**Estimation of genetic variability, and trait associationfor yield, and yield related traits ofchilli (*Capsicum annuum* L.)**

**Abstract**

The selection of better traits in plants is an important aspect of natural selection. Genetic diversity in plants is also considered one of the most fundamental reasons for natural selection, and it can provide potentially new avenues during crop trait selection. The current experiment was carried out on the chilli (*Capsicum annuum* L.) crop during the autumn and winter season of 2024-2025, with the aims of to determine the genetic variability among the genotypes and heritabilityin broad sense and genetic advance in percent of mean. The experimental sample size included 35 genotypes including one check (Kashi Anmol), in a Randomised Complete Block Design with three replications. Observation was based upon thirteen quantitative characteristics. For all characteristics the highest phenotypic as well as genotypic coefficients of variation were observed in case of ascorbic acid (39.13% and 37.48%) followed by average fruit weight (35.45% and 31.86%) fruit yield per plant (34.54% and 31.84%), fruit length (28.11% and 22.83%), plant height (22.65% and19.45%).Estimates of heritability (broad sense) and genetic advance for different characters. The heritability in broad sense ranged from 24.56 per cent in case of days to mature red ripe stage to 98.18 per cent for ascorbic acid.High estimates of heritabilityascorbic acid (98.18%) followed by fruit yield per plant (94.37 %), pedicel length (90.00%), average fruit weight (88.68%), fruit length (88.00%), no. of fruit per plant (79.89), plant height (74.90).As a result of the above data, it is potential to conclude that there is ample opportunity to achieve successful crop modification for improved yield and yield-attributing traits in current chilli germplasm.

**Keywords:** Chilli (*Capsicum annuum* L.), variability, GCV, PCV, heritability, genetic advances.

**Introduction**

Chilli is one of the most important vegetable crop grown almost throughout the country. It belongs to family Solanaceaewith chromosome number 2n=24.There are around 400 distinct types of chiles found throughout the world. India is one of the leading countries in terms of area and production, and it leads all of them in chilli exports. It accounts for more than 33% of India's total spice exports and 16% of worldwide spice commerce (Anon., 2020-21). In India, chilli ranks top among spice crops in terms of output; green chilli is grown on 1264.62 thousand hectares of land and produces 7278.32 thousand metric tonnes. Production (Anony., 2020-21).Chilli may be grown in warm, humid tropical and subtropical climates with temperatures surpassing 40°C. It is found in 45° latitudes on both sides of the equator and may reach elevations of 2000 meters above sea level. It is a frost-sensitive crop that loves temperatures ranging from 15 to 35 °C. Fruit setting is confined to temperatures below 10°C, although the ideal temperature is 24°C. Capsaicin's chemical name is N-Vanillyl-8-Methyl-6-E-Nonemide. Natural and manufactured versions of capsaicin are also used in the law enforcement and self-defence sectors as comparatively safe alternatives to other chemical, electric, or physical restraint methods. The red pigment (colour) in chilli is attributed to capsanthin (C40 H56 O3) (36%) and capsorubin, whereas the yellow and orange colours are due to lutein and beta-carotene, respectively. It also contains "oleoresin," which helps to improve the colour and flavour distribution in foods. (Chaptopadhyay*et al.,* 2011). An appropriate breeding strategy that takes use of the original population's natural variety, factors such as the genotypic and phenotypic coefficients of variation, heritability, and genetic progress for the various characteristics, is extremely important. Heritability is a trait that is important to breeders since it shows the possibility and extent of improvement through selection. It evaluates the relationship between parents and their children and is widely used to estimate the degree to which a character may be passed from parents to offspring. However, high heritability is inadequate for efficient selection in advanced generations unless it is accompanied by a large degree of genetic advancement (Burton, 1953). substantial heritability estimates, paired with substantial genetic improvement, provide enough chance for further advancement in future generations. Phenotypic variability changes in reaction to environmental variables, whereas genetic variability is continuous and more valuable to plant breeders for selection or hybridisation.

**Material and Methods**

The current research (experiment) was conducted in the Agriculture Research Farm of Rama University, Mandhana, Kanpur.The experiment was conducted in Randomized Block Design with three replications during autumn- winter season in 2024-2025 to assess the performance of 35 genotypes. Each treatment consisted of twelve plants in two rows, having spacing of 60 X 50cm with net plot size of 3.0 × 1.8 m2. All the recommended agronomic package of practices and plant protection measures were followed to raise a good crop. The observation includeddaysto50%flowering, days to mature(mature green stage), days to mature(redripest age), plant height(cm), primary branches per plant, secondary branches per plant, no. of fruits per plant, fruit length(cm), pedicel length (cm), fruit diameter(mm), averagefruitweight(g), yieldperplant(kg), ascorbic acid content(mg/100g)were recorded. The estimations of variability (GCV and PCV), heritability, and genetic progress were carried out by the methods proposed by Burton and de Vane (1953).









**Result and Discussion**

The mean squares owing to treatments were highly significant for all thirteen variables (Table 1), indicating considerable variation across genotypes for each character under examination. In other words, the genotypes' performance on these parameters differed statistically, indicating that there is plenty of room for selection in the existing chilli germplasm.

The estimates of genotypic and phenotypic coefficients of variations for thirteen characters of chilli germplasm had been presented in table 2. The estimates of phenotypic coefficients of variations (PCV) were higher than genotypic coefficients of variations (GCV)for all the characters. The highest phenotypic as well as genotypic coefficients of variation were observed in case of ascorbic acid (39.13% and 37.48%) followed by average fruit weight (35.45% and 31.86%) fruit yield per plant (34.54% and 31.84%), fruit length (28.11% and 22.83%), plant height (22.65% and19.45%). Moderate estimates of PCV and GCV were estimated for pedicle length (19.74% and 15.54%), no. of fruit per plant (15.33% and 13.85%), primary branches per plant (14.51% and 10.86%), fruit diameter (14.27% and 10.56), secondary branches per plant (11.65% and 7.74%).Similar, results have been reported by Singh *et al*.(2017),Kumari *etal*.(2017),Jogi *etal.*(2017) and Gulzar and Malik (2022).ModeratePCValong with GCV were recorded for days to 50% flowering (8.23% and 6.45%), Similar result was also reported by Janaki *et al.*(2015) and Maurya *et al*. (2017) Saisupriya *et al.* (2022a).

The phenotypic and genotypic coefficients of variations were lower for days to maturity(Mature Green Stage7.54% and 6.52%) and mature red ripe stage (7.52% and 4.66%) low GCV and PCV for these traits indicated that there was less variation for this trait.

Heritability in broad sense of a character is important to the breeder since it indicate the possibility and extent to which improvement is possible through selection. It also indicates direction of selection pressure to be applied for a trait during selection because it measures relationship between parents and their progeny, hence widely used in determining the degree to which a character may be transmitted from parents to offspring. However, high heritability alone is not enough to make efficient selection in advanced generation unless accompanied by substantial amount of genetic advance (Burton, 1953). High estimates of heritability along with high genetic advance provides good scope for further improvement in advance generations.

Estimates of heritability (broad sense) and genetic advance for different characters has been presented in table 2 The heritability in broad sense ranged from 24.56 per cent in case of days to mature red ripe stage to 98.18 per cent for ascorbic acid.

High estimates of heritability (>75%) were recorded for seven characters *viz*. ascorbic acid (98.18%) followed by fruit yield per plant (94.37 %), pedicel length (90.00%), average fruit weight (88.68%), fruit length (88.00%), no. of fruit per plant (79.89), plant height (74.90). However, moderate heritability (>50% and <75%) was no. of secondary branches per plant (58.28%) followed by no. of primary branches per plant (56.28%), fruit diameter (54.00) and days to 50% flowering (47.82) and lower heritability (<50%) was days to mature red ripe stage (28.15%), followed by days to mature green fruit (24.56%) estimated in all 13 characters. Highest value of genetic advance in percent of mean was shown by ascorbic acid (75.95). While days to mature green fruit exhibited lowest value (3.78) for this parameter. The characters which observed very high estimates of genetic advance was ascorbic acid (163.52) and lowest genetic advance in per cent of mean was estimated for pedicel length (0.18). Similar result was also reported by Farwah *et al. (*2020), Haralaya*et al.* (2020) and Saisupriya *et al.* (2022).

High heritability coupled with high genetic advance in per cent of mean were recorded for ascorbic acid (98.18% and 75.95%), fruit yield per plant (94.37% and 63.8969.15%), pedicel length (90.00% and 25.74%), average fruit weight (88.68% and 67.08%), fruit length (88.00% and 34.41%) indicating that these traits were little influenced by environment. Thus, require low selection intensity for improvement. Similar results were also reported by Nahak *et al*. (2018) and Lakshmidevamma*et al*. (2021).

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## **Table: 1. Analysis of variance(meansquares)for thirteen quantitative characters in chilli**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Traits** | **Source of variation** |
| **D.F.** | **Replication** | **Treatments** | **Error** |
| **2** | **31** | **62** |
| **1.** | Days to 50% flowering | 25.12 | 36.70\*\* | 7.81 |
| **2.** | Days to mature green stage | 138.88 | 340.17\*\* | 16.42 |
| **3.** | Days to mature red ripe stage | 284.41 | 55.21\*\* | 24.72 |
| **4.** | Plant height | 117.81 | 252.94\*\* | 26.79 |
| **5.** | Primary branches per plant | 0.15 | 0.37\*\* | 0.17 |
| **6.** | Secondary branches per plant | 0.72 | 1.18\*\* | 0.41 |
| **7.** | No. of fruit per plant | 8.25 | 165.38\*\* | 13.47 |
| **8.** | Fruit length | 2.45 | 8.53\*\* | 0.59 |
| **9.** | Pedicel length | 0.04 | 0.79\*\* | 0.19 |
| **10.** | Fruit diameter | 0.69 | 8.35\*\* | 1.46 |
| **11.** | Average fruit weight  | 0.16 | 1.37\*\* | 0.12 |
| **12.** | Ascorbic acid  | 1.47 | 3732.11\*\* | 4.51 |
| **13.** | Fruit yield per plant  | 467.22 | 39248.73\*\* | 1281.06 |

**\*\*Significant1%level, \*Significant at5%level**

**Table:2.Estimates of range, grand mean, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in the broad sense, genetic advance (Ga) and Ga in per cent of mean for thirteen characters in chilli germplasm.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Traits** | **Range** | **Grand Mean** | **ECV****%** | **PCV****%** | **GCV****%** | **h² (Broad Sense)****%** | **Genetic Advance 5%** | **Genetic Advance as % of****Mean 5%** |
| **Minimum** | **Maximum** |
| **Daysto50%flowering** | 44.00 | 52.57 | 48.35 | 7.18 | 8.23 | 6.45 | 47.82 | 4.41 | 6.48 |
| **Daystomaturegreen stage** | 65.67 | 77.39 | 69.42 | 5.88 | 7.54 | 6.52 | 24.56 | 3.35 | 3.78 |
| **Daystomature red-ripe stage** | 84.67 | 102.67 | 92.45 | 6.36 | 7.52 | 4.66 | 28.15 | 3.03 | 4.22 |
| **No.ofprimarybranchesperplant** | 2.22 | 4.12 | 3.78 | 11.52 | 14.51 | 10.86 | 56.68 | 0.94 | 17.24 |
| **No.ofsecondarybranchesperplant** | 5.00 | 7.87 | 6.64 | 8.21 | 11.65 | 7.74 | 58.28 | 0.68 | 9.52 |
| **Plantheight** | 38.12 | 72.00 | 58.54 | 19.24 | 22.65 | 19.45 | 74.90 | 18.15 | 24.41 |
| **Fruitlength** | 5.74 | 11.13 | 8.57 | 12.41 | 28.11 | 22.83 | 88.00 | 4.74 | 34.41 |
| **Fruitdiameter** | 5.15 | 13.55 | 7.52 | 11.54 | 14.27 | 10.56 | 54.00 | 0.74 | 15.35 |
| **Pedicellength** | 2.34 | 4.32 | 3.56 | 8.15 | 19.74 | 15.54 | 90.00 | 0.18 | 25.74 |
| **Averagefruitweight** | 2.21 | 10.13 | 5.74 | 9.23 | 35.45 | 31.86 | 88.68 | 17.80 | 67.08 |
| **No.offruitsperplant** | 45.47 | 77.20 | 61.45 | 7.20 | 15.33 | 13.85 | 79.89 | 2.86 | 24.72 |
| **Ascorbicacid** | 53.67 | 184.86 | 126.65 | 4.14 | 39.13 | 37.48 | 98.18 | 4.03 | 75.95 |
| **Fruityieldperplant** | 0.113 | .0289 | 0.210 | 11.45 | 34.54 | 31.84 | 94.37 | 163.52 | 69.15 |

**Conclusion**

 Based on the above result of the highest phenotypic as well as genotypic co efficients of variation were observed in case of ascorbic acid (39.13% and 37.48%) followed by average fruit weight (35.45% and 31.86%) fruit yield per plant (34.54% and 31.84%), fruit length (28.11% and 22.83%), plant height (22.65% and19.45%).The heritability in broad sense ranged from 24.56 per cent in case of days to mature red ripe stage to 98.18 per cent for ascorbic acid. s, there is plenty of room for improvement in the current germplasm to generate new enhanced varieties of chilli in the future.

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