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Short Communication

Assessment of morpho-physiological characters of inter-specific hybrids of tomato (*Solanum lycopersicum* × *Solanum pimpinellifolium)*

Prabalee Sarmah*, Amrit Tamuly[1], Kaushik Das[2] and Pranab Talukdar[1]

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Tomato (*Solanum lycopersicum* L.) is an important protective food containing abundant balanced nutrients like vitamins A, B C, minerals, dietary fibres and lycopene. Only 5% of the total genetic variability is contributed by *S. lycopersicum* to the tomato gene pool (Miller and Tanksley 1990). *S. pimpinellifolium*, a closely related species of *S. lycopersicum* is the only red fruited wild species from which natural introgression into cultivated tomato has been detected (Rick 1982). *S. pimpinellifolium* is also a good reservoir of a number of useful traits like high fruits per plant, fruits per cluster, quality traits and resistance to biotic stresses (Foolad 2007). The close phylogenetic relationship between these two species probably accounts for the bidirectional cross compatibility of *S. pimpinellifolium* with cultivated tomato (Bedinger et al. 2011). The inter-specific hybridization with *S. pimpinellifolium* is one of the many options for broadening the genetic base of the cultivated varieties of tomato along with the studies on the variability of morpho-physiological traits in parents and interspecific crosses. The present study was conducted with the aim that selection based on better cross combination through yield attributing traits of parents used in breeding programmes, perhaps may be a better way for exploiting the crosses further for inter-specific gene transfer from the wild species.

The experiment was carried out with six tomato varieties (*S. lycopersicum* L.) viz. Arka Alok, Arka Abha (IIHR, Bangalore); H-24, Punjab Chuhara, ARTH 2808, (IIVR, Varanasi); Singhimari (Farmers' field, Kamrup, Assam) and its crosses with *S. pimpinellifolium* (Farmers' field, Jorhat, Assam) grown in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, located at 26°47¢N latitude and 94°12¢E longitude. Crosses of the tomato varieties (*S. lycopersicum* L.) were made with *S. pimpinellifolium* in *Rabi* season 2014-15 and the parents and inter-specific hybrids were evaluated for nineteen morphological and eight physiological characteristics in *Rabi* season 2015-16. In the first year, the six *S. lycopersicum* genotypes were crossed with *S. pimpinellifolium* in crossing blocks at 60 × 50 cm distance. In the second year, the parents and inter specific hybrids were evaluated in a Randomized Block Design with 3 replications with the objective to evaluate genetic variability parameters of parents and inter specific hybrids for yield attributes and quality parameters. Observations on morphological traits were recorded on five randomly sampled plants. The fruit volume was measured by the standard water displacement method. Pulp P^H was determined following standard method from fresh juice of fruits. Leaf chlorophyll was estimated by DMSO extraction method (Palumbo et al. 1987). Ascorbic acid content of the fruit was determined by 2, 6 dichlorophenol indophenol titration method (Rangana 1986). The total soluble solid was estimated by Zeiss Hand Refractometer. Pericarp thickness and locule number per fruit were recorded at maturity stage of the fruit. All the statistical analyses were performed as per the procedure described in Singh and Choudhury (1985).

Performance of parents and inter specific hybrids: The results showed bidirectional inter-specific cross-compatibility of five varieties *viz*. Arka Alok, Arka Abha, H-24, Punjab Chhuhara and ARTH 2808 with *S. pimpinellifolium* suggesting enough scope for improvement through inter-specific hybridization. The mean performance of parents and crosses for morpho-physiological characters revealed that (Table 1a and Table 1b) among the crosses Punjab Chuhara x *S. pimpinellifolium* (59.87 cm) exhibited determinate

Department of Horticulture, Assam Agricultural University, Jorhat, Assam
[1]Department of Plant Breeding and Genetics, Assam Agricultural University, Jorhat, Assam
[2]Department of Crop Physiology, Assam Agricultural University, Jorhat, Assam
*Corresponding author, E-mail: prabalee@rediffmail.com

growth; whereas *S. pimpinellifolium* x Arka Abha exhibited semi-determinate growth (90.14 cm). The mean number of primary branches per plant for parents and crosses were 2.73 and 2.51, respectively. The average length of leaves of the crosses was less (5.54 cm) than that of the parents (6.25 cm). The parents were observed to be marginally earlier in flowering (62.36 days) compared to the crosses (67.20). The cross *S. pimpinellifolium* x Arka Alok took least days to flower (55.47days). The maximum number of flowers per cluster was found in *S. pimpinellifolium* x Arka Alok (10.33). *S. pimpinellifolium* x Arka Alok gave the maximum number of fruits per cluster (9.17). Fruits per plant were significantly greater in crosses (136.36) than that of parents (80.67). *S. pimpinellifolium* x Arka Alok showed the highest number of fruits per plant (230.20). Longest polar diameter was found in Punjab Chuhara (7.17 cm) and in the crosses Punjab Chuhara x *S. pimpinellifolium* (3.47 cm). Arka Alok x *S. pimpinellifolium* had the widest fruit equatorial diameter of 2.97cm. The parents exhibited higher mean fruit yield per plant (2.16 kg) than the crosses (0.52 kg). Highest fruit yield per plant was found in Arka Alok (3.07 kg) and in Arka Abha x *S. pimpinellifolium* (0.72 kg). The mean fresh and dry weight of seeds for parents was 11.53gm and 0.431gm respectively which was observed to be higher than that of the crosses (2.97 g and 0.245 g, respectively). Excellent mean performance

Table 1(a): Mean performance of parents and crosses of tomato for morphological characters

Variety/cross	Plant Height (cm)	Primary branches per plant	Leaf length (cm)	Leaf breadth (cm)	Days to 50% flowering	Flowers per cluster	Productive flower retention	Fruits per cluster	Fruits per plant	Days to maturity
Arka Abha	63.13	1.73	6.31	3.77	57.93	6.60	5.13	4.43	32.93	106.93
Arka Alok	64.33	2.73	5.57	2.94	59.80	7.33	5.80	5.07	38.13	101.23
H-24	66.20	2.80	6.97	2.85	55.93	7.15	6.73	6.07	40.00	104.85
Punjab Chuhara	70.93	3.00	5.35	2.83	61.73	7.80	6.83	6.17	28.93	112.30
ARTH 2808	68.44	2.33	7.72	4.12	69.53	7.27	6.45	5.90	33.42	100.93
Singhimari local	81.97	1.53	6.35	3.76	67.47	4.73	2.40	1.67	9.20	143.93
Solanum pimpinellifolium	92.95	5.00	5.49	2.31	64.13	10.53	9.87	8.78	368.33	153.73
Arka Abha x *Solanum pimpinellifolium*	73.47	2.53	4.59	2.33	67.00	7.93	6.95	6.20	202.73	96.93
Arka Alok x *Solanum pimpinellifolium*	74.07	2.00	6.11	2.81	70.60	7.87	7.10	6.18	180.17	99.20
H-24 x *Solanum pimpinellifolium*	66.63	1.47	4.58	3.10	69.00	9.93	8.70	8.13	112.00	100.27
Punjab Chuhara X *Solanum pimpinellifolium*	59.87	2.67	5.03	2.35	69.07	8.55	7.77	6.07	186.73	98.27
Solanum pimpinellifolium x Arka Abha	90.14	2.47	5.59	3.75	70.07	7.60	6.85	6.35	214.60	120.53
Solanum pimpinellifolium x Arka Alok	84.26	3.40	6.39	3.33	55.47	10.33	9.55	9.17	230.20	135.03
Solanum pimpinellifolium x H-24	85.87	3.07	6.52	3.07	69.20	9.53	7.93	7.03	145.87	132.73
Mean of Parents	76.33	2.73	6.25	3.23	62.36	7.34	6.17	5.44	78.71	117.70
Mean of Cross	72.57	2.51	5.54	2.96	67.20	8.82	7.84	7.02	181.76	111.19
SE(D)	6.17	0.16	0.26	0.16	1.59	0.24	0.46	0.26	9.35	4.87

Table 1(b): Mean performance of parents and crosses of tomato for morphological characters

Variety/cross	**Days to first picking**	**Harvest duration**	**Polar diameter of fruits (cm)**	**Equatorial diameter of fruits (cm)**	**Fruit weight (g) (10 fruit wt.)**	**Yield /plant (Kg)**	**Fresh weight of seeds (g)**	**Dry weight of seeds (g)**	**1000 seed weight (g)**
Arka Abha	91.40	28.96	4.26	5.89	726	2.39	16.75	0.93	2.71
Arka Alok	95.27	26.30	6.16	6.26	804	3.07	18.00	0.69	3.58
H-24	91.53	20.65	3.98	3.87	642	2.57	13.68	0.29	3.74
Punjab Chuhara	95.33	27.49	7.17	3.08	824	2.38	9.49	0.37	2.46
ARTH 2808	91.47	38.13	5.47	7.09	842	2.81	11.41	0.35	3.34
Singhimari local	100.47	26.33	3.86	7.78	920	0.85	8.02	0.29	3.05
Solanum pimpinellifolium	95.93	56.53	2.00	1.85	29	1.07	3.37	0.11	2.08
Arka Abha x *Solanum pimpinellifolium*	97.80	17.80	3.07	2.27	35.4	0.72	3.69	0.11	2.07
Arka Alok x *Solanum pimpinellifolium*	92.00	16.27	3.17	2.97	30.2	0.54	3.44	0.20	2.15
H-24 x *Solanum pimpinellifolium*	92.27	20.47	2.29	2.41	29.8	0.33	3.61	0.29	2.61
Punjab Chuhara X *Solanum pimpinellifolium*	92.87	16.27	3.47	2.27	36.8	0.69	3.74	0.29	2.72
Solanum pimpinellifolium x Arka Abha	89.87	34.33	2.51	2.68	24.3	0.52	2.34	0.33	2.86
Solanum pimpinellifolium x Arka Alok	89.67	41.47	3.45	2.91	22.2	0.51	2.15	0.30	1.70
Solanum pimpinellifolium x H-24	90.00	43.27	2.74	2.66	21.6	0.32	1.83	0.20	2.00
Mean of Parents	94.49	32.06	4.70	5.12	68.39	2.16	11.53	0.43	2.99
Mean of Cross	92.07	27.14	2.96	2.60	2.86	0.52	2.97	0.25	2.30
SE(D)	1.26	2.40	0.31	0.22	5.63	0.40	0.69	0.04	0.29

for yield and its attributing traits was exhibited by Arka Alok and among crosses Arka Abha x *S. pimpinellifolium* followed by Punjab Chuhara x *S. pimpinellifolium.*

The performances of parents and crosses for physiological characters (Table 2) revealed maximum pH in ARTH 2808 (4.78) for the cross H-24 x *S. pimpinellifolium* (4.37). Maximum fruit volume was observed in ARTH 2808 (57.40 cc) and the cross *S. pimpinellifolium* x Arka Alok (32.60cc). The chlorophyll content of leaves of *S. pimpinellifolium* was 1.93 mgg^{-1} fresh weight of leaves and that of *S. pimpinellifolium* x H-24 was 1.98 mgg^{-1} fresh weight. Maximum ascorbic acid was recorded in Arka Alok (15.97 mg/100 g) and *S. pimpinellifolium* x Arka Abha (19.10 mg/100 g). Highest TSS content was recorded in Punjab Chuhara

Table 2: Mean performance of parents and crosses of tomato for quality characters

Variety/cross	pH of pulp	Fruit volume (cm^3)	Chlorophyll content of leaf (mg/g)	Ascorbic acid content (mg/100g)	Total soluble sugars (Brix %)	Locules per fruit	Pericarp thickness (mm)	Shelf life at room temperature
Arka Abha	4.60	37.60	1.47	13.86	4.00	4.27	3.53	6.93
Arka Alok	4.13	52.34	1.70	15.97	4.23	4.20	3.49	6.87
H-24	4.43	30.61	2.04	10.58	4.50	4.20	4.05	5.93
Punjab Chuhara	4.52	41.33	1.44	12.58	4.80	4.40	3.46	9.53
ARTH 2808	4.78	57.40	2.23	13.74	4.23	2.87	5.70	7.33
Singimari local	3.01	38.60	2.04	10.21	2.60	2.93	4.53	13.13
Solanum pimpinellifolium	3.25	5.80	1.93	22.63	3.16	2.53	2.04	6.87
Arka Abha x S. *pimpinellifolium*	3.73	11.30	1.66	18.01	3.90	2.80	2.13	6.40
Arka Alok x S. *pimpinellifolium*	3.97	18.71	1.95	18.42	3.67	2.80	2.20	7.13
H-24 x S. *pimpinellifolium*	4.37	16.60	1.64	16.98	3.93	3.47	2.21	5.43
Punjab Chuhara X *Solanum pimpinellifolium*	3.47	20.53	1.87	17.62	4.07	2.47	2.46	6.33
Solanum pimpinellifolium x Arka Abha	3.51	12.27	1.70	19.10	4.20	3.20	2.28	7.00
Solanum pimpinellifolium x Arka Alok	3.95	32.60	1.67	16.06	3.67	3.13	2.29	7.20
Solanum pimpinellifolium x H-24	4.07	28.27	1.98	17.09	3.60	3.33	2.53	6.40
Mean of Parents	4.10	37.67	1.84	14.22	3.93	3.63	3.83	8.09
Mean of Cross	3.87	20.04	1.78	17.61	3.86	3.03	2.30	6.56
SE(D)	0.38	2.14	0.12	0.54	0.27	0.23	0.12	0.27

Table 3: Estimation of genetic variance for morphological biochemical quality traits

Characters	Mean ± SE	GCV (%)	PCV (%)	h^2 (bs)(%)	GA (% of mean)
Plant Height (cm)	74.45 ± 6.17	13.15	16.61	62.70	21.45
Primary branches per plant	2.62 ± 0.16	33.92	34.71	95.53	68.29
Leaf length (cm)	5.90 ± 0.26	14.83	15.81	88.00	28.65
Leaf breadth (cm)	3.09 ± 0.16	18.57	19.57	90.00	36.28
Days to 50% flowering	64.78 ± 1.59	8.370	8.90	88.50	16.22
Flowers per cluster	6.23 ± 0.24	16.61	17.25	92.80	32.96
Productive flower retention	6.13 ± 0.46	21.27	23.17	84.30	40.22
Fruits per cluster	6.68 ± 0.26	28.93	29.31	97.40	58.81
Fruits per plant	108.51 ± 9.35	91.11	91.71	98.70	186.43
Days to maturity	114.44 ± 4.87	16.06	16.89	90.50	31.48
Days to first picking	93.28 ± 1.26	3.33	3.72	80.22	6.14
Harvest duration	29.60 ± 2.40	39.66	40.89	94.12	79.27
Polar diameter of fruits (cm)	3.83 ± 0.31	38.87	40.10	94.02	77.63
Equatorial diameter of fruits (cm)	3.86 ± 0.22	51.75	52.22	98.21	105.63
Fruit weight (g)	131.48 ± 12.09	39.44	39.71	98.64	80.70
Yield per plant (Kg)	3.16 ± 0.40	55.16	57.33	92.50	109.31
Fresh weight of seeds (g)	7.25 ± 0.69	77.86	78.72	97.81	158.65
Dry weight of seeds (g)	0.34 ± 0.04	64.29	65.84	95.33	129.31
1000 seed weight (g)	2.64 ± 0.29	22.18	25.88	73.52	39.18
pH of pulp	3.98 ± 0.38	11.65	16.52	49.81	16.94
Fruit volume (cc)	28.85 ± 2.14	53.68	54.44	97.22	109.04
Chlorophyll content of leaf (mg/g)	1.81 ± 0.12	12.02	14.40	69.70	20.66
Ascorbic acid (mg/100g)	15.92 ± 0.54	21.38	21.79	96.32	43.23
Total soluble sugars (Brix %)	3.90 ± 0.27	13.31	15.72	71.72	23.23
Locules per fruit	3.33 ± 0.23	19.66	21.47	83.90	37.10
Pericarp thickness (mm)	3.07 ± 0.12	35.95	36.24	98.44	73.45
Shelf life at room temperature (days)	7.32 ± 0.27	26.00	26.37	97.25	52.79

(4.80%) and *S. pimpinellifolium* x Arka Abha (4.20%). Highest locules per fruit were recorded in Punjab Chuhara (4.40) and H-24 x *Solanum pimpinellifolium* (3.47). Maximum pericarp thickness was observed in ARTH 2808 (5.70 mm) and in *S. pimpinellifolium* x H-24 (2.53 mm). Shelf life was recorded maximum in Singhimari local (13.13 days) and *S. pimpinellifolium* x Arka Alok (7.20 days). The best mean performance for the physiological traits was exhibited by ARTH 2808 and *S. pimpinellifolium* x H-24.

Extent of genetic variation: The highest genotypic coefficient of variation (GCV) was recorded in number of fruits per plant (91.11) and in fruit volume (53.68) in Tables 3. High broad sense heritability was observed in fruits per plant (98.7%) and in pericarp thickness (98.4%). Expected genetic advance was highest for number of fruits per plant (186.43%) and for fruit volume (109.04%). Heritability and genetic advance considered together are more useful for predicting the outcome of selection for superior individual (Johnson et al. 1955). A high GCV followed by high heritability and high genetic advance was obtained in a number of useful characters like fruits per plant, fruit yield per plant, fruit volume and pericarp thickness which indicated high transmissibility of these characters from the parents to the progenies. Similar results were obtained by Madhurina et al. (2012) for fruits per plant, locules per fruit, fruit weight, ascorbic acid content, fruit yield per plant, fruit length and pericarp thickness. Effective selection based on quality characters could be anchored to fruit volume, pericarp thickness, ascorbic acid content. The results also highlights that the characters like fruits per cluster and number of fruits per plant were successfully transmitted from *S. pimpinellifolium* to its crosses with Arka Alok, Punjab Chuhara and H-24 indicating scope of exploitation of inter-specific gene.

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