Sardar Sunil Singh *et al*, International Journal of Advances in Agricultural Science and Technology,

Vol.1 Issue. 1, December- 2013, pg. 77-90 **ISSN: 2348-1358**

# Study of Genetic Diversity in Chickpea (*Cicer arietinum* L.)

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***ABSTRACT:*** ***The data obtained for thirteen characters namely days to 50% flowering, plant height (cm), number of primary branches, number of secondary branches, number of pod per plant, number of grain per pod, 100-seed weight (g), per cent infestation of pod borer, Score of wilt infestation, total protein (%), soluble protein (%) insoluble protein (%) and grain yield (Kg/ha) at three different locations viz. Dholi, Pusa (Samastipur) and Gaya for two consecutive years i.e. Rabi 2005-06 and 2006-07.High estimates of heritability coupled with high genetic advance were observed for yield contributing traits link number of secondary branches per plant, pods per plant and 100-seed weight indicating the preponderance of additive gene action; suggesting that selection pressure may be exercised in early generation. Grain yield (Kg/ha) was found to be associated significantly and positively with number of primary branches per plant and number of pods per plant across the six environments along with its high positive direct effects indicating the true***

 

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***relationship of these traits with grain yield. On the basis of genetic divergence study most divergent parents for number of primary branches per plant were IPC 2002-51, IPC 2000-33, IPC 2001-21, IPC 2003-37 and IPC 2002-71; for number of pods per plant were BG 362, BG 372, BG 256 and IPC 2003-51; for total protein were DCP 92-3, BG 2019, BG 256, IPC 2002-76 and IPC 2003-55 whereas for grain yield. IPC 2003-55, SAKI 9516, DCP 92-3 and IPC 2003-45 were observed most suitable.***

***Keywords: Sutability, Diversity,Chickpea, (Cicer arietinum L.)***

## INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the earliest grain crops cultivated by man. Even today, Chickpea continues to play an important role in agricultural system, ranking third after dry beans (*Phaseolus species*) and field pea (*Pissum sativum* L.) interms of world pulses production. It is a low input requiring crop, and fulfill over 70 per cent of its nitrogen requirements through symbiotic nitrogen fixation. Being a legume, it is particularly important to the farmers as rotation or second crop after cereals, often maturing in the driest and hottest part of the year. Around 95 per cent of total annual production (8.5 million tons) of chickpea occurs in Asia and Africa (FAO State 2006). Major chickpea production countries include India (65%), Pakistan (10%), Turkey (7%), Iran (3%), Myanmar (2%), Mexico and Austria (1.5%). South and South East Asia contributes about 81 per cent of world Chickpea production and India is the principal chickpea producing country with a share of 80 per cent in the region. Chickpea seed is a protein rich supplement to the cereal based diet, especially critical to the poor in the developing countries, where people can not afford animal protein or are vegetarians. Chickpea grain is relatively free from anti-nutritional factor, has high protein digestibility and riches in phosphorous and calcium than other pulse crops. It has importance in human food and animal feed, chickpea also plays an important roles in sustaining soil fertility by fixing up to 141 kg nitrogen per hectare (Rupela, 1987). Grain yield is a complex multigeneic group of characters with great genetic morph-physiological and pathological dependence. The heridetry potential of a cultivar/genotype depends on adaptability and yield security. Genetically, yield contributing attributes (i.e. yield components), their genetic nature and magnitude of association along with the cause and effects are responsible for realization of yield potential influence by changing

 

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edaphic, agro-climatic conditions. Thus, it is essential to gather information on this aspects to resolve and quantify their mode of contribution towards grain yield. The principal objectives of chickpea breeding programme aims an improvement in yield, reliability of performance, stability and adaptation over a wide array of environments and grain quality. Grain yield is a genetically established potentials to its components and realization of these components depends upon various other agro-environmental effects. The grain yield of chickpea plant is the photo-synthetic results of roots, stem, leaf and pods. All morphological and physiological properties that influence the yield are controlled by a complex genetic mechanism, which by nature can only be a complex multiplicative group of genes. The inherent yielding ability of chickpea may be expressed mainly through four components : number of primary branches, number of secondary branches, number of pods per plant and 100-seed weight. "Adaptability" and "Yielding security" are the factors contributing to achieve maximum yielding potential, through ecological tolerance of a cultivar in change adaphic, climatic and agronomic effects as well as its hereditary resistance to pathogens and insect pest. For successful exploitation of available genetic variability and in deciding the suitable breeding programme for genetic manipulation of chickpea crop involving spreading, semi-spreading and erect genotype, the knowledge of the type of gene effects involved in the expression of character is essential. High degree of yield potential can result from the combination of gene effects. Gamble (1962) reported that consistency of gene effects depends upon the number of genes involved in the inheritance of quantitative characters. The importance of genetic diversity in selecting parents to recover transgressive segregants has been repeatedly emphasised by many workers (Arunachalam, 1981; Jatsara and Paroda, 1983; Cox and Murphy, 1990). Information on the nature of degree of divergence provides a rational basis and helps the plant breeder in choosing suitable parents for realizing recombination in breeding programme. In present investigation 41 Chickpea genotypes of different genetic back ground were grown in six environments to judge the suitability of genotype for various yield components and quality traits.

## MATERIALS AND METHODS

The present investigations were carried out with forty one genotypes in RBD design with three replications at three different locations during Rabi 2005-06 and Rabi 2006-07. Spacing was maintained at 30 cm between rows and 10 cm between plants within a row. The plot size of an entry within a replication for the experiment was 6 $m^2$. The experimental materials for the present investigation comprised of 41 different genotypes of chickpea (*Cicer arietinum* L.) are presented in Table 1. These genotypes exhibited wide range of variation with respect to height, days to 50% flowering, number of primary branches, number of secondary branches, number of pod per plant, number of seed per pod and 100

 

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seed weight. The experiment s were carried at three different locations of Bihar and all locations were considered individual environment i.e. E1: RAU, Pusa, E2: TCA, Dholi and E3: Gaya KVK Farmer's field. Good agricultural practices were followed to raise the crops. Data were recorded on thirteen characters namely days to 50% flowering, plant height (cm), number of primary branches, number of secondary branches, number of pod per plant, number of grain per pod, 100-seed weight (g), per cent infestation of pod borer, Score of wilt infestation, total protein (%), soluble protein (%) insoluble protein (%) and grain yield (Kg/ha).

**Table 1: List of genotypes, pedigree and source of the experimental materials**

| Sl. No. | Genotype | Pedigree | Source |
|---|---|---|---|
| 1. | IPC 2000-33 | L 412 x KPT 1 | IIPR Kanpur |
| 2. | IPC 2001-02 | ICCV 10 x PDG 84-16 | IIPR Kanpur |
| 3. | ICP 2001-21 | Selection from 84396 | IIPR Kanpur |
| 4. | IPC 2002-26 | NARC 9004 x C 235 | IIPR Kanpur |
| 5. | IPC 2002-35 | PG 5 x IPC 92-39 | IIPR Kanpur |
| 6. | IPC 2002-51 | DCP 95-3 x KTP 1 | IIPR Kanpur |
| 7. | IPC 2002-71 | Phule G 5 x H 82-2 | IIPR Kanpur |
| 8. | IPC 2002-75 | Phule G 5 x H 82-80 | IIPR Kanpur |
| 9. | IPC 2003-06 | ICCV 10 x JG-315 | IIPR Kanpur |
| 10. | IPC 2003-07 | DCP 92-3 x BG 256 | IIPR Kanpur |
| 11. | IPC 2003-10 | NARC 9004 x C 235 | IIPR Kanpur |
| 12. | IPC 2003-27 | L 411 x BG 256 | IIPR Kanpur |
| 13. | IPC 2003-31 | ICC x 490220 | IIPR Kanpur |
| 14. | IPC 2003-35 | IXCC x 94049 | IIPR Kanpur |
| 15. | IPC 2003-37 | Phule G 5 X IPC 92-39 | IIPR Kanpur |
| 16. | IPC 2003-45 | PG 5 x IPC 92-1 | IIPR Kanpur |
| 17. | IPC 2003-46 | BG 364 x PDG 84-16 | IIPR Kanpur |

 

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| | | | |
|---|---|---|---|
| 18. | IPC 2003-51 | IPC 71 x ICCV 10 | IIPR Kanpur |
| 19. | IPC 2003-52 | DCP 92-1 x KPT 1 | IIPR Kanpur |
| 20. | IPC 2003-54 | PG 5 x H 82-2 | IIPR Kanpur |
| 21. | IPC 2003-55 | ICCV2 x ICC 202 | IIPR Kanpur |
| 22. | IPC 2003-56 | PG 5 x L 144 | IIPR Kanpur |
| 23. | IPC 2003-57 | (ICC 4958 x ICC 11322 ) x ICCV 10 | IIPR Kanpur |
| 24. | IPC 2003-60 | (IPC 6 x ICCV 10) x ICC 4958 | IIPR Kanpur |
| 25. | IPC 2003-66 | ICC 4958 x BG-364 | IIPR Kanpur |
| 26. | IPC 2003-68 | IPC 94-37 x KWR 108 | IIPR Kanpur |
| 27. | IPC 2003-69 | PG 5 x KWR 108 | IIPR Kanpur |
| 28. | IPC 2003-71 | KPG 59 x KPT 1 | IIPR Kanpur |
| 29. | ICP 2004-63 | NARC 9008 x C 235 | IIPR Kanpur |
| 30. | ICP 2004-64 | PG 5 x ICC 4958 | IIPR Kanpur |
| 31. | SAKI-9516 | ICCC 42 x ICCV 10 | Jabbalpur (MP) |
| 32. | DCP-92-3 | Selection from germplasm | IIPR Kanpur |
| 33. | ICCV-10 | P 1231 x P 1265 | ICRISAT |
| 34. | BG-2019 | Pusa 362 x (Avrodhi X Pusa 212) | IARI New Delhi |
| 35. | BG 2032 | (BG 361 x ICC 14309) X ICCV 89230 | IARI New Delhi |
| 36. | BG-2024 | (BG 261 x ICC 88503) x (GL 920 x BG 1003) | IIPR Kanpur |
| 37. | IPC 2003-11 | IPC 9511 X PDG 84-16 | IIPR Kanpur |
| 38. | IPC 99-18-6 | Selection from ICCV 940253 | IIPR Kanpur |
| 39. | BG 256 | (BG 62 x K 850-3/127) x (L 280 x H 75-35) | IARI New Delhi |
| 40. | BG 362 | (Pusa 303 x P 179) x Pusa 303 | IARI New Delhi |
| 41. | BG 372 | P 1231 x P 1265 | IARI New Delhi |

 

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## RESULTS AND DISCUSSION

The analysis of variance revealed considerable variability among the treatments for ten characters except number of primary branches and insoluble protein which shown the significant difference among the genotypes only in $E_3$, $E_6$ and $E_2$, $E_6$ respectively. It reflected the presence of wide range of variability in the base material (Table-2). Minimum days to 50% flowering was observed in IPC 2003-06 and IPC 2003-52 (74 days) followed by IPC 2003-07 and IPC 2003-27 (75 days), IPC 2004-63 (76 days) indicating that these genotypes may be selected for cultivation after early and mid early rice in Bihar condition with the mean yield potential of 800 kg/ha. BG 2019 and IPC 2000-33 were having the minimum plant height i.e. 44 cm followed by IPC 2003-55 (46 cm), whereas DCP 92-03 and ICCV 10 were having (47 cm) of height having maximum yield as compared to other test entries; suggesting that to have the higher yield of chickpea dwarf plant may be selected. Maximum number of primary branches was observed in IPC 2002-51, IPC 2003-56, IPC 2000-33, IPC 2001-02 and IPC 2001-21 (6 branches) along with the mean grain yield of 850 kg/ha; however, IPC 2003-56 had given the maximum yield (1283 kg/ha) suggesting that more number of primary branches is also enhancing the grain yield. Maximum number of secondary branches obtained in IPC 2003-37 (29 branches) followed by IPC 2002-71 (26 branches), IPC 2003-46 (25 branches), BG 256 and IPC 2003-54 (24 branches), along with the mean grain yield of 800 kg/ha indicating that number of secondary branches is not as responsive as number of primary branches to have the higher grain yield. Highest numbers of pods per plant was obtained in BG 362 (94 pods/plant) followed by BG 372 (75 pods/plant). IPC 2003-51 (71 pods/plant), BG 256 (61 pods/plant) and IPC 2002-71 (57 pods/plant) along with the mean grain yield of 800 kg/ha; but perusal of the table revealed that inspite of the very high number of pods per plant yield has gone down due to the higher per cent of the pod borer infestation as well as high wilt infestation score. The maximum 100-seed (g) weight was observed in IPC 2003-51 (32.03) followed by IPC 2003-60 and IPC 2003-35 (31 g), IPC 2004-63 (26.5 g) and IPC 2000-33 (25.62 g) exhibiting the mean grain yield 820 kg/ha. The minimum per cent of pod borer infestation was obtained in IPC 2003-07 and IPC 2003-27 (8%) followed by IPC 2003-10 (9%), where as IPC 2002-75, IPC 2002-51 and IPC 2001-21 (9.5%) with the mean grain yield of 850 kg/ha. IPC 2003-55, SAKI 9516 and IPC 2003-56 were found resistant to wilt along with the infestation score of (1.00); whereas IPC 2003-57, DCP 92-3 and ICCV-10 exhibited higher score of wilt infestation (1.6) suggesting that they are tolerant to wilt infestation as well as they are the highest yielder among all the forty one genotypes. All the six experimentation locations were highly prone to wilt infestation that's why the entries which could not been infested by wilt exhibited the highest mean grain yield (1272 kg/ha). The maximum total protein was estimated in DCP 92-3, BG 256, IPC 2003-55, IPC 2003-71 and BG 2019 lower per cent of insoluble protein (20.5%) along

 

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with the higher per cent of soluble protein and having the mean grain yield of 1067 kg/ha. Indicating that these above five genotypes are good yielder as well as having the higher protein percentage, may be recommended for cultivation in rice fallow in North Bihar. IPC 2003-55 exhibited the highest yield (14.38 kg/ha) along with the high protein per cent and least infestation of wilt having the plant height (45.6 cm) followed by SAKI 9516 (1384 kg/ha), also exhibited the resistance against wilt infestation, DCP 92-3 (1271 kg/ha) with highest protein percentage (20.5%) and moderately resistant to wilt, IPC 2003-45 (1224 kg/ha) and IPC 2003-57 (1169 kg/ha) (Table 3). Suggesting that these genotypes may be utilized directly for commercial cultivation as well as may be used in chickpea crop improvement programme. A perusal of table 3 revealed high heritability estimate coupled with high genetic advance observed for number of secondary branches, pods per plant, 100-seed weight, pod borer infestation per cent, score of wilt infestation and grain yield kg/ha. Similar results were also observed by Sharma *et al*. (2005) and Durga *et al*. (2007) for 100-seed weight, Sharma *et al*. (2005), Durga *et al*. (2007) for number of pods per plant and grain yield. It indicates preponderance of additive or fixable genetic variance suggesting that if these characters are subjected to any selection scheme wide adapted genotype can be developed and selection pressure should be exercised in early generation. High heritability coupled with low genetic advance were observed for days to 50% flowering, plant height (cm), number of primary branches, total protein and soluble protein. Similar result were also found by Sharma *et al*. (1990), Singh *et al*. (1990), Khan and Sharma (1999) and Muhammod *et al*. (2002) where as Insoluble protein exhibited low heritability coupled with low genetic advance, it indicates that this character is highly influenced by environmental effects and selection would be ineffective. It indicated that manifestation of these traits was governed by non-additive genetic effect and therefore the selection would be practiced in later generation. The forty one Chickpea genotype under study constellated into five clusters (Table 4). Cluster I : This cluster comprised of ten genotype namely IPC2000-33, IPC 2001-02, IPC 2001-21, IPC 2002-35, IPC 2002-51, IPC 2002-71, IPC 2003-35, IPC 2003-37, IPC 2003-52 and IPC 2003-60. Incidentally out of ten three genotypes are having the one of the similar parent, indicating the presence of similar genetic background as well as role of geographical distribution, which is playing the major role having the similar genetic back ground. Cluster II : This group consisted of seven genotype namely IPC 2003-10, IPC 2003-46, IPC 2003-54, IPC 2003-57, IPC 2003-68, IPC 2004-63 and BG 2024 in this cluster some of the genotype are also having the one of the similar parent indicating the presence of similar genetic background and all have been developed IIPR suggesting the presence of similar geographical distribution. Cluster III : This cluster comprised all the check namely BG 256, BG 362 and BG 372 and IPC 2003-51 all four genotypes having similar genetic background all three checks viz., BG 256, BG 362 and BG 372 have been developed from I.A.R.I., Pusa. Out of four genotypes three genotypes have been evolved by

 

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IARI, Pusa, Suggesting the role of geographical distribution and also may be the possibility to have some ancestral similarity. Cluster IV : This cluster consisted of ten genotypes namely IPC 2002-26, IPC 2002-75, IPC 2003-06, IPC 2003-07, IPC 2003-27, IPC 2003-71, IPC 2004-64, BG 2032, IPC 2003-11, IPC 99-18-06 in this cluster mostly plant are having the taller height and more than 50 pods per plant. In this group most of the genotypes are having the one of the common parent, owing to this reason they might be showing genetic similarity. Cluster V: This cluster comprise of nine genotypes viz. IPC 2003-45, IPC 2003-55, IPC 2003-56, IPC 2003-66, IPC 2003-69, SAKI 9516, DCP 92-3, ICCV 16 and BG 2019 in this cluster most of the genotypes are dwarf and semi spreading in nature. In this group also some of the genotypes are also having the one of the common parent suggesting the presence of genetic similarity among them. While grouping the varieties on the basis of $D^2$ it was seen that the intra cluster distances is zero in all the five clusters it indicate thus the genotype present in each and every clusters having very narrow distance within themselves. The inter cluster differences when compared indicated that the maximum distance between cluster number II and III followed by cluster number III and IV, cluster number III and V, cluster number I and III, cluster number I and IV, cluster number II and IV, cluster number IV and V, cluster number I and II, cluster number II and V and cluster number I and V. it may be emphasized that cluster II had the maximum distance with the cluster III, where cluster III comprising the all three checks which are having more similar genetic back ground than the other test entries (Table 5). The clusters have certain characteristic feature as is seen from the cluster means. Cluster I had the highest mean value for plant height, number of primary branches, number of secondary branches and 100-seed weight, cluster II had shown only highest mean value for grain yield, cluster III exhibited highest mean value for days to 50 % flowering, number of pods per plant, pod borer infestation, total protein and Insoluble protein per cent, cluster IV comprised of highest mean value for grain yield kg/ha and soluble protein, where as cluster V revealed highest mean value for score of wilt infestation. As regards to depended characters contribution towards the total divergence, 100-seed weight contributed maximum with a value of 20.81 per cent followed by grain yield kg/ha (17.85 %), total protein per cent (14.17%), days to 50% flowering (10.80%), number of pods per plant (8.98%), number of secondary branches per plant (7.68%), plant height (7.06%), score of wilt infestation (4.31 %), number of primary branches (3.65%), Insoluble (2.45%), pod borer infestation (1.67 %) and soluble protein in per cent (0.67%). Thus the first four characters are more important in this respect for the varieties under consideration and they have proved most useful for studying divergence among them. On the basis of genetic divergence study most divergent parents for number of primary branches per plant were IPC 2002-51, IPC 2000-33, IPC 2001-21, IPC 2003-37 and IPC 2002-71; for number of pods per plant were BG 362,

 

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BG 372, BG 256 and IPC 2003-51; for total protein were DCP 92-3, BG 2019, BG 256, IPC 2002-76 and IPC 2003-55 whereas for grain yield. IPC 2003-55, SAKI 9516, DCP 92-3 and IPC 2003-45 were observed most suitable.

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**Table 2 : Analysis of variance for thirteen characters of chickpea in each environment**

| Sl. No. | Characters | Source of variation | Mean sum of square | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | d.f. | $E_1$ | $E_2$ | $E_3$ | $E_4$ | $E_5$ | $E_6$ | Pooled |
| 1. | Days to 50% flowering | G | 40 | 71.819** | 71.575** | 71.098** | 72.025** | 71.059** | 69.198** | 71.129** |
| | | E | 80 | 1.750 | 1.404 | 1.338 | 1.330 | 1.314 | 1.342 | 1.413 |
| 2. | Plant height (cm) | G | 40 | 139.941** | 81.369** | 67.915** | 140.88** | 80.160** | 66.037** | 55.950** |
| | | E | 80 | 1.880 | 3.064 | 2.229 | 1.788 | 4.199 | 2.391 | 2.591 |
| 3. | No. of Primary branches | G | 40 | 1.247 | 0.863 | 4.065** | 1.213 | 0.796 | 4.051** | 2.042** |
| | | E | 80 | 0.205 | 0.205 | 0.115 | 0.185 | 0.189 | 0.118 | 0.286 |
| 4. | No. of Secondary branches | G | 40 | 38.398** | 24.461** | 175.663** | 40.033** | 23.947** | 129.957** | 71.243* |
| | | E | 80 | 20.454 | 1.423 | 0.716 | 1.683 | 1.370 | 15.569 | 6.869 |
| 5. | No. of pods per plant | G | 40 | 743.120** | 368.976** | 1059.491** | 755.638** | 368.735** | 1076.725** | 464.022** |
| | | E | 80 | 5.650 | 11.301 | 3.604 | 5.317 | 11.166 | 3.574 | 6.768 |
| 6. | No. of grain per pod | G | 40 | 0.212 | 0.212 | 0.212 | 0.207 | 0.181 | 0.182 | 0.201 |
| | | E | 80 | 0.273 | 0.273 | 0.273 | 0.270 | 0.289 | 0.275 | 0.275 |
| 7. | 100 seed weight (g) | G | 40 | 42.801** | 42.743** | 42.302** | 42.427** | 44.47** | 30.681** | 40.904* |
| | | E | 80 | 0.115 | 0.178 | 9.815 | 8.744 | 0.321 | 6.231 | 1.217 |
| 8. | Pod bore infestation (%) | G | 40 | 49.390** | 16.947** | 30.797** | 51.738** | 158.478** | 31.192** | 48.49** |
| | | E | 80 | 3.491 | 2.001 | 2.260 | 3.224 | 1.77 | 2.230 | 4.675 |
| 9. | Score of wilt infestation | G | 40 | 4.537** | 4.842** | 4.932** | 4.180** | 4.095** | 5.320** | 4.651* |
| | | E | 80 | 0.273 | 0.483 | 0.360 | 0.311 | 0.333 | 0.314 | 0.346 |
| 10. | Total protein (%) | G | 40 | 3.369** | 3.074** | 3.186** | 3.317** | 3.186** | 3.120** | 3.202** |
| | | E | 80 | 5.787 | 2.501 | 5.519 | 5.141 | 2.63 | 4.107 | 1.277 |
| 11. | Soluble protein (%) | G | 40 | 3.490** | 3.411** | 2.878** | 3.424** | 3.392** | 6.250** | 28.80* |
| | | E | 80 | 0.253 | 0.323 | 0.265 | 0.236 | 0.208 | 0.506 | 16.058 |

 

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | Insoluble protein (%) | G | 40 | 0.148 | 9.887** | 0.198 | 0.539 | 0.219 | 1.574** | 2.077** |
| | | E | 80 | -0.146 | 0.919 | 0.152 | 0.185 | 0.123 | 0.250 | 0.31 |
| 13 | Yield (kg/ha) | G | 40 | 153307.62** | 162444.71** | 144352.8** | 155737.88* | 157689.39** | 154463.56** | 15466.06* |
| | | E | 80 | 960.575 | 1119.83 | 462.341 | 410.885 | 347.397 | 104.741 | 567.628 |

* Significant at P = 0.05
** Significant at P = 0.01

**Table 3 : Pooled mean performance of 41 genotypes for twelve quantitative traits**

| Sl. No. | Genotypes | Days to 50% flowering | Plant height (cm) | No. of primary branches | No. of secondary branches | No. of pods per plant | 100 seed weight (cm) | Pod borer infestation | Score of wilt infestation | Total protein (%) | Soluble protein (%) | Insoluble protein (%) | Yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | IPC 2000-33 | 80.39 | 43.97 | 5.60 | 19.39 | 47.93 | 25.56 | 15.23 | 4.11 | 17.42 | 14.80 | 2.42 | 724.22 |
| 2 | IPC 2001-02 | 80.56 | 59.00 | 5.58 | 19.77 | 44.08 | 21.81 | 9.96 | 3.72 | 17.41 | 14.88 | 2.61 | 558.83 |
| 3 | ICP 2001-21 | 82.56 | 54.42 | 5.59 | 17.55 | 39.22 | 22.71 | 9.52 | 3.37 | 18.32 | 15.42 | 2.44 | 880.17 |
| 4 | IPC 2002-26 | 83.50 | 60.25 | 4.53 | 19.25 | 49.88 | 19.51 | 11.88 | 3.83 | 19.41 | 16.47 | 2.72 | 693.28 |
| 5 | IPC 2002-35 | 81.89 | 55.23 | 5.35 | 21.59 | 57.01 | 21.19 | 15.23 | 3.94 | 18.32 | 15.81 | 2.58 | 714.44 |
| 6 | IPC 2002-51 | 76.00 | 56.70 | 6.19 | 23.32 | 54.72 | 20.96 | 9.51 | 3.94 | 18.54 | 15.65 | 2.67 | 587.28 |
| 7 | IPC 2002-71 | 82.17 | 55.65 | 5.22 | 25.55 | 57.15 | 21.61 | 13.03 | 4.22 | 17.74 | 15.26 | 2.41 | 728.94 |
| 8 | IPC 2002-75 | 82.56 | 58.61 | 5.41 | 16.93 | 44.37 | 20.83 | 9.51 | 3.72 | 19.46 | 24.13 | 2.46 | 862.67 |
| 9 | IPC 2003-06 | 73.75 | 51.34 | 5.09 | 19.58 | 41.94 | 19.51 | 9.25 | 4.28 | 18.51 | 16.19 | 2.50 | 667.22 |
| 10 | IPC 2003-07 | 74.67 | 48.21 | 4.34 | 16.95 | 33.68 | 23.42 | 7.70 | 3.72 | 19.39 | 16.45 | 2.50 | 763.78 |

 

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | IPC 2003-10 | 76.17 | 50.78 | 4.48 | 13.66 | 45.70 | 23.11 | 8.81 | 2.11 | 17.41 | 15.08 | 2.78 | 1068.61 |
| 12 | IPC 2003-27 | 75.22 | 55.66 | 4.33 | 20.87 | 41.27 | 17.09 | 7.88 | 2.56 | 19.46 | 16.42 | 2.50 | 1019.11 |
| 13 | IPC 2003-31 | 79.83 | 54.16 | 4.26 | 17.25 | 45.81 | 19.39 | 9.11 | 6.17 | 19.42 | 16.28 | 2.69 | 487.22 |
| 14 | IPC 2003-35 | 82.83 | 55.43 | 4.48 | 15.52 | 45.59 | 31.01 | 11.56 | 3.61 | 18.35 | 15.99 | 2.53 | 487.22 |
| 15 | IPC 2003-37 | 84.17 | 53.20 | 4.25 | 28.60 | 39.70 | 17.11 | 10.28 | 3.83 | 17.23 | 14.93 | 2.54 | 764.67 |
| 16 | IPC 2003-45 | 79.94 | 47.43 | 4.65 | 15.90 | 33.61 | 20.41 | 10.06 | 1.83 | 19.35 | 16.29 | 2.50 | 1224.28 |
| 17 | IPC 2003-46 | 88.28 | 47.82 | 4.17 | 17.58 | 51.39 | 22.53 | 13.02 | 4.22 | 17.37 | 14.99 | 2.71 | 755.94 |
| 18 | IPC 2003-51 | 87.28 | 52.30 | 4.92 | 19.59 | 71.17 | 32.03 | 12.62 | 3.83 | 19.52 | 16.29 | 2.56 | 789.28 |
| 19 | IPC 2003-52 | 74.33 | 54.81 | 5.45 | 24.91 | 42.59 | 25.33 | 11.17 | 4.44 | 18.43 | 16.24 | 2.50 | 699.89 |
| 20 | IPC 2003-54 | 81.17 | 51.12 | 4.72 | 16.74 | 44.28 | 18.07 | 12.94 | 3.78 | 17.41 | 14.80 | 2.81 | 851.22 |
| 21 | IPC 2003-55 | 86.78 | 54.64 | 4.79 | 17.93 | 53.12 | 19.66 | 10.99 | 1.00 | 20.47 | 17.37 | 2.41 | 1438.44 |
| 22 | IPC 2003-56 | 88.83 | 56.36 | 5.76 | 23.52 | 49.57 | 22.10 | 15.05 | 1.28 | 19.14 | 16.86 | 2.56 | 1283.17 |
| 23 | IPC 2003-57 | 79.56 | 55.84 | 4.53 | 15.74 | 39.36 | 19.82 | 12.21 | 1.50 | 17.53 | 14.73 | 2.72 | 1169.39 |
| 24 | IPC 2003-60 | 88.89 | 56.92 | 5.30 | 17.36 | 50.64 | 31.46 | 13.96 | 2.06 | 18.51 | 15.90 | 2.48 | 1017.06 |
| 25 | IPC 2003-66 | 82.11 | 57.49 | 5.39 | 16.63 | 46.76 | 22.54 | 13.88 | 1.94 | 19.32 | 16.75 | 2.49 | 1045.78 |
| 26 | IPC 2003-68 | 89.78 | 50.89 | 4.76 | 14.46 | 49.05 | 21.62 | 14.60 | 1.94 | 17.48 | 14.55 | 2.54 | 1036.67 |
| 27 | IPC 2003-69 | 89.00 | 56.04 | 4.35 | 13.99 | 47.93 | 20.57 | 12.43 | 2.49 | 13.36 | 15.87 | 2.37 | 983.11 |
| 28 | IPC 2003-71 | 81.56 | 51.78 | 4.33 | 14.23 | 43.03 | 19.97 | 13.43 | 3.56 | 20.45 | 17.75 | 2.55 | 872.00 |
| 29 | ICP 2004-63 | 75.61 | 47.17 | 4.95 | 13.91 | 53.26 | 26.54 | 12.61 | 2.05 | 17.41 | 14.88 | 2.62 | 1017.56 |
| 30 | ICP 2004-64 | 77.72 | 50.55 | 4.51 | 18.14 | 53.28 | 18.31 | 13.23 | 3.44 | 19.49 | 16.57 | 2.82 | 800.61 |
| 31 | SAKI-9516 | 87.67 | 55.21 | 4.71 | 16.44 | 41.73 | 20.49 | 11.82 | 1.00 | 18.62 | 16.31 | 2.50 | 1383.89 |
| 32 | DCP-92-3 | 78.50 | 46.54 | 3.88 | 14.81 | 45.12 | 17.71 | 10.96 | 1.61 | 20.51 | 17.77 | 2.60 | 1271.17 |
| 33 | ICCV-10 | 80.44 | 47.96 | 5.25 | 19.82 | 46.32 | 17.14 | 13.99 | 1.83 | 19.54 | 16.94 | 2.61 | 1093.28 |
| 34 | BG-2019 | 84.33 | 43.53 | 4.55 | 18.11 | 41.90 | 22.17 | 13.03 | 3.17 | 20.41 | 17.63 | 2.30 | 867.72 |
| 35 | BG 2032 | 89.28 | 54.6 | 3.86 | 13.68 | 40.26 | 21.49 | 11.69 | 3.61 | 19.40 | 16.45 | 2.61 | 824.83 |
| 36 | BG-2024 | 86.78 | 48.46 | 3.94 | 12.12 | 35.38 | 22.04 | 11.65 | 4.31 | 18.37 | 15.46 | 2.55 | 737.22 |
| 37 | IPC 2003-11 | 77.33 | 54.92 | 4.43 | 16.32 | 53.20 | 18.28 | 12.63 | 4.44 | 17.54 | 15.24 | 2.53 | 664.39 |

 

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | IPC 99-18-6 | 77.34 | 56.51 | 4.43 | 17.81 | 51.80 | 17.09 | 11.31 | 4.11 | 18.53 | 16.42 | 2.12 | 747.32 |
| 39 | BG 256 | 89.50 | 56.02 | 4.73 | 17.50 | 60.96 | 22.69 | 10.93 | 3.28 | 20.49 | 17.41 | 2.67 | 883.50 |
| 40 | BG 362 | 88.69 | 55.65 | 4.74 | 21.10 | 91.35 | 21.21 | 15.94 | 3.78 | 19.62 | 16.81 | 2.78 | 748.61 |
| 41 | BG 372 | 87.17 | 51.70 | 4.75 | 23.70 | 74.83 | 19.19 | 16.12 | 3.50 | 19.57 | 16.96 | 2.80 | 841.11 |
| | **Mean ($\overline{X}$)** | **82.92** | **53.04** | **4.77** | **18.23** | **54.80** | **21.60** | **11.94** | **3.28** | **19.11** | **16.26** | **2.56** | **901.98** |

**Table 4 : Mean value of five clusters for twelve characters in chickpea**

| Cluster | Days to 50% flowering | Plant height (cm) | No. of primary branches | No. of secondary branches | No. of pods/ plant | 100 seed weight | Score of pod borer infestation | Wilt infesta-tion % | Total protein % | Soluble protein % | Insoluble protein % | Yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 81.36 | 54.19 | 5.28 | 21.23 | 47.30 | 23.70 | 11.72 | 3.79 | 17.85 | 15.47 | 2.53 | 446.72 |
| II | 82.05 | 49.85 | 4.39 | 15.07 | 44.95 | 21.69 | 12.04 | 2.89 | 17.40 | 14.99 | 2.68 | 948.03 |
| III | 87.67 | 53.40 | 4.64 | 20.12 | 73.94 | 23.37 | 13.72 | 3.56 | 19.66 | 16.73 | 2.69 | 819.28 |
| IV | 83.73 | 50.76 | 4.72 | 17.21 | 44.60 | 20.08 | 12.25 | 1.88 | 19.37 | 16.77 | 2.48 | 1176.83 |
| V | 78.89 | 53.76 | 4.37 | 16.98 | 44.75 | 19.05 | 10.52 | 4.01 | 19.04 | 16.37 | 2.58 | 768.35 |
| Mean | 82.74 | 52.39 | 4.68 | 18.13 | 51.10 | 21.67 | 12.05 | 3.22 | 18.66 | 16.07 | 2.59 | 831.84 |

 

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**Table 5: Per cent contribution of twelve characters towards divergence in chickpea**

| Sl. No. | Character | % contribution towards divergence |
|---|---|---|
| 1 | Days to 50 % flowering | 10.80 |
| 2 | Plant height (cm) | 7.06 |
| 3 | No. of primary branches | 3.55 |
| 4 | No. of secondary branches | 7.68 |
| 5 | No. of pods per plant | 8.98 |
| 6 | 100 seed weight | 20.81 |
| 7 | Pod borer infestation | 1.67 |
| 8 | Wilt infestation | 4.31 |
| 9 | Total protein (%) | 14.17 |
| 10 | Soluble protein (%) | 0.37 |
| 11 | Insoluble protein (%) | 2.45 |
| 12 | Yield (kg/ha) | 17.85 |

 