PHENOTYPIC SCREENING OF CHILLI GENOTYPES COLLECTED FROM DIFFERENT REGIONs

Abstract

The experiment was performed at Maharajpur Farm under the Department of Horticulture, College of Agriculture, J.N.K.V.V., Jabalpur (M.P.) during the Kharif season 2019-2022 and planted in Randomized Complete Block Design (RCBD) with three replications. The characterization of thirty genotype for thirty-five qualitative traits articulated no variability for trait i.e., the monomorphic trait was non-enveloping fruit calyx cover, two descriptors were found to be moderately diverse, which were with medium fruit intensity of the red colour (at the mature unripe stage) and the narrow triangular shape of fruit with the Shannon-Weaver diversity index H'=0.46 & H'=0.50, both of these traits are fruit related. The descriptor intensity of pubescence (hairiness) of the stem had the highest diversity index of 1.82. The studies highlighted some of the genotypes with the distinctness, MPKC-1(Katni collection) addressed unique features with green with purple tinge leaf colour, purple petal colour, upright fruit orientation, absence of fruit curvature, purple fruit colour at ripening maturity, ovate leaf and erect plant habit, depicting it like a wild relative of capsicum and could be utilized as the morphological descriptor.

Introduction

One of the most significant solanaceous vegetable and spice crops in India is the chilli (Capsicum annum Linn.). India is the largest producer, exporter and consumer of chillies in the world (Halder e al., 2021). Along with the convention utilization of capsicum as fresh fruits, processed sauce, pickling, canning, dried spices, industrial extract, etc requirements are also enhanced in the market. Further, capsicum is aggrandizing its significance due to the presence of nutrition sources like ascorbic acid (vitamin C), carotenoids (pro-vitamin A), tocopherols (vitamin E), flavonoids, capsaicinoids and also as a non-food it is used in defence as ethnobotanical products. (Kumar et al., 2006; Meghavansi et. al.,2010). The rise in importance of chilli demands yields enhancement, through the collection and characterization of genotype. The genetic diversity of germplasm resources is the basis of breeding, and the determination of plant genetic variation and diversity via phenotypic traits can be conducive to understanding the level of genetic variation in a short amount of time (Liu et al., 2022).

Furthermore, genetic variety is vital for selecting parents with stronger combination potential and for obtaining superior genotypes (Taki-Ajdukovi et al. 2017). The raw material
which is genotype to the plant breeder is the pool of genes that must be identified, isolated, and melded into the genome of a new genetic entity that expresses a unique and desirable phenotype (Orton and Ayeni, 2022). The crafting of raw material into high yielding varieties needs to go through domestication, refinement and maintenance, which is done by local farmers and characterization of these farmer's varieties could be a potential source of revolutionary genes in plant breeding. The diversified gene pool and intensive selection designed for varietal development followed by molecular characterization give a precise idea about the upcoming utilization of existing genetic diversity (Tiwari, et al., 2021). As per the Protection of Plant Varieties and Farmers' Right Act (PPV&FRA), 2001, the protection of these varieties is given based on Distinctiveness, Uniformity and Stability (DUS). The presented research phenotypically assessed the diversity, as the diverse genotype are an excellent source of developing new varieties for crop improvement (Tiwari et al., 2021)

Material method

The experiment was performed at Maharajpur Farm under the Department of Horticulture, College of Agriculture, J.N.K.V.V., Jabalpur (M.P.) during the Kharif season 2019-2022. The thirty genotypes of capsicum were collected from Indian Institute of Vegetable Research (IIVR), Varanasi, different regions of Madhya Pradesh and South (Table 01). The genotypes were planted in Randomized Complete Block Design (RCBD) with three replications. Phenotypic assessments of capsicum genotypes were done based on thirty-five qualitative traits (Table 02).

Shannon-Weaver diversity index (H) was used to calculate the phenotypic diversity of the characterized farmers' varieties following the protocol used by Sotto and Rabara (2007). An arbitrary scale was adapted from Jamago and Cortes (2012) to categorize the computed indices into maximum (H = 1.00), high (H = 0.76–0.99), and moderate (H = 0.46–0.75) and low diversity (0.01–0.45). The phenotypic frequencies calculated were further used to estimate Shannon's Diversity Index (H) according to Negassa (1985) to assess the present diversity.

\[ H = -\sum [p_i \times \log p_i] \]

Where, pi is the portion of the total number of entries belonging to the ith class.

| S.NO | MATERIAL     | COLLECTION | S.NO | MATERIAL     | COLLECTION |
|------|--------------|------------|------|--------------|------------|
| 1.   | KASHI ANMOL  | IIVR       | 16.  | RED TOP      | SOUTH      |
| 2.   | K2           | IIVR       | 17.  | GUNTUR       | SOUTH      |
### Table no. 02: MORPHOLOGICAL TRAITS

| A. Plant traits | E. Fruit traits |
|-----------------|-----------------|
| **Habit**       | Colour (at mature unripe stage) |
| **Anthocynin colour of node** | Intensity of colour (at mature unripe stage) |
| **B. Stem traits** | Shape |
| Intensity of Anthocynin colouration | Curvature |
| Intensity of pubescence (hairiness) | Intensity of Curvature |
| Pubescence (hairiness) | Neck at Basal End |
| Shape | Cross sectional corrugation (at level of placenta) |
| **C. Leaf traits** | Sinuation of Pericarp |
| Colour | Texture of surface |
| Intensity of green colour | Colour (at ripe maturity) |
| Intensity of purple colour | Intensity of colour (at maturity) |
| Shape | Colour Transition |
| Undulation | Glossiness |
| Pubescence (hairiness) | Shape at the base |
| Intensity of pubescence (hairiness) | Shape of apex |
| **D. Flower traits** | Calyx Cover |
| Petal colour | Calyx Margin |
Shannon diversity index ($H'$) was generated to compare phenotypic diversity for the characters utilised in the study and its assessment is an important activity in evaluating the germplasm collections in a gene bank. The diversity analysis of the chilli genotype revealed a low overall average Shannon Diversity index ($H'$) of 0.32, which did not agree with Nsabiyera et al. (2013) with a moderate mean $H'$ index (0.52).

From ancient times, these visual observations (scoring) were used as an aid in determining genetic diversity in the gene pool. The characterization of thirty chilli genotype for thirty-five qualitative traits articulated no variability for trait i.e., the monomorphic trait was non-enveloping fruit calyx cover. Among all the qualitative traits scores, the predominant descriptor with <90% frequent occurrence were green leaf colour, absence of intensity of leaf purple colour, white flower petal colour, drooping fruit or flower orientation, all these traits also revealed invariance with $H'=0.0$. Sean and Jindal, 2021; Fonseca et al., 2008 observed similar zero divergences for trait white flower petal colour, while the results were not in propinquity with Nahak et al. (2018). Twenty-seven traits scored were dominated by one descriptor in each trait, with the most frequent contribution ranges of 80-90% and low diversity indices ranging between 0.17-0.45 as depicted in table no. 02, were red fruit colour at ripening maturity (86.6%), absence of fruit neck at the basal end (83.3%), dark fruit intensity of colour at ripening maturity (83.3%), one stage fruit colour transition (83.3%), lanceolate leaf shape (83.3%), dented fruit calyx margin (80.0%) and presence of anthocyanin colouration of node (80.0%). The propinquity in results was found for traits of red fruit colour at ripening maturity, one stage fruit colour transition, dented fruit calyx margin and lanceolate leaf shape by Santhosha et al., 2019. Leaf pubescence with a similar low $H'$ index (0.25) predicted genotype belongs to a wild relative by Datt et al., 2017 and Sran and Jindal, (2021). The index is used to assess allelic richness and evenness in which a low $H'$ index suggests that the frequency classes for individual characters are very imbalanced and that there is a paucity of genetic diversity (Rabara et al., 2014; Upadhyaya, 2010). Two descriptors were found to be moderately diverse, which were medium fruit intensity of the red colour (at the mature unripe stage) and the narrow triangular shape of fruit with the indices $H'=0.46$ & $H'=0.50$, both of these traits are fruit related. The descriptor intensity of pubescence (hairiness) of the stem had the highest diversity index of 1.82.
The studies highlighted some of the genotypes with the distinctness of germplasms MPKC-1 addressed unique features such as green with purple tinge leaf colour, purple petal colour, upright fruit orientation, absence of fruit curvature, purple fruit colour at ripening maturity, ovate leaf and erect plant habit, depicting it like a wild relative of capsicum and could be utilized as a morphological marker.

**Conclusion**

The current study revealed the pattern and structure of phenotypic variation in a collection of 30 chilli genotype, which is important for successful pre-breeding, management, and exploitation in crop improvement programmes, as well as for increasing the crop's genetic potential. Several low diversity aspects may be highlighted in future collection visits to boost gene bank variation. Our findings indicate that indirect selection of chilli genitors based on various morphological traits could be beneficial for biotic and abiotic stress management, as the phenotypic feature leaf pubescence reduces water loss during heat stress and is a non-preference trait for many insects, and the drooping fruit habit and spreading plant habit protect the plant from direct incidence of light, making it suitable for biotic and abiotic stress management. Various morphological descriptors, such as yellow, orange, and purple fruit colour, upright fruit orientation, purple flower, cordate, oblate, and trapezoid fruit shape, might be employed in hybridised breeding programmes. Furthermore, the information we produced supplements the vigorous breeding programme of high-yielding and climate-resilient varieties of end users' preferences, as well as promotes varietal choice alternatives for expediting advantages and strengthening agro-biodiversity.

**Table 03 : Morphological Characters depicting the predominate state, frequency distribution and the calculated Shannon diversity indices (H’) for each descriptor scored in Chilli genotype**

| S.no | Characterises                  | States       | Freq % | H’ Index | Unique genotype |
|------|--------------------------------|--------------|--------|----------|-----------------|
| 1.   | Fruit: Calyx Cover            | Non-enveloping | 100.0  | 0.00     |                 |
|      |                                | Enveloping   | 00.00  |          |                 |
| 2.   | Leaf: Colour                   | Green        | 96.67  | 0.06     |                 |
|      |                                | Purple       | 3.33   |          | MPKC-1          |
| 3.   | Leaf: Intensity of purple colour| Absent     | 96.66  | 0.06     |                 |
|      |                                | Light        | 3.333  |          | MPKC-1          |
|      |                                | Medium       | 0      |          |                 |
|      |                                | Dark         | 0      |          |                 |
| 4.   | Flower: Petal colour           | White        | 96.66  | 0.06     |                 |
|      |                                | Yellowish green| 0   |          |                 |
|      |                                | Purple       | 3.33   |          | MPKC-1          |
|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 5. | Flower/fruit Orientation | Drooping | 90 | 0.17 | 2020/CHI VAR-6 |
|   |   | Semi-Drooping | 3.33 | 0.17 | 2020/CHI VAR-7, MPKC-1 |
|   |   | Erect | 6.66 |   |   |
| 6. | Fruit Curvature | Absent | 13.33 | 0.17 | MPC-1 |
|   |   | Present | 86.66 |   | MPC-2 |
| 7. | Neck at Basal End | Absent | 83.33 | 0.20 |   |
|   |   | Present | 16.66 |   |   |
| 8. | Fruit Colour Transition | One stage | 83.33 |   |   |
|   |   | Two stage | 16.66 | 0.20 | MPHC-1 |
|   |   | >Two stage | 0 |   | MPKC-1 |
| 9. | Leaf: Intensity of pubescence (hairiness) | Sparse | 66.66 |   |   |
|   |   | Medium | 3.333 | 0.22 |   |
|   |   | Strong | 3.333 |   |   |
| 10. | Plant: Anthocynin colour of node | Absent | 20 | 0.22 |   |
|   |   | Present | 80 |   |   |
| 11. | Fruit: Calyx Margin | Smooth | 20 | 0.22 |   |
|   |   | Dented | 80 |   |   |
| 12. | Fruit: Colour (at ripe maturity) | Yellow | 3.33 | 0.23 | MPKHC-1 |
|   |   | Orange | 3.33 |   | MPKHC-2 |
|   |   | Red | 86.66 |   |   |
|   |   | Brown | 0 |   |   |
|   |   | Purple | 6.66 |   | MPKC-1 |
| 13. | Stem: Pubescence (hairiness) | Absent | 23.33 | 0.24 | 2020/CHI VAR-1 |
|   |   | Present | 76.67 |   |   |
| 14. | Leaf: Shape | Lanceolate | 83.33 | 0.24 | MPCTC-1 |
|   |   | Ovate | 10 |   | MPKC-1 |
|   |   | Broad elliptical | 6.66 |   |   |
| 15. | Leaf: pubescence (hairiness) | Absent | 26.66 | 0.25 |   |
|   |   | Present | 73.33 |   |   |
| 16. | Fruit: Calyx Constriction | Absent | 26.66 | 0.25 |   |
|   |   | Present | 73.33 |   |   |
| 17. | Fruit: Intensity of colour (at maturity) | Light | 10 | 0.26 |   |
|   |   | Medium | 73.33 |   |   |
|   |   | Dark | 83.33 |   |   |
| 18. | Fruit: Colour (at mature unripe stage) | White | 0 | 0.27 |   |
|   |   | Cream | 0 |   |   |
|   |   | Green | 70 |   |   |
|   |   | Purple | 30 |   | MPKC-1, MPC-2 |
| 19. | Fruit: Pedicel attachment | Weak | 53.33 | 0.30 |   |
|   |                                |        | 0.30 |      | 0.33 |      | 0.35 |      | 0.38 |      | 0.41 |      | 0.45 |      | 0.46 |      |      |      |
|---|--------------------------------|--------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 20. | Anther Colour                  | Strong | 46.66|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Yellow | 0    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Blue   | 50   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Purple | 50   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Smooth | 16.66|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 21. | Fruit Texture of surface      | Slightly Rough | 73.33|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Rough  | 10   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Less   | 23.33|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 22. | Fruit Intensity of Curvature  | Medium | 60   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Strong | 3,333|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 23. | Stem: Shape                   | Angled | 70   | 0.33 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Flat   | 6.66 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 24. | Fruit: Shape of apex          | Acute  | 60   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Blunt  | 36.66| 0.34 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|   |                                | Depressed | 3.33 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 25. | Fruit: Cross sectional        | Round  | 20   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     | corrugation (at level of       | Slightly corrugated | 70   | 0.35 |      |      |      |      |      |      |      |      |      |      |      |      |
|     | placenta)                     | Strongly corrugated | 10   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 26. | Fruit: Shape at the base      | Round  | 50   | 0.35 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Sunken | 3.33 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 27. | Plant: Habit                  | Spreading | 13.33 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Semi-upright | 70   | 0.35 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Upright | 16.66|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 28. | Leaf: Undulation              | Weak   | 56.66| 0.38 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Medium | 36.66|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Strong | 6.666|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 29. | Leaf: Intensity of green      | Light  | 20   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     | colour                        | Medium | 63.33| 0.38 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Dark   | 13.33|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 30. | Fruit: Glossiness             | Weak   | 20   | 0.41 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Medium | 60   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Strong | 20   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 31. | Plant: Intensity of           | Weak   | 33.33| 0.45 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     | Anthocynin colouration         | Medium | 30   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Strong | 16.67|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 32. | Fruit: Sinuation of pericarp  | Medium | 43.33| 0.45 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Strong | 16.66|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 33. | Fruit: Intensity of colour (at | Light  | 26.66|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     | mature unripe stage)          | Medium | 46.66| 0.46 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Dark   | 26.66|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 34. | Fruit Shape                   | Oblate | 0    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Circular | 0   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Cordate | 3.33|      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|     |                                | Square | 0    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

**MEDIUM DIVERSITY**

|   |        | Light  | 26.66| 0.46 |      |      |      |      |
|---|--------|--------|------|------|------|------|------|------|
| 33. | Fruit: Intensity of colour (at | Medium | 46.66|      |      |      |      |
|     | mature unripe stage)           | Dark   | 26.66|      |      |      |      |      |
| 34. | Fruit Shape                    | Oblate | 0    |      |      |      |      |      |
|     |                                | Circular | 0   |      |      |      |      |      |
|     |                                | Cordate | 3.33|      |      |      |      |      |
|     |                                | Square | 0    |      |      |      |      |      |
| Shape               | Percentage | Code |
|---------------------|------------|------|
| Rectangular         | 0          | MPHC-1 |
| Trapezoidal         | 10         | MPKHC-1 |
| Moderate triangular | 30         | MPC-1  |
| Narrow Triangular   | 53.33      | MPC-2  |
| Horn Shape          | 3.33       |       |

**HIGH DIVERSITY**

35. Stem: Intensity of pubescence (hairiness)

| Intensity | Percentage | Code |
|-----------|------------|------|
| Sparse    | 16.66      |      |
| Medium    | 30         |      |
| Strong    | 30         |      |

**AVERAGE DIVERSITY** 0.32
Image 1: Morphological Images

Fig 01: Contribution percentage of highly divergent traits

A. Stem: Intensity of pubescence (hairiness)

B. Fruit: Intensity of colour (at mature unripe stage)

C. Fruit Shape

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