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Kashi Chayan: A new tomato variety resistant to *Tomato Leaf Curl virus*

Tomato leaf curl virus (ToLCV) disease caused by Gemini virus has become a threat for tomato cultivation in northern part of India. This disease is transmitted through whitefly and sometime yield loss goes upto 100%. Infected plants have small leaves, that curl upward, turn yellow around the margin; premature flower abortion and loss of small fruits; plants with short internodes that have developed a busy, stunted appearance are easily seen in the field.

THE disease can be partially managed by application of certain pesticides but it is more hazardous to health. In this regards, environmentally safer protection from the biotic and abiotic stresses appears more preferred and effective option. The transfer of economical attributes from wild species to cultivar requires more time comparatively than transfer of economical attributes from a cultivar to another cultivar. Although, the transfer of resistance genes from wild species to cultivars faces the problem of linkage of undesirable traits with the resistance. Most cultivated varieties of tomato are susceptible to ToLCV. Moreover, some varieties/lines derived from wild species either by its derivatives has been developed for resistance to ToLCV and carrying *Ty2* and *Ty3* gene (Table 1).

Table 1. Sources of tomato carrying *Ty2* and *Ty 3* genes for *Tomato leaf curl virus* resistance

Tomato Leaf Curl Virus	Sources
H-88-87	*Ty3*
H-88-78-1	*Ty3*
H-88-78-2	*Ty3*
H-88-78-3	*Ty3*
H-88-78-4	*Ty3*
H-88-78-5	*Ty3*
Hisar Anmol (H-24)	*Ty2*
Hisar Gaurav (H-36)	*Ty2*
Kashi Aman	*Ty2 and Ty3*
Kashi Adarsh	*Ty3*
Kashi Chayan	***Ty3***
TLB-111	*Ty2*
TLB-119	*Ty2*
TLB-183	*Ty2*

(*Source:* Singh *et al.,* 2018)

Therefore, in queue of theses resistant varieties a new tomato variety Kashi Chayan (Kashi Tamatar-8) carrying *Ty-2* and *Ty-3* gene, has been developed and identified for commercial cultivation in Indian states like Uttar Pradesh, Bihar, Jharkhand and states of North East region through All India Co-ordinated Research Program on Vegetable Crops (AICRP –VC) in *XXXVII*th group meeting, 2019.

Development and morphological characters of Kashi Chayan

Kashi Chayan (Kashi Tamatar -8) is developed by an intra-specific cross of Meghalaya Local × H-88-78-2. The developed F_1 was selfed and segregated for F_2 generation. Individual F_2 seeds were used for developing progeny of F_3 as recombinant inbred lines (RILs). The F_3:F_8 generations were proceeded through single plant selection (SPS). Morphological characters, plant type, fruit size, shape, colour and quality of KT-8 represents H-88-78-2 (Table 2).

Kashi Tamatar-8 (Kashi Chayan)

Table 2. Characters of Kashi Chayan and both parents Meghalaya Local and H-88-78-2

Characters	Meghalaya Local	H-88-78-2	Kashi Chayan
Seedling: anthocyanin colouration of hypocotyls	Absent	Present	Present
Leaf: Intensity of green colour	Green	Dark green	Dark green
Plant: Growth habit	Indeterminate	Semi- determinate	Indeterminate
Plant height	112.5	93.6	125.8
Days to 50% flowering	45	55	65-80
Days to first fruit picking	90	105	90
Time of fruit maturity (from seed sowing)	110	120	110-140
Crop duration	123	132	140
Number of fruits /plant	48.6	33.5	51.3
Fruit shape in longitudinal section	Slightly flattened	Circular	Circular
Fruit size (average weight of 10 fruits in g)	Small (<50 g)	Very large (>1000 g)	Very large (>1000 g)
Equatorial fruit length (cm)	3.5	6.3	5.3
Longitudinal fruit length (cm)	3.8	7.0	6.4
Per fruit weight (g)	25.8	149.5	100-120
Number of locules per fruit	3.0	5.2	4.5
Pericarp thickness (cm)	0.20	0.52	0.40-0.60
Green shoulder	Absent	Dark green	Dark green
Fruit firmness (kg/cm^2)	Soft(<3)	Firm(>6)	Firm(>6)
Total soluble solids (^{0}B)	4.3	4.5	4.2-5.0
Acidity	1.2%	1.6%	1.8-2.0%
Lycopene	3.2 mg/g	4.5 mg/g	5.4 mg/g
Beta-carotene	0.67 mg/g	0.98 mg/g	0.98-1.3 mg/g
Ascorbic acid	2.0 mg/g	1.5 mg/g	8.4-8.7 mg/g
Fruit colour at maturity	Red	Red	Red
Colour of flesh at maturity	Pink	Red	Red
ToLCV reaction	Susceptible	Resistant	Resistant
Early blight reaction	Susceptible	Moderately resistant	Moderately resistant
High Temperature (upto night temperature 30^{0}C)	Susceptible	Tolerant	Tolerant

Performance of Kashi Chayan

(a) Performance for high yield

In multi-location testing under AICRP (VC), this variety was tested for three years from 2015-2018 (Table 3) and yielded 57.48% and 58.67% more fruit yield respectively with two national checks Arka Vikas and Kashi Vishesh (H-86), however, at farmer's field it was increased to 71.48% and 60.50%, respectively (Table 4).

Table 3. Three year performance of KT-8 in different zone under AICRP (VC) programme

Year	No of centers	Name of the center	Performing zones
2015-2016	7	Allahabad, Dharwad, Navsari, Rahuri, Raipur, IIVR and Passighat	III, IV, VI, VII, VIII
2016-2017	5	Allahabad, Dharwad, Navsari, IIVR and Parbhani	IV, VI, VII, VIII
2017-2018	11	Dharwad, Allahabad, Navsari, Hyderabad, Junagadh, IIVR, Rahuri, Parbhani, Barapani, Sabour and Raipur	III, IV, V, VI, VII, VIII

Table 4. Fruit yield performance of Kashi Tamatar-8 (Kashi Chayan) along with national checks Arka Vikas and Kashi Vishesh at ICAR-IIVR, Varanasi and farmer's field

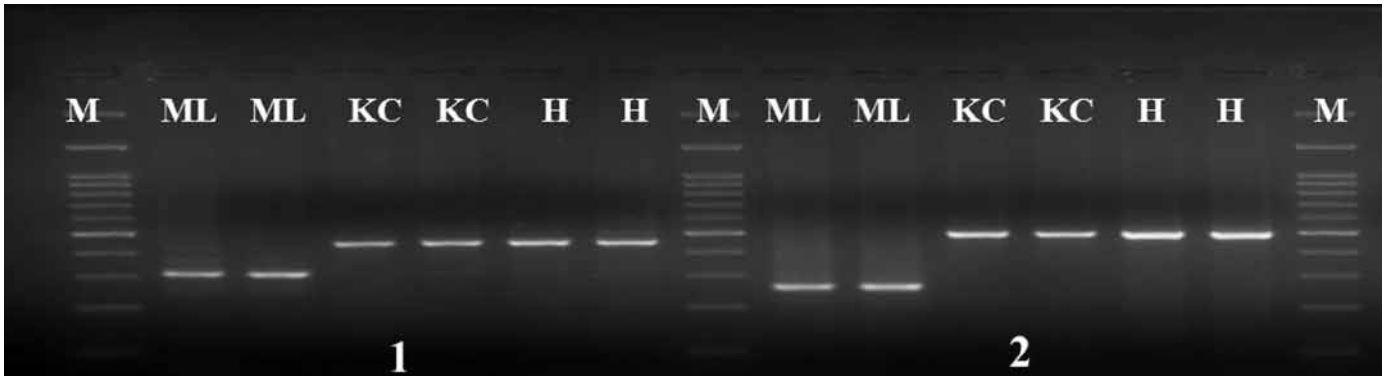
Yield	Kashi Tamatar-8	ArkaVikas (C)	KashiVishesh (H-86) (C)
Average yield at IIVR (q/h)	595.4	342.27	442.76
Average yield at farmer's fields (q/h)	468.14	334.61	283.24

Table 5. Enhancement of Kashi Chayan yield grafted on brinjal root stock IC-354557

Rootstock + Scion	KT-8 (Control)	S. torvum + KT-8	IC-354557 + KT-8	K. Taru + KT-8	Surya + KT-8	IC-111056 + KT-8
Yield/ Plant (kg)	3.36	4.85	5.60	5.00	5.27	5.40
% Change in yield	-	44.35	66.67	48.81	56.85	60.71

Table 6. Reaction of biotic and abiotic stresses on Kashi Chayan (Kashi Tamatar-8) along with checks at ICAR-IIVR, Varanasi

Varieties	Reaction to Tomato Leaf Curl Virus	Reaction to Early blight	Reaction to Bacterial leaf spot	Reaction to high temperature
Kashi Tamatar-8	Resistant (PDI= 6.25)	Moderately resistant (PDI= 9.63)	Moderately resistant (PDI= 10.20)	Tolerant
Arka Vikas (C)	Moderately susceptible	Susceptible	Susceptible	Susceptible
Kashi Vishesh (C)	Susceptible	Susceptible	Susceptible	Susceptible



M, Ladder; ML, Meghalaya Local; KC, Kashi Chayan (Kashi Tamatar-8); H H-88-78-2
The SCAR marker P6-25 (1) amplified a 450 bp fragment that was associated with *Ty-3* in lines Kashi Chayan and H-88-78-2 respectively. The Ty-3 SCAR marker (2) amplified a 510 bp fragment that was associated with *Ty-3* in lines Kashi Chayan and H-88-78-2 respectively. Lane M, size marker ladder.

(b) Performance of Kashi Chayan in grafting technology used as scion

Kashi Chyan (Kashi Tamatar-8) was also tested in grafting technology as scion onto Brinjal root stocks. It was found that when this variety was grafted onto a root stock of IC-354557 the yield was enhanced upto 66.67% (Table 5).

(c) Performance for resistant/tolerant capacity

Kashi Chayan (Kashi Tamatar-8) is resistant to Tomato Leaf Curl Virus (carrying *Ty3* gene). Additionally, this variety has also been recorded Moderately resistant to early blight and bacterial leaf spot and ability to fruit set at high temperature (upto night temperature 30°C)

DNA fingerprinting and confirmation of ToLCV resistance gene '*Ty3*' in Kashi Chayan

A total 12 universal ISSR primers No. UBC-807, 808, 809, 810, 811, 813, 848, 825, 834, 835, 836, and 840 were used for confirmation of parentage (Meghalaya Local and H-88-78-2) of Kashi Chayan. These primers gave positive results and located similar banding pattern of both parents. However, two developed *Ty3* SCAR markers were also used in Kashi Chayan (KC) along with the parents for confirming the presence of *Ty3* gene. In results, the presence of ToLCV resistance gene '*Ty3*' has been confirmed in Kashi Chayan.

SUMMARY

Developed new tomato variety Kashi Tamatar-8 (Kashi Chayan) performed as high yielder against national checks in different states, at ICAR-IIVR, Varanasi and at farmer's field. This variety is confirmed by ICAR-IIVR, Varanasi for being resistant / tolerant to some biotic and abiotic problems, specially for resistance to ToLCV and carrying '*Ty3*' gene. Keeping view of above facts this variety can be used for cultivation in climatic zone IV, VI, VII and VIII and could also be utilized in breeding programs for developing new resistant / tolerant variety for biotic and abiotic problems.

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