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Short Communication

PTH-2: A multiple disease resistant hybrid of tomato

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Tomato (*Solanum lycopersicum* L.), a member of family Solanaceae is the most popular and profitable summer vegetable crop due to its versatile uses, nutritive value, unique flavour and processability. It is the third most important vegetable after potato and onion in India, while second in the world after potato. Agro-statistics include India as second highest tomato producer in the world after China. In 2016, the growing area reached 760.0 thousand ha (6.28% of world tomato area), resulting in a total production of about 18.39 million tonnes (9.62% of the world tomato production), with an average productivity of 24.21 tonnes/ha (Anonymous 2016). In India, tomato crop is grown almost round the year, but cultivation of tomato is adversely affected due to high incidence of late blight caused by *Phytophthora infestans* (Mont.) de Bary and root knot caused by *Meloidogyne species*. These pathogens have enormous capacity to generate new forms. From long time, control of diseases was mainly achieved by cultural practices, pesticides, biological approaches but they are not very effective and add an extra cost in tomato production. In addition to this, use of chemicals also causes critical environmental pollution and human hazards due to residue in vegetable products. Resistant breeding is the best alternative to manage these types of diseases without affecting environment and living organisms. Keeping in view, the present hybrid 'PTH-2' was developed having resistance to late blight and root knot nematodes.

The trials were conducted from 2014-15 to 2017-18 at PAU, Ludhiana by taking newly developed F_1 hybrid PTH-2 along with previously released hybrid TH-1 and commercial check 'Shivaji' (Golden Seeds Private Limited, India). During 2016-17, the trials were conducted at other locations i.e. at Bathinda, Gurdaspur, Ballowal Saunkri and Amritsar in addition to PAU, Ludhiana in randomized complete block design with 3 replications. During 2017-18, on farm testing (adaptive research trials) were conducted on 31 locations of the state. The data was recorded for total yield (q/ ha), days from transplanting to first harvest, fruit weight (g), fruit shape index (P/E diameter), pericarp thickness (mm), number of locule per fruit, dry matter (%), total soluble solids (TSS, °Brix), acidity (mg/ 100 ml juice), ascorbic acid (mg/ 100 ml juice), lycopene content (mg/ 100 g), late blight (% disease index), root gall index (0- 5 scale), percent fruit damage by *Heliothus armigera*, number of aphid and whitefly population present per 3 leaves. The disease data on late blight and root gall index under artificial conditions was recorded as per the method given by Thind et al. (1989) and Taylor and Sasser (1978), respectively whereas the data on percent fruit damage, number of aphid and whitefly was recorded under open field conditions in non-sprayed conditions. However, the performance of 'PTH-2' and checks are based on the overall mean obtained from the 3 levels of evaluation trials. The data collected at PAU and other locations were subjected to analysis to calculate least square differences; adaptive trials from 31 locations were averaged.

Performance for total yield: In local research trials, first picking of PTH-2 was possible 114 days after transplanting (Table 3) which was 3.14% and 3.47% earlier than TH-1 (117.9 days) and Shivaji (118.3 days) respectively. For total yield, PTH-2 recorded average fruit yield of 658.34q/ ha (Table 1) in local research trials, which was approximately 37.75% and 9.08% higher than the checks TH-1 and Shivaji, respectively. In multilocation trials, fruit yield of PTH-2 was recorded to be 678.56q/ ha (Table 2) which was 13.75% to 44.35% higher than the checks. Based on the mean performance of 31 on-farm trials, PTH-2 out yielded the checks by 29.63% to 44.23% (Table 2). Overall, PTH-2 recorded an average yield of 676.89q/ ha which was 42.30% and 17.02% more than the checks TH-1 and Shivaji, respectively. Cheema *et al.* 2013 and Jindal

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Table 1: Relative yield performance (q/ha) of tomato hybrids at PAU, Ludhiana

Hybrid	Year				Mean	Per cent increase/ decrease over check
	2014-15	2015-16	2016-17	2017-18		
PTH-2	662.50	650.45	654.89	665.50	658.34	-
TH-1(check)	480.00	461.21	472.43	496.00	477.91	+37.75
Shivaji (check)	590.56	606.90	601.76	615.00	603.56	+09.08
CD at p=0.05	72.50	83.40	89.45	76.92	75.23	-

Table 2: Overall performance of tomato hybrids for total yield (q/ha) at on station, multilocation and On-farm trials

Hybrid	On station research trials (average of 4 years)	Multilocation research trials (average of 5 locations)	Adaptive research trials (average of 31 locations	Overall mean	Per cent increase / decrease over check
PTH-2	658.34	678.56	693.77	676.89	-
TH-1 (check)	475.91	470.09	481.01	475.67	+42.30
Shivaji (check)	603.56	596.54	535.18	578.43	+17.02
CD at p=0.05	75.23	102.65	-	-	-

et al. 2015 also recorded higher total yield of tomato hybrids.

Physical and chemical fruit traits: Based on the research trials (Table 3), average fruit weight (Table 3) of PTH-2 was 75.5g which was higher than the hybrid TH-1 (69.4g) and Shivaji (69.9g) which contributes to its significant higher yield. The fruit shape index of PTH-2 was less than unity (Table 3) indicating its round fruit shape. From checks, TH-1 was also round in shape and Shivaji was oval in shape due to shape index more than unity. The pericarp of PTH-2 (5.45mm) was thicker than both the check hybrids (4.33mm of TH-1 and 5.08mm of Shivaji), while the number of locules of PTH-2 (3.61) was 2.69% less than TH-1 (3.71) but 27.11% more than Shivaji (2.84). Thicker pericarp and lesser number of locules are desirable as these are associated with fruit firmness. Jindal *et al.* 2015 also observed that the genotype having thicker pericarp has longer shelf life, higher fruit firmness and high transportation ability. All the entries were also evaluated for important fruit quality attributes (Table 3). These included dry matter (DM %), total soluble solids (TSS °Brix), acidity (g $100ml^{-1}$), vitamin C (g $100ml^{-1}$) and lycopene (mg $100g^{-1}$). Dry matter % and TSS % of PTH-2 (5.00 and 4.15) was more than TH-1 (4.76 and 3.88) and Shivaji (4.77 and 3.94), respectively. Acidity content of PTH-2 was 0.53g ml^{-1} which was significantly higher than the checks however, Vitamin C content (Table 3) of PTH-2 was less than both the test entries. The lycopene content of PTH-2 (4.68) had significantly higher than the checks TH-1 (4.04mg) and Shivaji (4.07mg) which contributes to deep red fruit colour.

Table 3: Performance of tomato hybrids for horticultural and quality traits (average of 2015-16, 2016-17 & 2017-18)

Trait	PTH-2	TH-1 (check)	Shivaji (check)	CD at p=0.05
Days from transplanting to first harvest	114.2	117.9	118.3	1.7
Fruit weight (cm)	75.5	69.4	69.9	3.3
Fruit shape index	0.92	0.85	1.18	0.07
Pericarp thickness (mm)	5.45	4.33	5.08	0.67
Number of locules per fruit	3.61	3.71	2.84	0.35
Plant height (cm)	108.3	98.3	92.3	2.84
Dry matter (%)	5.00	4.76	4.77	0.25
TSS (ºBrix)	4.15	3.88	3.94	0.21
Acidity (g/100ml of juice)	0.53	0.46	0.45	0.04
Vitamin C (mg/100ml of juice)	21.99	25.85	25.16	2.77
Lycopene (mg/100g of fresh weight)	4.68	4.04	4.07	0.19

Reaction against diseases and insects: The hybrid PTH-2 (0.2) was resistant to root knot nematodes (Table 4)

Table 4: Reaction of tomato hybrids against important diseases (under artificial inoculation conditions) and insect-pests (under natural conditions) *

Hybrid	Root gall index, (0-5 scale)**	Late blight, Whole plant assay (Percent Disease Severity) ***	Number of aphids per 3 leaves	Number of white flies per 3 leaves	Per cent fruit damage by *H. armigera*
PTH-2	0.2 (R)	2.8 (R)	3.83	0.33	18.05
TH-1(check)	2.9 (MS)	56.0 (HS)	4.28	0.29	17.17
Shivaji (check)	3.6 (S)	52.2 (HS)	5.28	0.37	20.03
Punjab Upma (Susceptible check)	4.2 (HS)	55.1 (HS)	-	-	-

*average of 2015-16, 2016-17 and 2017-18

**Root gall index scale (0-5); where 0-1.0: Resistant, 1.1-2.0: Moderately resistant, 2.1-3.0: Moderately susceptible, 3.1-4.0: Susceptible, 4.1-5.0: Highly susceptible

***R-Resistant, HS-Highly Susceptible; where, 0-immune, Traces/0.1-1.0: Highly resistant, 1.1-10%: Resistant, 10.1-15.0%: Moderately resistant, 15.1-40.0%: Moderate susceptible, 40.1-50.0%: Susceptible, >50.1%: Highly susceptible

as compare to checks which were susceptible in sick plot. Similarly, the hybrid PTH-2 was also resistant to late blight (2.8%) when compared with check hybrids (Table 4) which showed highly susceptible reaction (50-56%) under artificial inoculation conditions. The percent fruit damage, number of white flies and number of aphids per 3 leaves were recorded under natural conditions (Table 4). The hybrid PTH-2 recorded 3.83 and 0.33 aphids and white flies per 3 leaves which were less than the commercial check Shivaji (5.28 and 0.37). The fruit borer causes great loss to the tomato crop and it was found that percent fruit damage due to fruit borer was 18.05% in PTH-2 as compared to 20.03% in commercial check Shivaji.

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