

## Original Research Article

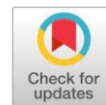
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# Breeding *Capsicum annuum* L. 'Anand Tej' for Enhanced Yield, Quality, and Leaf Curl Virus Tolerance

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## ABSTRACT

*Chili (Capsicum annuum var. annuum L.), a crucial Solanaceae crop with significant economic value in India, faces a major threat from leaf curl disease, particularly during the kharif season, which can result in total crop loss. A novel genotype was developed through a cross between 9639 and ACS 01-04, followed by a single backcross to ACS 01-04, using the pedigree selection method to enhance green fruit yield and leaf curl tolerance. This variety achieved an average yield of 148.96 q/ha, surpassing controls GVC 111, GAVC 112, GVC 121, and CA 283 by 12.09%, 27.63%, 36.89%, and 64.72%, respectively. The cultivar exhibits a dense canopy, weak anthocyanin pigmentation at nodes, moderate stem pubescence, and medium green leaves. The fruit, characterized by its medium color, smooth surface, high gloss, absence of curvature, and minimal pericarp sinuation, also has a weak pedicel attachment at the mature unripe stage. The ACS 13-24 line shows higher ascorbic acid (16.37 mg/100g), total soluble sugars (3.78%), and reducing sugars (0.50%) compared to controls GVC 111 and GAVC 112. Anand Tej demonstrates reduced leaf curl disease incidence relative to controls GAVC 112 and JCA 283 and exhibits lower fruit damage from borers and minimal thrips infestation at the Anand location. DNA fingerprinting using SSR markers (P459: CaBR82 and P468: CaBR107) confirmed the genetic distinctiveness of ACS 13-24 against reference varieties GVC-101, GVC-111, GAVC-112, and Kashi Anmol. This cultivar is highly suitable for cultivation in central Gujarat, combining high yield potential, leaf curl disease tolerance, and an appealing phenotype.*

**Keywords:** Anand Tej, Chilli, Leafcurl, Tollerent, Yield

## Introduction

Chili (*Capsicum annuum* var. *annuum* L.), a vital crop within the *Solanaceae* family, holds significant economic importance and serves as a key culinary spice in India [1]. Its cultivation extends across numerous tropical and subtropical regions, including Japan, Mexico, Turkey, the United States, and various African nations [2]. India stands among the foremost producers and exporters of chili globally. Nonetheless, chili production faces substantial challenges from biotic stressors, particularly viral pathogens, with over 65 viruses documented to infect the crop [3]. Leaf curl disease has emerged as a critical threat in Indian chili cultivation, potentially causing complete crop failure during the *kharif* season. Initial symptoms of leaf curl virus include vein thickening in young leaves, progressing to leaf curling and thickening, typically manifesting within 10-18 days post-infection [4].

Extensive reports indicate the prevalence of chili leaf curl disease in India, caused by begomoviruses of the Geminiviridae family. Notable molecular diversity of these viruses and their satellite components is observed in Southeast Asia. In India, several begomoviruses are implicated in leaf curl disease, including Chilli Leaf Curl Virus (ChiLCV), Chilli Leaf Curl India Virus (ChiLCINV), Chilli Leaf Curl Vellanad Virus (ChiLCVV), Tomato Leaf Curl Joydebpur Virus (ToLCJV), Tomato Leaf Curl

Bangalore Virus (ToLCBaV), Tomato Leaf Curl Palampur Virus (ToLCPaV), and Tomato Leaf Curl New Delhi Virus (ToLCNDV) [5].

ChiLCV in India is identified as a monopartite begomovirus associated with a DNA beta satellite [6]. The complete genome of ChiLCV comprises a single component equivalent to DNA A, responsible for the viral establishment in the host. However, severe symptoms in chili plants are linked to a bipartite begomovirus and a beta satellite [7]. Bipartite begomoviruses possess two genomic components, DNA A and DNA B. In India, the beta satellites Tomato Leaf Curl Bangladesh Beta Satellite (ToLCBDB) and Chilli Leaf Curl Beta Satellite (ChiLCB) are associated with the disease [8].

Various factors contribute to the spread and impact of these viruses, including large populations of insect vectors, a wide host range, the emergence of new viral strains through recombination, and the dissemination of begomoviruses [9]. Managing leaf curl disease in susceptible chili cultivars is challenging. Common field production strategies involve insecticide rotation to control vectors and cultural practices to reduce virus reservoirs and whitefly populations. However, these methods do not offer sustainable disease control.

Resistance breeding is the most ecologically and economically viable approach to mitigate disease incidence. At our research station, we have developed the variety 'Anand Tej' as a resistant source to leaf curl disease. Additional resistant sources from various regions in India include BS-35, GKC-29, and Bhut Jhalokia from IIVR, Varanasi, Saurian 2010, Perennial, Japan Loungi, and S-343, SL 475, and SL 476. Anand serves as a hotspot for chili leaf curl virus, providing a natural facility for germplasm screening.

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Varieties developed in this region are adaptable for cultivation across most parts of the country due to the area's hotspot nature.

The novel genotype was derived from a cross of (9639 x ACS 01-04) followed by a single backcross to ACS 01-04, utilizing the pedigree selection method, specifically for green fruit production and chili leaf curl resistance. This genotype underwent rigorous evaluation in Preliminary Evaluation Trials (PET) starting in 2013, with extensive multi-location trials conducted across various sites within the state from 2017 to 2019, encompassing the *Kharif-rabi* growing seasons. Based on the superior performance metrics of genotype ACS 13-24, it is now being proposed for recommendation under the agronomic conditions prevalent in middle Gujarat.

## Material and Method

### Experimental materials and design

The genotype ACS 13-24, alternatively known as Gujarat Anand Vegetable Chilli 141 and Anand Tej emerged from the controlled crossbreeding program involving 9639 x ACS 01-04 followed by a single backcross to ACS 01-04, utilizing the pedigree selection method of plant breeding at the main vegetable research station of Anand Agricultural University, Anand, spanning the years 2017 to 2019. The field experiment was executed following a randomized complete block design, comprising three replications, while GVC 111, GAVC 112, GVC 121, and JCA 283 were deployed as check varieties. Each experimental plot encompassed 20 plants in 2 lines, adhering to a spacing pattern of 60 × 60 cm across various years and locations. Planting involved the transplanting of two seedlings per hole, with subsequent thinning to a singular plant per hole once plants attained stability.

### Phenotyping and Statistical Analysis

Data were systematically collected encompassing a range of phenology traits, including days to 50% flowering, days to first picking, plant height (cm), plant spread (cm), length of first internode (cm), length of blade (cm), width of blade (cm), fruit length (cm), fruit diameter (cm), fruit girth (cm), fruit: stalk length (cm), no. of fruits/plant, green fruit weight (g), dry fruit weight (g), dry to green fruit weight ratio and dry chilli powder (g/100g). Additionally, biochemical attributes including moisture (%), chlorophyll (mg/g), ascorbic acid (mg/100g), capsaicin (%), phenol (%), total soluble sugars (%), reducing sugars (%), acidity (%) were meticulously recorded following standardized protocols at the Biochemistry Department, A.A.U., Anand. Subsequent statistical analyses were conducted utilizing the INDOSTATE software (IndoStat Inc., Hyderabad, India) within the Statistical Department at A.A.U., Anand.

### Genotypic Diversity Analysis

CTAB protocol of Doyle and Doyle [10] was used to extract the genomic DNA. PCR reaction was performed using SSR marker and the result was observed using 3% agarose gel electrophoresis at the department of Plant Biotechnology, A.A.U., Anand.

## Result and Discussion

### Yield Performance

Chilli accession ACS 13-24 was derived from the segregating population resulting from the cross (9639 x ACS 01-04) x ACS 01-04. The morphological attributes of ACS 13-24 along with checks are delineated in Tables 1. ACS 13-24 exhibited higher plant height (cm) (94.67), plant spread (cm) (66.37), length of

first internode (cm) (5.34), the width of blade (cm) (2.78), fruit diameter (cm) (1.22), fruit girth (cm) (4.54), fruit: stalk length (cm) (3.25), green fruit weight (g) (8.36), dry fruit weight (g) (3.42), dry to green fruit weight ratio (0.41) and dry chili powder (g/100g) (64.8) during the *kharif-rabi* season. The variety showcased a mean yield of 148.96 q/ha, exhibiting 12.09, 27.63, 36.89 and 64.72 % higher fruit yield in Gujarat as well as anand location compared to the controls GVC 111, GAVC 112, GVC 121 and CA 283 respectively (Table 2 and 3) while evaluating under PET, SSVT and LSVT. ACS 13-24 emerges as a high-yielding, rendering it favorable for farmers. The superior performance of ACS 13-24 across various locations and seasons of Gujarat is depicted in Tables 2 and 3.

### Morphological characters

Fruits of this variety has a dense canopy (Fig. 1). The nodes exhibit weak anthocyanin coloration (Fig. 2). The stem has medium pubescence. The leaves display a medium-intensity of green color. The fruit, at the mature unripe stage, shows a medium intensity of color (Fig. 3), is smooth (Fig. 4), and has strong glossiness. There is no curvature in the fruit, and the sinuation of the pericarp is weak. Finally, the pedicel attachment is also weak. Morphological diversity of the developed variety Anand Tej (ACS 13-24) is described in the table 4 as per the DUS guideline. The NBPGR has assigned the National Identity number as IC 638929.

### Nutritional Quality

The line ACS 13-24 contains higher ascorbic acid (mg/100g) (16.37), total soluble sugars (%) (3.78), and reducing sugars (%) (0.50) as compared to the checks GVC 111 and GAVC 112 (Table 12).

### Biotic stress tolerance

Anand Tej exhibits reduced incidence rates of leaf curl disease in contrast to the control varieties GAVC 112 and JCA 283 (Table 6). Moreover, this genotype manifests diminished Fruit damage by fruit borer and minimal infestation levels of Number of thrips/leaf when juxtaposed with the GAVC 112 and JCA 283 at Anand location (Table 7).

### Molecular Characterisation

The DNA fingerprinting analysis utilizing the SSR marker "(P459): CaBR82 and (P468): CaBR107" delineated distinct genetic profiles among the chilli varieties, particularly highlighting the genetic uniqueness of variety ACS 13-24 in comparison to its reference varieties, namely GVC-101, GVC-111, GAVC-112 and Kashi Anmol. A total of 3 bands were observed in both markers, ranging from 118 to 170 bp. Notably, the absence of the band, which typically appears in ACS 13-24 underscores its genetic disparity from the aforementioned reference cultivars (Table 8 and Fig. 5). 100 plus ladder was used as reference to measure band size.

### Conclusion

ACS 13-24 demonstrated a mean yield of 148.96 q/ha, surpassing the control varieties up to 64.72% across Gujarat and Anand locations. The cultivar displays distinct phenotypic and molecular divergence compared to the controls. ACS 13-24 contains higher ascorbic acid (16.37 mg/100g), total soluble sugars (3.78%), and reducing sugars (0.50%) compared to GVC 111 and GAVC 112. Anand Tej shows lower leaf curl disease incidence compared to GAVC 112 and JCA 283. This cultivar is optimally adapted for cultivation in central Gujarat, exhibiting

high yield potential, leaf curl disease tolerance, and an aesthetically appealing phenotype.

Conflict of interest

Author finds No conflict of intret.

Acknowledgment

We are thankful to director of research, Anand Agricultural University, Anand for providing resourcs and support.

Table 1: Ancillary observations of economic attribute of proposed entry along with checks

| Sr. No. | Characters                      | ACS 13-24              | GVC 111 (C)             | GAVC 112 (C)            |
|---------|---------------------------------|------------------------|-------------------------|-------------------------|
| 1       | Days to 50% flowering           | 40.00<br>(39.00-41.00) | 43.67<br>(42.00-45.00)  | 39.67<br>(38.00-42.00)  |
| 2       | Days to first picking           | 56.67<br>(55-58)       | 62.00<br>(60-64)        | 54.67<br>(53-56)        |
| 3       | Plant height (cm)               | 94.67<br>(77-120)      | 77.14<br>(63-95)        | 87.55<br>(68-115)       |
| 4       | Plant spread (cm)               | 66.37<br>(55-81)       | 65.54<br>(50-75)        | 58.77<br>(44-75)        |
| 5       | Length of first internode (cm)  | 5.34<br>(4.0-6.50)     | 3.02<br>(2.00-4.00)     | 2.93<br>(2.00-4.20)     |
| 6       | Length of blade (cm)            | 5.89<br>(4.50-6.80)    | 6.27<br>(4.80-8.20)     | 5.41<br>(4.20-7.50)     |
| 7       | Width of blade (cm)             | 2.78<br>(2.00-4.10)    | 2.77<br>(2.40-3.50)     | 2.60<br>(2.00-3.20)     |
| 8       | Fruit length (cm)               | 12.62<br>(10.20-16.20) | 14.28<br>(12.20-16.30)  | 13.91<br>(11.10-16.30)  |
| 9       | Fruit diameter (cm)             | 1.22<br>(0.50-1.80)    | 0.82<br>(0.50-1.20)     | 0.88<br>(0.50-1.40)     |
| 10      | Fruit girth (cm)                | 4.54<br>(3.50-5.50)    | 3.40<br>(2.50-4.20)     | 4.07<br>(2.80-5.20)     |
| 11      | Fruit: Stalk length (cm)        | 3.25<br>(2.50-4.10)    | 2.86<br>(2.00-3.50)     | 3.00<br>(2.50-3.80)     |
| 12      | No. of fruits/plant             | 91.00<br>(75.0-114.0)  | 114.60<br>(105.0-131.0) | 124.00<br>(109.0-135.0) |
| 13      | Green fruit weight (g)          | 8.36<br>(7.6-9.0)      | 5.26<br>(4.8-5.8)       | 5.54<br>(5.0-6.3)       |
| 14      | Dry fruit weight (g)            | 3.42<br>(3.05-3.87)    | 1.99<br>(1.78-2.26)     | 2.05<br>(1.80-2.40)     |
| 15      | Dry to Green fruit weight ratio | 0.41<br>(0.40-0.43)    | 0.38<br>(0.37-0.39)     | 0.37<br>(0.36-0.38)     |
| 16      | Dry chilli powder (g/100g)      | 64.8<br>(63-67)        | 43.6<br>(42-45)         | 47.0<br>(45-50)         |

Table 2: Yield performance of chilli entry ACS 13-24 in comparison with check varieties in the Gujarat state

| Year/<br>Season                    | Name of<br>trial | Locations              | Green fruit yield (q/ha) |                |                    |                |                | S. Em $\pm$ | CD at 5% | CV%   |
|------------------------------------|------------------|------------------------|--------------------------|----------------|--------------------|----------------|----------------|-------------|----------|-------|
|                                    |                  |                        | ACS<br>13-24             | GVC 111<br>(a) | GAVC<br>112<br>(b) | GVC 121<br>(c) | JCA 283<br>(d) |             |          |       |
| 2013-14<br>/Kharif-<br>Rabi        | PET              | Anand                  | 114.59                   | 102.23         | 110.56             | 104.87         | -              | 11.51       | 34.19    | 16.59 |
|                                    |                  | % Inc. over the checks |                          | 12.09          | 03.65              | 09.27          |                |             |          |       |
| 2016-17<br>/Kharif-<br>Rabi        | PET              | Anand                  | 157.70 <sup>bc</sup>     | -              | 87.79              | 94.04          | -              | 7.60        | 22.56    | 12.82 |
|                                    |                  | % Inc. over the checks |                          | -              | 79.63              | 67.70          |                |             |          |       |
| 2017-18<br>/Kharif-<br>Rabi        | LSVT             | Anand                  | 132.61 <sup>bd</sup>     | -              | 100.14             | -              | 95.25          | 8.96        | 27.18    | 15.30 |
|                                    |                  | Jagudan <sup>#</sup>   | 102.03 <sup>bd</sup>     | -              | 69.22              | -              | 23.54          | 7.42        | 22.50    | 21.79 |
|                                    |                  | Mean (1)               | 132.61                   |                | 100.14             |                | 95.25          |             |          |       |
|                                    |                  | % Inc. over the checks |                          |                | 32.42              |                | 39.22          |             |          |       |
| 2018-19/<br>Kharif-Rabi            | LSVT             | Anand                  | 160.01 <sup>bd</sup>     | -              | 135.01             | -              | 101.94         | 8.34        | 24.77    | 11.79 |
|                                    |                  | Jagudan <sup>#</sup>   | 17.08                    | -              | 13.87              | -              | 31.94          | 2.19        | 6.57     | 10.79 |
|                                    |                  | Mean (1)               | 160.01                   |                | 135.01             |                | 101.94         |             |          |       |
|                                    |                  | % Inc. over the checks |                          |                | 18.52              |                | 56.96          |             |          |       |
| 2019-20<br>/Kharif-<br>Rabi        | LSVT             | Anand                  | 165.80 <sup>bd</sup>     | -              | 142.36             | -              | 83.19          | 7.66        | 22.60    | 10.86 |
|                                    |                  | Jagudan <sup>#</sup>   | 91.93 <sup>bd</sup>      | -              | 65.51              | -              | 66.67          | 7.67        | 22.64    | 12.85 |
|                                    |                  | Mean (1)               | 165.80                   |                | 142.36             |                | 83.19          |             |          |       |
|                                    |                  | % Inc. over the checks |                          |                | 16.47              |                | 99.30          |             |          |       |
| 2020-21<br>/Kharif-<br>Rabi        | LSVT             | Anand                  | 163.02 <sup>bd</sup>     | -              | 124.41             | -              | 96.90          | 8.45        | 24.67    | 12.42 |
|                                    |                  | % Inc. over the checks |                          |                | 31.04              |                | 68.24          |             |          |       |
| Over all Mean (1)                  |                  |                        | 114.59                   | 102.23         |                    |                |                |             |          |       |
| Over all Mean (6)                  |                  |                        | 148.96                   |                | 116.71             |                |                |             |          |       |
| Over all Mean (2)                  |                  |                        | 136.15                   |                |                    | 99.46          |                |             |          |       |
| Over all Mean (4)                  |                  |                        | 155.36                   |                |                    |                | 94.32          |             |          |       |
| Overall % increase over checks     |                  |                        |                          | 12.09          | 27.63              | 36.89          | 64.72          |             |          |       |
| Frequency in top non-signi. groups |                  |                        | 5/6                      | 0/1            | 0/6                | 0/2            | 0/4            |             |          |       |

**Note:** (1) a, b, c and d indicates the significantly superior than respective check  
 (2) # was not included in the mean due to below average yield and/or high CV%  
 (3) The experiment for the year 2014-15 & 2015-16 was vitiated due to poor plant stand

**Table 3: Yield performance of chilli entry ACS 13-24 in comparison with checks in the middle Gujarat**

| Year/<br>Season                    | Name<br>of trial | Location        | Green fruit yield (q/ha) |                |                 |                |                | S. Em $\pm$ | CD at 5% | CV%   |
|------------------------------------|------------------|-----------------|--------------------------|----------------|-----------------|----------------|----------------|-------------|----------|-------|
|                                    |                  |                 | ACS<br>13-24             | GVC 111<br>(a) | GAVC 112<br>(b) | GVC 121<br>(c) | JCA 283<br>(d) |             |          |       |
| 2013-14<br>/Kharif-<br>Rabi        | PET              | Anand           | 114.59                   | 102.23         | 110.56          | 104.87         | -              | 11.51       | 34.19    | 16.59 |
|                                    |                  | % increase over |                          | 12.09          | 03.65           | 09.27          |                |             |          |       |
| 2016-17<br>/Kharif-<br>Rabi        | PET              | Anand           | 157.70 <sup>bc</sup>     | -              | 87.79           | 94.04          | -              | 7.60        | 22.56    | 12.82 |
|                                    |                  | % increase over |                          | -              | 79.63           | 67.70          |                |             |          |       |
| 2017-18<br>/Kharif-<br>Rabi        | LSVT             | Anand           | 132.61 <sup>bd</sup>     | -              | 100.14          | -              | 95.25          | 8.96        | 27.18    | 15.30 |
|                                    |                  | % increase over |                          |                | 32.42           |                | 39.22          |             |          |       |
| 2018-19/<br>Kharif-Rabi            | LSVT             | Anand           | 160.01 <sup>bd</sup>     | -              | 135.01          | -              | 101.94         | 8.34        | 24.77    | 11.79 |
|                                    |                  | % increase over |                          |                | 18.52           |                | 56.96          |             |          |       |
| 2019-20/<br>Kharif-Rabi            | LSVT             | Anand           | 165.80 <sup>bd</sup>     | -              | 142.36          | -              | 83.19          | 7.66        | 22.60    | 10.86 |
|                                    |                  | % increase over |                          |                | 16.47           |                | 99.30          |             |          |       |
| 2020-21/<br>Kharif-Rabi            | LSVT             | Anand           | 163.02 <sup>bd</sup>     | -              | 124.41          | -              | 96.90          | 8.45        | 24.67    | 12.42 |
|                                    |                  | % increase over |                          |                | 31.04           |                | 68.24          |             |          |       |
| Over all Mean (1)                  |                  |                 | 114.59                   | 102.23         |                 |                |                |             |          |       |
| Over all Mean (6)                  |                  |                 | 148.96                   |                | 116.71          |                |                |             |          |       |
| Over all Mean (2)                  |                  |                 | 136.15                   |                |                 | 99.46          |                |             |          |       |
| Over all Mean (4)                  |                  |                 | 155.36                   |                |                 |                | 94.32          |             |          |       |
| Overall % increase over checks     |                  |                 |                          | 12.09          | 27.63           | 36.89          | 64.72          |             |          |       |
| Frequency in top non-signi. groups |                  |                 | 5/6                      | 0/1            | 0/6             | 0/2            | 0/4            |             |          |       |

Note: (1) a, b, c and d indicates the significantly superior than respective check  
 (2) The experiments during the year 2014-15 and 2015-16 were vitiated due to poor plant stand

**Table 4: Morphological characters of proposed entry along with checks (As per DUS Guidelines)**

| Sr. No. | Characters                                                                                           | ACS 13-24  | GVC 111 (C)    | GAVC 112 (C)   |
|---------|------------------------------------------------------------------------------------------------------|------------|----------------|----------------|
| 1       | Seedling: Anthocyanin colouration of hypocotyl                                                       | Absent     | Absent         | Absent         |
| 2a      | Plant: Habit                                                                                         | Upright    | Upright        | Upright        |
| 2b      | Plant: Canopy                                                                                        | Dense      | Dense          | Sparse         |
| 3       | Plant: Length of main stem                                                                           | Long       | Medium         | Medium         |
| 4       | Plant: Length of first internode<br>(on primary branches)                                            | Long       | Medium         | Medium         |
| 5       | Plant: Anthocyanin colouration of nodes                                                              | Present    | Absent         | Present        |
| 6       | Plant: Intensity of anthocyanin colouration of nodes                                                 | Weak       | Not Applicable | Weak           |
| 7       | Plant: Height                                                                                        | Tall       | Medium         | Tall           |
| 8       | Plant: Spread (average of distance between the<br>extremes at widest points taken in two directions) | Medium     | Medium         | Medium         |
| 9       | Stem: Pubescence (hairiness)                                                                         | Present    | Absent         | Absent         |
| 10      | Stem: Intensity of pubescence (hairiness)                                                            | Medium     | Not Applicable | Not Applicable |
| 11      | Stem: Shape                                                                                          | Round      | Round          | Round          |
| 12      | Leaf: Length of blade (measured from leaf base to leaf<br>tip)                                       | Medium     | Medium         | Medium         |
| 13      | Leaf: Width of blade (measured on the widest part of the<br>leaf)                                    | Narrow     | Narrow         | Narrow         |
| 14      | Leaf: Colour                                                                                         | Green      | Green          | Green          |
| 15      | Leaf: Intensity of green colour                                                                      | Medium     | Light          | Light          |
| 16      | Leaf: Shape                                                                                          | Lanceolate | Lanceolate     | Lanceolate     |
| 17      | Leaf: Undulation of margin                                                                           | Weak       | Weak           | Weak           |
| 18      | Leaf: pubescence (hairiness)                                                                         | Absent     | Absent         | Absent         |
| 19      | Flower: Petal colour                                                                                 | White      | White          | White          |
| 20      | Flower: Anther colour                                                                                | Purple     | Purple         | Purple         |
| 21      | Flower: Days to 50% flowering<br>(from the date of sowing)                                           | Early      | Early          | Early          |
| 22      | Flower/ Fruit: Orientation                                                                           | Drooping   | Drooping       | Drooping       |
| 23      | Fruit: Bearing habit (No. of fruits/ node)                                                           | Solitary   | Solitary       | Solitary       |
| 24      | Fruit: Colour (at mature unripe stage)                                                               | Green      | Green          | Green          |
| 25      | Fruit: Intensity of colour (at mature unripe stage)                                                  | Medium     | Light          | Light          |
| 26      | Fruit: Length                                                                                        | Long       | Long           | Long           |
| 27      | Fruit: Diameter (fruits measured at the widest point )                                               | Medium     | Medium         | Medium         |

|    |                                                           |                     |                     |                     |
|----|-----------------------------------------------------------|---------------------|---------------------|---------------------|
| 28 | Fruit: Shape in longitudinal section                      | Narrowly Triangular | Narrowly Triangular | Narrowly Triangular |
| 29 | Fruit: Curvature                                          | Absent              | Present             | Absent              |
| 30 | Fruit: Curvature intensity                                | -                   | Medium              | -                   |
| 31 | Fruit: Neck at basal end                                  | Present             | Present             | Present             |
| 32 | Fruit: Cross sectional corrugation (at level of placenta) | Round               | Round               | Round               |
| 33 | Fruit: Situation of pericarp                              | Weak                | Strong              | Medium              |
| 34 | Fruit: Texture of surface                                 | Smooth              | Rough               | Slightly rough      |
| 35 | Fruit: Colour (at ripe maturity)                          | Red                 | Red                 | Red                 |
| 36 | Fruit: Intensity of colour (at maturity)                  | Dark                | Dark                | Dark                |
| 37 | Fruit: Color transition                                   | Two stages          | Two stages          | Two stages          |
| 38 | Fruit: Glossiness                                         | Strong              | Weak                | Medium              |
| 39 | Fruit: Shape at the base                                  | Acute               | Acute               | Acute               |
| 40 | Fruit: Shape of apex                                      | Acute               | Acute               | Acute               |
| 41 | Fruit: Pericarp thickness (at physiological mature stage) | Very thin           | Very thin           | Very thin           |
| 42 | Fruit: Stalk Length                                       | Medium              | Medium              | Medium              |
| 43 | Fruit: Calyx Cover                                        | Enveloping          | Enveloping          | Enveloping          |
| 44 | Fruit: Calyx Margin                                       | Dented              | Dented              | Dented              |
| 45 | Fruit: Calyx Constriction                                 | Present             | Present             | Present             |
| 46 | Fruit: Pedicel attachment                                 | Weak                | Strong              | Weak                |
| 47 | Fruit: Blossom end appendage                              | Absent              | Absent              | Absent              |
| 48 | Fruit: Days to 50% ripening (from the date of sowing)     | Early               | Early               | Early               |
| 49 | Seed: 1000 seed weight                                    | Low                 | Low                 | Low                 |
| 50 | Seed: Recovery                                            | Low                 | Low                 | Low                 |
| 51 | Seed: Colour                                              | Yellow              | Yellow              | Yellow              |

Table 5: Biochemical parameters of the proposed entry along with checks

| Sr. No. | Characters               | ACS 13-24 | GVC 111 (C) | GAVC 112(C) |
|---------|--------------------------|-----------|-------------|-------------|
| 1       | Moisture (%)             | 82.86     | 79.16       | 80.11       |
| 2       | Chlorophyll (mg/g)       | 0.29      | 0.30        | 0.32        |
| 3       | Ascorbic acid (mg/100g)  | 16.37     | 14.44       | 11.09       |
| 4       | Capsaicin (%)            | 0.22      | 0.17        | 0.27        |
| 5       | Phenol (%)               | 0.18      | 0.21        | 0.24        |
| 6       | Total soluble sugars (%) | 3.78      | 2.88        | 3.01        |
| 7       | Reducing sugars (%)      | 0.50      | 0.36        | 0.35        |
| 8       | Acidity (%)              | 0.10      | 0.08        | 0.10        |

Table 6: Rating of incidence of diseases at Anand centre

| Disease                      | Year and Season     | Name of trial | ACS 13-24 | GAVC 112 (C) | JCA 283 (C) |
|------------------------------|---------------------|---------------|-----------|--------------|-------------|
| Chilli leaf curl disease (%) | 2017-18 Kharif-Rabi | LSVT          | 6.21      | 8.80         | 6.60        |
|                              | 2018-19 Kharif-Rabi | LSVT          | 6.62      | 8.82         | 6.21        |
|                              | 2019-20 Kharif-Rabi | LSVT          | 4.17      | 8.33         | 8.33        |
|                              | 2020-21 Kharif-Rabi | LSVT          | 3.00      | 11.54        | 5.66        |
|                              | Range               |               | 3.00-6.62 | 8.33-11.54   | 5.66-8.33   |
|                              | Reaction            |               | R         | R            | R           |

Table 7: Rating of incidence of insect-pests at Anand centre

| Insect-pests                    | Year and Season     | Name of trial | ACS 13-24 | GAVC 112 (C) | JCA 283 (C) |
|---------------------------------|---------------------|---------------|-----------|--------------|-------------|
| Number of thrips/leaf           | 2017-18 Kharif-Rabi | LSVT          | 2.89      | 6.89         | 2.74        |
|                                 | 2018-19 Kharif-Rabi | LSVT          | 3.78      | 4.89         | 4.78        |
|                                 | 2019-20 Kharif-Rabi | LSVT          | 3.11      | 4.58         | 5.33        |
|                                 | 2020-21 Kharif-Rabi | LSVT          | 3.56      | 2.70         | 4.08        |
|                                 | Range               |               | 2.89-3.78 | 2.70-6.89    | 2.74-5.33   |
| Fruit damage by fruit borer (%) | 2017-18 Kharif-Rabi | LSVT          | 3.08      | 4.85         | 5.30        |
|                                 | 2018-19 Kharif-Rabi | LSVT          | 3.22      | 5.56         | 5.00        |
|                                 | 2019-20 Kharif-Rabi | LSVT          | 3.33      | 6.67         | 6.67        |
|                                 | 2020-21 Kharif-Rabi | LSVT          | 3.00      | 3.98         | 5.21        |
|                                 | Range               |               | 3.00-3.33 | 3.98-6.67    | 5.00-6.67   |

Table 8: Genetic diversity in band size of the chilli entry ACS 13-24

| Primer Name (P459): CaBR82  |           |             |             |              |                  |
|-----------------------------|-----------|-------------|-------------|--------------|------------------|
|                             | 1         | 2           | 3           | 4            | 5                |
| Band number                 | ACS-13-24 | GVC-101 (C) | GVC-111 (C) | GAVC-112 (C) | Kashi Anmol (NC) |
| 1                           | 160       | -           | 160         | 160          | -                |
| 2                           | -         | -           | -           | -            | 166              |
| 3                           | -         | 170         | -           | -            | -                |
| Primer Name (P468): CaBR107 |           |             |             |              |                  |
|                             | 1         | 2           | 3           | 4            | 5                |
| Band number                 | ACS-13-24 | GVC-101 (C) | GVC-111 (C) | GAVC-112 (C) | Kashi Anmol (NC) |
| 1                           | -         | 118         | 118         | 118          | -                |
| 2                           | -         | -           | -           | -            | 122              |
| 3                           | 125       | -           | -           | -            | -                |



Fig. 1 Dense canopy of the chilli entry ACS 13-24



Fig. 2 Weak intensity of anthocyanin coloration at nodes of the chilli entry ACS 13-24



Fig. 3 Medium intensity of green colour at unripe stage



Fig. 4 Weak sinuation of pericarp, smooth texture, and strong glossiness on fruits

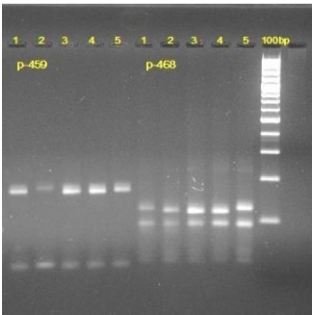


Fig. 5 DNA fingerprinting of chili genotypes by SSR marker

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