**Assessment of Distinctness, Uniformity and Stability (DUS) characteristics in chilli (*Capsicum annuum* L.)**

***ABSTRACT:***

Distinctness, Uniformity, and Stability (DUS) analysis for total of 54 morphological, phenological, and fruit-related traits in 32 hot pepper test genotypes alongside 14 reference varieties at the DUS testing center, HREC, Devihosur, following PPV&FRA guidelines. Significant variability was observed across key descriptors, aiding in varietal differentiation and trait-based grouping. Correlation and path analyses revealed that the number of fruits per plant (direct effect: 0.91) and single fruit weight (indirect effect via fruit breadth: 0.50) had the strongest positive effects on yield, while fruit length showed a negative indirect influence on yield (−0.37). Several genotypes such as MHCP -350, RHHP -3452, BIO- 1006, and Lena demonstrated superior performance and distinct traits comparable to elite references like Byadagi Dabbi and Pusa Jwala. The results emphasize the importance of DUS testing in protecting new varieties, supporting breeding programs, and enhancing the commercial potential of chilli under diverse agro-ecological conditions.

**Keywords:** Chilli, DUS characterization, Morphological diversity, and Plant variety protection.

1. **INTRODUCTION**

Chilli pepper (*Capsicum annuum* L.) is a widely cultivated vegetable crop that is grown for its pungent or non-pungent fruit and belongs to the *Capsicum* genus of the *Solanaceae* family. Originating in Mexico and Central America, this crop is now cultivated worldwide and is widely used as a spice in various cuisines. Additionally, it plays a significant role in the pharmaceutical industry in the extraction of bioactive compounds known as capsaicinoids, which possess antioxidant, anti-inflammatory, and anticancer properties (Maharjan *et al.,* 2024). Chilli pepper is rich in essential nutrients including carbohydrates, minerals, proteins, amino acids, antioxidants, phytochemicals, and vitamins (Olatunji and Afolayan, 2018). In recent years, the demand for healthy, nutrient-dense, eco-friendly, and flavourful chilli peppers has been on the rise. Consequently, production has steadily increased across many regions of the world (Khaitov *et al*., 2019).

India’s chilli production, with an area of 0.922 million hectares and a total yield of 2.693 million tonnes (Spices Board of India, 2024–25), with high production in states like Andhra Pradesh and Telangana, and Karnataka. To achieve higher productivity with minimal resources, the development of superior varieties or hybrids that can withstand the stresses and contribute to higher yields is required (Coşkun and Toprak, 2023).

Chilli producers worldwide, including those in India, face numerous challenges that impact both yield and quality. These include climate variability, pest and disease outbreaks (such as black thrips and Chilli Leaf Curl Viruses), and limited access to improved stress-tolerant, and high-yielding varieties. Post-harvest issues like poor handling, inadequate storage, and inconsistent quality standards further reduce profitability, especially for smallholder farmers who often lack technical support and quality seed. In India, these problems are intensified by diverse agro-climatic conditions and fragmented landholdings. This underscores the urgent need for the development and dissemination of superior chilli varieties. In this context, DUS (Distinctiveness, Uniformity and Stability) testing plays a critical role by ensuring the genetic identity and performance of varieties, supporting plant variety protection under the Protection of Plant Varieties and Farmers’ Rights Act (PPV&FRA), and promoting sustainable production and varietal innovation.

Similarly, the growing global demand for bell peppers and paprika is steadily increasing, driven by their diverse culinary applications and health benefits. For instance, the global bell peppers market was valued at approximately USD 10.65 billion in 2024 and is projected to reach around USD 17.57 billion by 2033, growing at a CAGR of 6.5% during the forecast period. Similarly, the global paprika market is expected to grow from USD 1.2 billion to USD 1.8 billion by 2025, reflecting a CAGR of 6.5% (Anon., 2024a; 2025) benefits from DUS testing, which ensures that these varieties are distinct, uniform, and stable. India, as a major producer of Capsicum species including chillies, bell peppers, and paprika, has significant potential for use in both domestic and international markets. DUS testing guarantees that new varieties of these crops meet the genetic and market standards, thereby enhancing their competitiveness. This is particularly important, as the demand for high-quality, climate-resilient varieties continues to rise globally (Agricultural Market Intelligence Centre, PJTSAU).

To protect these newly developed varieties/hybrids under the Protection of Plant Varieties and Farmers’ Rights Authority (PPV&FRA), highlights the need for effective Distinctiveness, Uniformity, and Stability (DUS) testing. This test ensured that new chilli varieties met the required standards for distinct traits, consistent performance, and long-term stability, which are essential for improving yield and resilience. Beyond its regulatory role in variety registration, DUS testing also provides a robust phenotypic baseline that complements molecular diversity analyses by identifying genotype-specific traits that can be associated with molecular markers. This integration enables precise selection in marker-assisted breeding and genomic selection strategies. Moreover, DUS characterization helps streamline breeding pipelines by grouping genotypes based on agro-morphological traits, thereby accelerating the development of targeted varieties for specific agro-ecological zones and consumer preferences.

Therefore, this study aims to evaluate the phenotypic diversity and distinctiveness of hot pepper genotypes in comparison with reference varieties using DUS characterization, with an emphasis on identifying key morphological and yield-related traits for varietal registration and integration into breeding programs

1. **MATERIAL AND METHODS**

The DUS testing in Chilli was conducted in the Coordinated DUS centre on DUS testing in Chilli, Bell Pepper, and Paprika crop species at Horticultural Research and Extension Center, Haveri (Devihosur), University of Horticultural Sciences, Bagalkot. The experiment followed a randomized block design (RBD) with three replications, and each replication consisted of 40 plants per accession/variety (Table 1). The spacing between rows was 90 cm, and the plant-to-plant distance was maintained at 45 cm. The experimental site (14o 47’ N, 75o 21’ E; 575 m MSL) receives an average annual rainfall of 750 mm and seasonal temperatures ranging from 16°C to 34°C. The soil type is red loam with moderate drainage, high fertility, and it is conducive to chilli cultivation. Standard agronomic practices were adopted for all genotypes, including timely irrigation, nutrient application, and pest and disease management as per the recommended Package of Practices for chilli by the University of Horticultural Sciences, Bagalkot (Anon., 2024b).

DUS characterization was conducted following the guidelines issued by the Protection of Plant Varieties and Farmers’ Rights Authority (PPV&FRA), Government of India for Chilli, and Sweet Pepper (*Capsicum annuum* L.). A total of 54 characteristics (as prescribed in the official PPV & FRA DUS Test Guidelines) were recorded (<https://plantauthority.gov.in/crop-dus-guidelines>) in the genotypes of 21 Hybrids (from controlled crosses), 11 of Typical (stable non-hybrid cultivars or landraces), and 14 of Reference (standard commercial or traditional varieties) varieties which were provided by PPV&FRA, New Delhi.

Various parameters were measured, including plant height (cm), which was recorded from the base to the tip of the main stem at harvest; plant spread (cm), plant spread was measured in both north-south and east-west directions, and the mean value used; fruit length (cm), and fruit breadth (cm), which were measured using a Vernier caliper at maturity; stalk length (cm), measured from the point of attachment to the tip of the stalk; single fruit weight (g), recorded using a precision balance; number of fruits per plant, counted at harvest; and yield per plant (g), which was determined by the total weight of fruits harvested from each plant.

The collected data were subjected to statistical analysis. Correlation analysis using Pearson’s correlation coefficient was conducted to determine the relationships between the different morphological traits and yield traits. Path analysis was used to assess the direct and indirect effects of traits such as plant height, fruit length, fruit breadth, stalk length, and number of fruits per plant on yield. All statistical analyses were performed using R software, and results were considered statistically significant at p < 0.05.

**Table 1. List of genotypes and references studied**

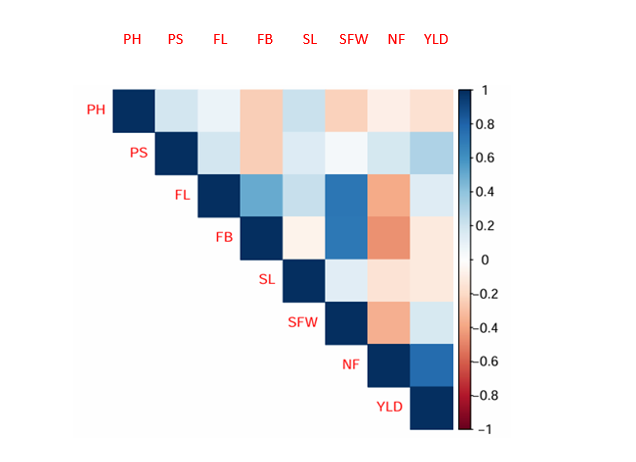
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| --- | --- | --- | --- | --- | --- |
| Sl. No. | **Hybrid entries** | Sl.  No | **Typical entries** | Sl. No | **Reference varieties** |
| 1 | TMPH- 489 | 22 | RHHP -3539 | 1 | Byadagi Kaddi |
| 2 | Lena | 23 | RHHP- 0143 | 2 | Byadagi Dabbi |
| 3 | HP-407 | 24 | MCP-2881 | 3 | Kashi Anmol |
| 4 | NBH-1216 | 25 | RHHP- 3452 | 4 | Arka Lohit |
| 5 | MHCP-306 | 26 | RHHP- 0142 | 5 | Arka Abhir |
| 6 | TMPH -477 | 27 | RHHP- 0144 | 6 | G-4 |
| 7 | TMPH -463 | 28 | RHHP- 0443 | 7 | Kt-Pl-19 |
| 8 | Karaari | 29 | RHHP -0431 | 8 | Phule Jyothi |
| 9 | MHCP -350 | 30 | RHHP -0075 | 9 | Pusa Jwala |
| 10 | Rewa | 31 | RHHP-5801 | 10 | Arka Haritha |
| 11 | HYVEG-78 | 32 | RHHP-2168 | 11 | Arka Suphal |
| 12 | Jockey |  |  | 12 | Pant C-1 |
| 13 | Aastha |  |  | 13 | Arka Kyathi |
| 14 | HYVEG-48 |  |  | 14 | Punjab Gucchedhar |
| 15 | MHCP -345 |  |  |  |  |
| 16 | MHCP -343 |  |  |  |  |
| 17 | SANIYA |  |  |  |  |
| 18 | Eagle |  |  |  |  |
| 19 | Gouri |  |  |  |  |
| 20 | BIO -1006 |  |  |  |  |
| 21 | Ojas |  |  |  |  |

1. **RESULTS AND DISCUSSION**

**3.1 Correlation Analysis of Morphological and Yield Traits**

The correlation matrix revealed critical relationships among the eight traits evaluated in 46 chilli genotypes, including 32 test entries and 14 reference varieties. The correlation matrix heatmap (Fig.1) illustrates the pairwise Pearson correlation coefficients among key morphological and yield-related traits in *Capsicum annuum* L. genotypes. Traits analyzed include plant height (PH), plant spread (PS), fruit length (FL), fruit breadth (FB), stalk length (SL), single fruit weight (SFW), number of fruits per plant (NF), and yield per plant (YLD).

Significant positive correlations were observed between fruit breadth (FB) and single fruit weight (SFW), suggesting that wider fruits tend to be heavier. Additionally, plant height (PH) showed a positive correlation with plant spread (PS), indicating that taller plants may also have a broader canopy. Conversely, a negative correlation was noted between stalk length (SL) and fruit breadth (FB), implying that longer stalks may be associated with narrower fruits.

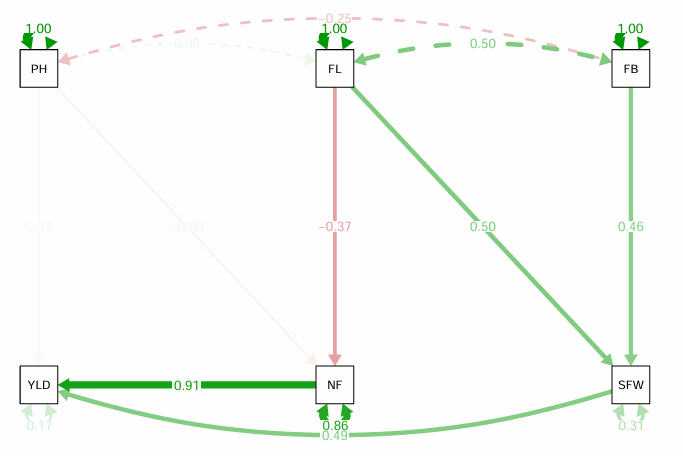


**Fig. 1.** Correlation Matrix Depicting Interrelationships Among Morphological and Yield-Related Traits in Chilli (*Capsicum spp*.) Genotypes

These interrelationships among traits are consistent with findings from previous studies. For instance, Bijalwan and Mishra (2016) reported positive associations between fruit yield per plant and traits such as fruit length and fruit diameter in chilli genotypes. Similarly, (Sharma *et al*., 2019; Janaki 2018) found significant positive correlations between yield and traits like number of fruits per plant and average fruit weight in bell pepper. Understanding these correlations is crucial for breeding programs aiming to improve yield and fruit quality in *Capsicum annuum* L. Path coefficient analysis was conducted using the ‘lavaan’ package in R, which supports structural equation modelling to estimate direct and indirect effects of morphological traits on yield.

**3.2 Path Coefficient Analysis for Yield Determination**

The path coefficient diagram reveals the magnitude and direction of direct and indirect effects of various yield-contributing traits on fruit yield (YLD) in hot pepper genotypes (Fig. 2). Notably, the number of fruits per plant (NF) exhibited the highest positive direct effect on yield (0.91), highlighting it as the most influential trait for yield improvement. This is supported by strong indirect effects through single fruit weight (SFW, 0.86) and fruit breadth (FB, 0.46), indicating that both size and fruit load contribute significantly to productivity. Plant height (PH) and fruit length (FL) showed negative indirect effects on NF and YLD, suggesting that excessive vegetative growth may not always translate into higher yield. Similar findings were reported by Sharmeen *et al.* (2024), who observed that NF, fruit diameter, and single fruit weight significantly influenced yield in *Capsicum annuum* L.



**Fig. 2:** Path Coefficient Analysis Depicting Direct and Indirect Effects of Morphological and Yield-Related Traits on Fruit Yield per Plant

Sharmeen and Islam (2024) also emphasized the importance of fruit weight and NF as major contributors to yield variation. The negative path from FL to NF (-0.37) indicates that longer fruits may bear fewer numbers, possibly due to increased resource allocation per fruit. The robustness of the model is further affirmed by high correlations among traits like SFW–NF (0.49) and FB–SFW (0.50), thicker and heavier fruits consistently contributed more to total yield. These insights confirm that selection for higher fruit number and better fruit weight should be prioritized in hot pepper breeding programs.

**3.3 DUS Characterization: Distinctness, Uniformity, and Stability Evaluation of Chilli Genotypes**

The evaluation of DUS traits in chilli genotypes provides a scientific basis for identifying and protecting novel varieties under the PPV&FRA framework. This assessment focuses on distinguishing morphological characteristics, trait uniformity, and stability across observations (Table. 2-5).

There was a characteristic presence of anthocyanin color on seedlings, particularly on hypocotyls, and varying degrees of pubescence and anthocyanin coloration on plant nodes and stems (Aza-González *et al.,* 2012). The test entries displayed a predominantly semi-upright or upright plant habit, with some genotypes such as TMPH 477 and RHHP 3539 demonstrating a stronger upright compared to others that were semi-upright, a trait commonly linked to improved yield in peppers (Cruz-Ricardez *et al.,* 2023). In terms of plant height, the test entries generally ranged from short to medium in comparison to reference genotypes like Byadagi Kaddi and Pusa Jwala, which were typically medium to tall. Notably, TMPH 489 and RHHP 0443 exhibited medium to strong pubescence, which is often correlated with increased pest resistance in peppers. Leaf length was consistently long (>8 cm) across both the test and reference genotypes, signifying a trait critical for effective photosynthesis and yield potential (Zhou *et al*., 2024).These growth forms are advantageous for intercultural operations and light interception (Sreelathakumary & Rajamony, 2004).

There is notable diversity in morphological traits such as leaf shape, leaf blade width, pubescence, anther color, and flowering behavior. Most test entries exhibited medium leaf blade width (3.01–5.0 cm), whereas MCP 2881, Byadagi Kaddi, and Kashi Anmol had narrow blades (<3 cm). Leaf shape varied from lanceolate in the test entries to predominantly ovate among the reference genotypes, consistent with the findings of Gor *et al.* (2024), who highlighted the importance of leaf shape as a descriptor in Capsicum characterization. Sparse to medium pubescence was common among test entries, whereas strong pubescence was observed in traditional varieties, such as Byadagi Dabbi and G-4, confirming earlier reports that pubescence can influence pest resistance, stress tolerance, productivity, and adaptability (Ratna *et al.,* 2024; Wahyuni *et al.,* 2013). All genotypes exhibited white petal color, but the anther color ranged from pale blue to purple, reflecting genotypic variation, as also reported by Joshi *et al.*(2020). Days to 50% flowering ranged from early (<70 days) in TMPH 477 and MHCP 350 to late (>90 days) in reference varieties, such as Arka Lohit, emphasizing the potential of early flowering genotypes for short-duration cropping systems, as supported by Sushmitha *et al.* (2024).

These findings on morphological diversity set the stage for exploring how such variation translates into differences in yield-related traits. The fruit-bearing habit was predominantly solitary, except in RHHP 0075 and RHHP-2168, which exhibited multiple fruiting per axil, comparable to that of Punjab Gucchedhar, indicating the potential for higher yield per plant, which is associated with increased marketable yield. Fruit color at the mature unripe stage ranged from dark green to light green, reflecting genotypic differences in chlorophyll content and pigment biosynthesis, a trait previously used to distinguish Capsicum types. Fruit length showed a wide range from medium (3.01–6 cm) to very long (>15 cm), with genotypes like Rewa, Jockey, and SANIYA comparable to Byadagi Kaddi, supporting their suitability for dry chilli production, which linked longer fruit length with higher dry recovery and consumer preference. Fruit diameter ranged from narrow (<0.8 cm) to broad (>1.5 cm), with genotypes such as RHHP 3539 and SANIYA showing broader fruits, similar to Byadagi Dabbi, a characteristic associated with higher oleoresin content and processing value (Bosland and Votava, 2012).

Longitudinal fruit shape was predominantly narrowly triangular with acute base and apex, ideal for uniform drying, whereas references like Arka Abhir and Pant C-1 showed moderate triangularity. Most test entries lacked fruit curvature, but 13 genotypes, along with references like Kashi Anmol and Arka Lohit, showed low to medium curvature — a trait that, according to Gurung *et al.* (2012), contributes to consumer appeal and market classification. The presence of the basal neck in several entries and references (e.g., Arka Lohit and Pusa Jwala) served as a key differentiating trait for varietal identification. Cross-sectional shape varied from round to strongly corrugated, with strong corrugation found mainly in Byadagi genotypes, which described corrugation as a stable trait linked to traditional landraces. The pericarp sinuosity varied from weak to strong, with TMPH 489 and Karaari showing strong undulations. Surface texture ranged from smooth to rough, with rough fruits observed in HYVEG-78, MHCP 345, and Jockey, suggesting potential linkage to higher cuticle thickness and possibly resistance to fruit borers

Most test entries and reference genotypes exhibited red mature fruit color at physiological maturity, with intensities ranging from light to dark. Test entries such as MHCP 306 and HYVEG-78 showed dark red coloration, whereas TMPH 489, Lena, and Rewa displayed lighter hues. Among reference genotypes, Byadagi Kaddi, Kashi Anmol, and Pusa Jwala also showed dark red fruits. This variation aligns with earlier findings that fruit color intensity in *Capsicum* is genotype-dependent and primarily influenced by carotenoid composition (Sreelathakumary and Rajamony, 2004). All entries exhibited an acute fruit base shape, while genotypes such as Byadagi Dabbi and Arka Abhir had a round base shape, a trait positively correlated with improved fruit set and consumer preference (Singh *et al.,* 2015). Conversely, acute are beneficial for minimizing mechanical damage during harvesting and transport, thus supporting better post-harvest handling.

The calyx covering was predominantly enveloping across most test entries and reference genotypes, enhancing fruit protection during development, and reducing moisture loss. Exceptions included Rewa and Kashi Anmol, which exhibited non-enveloping types, potentially compromising postharvest quality and increasing susceptibility to pathogens. Calyx dentation was consistently observed among genotypes, indicating a stable genetic trait contributing to physical defense, whereas entries such as RHHP 0143 and Pusa Jwala had smooth calyx margins, which may facilitate ease of harvesting and handling. Pericarp thickness varied notably—very thin (<1 mm) in TMPH 489, Lena, and Byadagi Dabbi, making them suitable for drying and pickling, whereas MHCP 306 and Arka Abhir showed slightly thicker pericarps (1.01–2 mm), which enhance texture, storability, and market value. This trait diversity is crucial for selecting genotypes based on specific postharvest and culinary requirements.

The test entries displayed considerable variation in stalk length, ranging from long (3.6–4.5 cm) in genotypes such as RHHP 0143 to short (1.6–2.5 cm) in the Rewa and Kashi Anmol. Shorter stalks are advantageous for easier and damage-free harvesting, especially under mechanized systems, enhancing harvest efficiency, and reducing post-harvest losses. Most genotypes, including the test and reference lines, showed absent or minimal calyx constriction, while MHCP 306 and Arka Abhir exhibited distinct calyx constriction, a trait associated with improved fruit firmness and reduced susceptibility to cracking during maturation and handling. All the evaluated genotypes exhibited strong pedicel attachment and lacked blossom end appendages, reflecting desirable traits for breeding programs targeting uniform fruit detachment and clean fruit appearance. These traits are known to improve both mechanical harvesting compatibility and market appeal, as observed in Guajillo chile landraces (Moreno-Ramírez *et al*. 2019).

The test genotypes predominantly exhibited medium maturity (101–120 days), with early maturity (<100 days) observed in RHHP 3452, Kashi Anmol, Arka Abhir, Phule Jyothi, Pusa Jwala, and P. Gucchedhar. In contrast, reference genotypes such as Byadagi Kaddi and Arka Lohit were late maturing (>120 days). Early maturity is beneficial in multiple cropping systems and helps to avoid yield losses from late-season biotic stresses. Several test entries such as Lena, MHCP 306, MHCP 350, Rewa, and RHHP 3539 showed high 1000-seed weight, indicating well-developed seeds and greater seedling vigour, a trait also observed in reference genotypes, such as Byadagi Dabbi and G-4. Seed weight is positively correlated with seedling emergence and early growth (Wahyuni *et al.,* 2013 and Gulzar, 2023). High seed recovery rates were recorded in HP-407, NBH-1216, MHCP 306, and MHCP 350 among the test entries and in Arka Lohit and G-4 among the reference genotypes. Efficient seed recovery is essential for commercial seed production and reduces unit production costs. The seed colour was mostly yellow across the test entries, with occasional light yellow to orange-yellow tones. This trait is considered important for market acceptance, and is often associated with better seed quality and phytochemical profiles (Sreelathakumary and Rajamony, 2004).

**Table 2. Expression of Distinctness, Uniformity, and Stability (DUS) Morphological**

**Traits Among Chilli (*Capsicum spp*.) Genotypes (Part-I)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Genotypes** | **Characteristics of DUS guidelines** | | | | | | | | | | |
| **1** | **5** | **9** | **19** | **31** | **33** | **46** | **47** | **48** | **49** | **50** |
| TMPH 489 | 9 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 1 | 9 | 1 |
| Lena | 9 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 1 | 9 | 1 |
| HP-407 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 1 |
| NBH-1216 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 | 9 | 1 |
| MHCP-306 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 9 | 9 | 1 |
| TMPH -477 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 1 | 9 | 1 |
| TMPH -463 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 |
| Karaari | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 9 | 9 | 1 |
| MHCP- 350 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 |
| Rewa | 9 | 9 | 9 | 9 | 1 | 9 | 1 | 9 | 9 | 9 | 1 |
| HYVEG-78 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 1 |
| Jockey | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 |
| Aastha | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 1 | 9 | 1 |
| HYVEG-48 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 9 | 9 | 1 |
| MHCP -345 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 9 | 9 | 1 |
| MHCP -343 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 1 | 9 | 9 | 1 |
| SANIYA | 9 | 9 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 1 |
| Eagle | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 1 | 9 | 1 |
| Gouri | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 1 | 9 | 9 | 1 |
| BIO -1006 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 |
| Ojas | 1 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 9 | 9 | 1 |
| RHHP- 3539 | 9 | 9 | 9 | 9 | 1 | 1 | 1 | 9 | 9 | 9 | 1 |
| RHHP -0143 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 1 | 9 | 9 | 1 |
| MCP-2881 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 1 | 9 | 9 | 1 |
| RHHP- 3452 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 |
| RHHP -0142 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 1 | 1 | 9 | 1 |
| RHHP -0144 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 1 | 9 | 9 | 1 |
| RHHP -0443 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 1 |
| RHHP -0431 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 1 | 9 | 9 | 1 |
| RHHP -0075 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 9 | 1 | 9 | 1 |
| RHHP-5801 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 9 | 9 | 9 | 1 |
| RHHP-2168 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 1 | 9 | 9 | 1 |
| Byadagi Kaddi | 9 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 9 | 1 |
| Byadagi Dabbi | 9 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 9 | 9 | 1 |
| Kashi Anmol | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 1 | 1 | 9 | 1 |
| Arka Lohit | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 1 |
| Arka Abhir | 9 | 9 | 9 | 9 | 1 | 1 | 1 | 9 | 9 | 9 | 1 |
| G-4 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 9 | 9 | 1 |
| Kt-Pl-19 | 1 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 9 | 9 | 1 |
| Phule Jyothi | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 |
| Pusa Jwala | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 | 9 | 1 |
| Arka Haritha | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 9 | 1 | 9 | 1 |
| Arka Suphal | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 9 | 1 | 9 | 1 |
| Pant C-1 | 9 | 9 | 9 | 9 | 1 | 1 | 9 | 9 | 9 | 9 | 1 |
| Arka Kyathi | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 1 |
| P. Gucchedhar | 9 | 9 | 9 | 9 | 9 | 1 | 9 | 9 | 9 | 9 | 1 |

**1.Seedling Anthocyanin colouration of hypocotyl**, **5.Plant anthocyanin colouration of nodes**, **9.Stem Pubescence (hairiness)**, **19. Leaf Pubescence (hairiness)**, **31.Fruit Curvature**, **33. Fruit Neck at basal end**, **48.Fruit Calyx Constriction**, **50.Fruit Blossom end appendage**: Absent-1, Present-9; **46.Fruit Calyx Cover**: Non-enveloping-1, Enveloping-9; **47.Fruit Calyx Margin**: Smooth-1, Dented-9; **49.Fruit Pedicel attachment**: Weak-1, Strong-9.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Genotypes** | **Characteristics of DUS guidelines** | | | | | | | | | | | | | | |
| **2** | **3** | **6** | **7** | **8** | **10** | **11** | **12** | **13** | **15** | **17** | **18** | **20** | **23** | **24** |
| TMPH- 489 | 5 | 3 | 7 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 3 | 3 | 5 | 3 |
| Lena | 5 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 3 | 3 | 5 | 5 | 5 |
| HP-407 | 5 | 3 | 3 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 5 | 3 | 5 | 5 | 3 |
| NBH-1216 | 5 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 3 | 3 | 3 | 5 | 3 |
| MHCP-306 | 5 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 5 | 5 | 5 | 5 |
| TMPH -477 | 7 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 5 | 5 | 3 | 3 | 5 |
| TMPH -463 | 5 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 3 | 3 | 5 | 5 |
| Karaari | 5 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 3 | 5 | 5 | 3 |
| MHCP -350 | 5 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 3 | 3 | 3 | 3 |
| Rewa | 5 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 5 | 3 | 3 | 3 | 3 |
| HYVEG-78 | 5 | 3 | 3 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 7 | 3 | 3 | 3 |
| Jockey | 5 | 5 | 7 | 5 | 3 | 7 | 5 | 7 | 5 | 7 | 5 | 3 | 3 | 3 | 3 |
| Aastha | 5 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 3 | 5 | 5 | 5 | 3 |
| HYVEG-48 | 5 | 3 | 5 | 5 | 3 | 3 | 5 | 7 | 5 | 7 | 3 | 3 | 3 | 3 | 3 |
| MHCP -345 | 7 | 5 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 3 | 3 | 5 | 3 |
| MHCP -343 | 5 | 3 | 7 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 3 | 5 | 5 | 5 | 5 |
| SANIYA | 5 | 3 | 3 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 5 | 3 | 3 | 3 | 3 |
| Eagle | 5 | 5 | 3 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 5 | 3 | 5 | 3 |
| Gouri | 3 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 3 | 5 | 3 | 3 | 3 |
| BIO -1006 | 5 | 3 | 7 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 3 | 3 | 3 | 3 | 3 |
| Ojas | 5 | 5 | 3 | 5 | 3 | 3 | 5 | 7 | 5 | 5 | 5 | 3 | 3 | 3 | 3 |
| RHHP- 3539 | 7 | 3 | 3 | 5 | 3 | 3 | 5 | 7 | 5 | 3 | 5 | 3 | 3 | 3 | 3 |
| RHHP -0143 | 5 | 3 | 3 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 3 | 5 | 5 | 3 |
| MCP-2881 | 5 | 3 | 3 | 5 | 3 | 5 | 5 | 7 | 3 | 7 | 3 | 3 | 3 | 5 | 3 |
| RHHP- 3452 | 7 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 5 | 3 | 3 | 3 | 3 |
| RHHP -0142 | 5 | 5 | 7 | 5 | 3 | 3 | 5 | 7 | 5 | 7 | 5 | 3 | 5 | 5 | 7 |
| RHHP -0144 | 5 | 3 | 3 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 3 | 3 | 3 | 3 |
| RHHP -0443 | 7 | 3 | 5 | 5 | 3 | 5 | 5 | 5 | 5 | 7 | 3 | 3 | 3 | 3 | 3 |
| RHHP -0431 | 5 | 3 | 7 | 5 | 3 | 7 | 5 | 7 | 5 | 7 | 5 | 5 | 3 | 5 | 3 |
| RHHP -0075 | 5 | 5 | 3 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 3 | 7 | 3 | 5 | 3 |
| RHHP-5801 | 3 | 3 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 3 | 5 | 3 | 5 | 3 |
| RHHP-2168 | 5 | 5 | 3 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 3 | 3 | 3 | 5 | 3 |
| Byadagi Kaddi | 7 | 3 | 5 | 7 | 3 | 7 | 5 | 7 | 3 | 5 | 3 | 5 | 7 | 5 | 3 |
| Byadagi Dabbi | 7 | 7 | 5 | 7 | 3 | 7 | 5 | 7 | 5 | 5 | 5 | 5 | 7 | 5 | 3 |
| Kashi Anmol | 3 | 3 | 5 | 3 | 3 | 5 | 5 | 7 | 3 | 5 | 3 | 5 | 5 | 3 | 3 |
| Arka Lohit | 7 | 7 | 5 | 7 | 3 | 5 | 5 | 5 | 5 | 5 | 3 | 5 | 5 | 7 | 5 |
| Arka Abhir | 5 | 3 | 5 | 5 | 3 | 5 | 3 | 7 | 5 | 5 | 3 | 5 | 5 | 3 | 3 |
| G-4 | 7 | 3 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 5 | 3 | 7 | 7 | 3 |
| Kt-Pl-19 | 7 | 3 | 5 | 5 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 3 | 3 |
| Phule Jyothi | 7 | 3 | 5 | 5 | 3 | 7 | 5 | 7 | 5 | 5 | 3 | 3 | 7 | 3 | 5 |
| Pusa Jwala | 7 | 7 | 3 | 5 | 3 | 5 | 5 | 7 | 5 | 5 | 3 | 7 | 7 | 3 | 3 |
| Arka Haritha | 7 | 5 | 5 | 5 | 3 | 5 | 5 | 7 | 5 | 7 | 3 | 3 | 5 | 5 | 3 |
| Arka Suphal | 7 | 3 | 7 | 5 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 3 | 3 | 3 | 3 |
| Pant C-1 | 5 | 3 | 3 | 5 | 3 | 5 | 5 | 5 | 5 | 7 | 5 | 5 | 3 | 3 | 7 |
| Arka Kyathi | 7 | 3 | 5 | 5 | 3 | 5 | 5 | 5 | 5 | 5 | 3 | 7 | 3 | 3 | 3 |
| P. Gucchedhar | 7 | 3 | 7 | 5 | 3 | 5 | 5 | 7 | 5 | 3 | 3 | 3 | 3 | 3 | 7 |

**Table 3. Expression of Distinctness, Uniformity, and Stability (DUS) Morphological**

**Traits Among Chilli (*Capsicum spp*.) Genotypes (Part-II)**

**2.Plant: Habit**:Spreading-3, Semi-upright-5, Upright-7; **3.Plant Length of main stem (cm)**:Very short (up to 1)-3, Medium (5.01-10)-5, Long (>10)-7; **6.Plant: Intensity of anthocyanin colouration of nodes, 18.Leaf: Undulation of margin**: Weak-3, Medium-5, Strong-7; **7.Plant: Height (cm) (Hot pepper and paprika):**Short (<40)-3, Medium (40.01-80)-5, Tall (>80)-7; **8.Plant: Spread (cm)**: Narrow (<50)-3, Medium (50.01-100)-5, Broad (>100)-7; **10.Stem: Intensity of pubescence (hairiness), 20.Leaf: Intensity of pubescence (hairiness):** Sparse-3, Medium-5, Strong-7; **11.Stem: Shape:** Round-3, Angled-5, Flat-7; **12.Leaf: Length of blade (measured from leaf base to leaf tip in cm):** Short (<4)-3, Medium (4.01-8)-5, Long (>8)-7; **13.Leaf: Width of blade (measured on the widest part of the leaf in cm):** Narrow (<3)-3, Medium (3.01-5)-5, Broad (>5)-7; **15.Leaf: Intensity of green colour:** Light-3, Medium-5, Dark-7; **17.Leaf: Shape:** Lanceolate-3, Ovate-5, Broad elliptic-7; **23. Flower: Days to 50% flowering (from the date of sowing):** Early(<70 days)-3, Medium (70-90)-5, Late (>90) -7; **24.Flower/ Fruit: Orientation:** Drooping-3, Semi drooping-5, Erect-7.

**Table 4. Expression of Distinctness, Uniformity, and Stability (DUS) Morphological**

**Traits Among Chilli (*Capsicum spp*.) Genotypes (Part-II)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Genotypes** | **Characteristics of DUS guidelines** | | | | | | | | | | | | | |
| **25** | **27** | **29** | **32** | **34** | **35** | **36** | **38** | **39** | **40** | **41** | **51** | **52** | **53** |
| TMPH 489 | 3 | 7 | 3 | 3 | 3 | 5 | 5 | 3 | 3 | 5 | 3 | 5 | 5 | 5 |
| Lena | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 5 | 3 | 5 | 7 | 5 |
| HP-407 | 3 | 5 | 3 | 3 | 3 | 5 | 5 | 5 | 3 | 5 | 3 | 5 | 5 | 7 |
| NBH-1216 | 3 | 5 | 3 | 3 | 3 | 5 | 5 | 5 | 3 | 5 | 3 | 5 | 5 | 7 |
| MHCP-306 | 3 | 3 | 5 |  | 3 | 3 | 3 | 7 | 3 | 5 | 3 | 5 | 7 | 7 |
| TMPH -477 | 3 | 5 | 3 |  | 3 | 7 | 5 | 5 | 3 | 7 | 3 | 5 | 5 | 7 |
| TMPH -463 | 3 | 3 | 5 | 3 | 3 | 3 | 3 | 5 | 3 | 5 | 3 | 5 | 5 | 5 |
| Karaari | 3 | 3 | 3 |  | 3 | 7 | 3 | 3 | 3 | 7 | 3 | 5 | 5 | 7 |
| MHCP -350 | 3 | 5 | 5 | 3 | 3 | 5 | 3 | 5 | 3 | 7 | 3 | 5 | 7 | 7 |
| Rewa | 3 | 5 | 7 |  | 3 | 3 | 3 | 3 | 3 | 7 | 5 | 5 | 7 | 5 |
| HYVEG-78 | 3 | 3 | 3 | 3 | 3 | 7 | 7 | 7 | 3 | 7 | 3 | 5 | 5 | 7 |
| Jockey | 3 | 5 | 7 | 3 | 3 | 5 | 7 | 5 | 3 | 3 | 5 | 5 | 5 | 5 |
| Aastha | 3 | 3 | 3 |  | 3 | 5 | 5 | 5 | 3 | 7 | 3 | 7 | 5 | 5 |
| HYVEG-48 | 3 | 3 | 3 |  | 3 | 7 | 5 | 5 | 3 | 7 | 3 | 5 | 5 | 7 |
| MHCP -345 | 3 | 7 | 3 |  | 3 | 7 | 7 | 5 | 3 | 7 | 3 | 7 | 7 | 7 |
| MHCP -343 | 3 | 5 | 3 |  | 3 | 7 | 5 | 3 | 3 | 5 | 3 | 7 | 5 | 5 |
| SANIYA | 3 | 3 | 7 | 3 | 3 | 3 | 3 | 5 | 3 | 3 | 5 | 7 | 3 | 3 |
| Eagle | 3 | 7 | 3 |  | 3 | 7 | 5 | 7 | 3 | 5 | 3 | 7 | 5 | 7 |
| Gouri | 3 | 7 | 3 |  | 3 | 5 | 5 | 5 | 3 | 7 | 3 | 5 | 5 | 5 |
| BIO -1006 | 3 | 5 | 5 | 5 | 3 | 5 | 5 | 5 | 3 | 7 | 3 | 5 | 5 | 7 |
| Ojas | 3 | 5 | 7 | 3 | 3 | 3 | 3 | 7 | 3 | 5 | 5 | 5 | 5 | 3 |
| RHHP- 3539 | 3 | 5 | 7 |  | 3 | 3 | 3 | 7 | 3 | 3 | 5 | 5 | 7 | 3 |
| RHHP -0143 | 3 | 3 | 5 |  | 3 | 5 | 7 | 7 | 3 | 3 | 3 | 5 | 5 | 7 |
| MCP-2881 | 3 | 7 | 5 |  | 3 | 5 | 5 | 5 | 3 | 5 | 3 | 5 | 5 | 3 |
| RHHP- 3452 | 3 | 5 | 7 | 3 | 3 | 3 | 7 | 5 | 3 | 3 | 5 | 3 | 7 | 5 |
| RHHP -0142 | 3 | 3 | 5 |  | 3 | 3 | 5 | 3 | 3 | 3 | 3 | 5 | 5 | 7 |
| RHHP -0144 | 3 | 5 | 5 |  | 3 | 5 | 5 | 3 | 3 | 5 | 3 | 5 | 5 | 7 |
| RHHP -0443 | 3 | 5 | 5 | 3 | 3 | 3 | 5 | 7 | 3 | 5 | 3 | 5 | 5 | 5 |
| RHHP -0431 | 3 | 5 | 5 |  | 3 | 3 | 5 | 7 | 3 | 5 | 3 | 7 | 5 | 7 |
| RHHP -0075 | 7 | 5 | 5 |  | 3 | 3 | 3 | 7 | 3 | 5 | 3 | 7 | 3 | 7 |
| RHHP-5801 | 3 | 7 | 5 |  | 3 | 3 | 3 | 7 | 3 | 5 | 3 | 7 | 5 | 5 |
| RHHP-2168 | 7 | 7 | 3 |  | 3 | 5 | 3 | 5 | 3 | 7 | 3 | 5 | 5 | 7 |
| Byadagi Kaddi | 3 | 3 | 3 | 7 | 9 | 5 | 7 | 7 | 3 | 5 | 3 | 7 | 5 | 5 |
| Byadagi Dabbi | 3 | 5 | 7 | 3 | 9 | 5 | 7 | 7 | 5 | 5 | 5 | 7 | 7 | 5 |
| Kashi Anmol | 3 | 5 | 5 |  | 3 | 3 | 3 | 5 | 3 | 5 | 3 | 3 | 3 | 7 |
| Arka Lohit | 3 | 5 | 3 | 3 | 5 | 5 | 3 | 5 | 3 | 5 | 3 | 7 | 7 | 7 |
| Arka Abhir | 3 | 5 | 5 |  | 3 | 3 | 5 | 7 | 3 | 5 | 5 | 3 | 5 | 5 |
| G-4 | 3 | 3 | 5 |  | 3 | 5 | 5 | 5 | 3 | 5 | 3 | 7 | 7 | 7 |
| Kt-Pl-19 | 3 | 5 | 7 | 3 | 3 | 3 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 7 |
| Phule Jyothi | 3 | 7 | 5 | 3 | 3 | 5 | 3 | 5 | 3 | 7 | 3 | 3 | 7 | 5 |
| Pusa Jwala | 3 | 5 | 3 | 5 | 3 | 5 | 5 | 3 | 3 | 7 | 3 | 3 | 5 | 3 |
| Arka Haritha | 3 | 3 | 5 |  | 3 | 3 | 3 | 3 | 3 | 7 | 3 | 7 | 5 | 3 |
| Arka Suphal | 3 | 7 | 5 |  | 3 | 3 | 3 | 7 | 3 | 7 | 3 | 5 | 5 | 5 |
| Pant C-1 | 3 | 3 | 5 |  | 3 | 5 | 3 | 7 | 3 | 5 | 3 | 5 | 5 | 7 |
| Arka Kyathi | 3 | 3 | 5 | 3 | 3 | 5 | 3 | 7 | 3 | 7 | 3 | 5 | 5 | 3 |
| P. Gucchedhar | 5 | 7 | 5 | 3 | 3 | 3 | 3 | 7 | 3 | 7 | 5 | 3 | 5 | 7 |

**25. Fruit: Bearing habit (No. of fruits/ node):**1 (Solitary)-3, 2-3 -5, >3 (Cluster) -7; **27. Fruit: Intensity of colour (at mature unripe stage), 38. Fruit: Intensity of colour (at maturity):** Light-3, Medium-5, Dark-7; **29. Fruit: Diameter (fruits measured at the widest point in cm) [hot pepper and paprika]:** Narrow (<0.8)-3, Medium (0.81-1.5)-5, Broad (>1.5)-7; **32.Fruit: Curvature intensity:** Low-3, Medium-5, High-7; **34. Fruit: Cross sectional corrugation (at level of placenta):** Round-3, Slightly corrugated-5, Strongly corrugated-7; **35. Fruit: Sinuation of pericarp, 40. Fruit: Glossiness:** Weak-3, Medium-5, Strong-7; **36. Fruit: Texture of surface:** Smooth-3, Slightly rough-5, Rough-7; **39. Fruit: Colour transition:** One stage-3, Two stages-5, > Two stages-7; **41. Fruit: Shape at the base:** Acute-3, Round-5, Sunken-7; **51. Fruit: Days to 50% ripening (from the date of sowing)**, Early (<100days)-3, Medium(101-120days)-5, Late (>120 days)-7; **52. Seed: 1000 seed weight (g):** Low (<4)-3, Medium (4.01-6)-5, High (>6)-7; **53. Seed: Recovery (%):** Low (<30)-3, Medium (30.1-50)-5, High (>50)-7.

**Table 5. Expression of Distinctness, Uniformity, and Stability (DUS) Morphological**

**Traits Among Chilli (*Capsicum spp*.) Genotypes (Part-IV)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Genotypes** | **Characteristics of DUS guidelines** | | | | | | | | | | | |
| **4** | **14** | **21** | **22** | **26** | **28** | **30** | **37** | **42** | **44** | **45** | **54** |
| TMPH- 489 | 5 | 3 | 3 | 5 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 5 |
| Lena | 5 | 3 | 3 | 7 | 7 | 7 | 7 | 3 | 1 | 1 | 5 | 5 |
| HP-407 | 5 | 3 | 5 | 7 | 7 | 5 | 7 | 3 | 1 | 1 | 3 | 5 |
| NBH-1216 | 7 | 3 | 3 | 7 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 5 |
| MHCP-306 | 5 | 3 | 3 | 7 | 7 | 5 | 7 | 3 | 1 | 1 | 3 | 3 |
| TMPH -477 | 7 | 3 | 3 | 3 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 5 |
| TMPH -463 | 5 | 3 | 3 | 7 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 7 |
| Karaari | 7 | 3 | 3 | 7 | 7 | 7 | 7 | 3 | 1 | 1 | 5 | 5 |
| MHCP -350 | 5 | 3 | 3 | 3 | 7 | 7 | 7 | 3 | 1 | 1 | 5 | 3 |
| Rewa | 7 | 3 | 3 | 5 | 7 | 9 | 7 | 3 | 3 | 3 | 5 | 3 |
| HYVEG-78 | 7 | 3 | 3 | 5 | 7 | 7 | 7 | 3 | 1 | 3 | 5 | 3 |
| Jockey | 7 | 3 | 3 | 5 | 7 | 9 | 7 | 3 | 1 | 3 | 3 | 5 |
| Aastha | 5 | 3 | 5 | 3 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 3 |
| HYVEG-48 | 5 | 3 | 3 | 3 | 7 | 7 | 7 | 3 | 1 | 1 | 5 | 5 |
| MHCP -345 | 7 | 3 | 3 | 5 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 3 |
| MHCP -343 | 5 | 3 | 5 | 7 | 7 | 5 | 7 | 3 | 1 | 1 | 3 | 7 |
| SANIYA | 5 | 3 | 5 | 3 | 7 | 9 | 7 | 3 | 1 | 3 | 5 | 3 |
| Eagle | 5 | 3 | 5 | 3 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 3 |
| Gouri | 5 | 3 | 3 | 7 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 3 |
| BIO -1006 | 5 | 3 | 5 | 3 | 7 | 7 | 7 | 3 | 1 | 3 | 5 | 5 |
| Ojas | 5 | 3 | 5 | 7 | 7 | 9 | 7 | 3 | 1 | 3 | 7 | 5 |
| RHHP- 3539 | 5 | 3 | 5 | 5 | 7 | 7 | 7 | 3 | 3 | 5 | 3 | 5 |
| RHHP -0143 | 5 | 3 | 3 | 3 | 7 | 7 | 7 | 3 | 1 | 5 | 5 | 5 |
| MCP-2881 | 5 | 3 | 3 | 7 | 7 | 7 | 7 | 3 | 1 | 3 | 5 | 5 |
| RHHP- 3452 | 7 | 3 | 5 | 7 | 7 | 7 | 7 | 3 | 1 | 3 | 5 | 3 |
| RHHP -0142 | 5 | 3 | 3 | 5 | 7 | 5 | 7 | 3 | 1 | 1 | 3 | 7 |
| RHHP -0144 | 5 | 3 | 3 | 3 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 7 |
| RHHP -0443 | 5 | 3 | 3 | 7 | 7 | 7 | 7 | 3 | 1 | 3 | 3 | 5 |
| RHHP -0431 | 7 | 3 | 3 | 7 | 7 | 7 | 7 | 3 | 1 | 1 | 3 | 7 |
| RHHP -0075 | 5 | 3 | 3 | 3 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 5 |
| RHHP-5801 | 5 | 3 | 3 | 7 | 7 | 5 | 7 | 3 | 1 | 1 | 3 | 3 |
| RHHP-2168 | 5 | 3 | 3 | 3 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 3 |
| Byadagi Kaddi | 5 | 3 | 3 | 5 | 7 | 9 | 7 | 3 | 1 | 3 | 3 | 5 |
| Byadagi Dabbi | 5 | 3 | 3 | 5 | 7 | 7 | 8 | 3 | 3 | 5 | 3 | 5 |
| Kashi Anmol | 5 | 3 | 5 | 3 | 7 | 5 | 7 | 3 | 1 | 3 | 1 | 3 |
| Arka Lohit | 7 | 3 | 5 | 3 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 5 |
| Arka Abhir | 5 | 3 | 3 | 5 | 7 | 5 | 8 | 3 | 3 | 5 | 5 | 3 |
| G-4 | 5 | 3 | 3 | 5 | 7 | 5 | 7 | 3 | 1 | 3 | 5 | 5 |
| Kt-Pl-19 | 5 | 3 | 3 | 5 | 7 | 5 | 8 | 3 | 3 | 1 | 3 | 3 |
| Phule Jyothi | 5 | 3 | 3 | 3 | 7 | 5 | 7 | 3 | 1 | 1 | 5 | 5 |
| Pusa Jwala | 9 | 3 | 3 | 5 | 7 | 5 | 7 | 3 | 1 | 1 | 7 | 5 |
| Arka Haritha | 7 | 3 | 3 | 5 | 7 | 5 | 7 | 3 | 1 | 1 | 3 | 5 |
| Arka Suphal | 5 | 3 | 3 | 5 | 7 | 5 | 7 | 3 | 3 | 3 | 5 | 5 |
| Pant C-1 | 5 | 3 | 3 | 3 | 7 | 3 | 8 | 3 | 1 | 1 | 3 | 5 |
| Arka Kyathi | 9 | 3 | 3 | 5 | 7 | 7 | 7 | 3 | 1 | 3 | 5 | 3 |
| P. Gucchedhar | 5 | 3 | 3 | 7 | 7 | 7 | 8 | 3 | 1 | 3 | 3 | 7 |

**4. Plant: Length of first internode:** Very short (up to 1)-1, Short (1.01-2)-3, Medium (2.01-4)-5, Long (4.01-6) -7, Very long (>6)-9**; 14. Leaf: Colour:** Green-3, Purple-5**,** Green with purple tinge-7, Purple with green tinge-9; **21. Flower: Petal colour:** White-3, yellowish green-5, Purple-7, others (specify)-9; **22. Flower: Anther colour:** Yellow-3**,** Pale blue-5, Purple-7, others (specify)-9; **26. Fruit: Colour (at mature unripe stage):** Yellow-3, Pale blue-5, Purple-7**,** others (specify)-9; **28. Fruit: Length (cm) (hot pepper and paprika):** Very short (<2)-1, Short (2.01-5.0)-3, Medium (5.01-10)-5**,** Long (10.01-15)**-7,** Very long (>15)**-9; 30. Fruit: Shape in longitudinal section:** Oblate-1, Circular-2**,** Cordate-3, Square-4, Rectangular-5, Trapezoidal-6, Moderately triangular-7, Narrowly triangular-8, Horn shaped-9, others (specify)-10; **37. Fruit: Colour (at ripe maturity):** Yellow-1, Orange-2**,** Red-3, Brown-4, others (specify)-5; **42. Fruit: Shape of apex:** Acute-1**,** Blunt-3, Depressed-5, Depressed & Acute-7, others (specify)-9; **44. Fruit: Pericarp thickness (at physiological mature stage):** Very thin (<1)-1, Thin (1.01-2)-3, Medium (2.01-3)-5, Thick (3.01-4)-7**,** Very thick (>4)-9; **45. Fruit: Stalk Length (cm):** Very short (<1.5)-1,Short (1.6-2.5)-3, Medium (2.6-3.5), Medium (2.6-3.5)**-**5, Long (3.6-4.5)-7**,** Very long (>4.5)-9; **54. Seed: Colour:** Light yellow-3, Yellow-5, Orange yellow-7, others (specify)-9.

**4. Conclusion**

The comprehensive evaluation of 32 hot pepper test genotypes against 14 reference varieties based on 54 morphological, phenological, fruit, and seed traits revealed considerable phenotypic variation essential for DUS characterization, varietal distinction, and breeding. While all genotypes exhibited strong pedicel attachment and absence of blossom end appendage, significant diversity was recorded in key grouping traits such as fruit shape, size, curvature, surface texture, pericarp sinuosity, neck presence, and seed characteristics including 1000-seed weight, seed recovery, and colour. Variation in days to 50% ripening (early to late) and seed recovery (<30% to >50%) further enabled differentiation among entries. Notably, genotypes like MHCP 350, RHHP 3452, BIO 1006, and Lena displayed highly desirable traits comparable or superior to elite references such as Byadagi Dabbi and Pusa Jwala, indicating their promise for varietal registration and targeted breeding. The observed variability across multiple DUS traits confirms the distinctiveness and breeding potential of the test genotypes for diverse agro-ecological adaptation and market preferences.

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**References**

Anonymous., 2024a, Business Research Insights: Bell Peppers Market Size, Share & Outlook to 2033. https://www.businessresearchinsights.com/market-reports/bell-peppers-market-117840Business Research Insights

Anonymous., 2024b. Package of Practices for Horticultural Crops: Chilli (*Capsicum annuum* L.). University of Horticultural Sciences, Bagalkot, Karnataka, India.

Anonymous., EssFeed, 2025, The Global Paprika Market in 2025: Trends, Opportunities, and Challenges. <https://essfeed.com/the-global-paprika-market-in-2025-trends-opportunities-and-challenges-the-global-paprika-market-in-2025-trends-opportunities-and-challenges/>

Aza-González C., Núñez-Palenius H. G. and Ochoa-Alejo N., 2012, Molecular biology of chili pepper anthocyanin biosynthesis. *J. Mex. Chem. Soc*., 56(1): 93-98.

Bijalwan P. and Mishra A. C., 2016, Correlation and path coefficient analysis in chilli (*Capsicum annuum* L.) for yield and yield attributing traits. *Int. J. Sci. Res.*, *5*(3): 1589-1592.

Bosland P. W. and Votava E. J. eds., 2012. Peppers: vegetable and spice capsicums. Cabi.

Coşkun, Ö.F. and Toprak, S., 2023. Determination of the effect of cucumber grafting on some morphological and physiological characteristics in hydroponic conditions.  *JAFES*., 7(1):163-170.

Cruz-Ricardez D. D .L., Lagunes-Espinoza L. D. C., Ortiz-García C. F., Hernández-Nataren E., Soto-Hernández R. M. and Acosta-Pech R. G., 2023, Phenology, yield, and phytochemicals of *Capsicum spp*. in response to shading. *Bot. Sci.*, 101(3): 865-882.

del Rocio Moreno-Ramírez Y., Santacruz-Varela A., López P. A., López-Sánchez H., Córdova-Téllez L., González-Hernández V. A., Corona-Torres T. and López-Ortega R., 2019, Morphological diversity of Zacatecas Guajillo chile landraces is broad and is given mainly by fruit traits. *EJFA.*, 31(6): 440-448.

Department of Agricultural Marketing, Govt. of Telangana. https://agmarknet.gov.in

Gor Dimple, Diwakar Singh, Gaurang Patel, Parth Bagadiya, Vidyut Balar, and Ankit Yadav. 2024, Assessment of genetic diversity in different Chilli (*Capsicum annuum* L.) genotypes using morphological, biochemical and molecular characters.*Int. J. Adv. Biochem. Res.,* 8(1): 385-397.

Gulzar, I., Evaluation of Rajmash (*Phaseolus vulgaris* L.) Genotypes for DUS traits and Seed Quality Parameters. 2023, M. Sc. (Thesis), krishikosh.egranth.ac.in

Gurung, T., Techawongstien, S., Suriharn, B. and Techawongstien, S., 2012. Stability analysis of yield and capsaicinoids content in chili (*Capsicum spp*.) grown across six environments. *Euphytica.*, 187:11-18.

Janaki M. 2018, Correlation and path analysis studies among biochemical traits and yield in chilli (*Capsicum annuum* L.) genotypes. *Electron. J. Plant. Breed*., 9(4):1563–1569.

Joshi U., Rana D. K., Singh V. and Bhatt R., 2020, Morphological characterization of chilli (*Capsicum annum* L.) genotypes. *AIR*., 2:231-236

Khaitov B., Umurzokov M., Cho K. M., Lee Y. J., Park K. W. and Sung J., 2019, Importance and production of chilli pepper; heat tolerance and efficient nutrient use under climate change conditions. *Korean J. Agric. Sci.,* 46(4):769-779.

Maharjan, A., Vasamsetti, B. and Park, J.H., 2024. A Comprehensive review of Capsaicin: Biosynthesis, Industrial productions, Processing to Applications, and Clinical uses. *Heliyon.,*10: e39721.

Olatunji T. L. and Afolayan A. J., 2018, The suitability of chili pepper (*Capsicum annuum* L.) for alleviating human micronutrient dietary deficiencies: A review. *Food sci. Nutr.*, 6(8): 2239-2251.

Ratna M., Chowdhury A. K., Mahmud F., Rohman M. M., Ali M. Z., Syed M. A., Almoallim H. S., Ansari M. J. and Hossain A., 2024, Morphological and yield trait-based evaluation and selection of chili (*Capsicum annuum* L.) genotypes suitable for both summer and winter seasons*. Open Agric*., 9(1): l20220298.

Sharma A., Kumar M., Kumar N., Dogra R. K., and Kumari, 2019, Studies on interrelationships among yield and yield contributing traits in bell pepper (*Capsicum annuum* L. *var. grossum*). *JPP.*, 8(2): 7671.

Sharmeen F., Islam A. A. and Nuruzzaman M., 2024, Correlation and path coefficient analysis in chilli (*Capsicum annuum* L.) based on yield and yield related traits. *RALF.*, 11(2): 231-238.

Sharmeen, F. and Islam, A.A., 2024. Genetic variability and correlation analysis based on yield and yield related traits in chilli (*Capsicum annuum* L.). *Fundam. Appl. Agric.*, 9(1): 44-50.

Singh P., Cheema D. S., Dhaliwal M. S., Garg N., Jindal S. K. and Chawla N., 2015, Combining ability and heterosis for quality and processing traits in chili pepper (*Capsicum annuum* L.) involving male sterile lines. *J. Crop Improv.*, 29(4): 379-404.

Spices Board of India, \*3rd Advance Estimates, 2023-24

Sreelathakumary I. and Rajamony L., 2004. Genetic divergence in chilli (*Capsicum annuum* L.). *Indian J. Hortic.*, 61(2):137-139.

Sushmitha L. C., Srivastava A., Behera T. K., Singh A. K., Patnaykuni B. and Mangal M., 2024, Evaluation of chili genotypes for yield and yield attributing traits in two contrasting Indian environments. *Vegetable Science.*, 51(02): 242-248.

Wahyuni Y., Ballester A. R., Sudarmonowati E., Bino R. J. and Bovy A. G., 2013, Secondary metabolites of Capsicum species and their importance in the human diet. *J. Nat. Prod*., 76(4): 783-793.

Zhou Y., Wu W., Sun Y., Shen Y., Mao L., Dai Y., Yang B. and Liu Z., 2024, Integrated transcriptome and metabolome analysis reveals anthocyanin biosynthesis mechanisms in pepper (*Capsicum annuum* L.) leaves under continuous blue light irradiation. *BMC Plant Biol.*, 24(1): 210.