b_6x_6 + b_3x_3$	0.97,0.93,1.09,0.78,0.27	36.99	200.49
37.	$b_7x_7+ b_{10}x_{10}+ b_1x_1 + b_6x_6 + b_4x_4$	0.98,0.99,1.10,0.81,0.15	37.51	203.30
38.	$b_7x_7+ b_{10}x_{10}+ b_1x_1 + b_6x_6 + b_5x_5$	0.97,0.97,1.08,0.82,0.68	37.38	202.60
39.	$b_7x_7+ b_{10}x_{10}+ b_1x_1 + b_6x_6 + b_8x_8$	0.98,0.87,1.06,0.80,0.18	37.06	200.87
40.	$b_7x_7+ b_{10}x_{10}+ b_1x_1 + b_6x_6 + b_9x_9$	0.99,0.78,1.06,0.81,1.04	37.60	203.79
41.	$b_7x_7+ b_{10}x_{10}+ b_1x_1 + b_6x_6 + b_2x_2 +b_3x_3$	0.97,0.97,1.13,0.80,0.66,0.90	38.10	206.50
42.	$b_7x_7+ b_{10}x_{10}+ b_1x_1 + b_6x_6 + b_2x_2 +b_4x_4$	0.97,1.10,1.14,0.82,0.63,0.32	38.55	208.94

Table 1 contd…

Table 1 contd….

43	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_5x_5$	0.97,1.00,1.11,0.83,0.60,0.92	38.90	210.84
44.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_8x_8$	0.98,0.94,1.09,0.82,0.64,-0.73	38.10	206.50
45.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9$	0.99,0.84,1.10,0.82,0.67,1.05	38.97	211.22
46.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_3x_3$	0.99,0.85,1.10,0.81,0.67,1.05, 0.81	39.07	211.76
47.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_4x_4$	0.99,0.95,1.11,0.83,0.64,1.07, -0.30	39.56	214.42
48.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_5x_5$	0.99,0.86,1.08,0.84,0.64,1.06, 0.86	40.27	218.26
49.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_8x_8$	0.94,1.18,1.11,0.79,0.64,0.88, -2.19	38.85	210.57
50.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_5x_5 + b_3x_3$	0.99,0.89,1.09,0.83,0.64,1.05, 0.86,1.02	40.41	219.02
51.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_5x_5 + b_4x_4$	0.99,0.98,1.09,0.86,0.59,1.07, 0.94-0.30	40.86	221.46
52.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_5x_5 + b_8x_8$	0.92,1.29,1.10,0.80,0.60,0.85, 0.90,-2.91	40.14	217.56
53.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_5x_5 + b_4x_4 + b_3x_3$	0.99,1.02,1.10,0.85,1.06,0.93, -0.10,1.12	40.01	222.27
54.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_5x_5 + b_4x_4 + b_8x_8$	0.97,1.13,1.09,0.84,0.57,0.99, 0.95,-0.001,-0.44	40.72	220.70
55.	$b_7x_7 + b_{10}x_{10} + b_1x_1 + b_6x_6 + b_2x_2 + b_9x_9 + b_5x_5 + b_4x_4 + b_3x_3 + b_8x_8$	0.96,1.16,1.11,0.83,0.57,0.99, 0.95,-0.07,1.04,-0.39	40.86	221.46

X_1 = Days to 50 % flowering, X_2 = Plant height (cm), X_3 = Primary branches plant^{-1}, X_4= Secondary branches,X_5 = Pod bearing length(cm) X_6 = Days to maturity, X_7 = Pods plant^{-1}, X_8 = Seeds pod^{-1}, X_9 = 100 seed weight, X_{10} = Seed yield plant^{-1}

discriminant function is one of the most sophisticated and efficient technique for plant breeders for selection of suitable plant type based on phenotypic worth of different component characters. Selection indices of different character combinations without yield were constructed to identify characters, which will be helpful in selection programme. Selection indices were constructed separately for stress and non-stress conditions to determine the selection criterion for such situation. The results are summarized in Table 1 and 2.

Rainfed condition: The expected genetic gain in straight selection for seed yield was merely 5.42 per cent (RE 100%) while, expected genetic gain was highest for number of pods plant^{-1} 31.40 per cent (RE 170.19) indicating that higher number of effective pods plant^{-1} was the most important component for obtaining high genetic gain for seed yield plant^{-1}. Other important traits were seed mass (13.44%) and days to 50 per cent flowering (7.99%). The Relative Efficiency over straight selection ranged up to 222.27 per cent when nine characters *viz.*, pods plant^{-1}, seed yield plant^{-1}, days to 50 per cent flowering, days to maturity, plant height, hundred seed weight, pod bearing length, primary and secondary branches plant^{-1} were included in a discriminate function. Two character combination-involving pods plant^{-1} and seed yield plant^{-1} showed maximum gain (RE-189.05%) over straight selection for seed yield. The pods plant^{-1} when considered individually was found most potent character (RE-170.19%) in its power of discrimination. Hence, this trait should be given top priority in an effective selection scheme.

The combination of three factors namely pods plant^{-1}, seed yield plant^{-1} and days to 50 per cent flowering gave the maximum relative efficiency (193.01%) followed by pods plant^{-1}, seed yield plant^{-1} and plant height (192.25%) and pods plant^{-1}, seed yield plant^{-1} and secondary branches (191.16%) over straight selection. The selection indices involving four characters pods plant^{-1}, seed yield plant^{-1}, days to 50 per cent flowering and maturity resulted RE up to 200.92 per cent. Another effective indices were combination of pods plant^{-1}, seed yield plant^{-1}, days to 50 per cent flowering and plant height with RE of 197.67 per cent.

The indices based on five characters combination involving pods plant^{-1}, seed yield plant^{-1}, days to 50 per cent flowering, days to maturity and plant height was considered an effective discriminate than any other combination having relative efficiency of 206.66 per cent and genetic gain of 38.13 per cent. The selection indices based on six characters combination of pods plant^{-1}, seed yield plant^{-1}, days to 50 per cent flowering, days to maturity, plant height and hundred seed weight gave the highest relative efficiency (211.22%) over straight selection. Selection indices based on seven characters gave maximum relative efficiency (218.26%) for pods plant^{-1}, seed yield plant^{-1}, days to 50 % flowering, plant height, hundred seed weight and pod bearing length. Selection indices based on eight characters gave highest relative efficiency (221.46%) for pods plant^{-1}, seed yield plant^{-1}, days to 50 per cent flowering, maturity, plant height, hundred seed weight, pod bearing length and secondary branches plant^{-1}.

Table 2 : Discriminate function for seed yield and their expected genetic gain (%) over straight selection in chickpea under irrigated situation

Sr. No.	Function	Bi Values	Expected genetic advance	Expected gain (%) over straight selection
1.	b_1x_1	0.96	8.45	33.38
2.	b_2x_2	0.59	7.83	30.93
3.	b_3x_3	0.31	0.30	1.19
4.	b_4x_4	0.46	1.77	6.99
5.	b_5x_5	0.31	1.96	7.74
6.	b_6x_6	0.91	8.10	31.99
7.	b_7x_7	0.80	23.73	93.73
8.	b_8x_8	0.98	0.61	2.41
9.	b_9x_9	0.99	14.23	56.21
10.	$b_{10}x_{10}$	0.75	3.95	100
11.	$b_7x_7+ b_1x_1$	0.80,0.95	24.88	98.28
12.	$b_7x_7+ b_2x_2$	0.81,0.60	25.60	101.12
13.	$b_7x_7+ b_3x_3$	0.77,-3.33	23.46	92.67
14.	$b_7x_7+ b_4x_4$	0.76,-0.66	22.72	89.74
15.	$b_7x_7+ b_5x_5$	0.81,0.24	24.90	98.36
16.	$b_7x_7+ b_6x_6$	0.80,1.02	26.29	103.84
17.	$b_7x_7+ b_8x_8$	0.80,1.87	24.05	94.99
18.	$b_7x_7+ b_9x_9$	0.77,0.82	21.51	84.96
19.	$b_7x_7+ b_{10}x_{10}$	0.83,0.30	25.13	99.26
20.	$b_7x_7+ b_{10}x_{10}+b_1x_1$	0.79,0.83,0.86	26.82	105.94
21.	$b_7x_7+ b_{10}x_{10}+b_2x_2$	0.82,0.64,0.62	28.20	111.39
22.	$b_7x_7+ b_{10}x_{10}+b_3x_3$	0.78,0.34,-4.12	23.32	92.11
23.	$b_7x_7+ b_{10}x_{10}+b_4x_4$	0.75,0.43,-0.34	20.98	82.87
24.	$b_7x_7+ b_{10}x_{10}+b_5x_5$	0.82,0.27,0.29	22.73	89.78
25.	$b_7x_7+ b_{10}x_{10}+b_6x_6$	0.79,0.82,0.96	28.40	112.18
26.	$b_7x_7+ b_{10}x_{10}+b_8x_8$	0.80,0.41,-0.53	22.93	90.57
27.	$b_7x_7+ b_{10}x_{10}+b_9x_9$	0.80,0.31,0.94	22.30	88.10
28.	$b_7x_7+ b_{10}x_{10}+b_6x_6 + b_1x_1$	0.77,1.26,1.15,0.64	30.90	122.10
29.	$b_7x_7+ b_{10}x_{10}+b_6x_6 + b_2x_2$	0.80,1.12,1.00,0.62	31.27	123.52
30.	$b_7x_7+ b_{10}x_{10}+b_6x_6 + b_3x_3$	0.77,0.80,0.95,-4.20	28.10	111.00
31.	$b_7x_7+ b_{10}x_{10}+b_6x_6 + b_4x_4$	0.74,0.90,0.91,-0.45	26.40	104.28
32.	$b_7x_7+ b_{10}x_{10}+b_6x_6 + b_5x_5$	0.80,0.69,0.99,0.49	28.42	112.26
33.	$b_7x_7+ b_{10}x_{10}+b_6x_6 + b_8x_8$	0.81,0.51,1.01,2.86	28.14	111.15
34.	$b_7x_7+ b_{10}x_{10}+b_6x_6 + b_9x_9$	0.77,0.80,0.99,0.85	27.01	106.70
35.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_1x_1$	0.77,1.57,1.78,0.64,0.66	32.89	129.92
36.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_3x_3$	0.76,1.07,1.00,0.56,-7.21	30.85	121.86
37.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_4x_4$	0.73,1.32,0.93,0.53,-1.15	29.67	117.20
38.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5$	0.80,0.93,1.05,0.63,0.79	32.90	129.96
39.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_8x_8$	0.83,0.66,1.08,0.67,4.56	31.40	124.03
40.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_9x_9$	0.77,1.11,1.03,0.66,0.86	31.00	122.45
41.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1$	0.78,1.34,1.22,0.64,0.95,0.68	35.35	139.63
42.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_3x_3$	0.77,0.87,1.05,0.57,0.86,-7.33	32.50	128.38

Table 2 contd..

Table 2 contd…

43	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_4x_4$	0.74,1.13,0.97,0.57,0.69,-0.98	30.90	122.06
44.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_8x_8$	0.82,0.69,1.08,0.66,0.76,2.33	32.71	129.20
45.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_9x_9$	0.79,0.90,1.07,0.66,0.80,0.92	32.91	129.99
46.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1+b_3x_3$	0.73,1.24,1.37,0.58,1.04,0.47, -8.50	34.93	137.97
47.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1+b_4x_4$	0.71,1.59,1.05,0.56,0.84,0.80, -1.13	34.22	135.17
48.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1 +b_8x_8$	0.82,0.78,1.24,0.71,0.93,0.79, 5.87	35.59	140.58
49.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1 +b_9x_9$	0.75,1.35,1.20,0.68,0.96,0.76, 0.83	35.77	141.29
50.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1+b_9x_9 +b_3x_3$	0.70,1.24,1.36,0.62,1.05,0.55, 0.83,-8.54	35.35	139.63
51.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1+b_9x_9 + b_4x_4$	0.70,1.56,1.06,0.58,0.85,0.82, 0.94,-1.10	35.05	138.45
52.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1+b_9x_9 +b_8x_8$	0.82,0.72,1.26,0.71,0.94,0.77, 1.03,5.87	35.91	141.84
53.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1+b_9x_9 +b_8x_8 + b_3x_3$	0.76,0.74,1.40,0.65,1.03,0.57, 0.99,4.71,-8.22	35.50	140.23
54.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1+b_9x_9 +b_8x_8 + b_4x_4$	0.77,0.94,1.11,0.61,0.83,0.84, 1.15,5.97,-1.18	35.02	138.33
55.	$b_7x_7+ b_{10}x_{10}+ b_6x_6 + b_2x_2 + b_5x_5 +b_1x_1+b_9x_9 +b_8x_8 + b_3x_3+b_4x_4$	0.74,0.81,1.30,0.58,0.97,0.64, 1.05,4.11,-6.90,-0.12	34.60	136.67

X_1 = Days to 50 % flowering, X_2 = Plant height (cm), X_3 = Primary branches plant^{-1}, X_4= Secondary branches,X_5 = Pod bearing length(cm)
X_6 = Days to maturity, X_7 = Pods plant^{-1}, X_8 = Seeds pod^{-1}, X_9 = 100 seed weight, X_{10} = Seed yield plant^{-1}

Maximum gain (40.01%) with highest RE of 222.27% over straight selection was obtained from nine characters combination involving pods plant^{-1}, seed yield plant^{-1}, days to 50 per cent flowering, days to maturity, plant height, hundred seed weight, pod bearing length, secondary and primary branches plant^{-1}. Undoubtedly, this character combination had shown maximum relative efficiency but there was no additional genetic gain for seed yield. It is a concluded from the present findings that expected genetic gain over straight selection for seed yield may up to 37.07 per cent with the relative efficiency of 200.92 per cent in four character combination of pods plant^{-1}, seed yield plant^{-1}, days to 50 per cent flowering and days to maturity. It is further revealed that number of effective pods alone has 31.04 per cent genetic gain over straight selection for seed yield and combination of these two characters as shown genetic gain of 34.88 per cent. This result further revealed that there was no much gain by involving more characters combination in selection indices. The best combination may be of pods plant^{-1} with seed yield plant^{-1} or pods plant^{-1}, seed yield plant^{-1}, days 50 to per cent flowering and days to maturity. It is well established that involving more characters will create complication in selection of desirable superior plants hence, most potential characters like higher number of effective pods, high seed mass, with early flowering and maturity should be considered in an effective selection scheme for betterment of seed yield in chickpea under rainfed situation which is more prevalent in India.

Irrigated condition:

Determination of yield components revealed that pods plant^{-1} had the higher relative efficiency (93.73%) with genetic gain of 23.73 per cent. In two characters combination the highest relative efficiency (103.84%) was obtained for pods plant^{-1} and days to maturity. The combination of three characters, gave the highest relative efficiency of 112.18 per cent for pods plant^{-1}, seed yield plant^{-1} and days to maturity. The selection indices involving four characters gave higher relative efficiency (123.52%) for pods plant^{-1}, seed yield plant^{-1}, days to maturity and plant height. In five characters combination the highest relative efficiency (129.96%) was for pods plant^{-1}, seed yield plant^{-1}, days to maturity, plant height and pod bearing length.

The selection indices based on six characters gave the highest relative efficiency (139.63%) for pods plant^{-1}, seed yield plant^{-1}, days to maturity, plant height, pod bearing length and days to 50 per cent flowering. Selection indices based on seven characters gave maximum relative efficiency of 141.29 per cent for pods plant^{-1}, seed yield plant^{-1}, days to maturity, plant height, pod bearing length, days to 50 per cent flowering and hundred seed weight. Selection indices based on eight characters gave the highest relative efficiency (141.84%) for pods plant^{-1}, seed yield plant^{-1}, days to maturity, plant height, pod bearing length, hundred seed weight and seeds pod^{-1}. Results further revealed that involving higher number of characters under irrigated condition was not found effective and there was no further gain for seed yield.

The most effective indices may include

The present findings clearly revealed that construction of selection indices involving more than one trait possessed greater efficiency as compare to straight selection of seed yield. The results further indicated the similar selection indices would be considered for rainfed as well as irrigated chickpea. It was also observed that relative efficiency and genetic gain were comparatively low in irrigated condition. This clearly indicates that application of water may be helpful for developmental characters hence, attention should be given on attributes directly contributing seed yield and are helpful in increasing the harvest index under irrigated condition. For better genetic gain at the most three to four characters may be considered while exercising selection for high seed yield.

		GA	RE
A.	Three characters in combination		
RF.	Pods per plant, seed yield and days to 50% flowering	35.61	193.01
I.	Pods per plant, seed yield and days to maturity	28.40	112.18
B.	Four characters in combination		
RF.	Pods per plant, seed yield, days to 50% flowering and maturity	37.07	200.92
I.	Pods per plant, seed yield, days to maturity and plant height	31.27	123.52
C.	Six characters in combination		
RF.	Pods per plant, seed yield, days to flowering, days to maturity, plant height and hundred seed weight	38.97	211.22
I.	Pods per plant, seed yield, days to maturity, plant height, pod bearing length and flowering	35.35	139.63

The results clearly showed that selection indices for more than one trait possessed greater efficiency as compared to straight selection for seed yield. Samal and Jagadev (1996) had also observed that the efficiency of indices increased with increasing number of characters. The mean predicted genetic advance and efficiency of groups of indices indicated that for constructing a selection index to select high yielding genotypes, yield should be indicated first followed by characters having higher heritability and genotypic correlation values. Gumber *et al.* (2000) had also indicated that a combination of four characters involving secondary branches per plant, harvest index, pods plant^{-1} and seed yield plant^{-1} in function gave the highest genetic gain in chickpea. It is true that inclusion of more number of component characters may create complication while exercising selection for higher seed yield. Pandey *et al.* (2003) had also emphasized that for maximization of seed yield under rainfed and irrigated conditions the higher selection efficiency was obtained for pods plant^{-1}, seed yield plant^{-1}, secondary branches plant^{-1}, seeds pod^{-1}, harvest index. In addition to this days to 50 per cent flowering and days to maturity were found to be important under rainfed and irrigated conditions, respectively.

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