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**Short Communication**

# PSM-1: A high yielding bell pepper variety having seed production potential under North Indian plains

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Capsicum or bell pepper, botanically known as *Capsicum annuum* L var. *grossum* Sendt, is a member of family Solanaceae. It originated in Brazil in Tropical South America. Most peppers are bell-shaped; therefore, the name bell pepper is common. Bell pepper is sometimes grouped with less pungent pepper varieties as "sweet pepper". However, sweet peppers come in a range of shapes from round to oblong to taper. Sweet pepper is one of the most popular, remunerative, widely grown and indispensable spice as well as high value vegetable crop grown for its immature fruits in most parts of the world especially in temperate regions of Central and South America and European countries, tropical and subtropical regions of Asian continent. Bell pepper is very sensitive to temperature fluctuations and the optimum temperature for growth and development ranges between 20-25$^0$C and when day temperature rises above 32$^0$C and/or night temperature above 20$^0$C, great losses in yield occur due to reduced fruit set (Erickson and Markhart 2002). Capsicum was grown on an area of 46 thousand hectare with annual production of 288 thousand MT in India. In Punjab, bell pepper is grown on an area of 0.51 thousand hectare with annual production of 4.81 thousand MT during the year 2015-16 (Anonymous 2017). The crop is transplanted in September-October under poly-net house and also in second fortnight of November under low tunnels by covering with a poly-sheet till February. Thus, the bell pepper crop is exposed to low temperature in December-January and to high temperature during May and June. In comparison to low temperature, high temperature affects several physiological and biochemical processes of the plant leading to impaired growth and reproduction; shorten life cycle by hastening flowering and maturity; and reduced yield of quality fruits (Sato *et al* 2002, Long and Ort 2010). The adverse effects of heat stress can be mitigated by developing crop cultivars with improved thermo-tolerance. Thus, the breeding programme for development of heat tolerant variety/hybrid has been established in PAU, Ludhiana because the varieties/ hybrids now available for cultivation in Punjab are mostly from private sector of which, seed cannot be multiplied in plains of Punjab. Also, the seed cost of these hybrids are very high which limits the large scale adoption of these private sector hybrids. Thus, the main objective of present breeding programme is to develop a variety tolerant to high temperature during hot summers of May and June along with good colour, uniform shape and size, uniform locule/lobe number, thicker pericarp, lack of pungency and also able to produce viable seed under North Indian plains. This will in turn make possible for the farmers of the state to retain the seed of variety for next year.

The trials were conducted from 2015-16 to 2017-18 at PAU, Ludhiana by taking newly developed bell pepper cultivar 'PSM-1' along with commercially grown bell pepper variety 'Royal Wonder' (from Seminis Seeds Private Limited, India) and hybrid 'Indra' (from Syngenta Seeds Private Limited, India) used as checks were evaluated in a naturally ventilated polynet house. During 2016-17, the experiment was conducted at other locations i.e at Krishi Vigyan Kendras (Farm Science Centre of PAU Ludhiana) situated at Sangrur, Bathinda and Ferozepur, in addition to PAU, Ludhiana in completely randomized block design with 3 replications in a naturally ventilated polynet house. During 2017-18, on farm testing (adaptive research trials) was done at 14 locations of the state under polynet house. The data was recorded for early yield (q/ ha), total yield (q/ ha), fruit weight (g), days from transplanting to first harvest, fruit length (cm), fruit width (cm), pericarp thickness (mm), number

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of locule per fruit, dry matter (%), ascorbic acid (mg/ 100 ml juice), capsaicin content (%), total chlorophyll (mg/ 100 g), white rot (% disease index), root gall index (0- 5 scale), leaf curl virus (% incidence), number of aphid, thrips and whitefly population present per 3 leaves. The disease data on root gall index and leaf curl virus under artificial conditions was recorded as per the method given by Taylor and Sasser (1978) and Sharma *et al* 2018, respectively whereas the data on number of aphid, thrip and whitefly was recorded under open field conditions in non sprayed conditions. However, the performance of 'PSM-1' and checks are based on the overall mean obtained from the 3 levels of evaluation trials under polynet house conditions. The data collected at PAU and other locations were subjected to analysis to calculate least square differences; adaptive trials from 14 locations under polynet house were averaged. Early yield comprised fruit harvest till the end of March since the normal crop harvest in open starts in April. Fruit weight was recorded by taking mean of ten representative fruits.

*Performance for early yield and total yield:* In local research trials, first picking of PSM-1 (Table 3) was possible after 109 days which was at par with check variety Royal Wonder but 8.9% late than the check hybrid Indra (100.41) under polynet house conditions. Similarly, early yield (harvested till end March) of PSM-1 and Royal Wonder (Table 3) was 220.56q ha$^{-1}$ and 210.87 q ha$^{-1}$ respectively. Thus, the early yield of PSM-1 was 4.60% higher than check Royal Wonder but 17.95% less the check hybrid Indra (268.80q ha$^{-1}$). For total yield, PSM-1 recorded average fruit yield of 620.67 q ha$^{-1}$ in local research trials (Table 1) which was 0.76% higher the Royal Wonder (615.96 q ha$^{-1}$) and 17.92% less than the hybrid Indra (756.17 q ha$^{-1}$) under polynet house conditions. In multilocation trials, fruit yield of PSM-1 (Table 1) was recorded 622.81 q ha$^{-1}$ which was only 0.26% more than Royal Wonder (621.21 q ha$^{-1}$) and 17.12% less than hybrid Indra (748.29 q ha$^{-1}$). Based on the on-farm trials on 14 locations, PSM-1 and Royal Wonder gave fruit yield of 601.65 q ha$^{-1}$ and 602.50 q ha$^{-1}$ respectively whereas hybrid Indra yielded 751.46 q ha$^{-1}$ which was 19.94% higher than the variety PSM-1 (Table 1). Overall, PSM-1 out yielded 615.04 q ha$^{-1}$ which was 0.30% more than Royal Wonder (613.22 q ha$^{-1}$) but 18.21% less the check hybrid Indra (751.97 q ha$^{-1}$). Dhaliwal *et al* 2017 also reported high early and total yield of bell pepper under naturally ventilated polyhouse. However, the early and total yield of hybrid Indra was more than the varieties because hybrids are generally high in vigor and yielded more than the varieties.

Table 1: Overall performance of bell pepper lines for total yield (q/ha) under poly-net house at on-station, multilocation and On-farm trials

| Variety/hybrid | On station research trials (average of 3 years) | Multilocation research trials (average of 4 locations) | Adaptive research trials (average of 14 locations | Overall mean | Per cent increase/ decrease over check |
|---|---|---|---|---|---|
| PSM-1 | 620.67 | 622.81 | 601.65 | 615.04 | - |
| Royal Wonder (check variety) | 615.96 | 621.21 | 602.50 | 613.22 | +00.30 |
| Indra (check hybrid) | 756.17 | 748.29 | 751.46 | 751.97 | -18.21 |
| CD at p=0.05 | 20.16 | 30.12 | - | | - |

*Physical and chemical fruit traits:* Based on the research trials, average fruit weight (Table 2) of PSM-1 was 81.85g which was at par with Royal Wonder (81.26g); lower than hybrid Indra (108.63g). Similarly, the fruit length and fruit width of PSM-1 was 8.24cm and 6.92cm, respectively which was less than with Royal Wonder (8.65 and 7.58) and hybrid Indra (10.17 and 7.41). The pericarp of PSM-1 (4.88mm) was thicker than the checks Royal Wonder (4.40mm) but thinner than Indra (5.43mm). The number of locules/lobes of PSM-1 (3.14) was 30.22% and 24.33% less than Royal Wonder (4.50) and Indra (4.15). Thicker pericarp and lesser number of locules are desirable as these are

Table 2: Performance of bell pepper lines for important horticultural and quality traits (average of 2015-16, 2016-17 and 2017-18)

| Trait | PSM-1 | Royal Wonder (check variety) | Indra (check hybrid) | CD at p=0.05 |
|---|---|---|---|---|
| Early yield (q/ha) | 220.56 | 210.87 | 268.80 | 8.28 |
| Days from transplanting to first harvest | 109.31 | 108.99 | 100.41 | 1.30 |
| Fruit weight (cm) | 81.85 | 81.26 | 108.63 | 3.11 |
| Fruit length (cm) | 8.24 | 8.65 | 10.17 | 0.73 |
| Fruit width (cm) | 6.92 | 7.58 | 7.41 | 0.45 |
| Pericarp thickness (mm) | 4.88 | 4.40 | 5.43 | 0.39 |
| Number of lobes per fruit | 3.14 | 4.50 | 4.15 | 0.62 |
| Number of primary branches per plant | 4.42 | 4.17 | 5.17 | 0.06 |
| Plant height (cm) | 95.44 | 73.70 | 100.92 | 4.70 |
| Plant spread (cm) | 66.76 | 60.14 | 73.36 | 3.80 |
| Seed yield (Kg/ha) | 49.60 | 10.21 | 11.54 | 2.73 |
| Number of seeds per fruit | 72.84 | 65.67 | 74.50 | 9.80 |
| 1000 seed weight (g) | 6.14 | 3.46 | 3.24 | 0.20 |
| Seed germination (%) | 80.67 | 9.25 | 5.25 | 5.07 |
| Dry matter (%) | 5.20 | 5.10 | 4.84 | 0.20 |
| Vitamin C (mg/100g) | 85.82 | 116.32 | 99.07 | 5.21 |
| Capsaicin content (%) | 0.19 | 0.22 | 0.20 | 0.02 |
| Total chlorophyll (mg/g) | 0.058 | 0.052 | 0.064 | 0.004 |
| Proline content in leaves (µg g$^{-1}$ FW) | 4.64 | 3.65 | 3.71 | 0.13 |
| Hill reaction activity in leaves (Δ OD mg$^{-1}$ chl h$^{-1}$) | 0.091 | 0.081 | 0.090 | 0.003 |

associated with fruit firmness. Jindal *et al* 2015; and Dhaliwal and Jindal (2018) also observed in tomato 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 2). These included dry matter (DM %), vitamin C (g $100ml^{-1}$), capsaicin content (%) and total chlorophyll (mg $100g^{-1}$). Dry matter % of PSM-1 was (5.20) which were more than both the checks Royal Wonder (5.10) and Indra (4.84), however, Vitamin C content (Table 2) PSM-1 (85.82) was less than all the test entries. The capsaicin content of PSM-1 (0.019%) was less than both the checks Royal Wonder (0.22) and Indra (0.20) whereas total chlorophyll content of PSM-1 was 0.058 which was more than Royal Wonder (0.052) and less than the Indra (0.064). Less capsaicin content of PSM-1 than both the checks signifies the non-pungency which is the desirable trait in bell pepper and results of total chlorophyll implies that the new variety PSM-1 was deep green than Royal Wonder but less green than the hybrid Indra. The colour of bell pepper affects the consumer preference as deeper the green colour, more is the liking of consumers.

*Seed production potential:* As PSM-1 is the first variety of bell pepper developed by the university which has the potential to set seed under plains of Punjab. It was found that fruit of PSM-1 has 72.84 immature seeds (Table 2) which were less than the hybrid Indra (74.50) but more than Royal Wonder (65.67). However, on comparing seed production potential, PSM-1 has produced 49.60 kg of mature seed in a hectare (Table 2) whereas Royal Wonder produced only 10.21kg per hectare. It was thus concluded that even there is not much significant difference in number of seeds per fruit between new and check variety but there is significant difference in quantity of seed produced per hectare. On testing the germination percent, it was found that PSM-1 has 80.67% whereas Royal Wonder has 9.25% germination of the seed produced. The 1000 seed weight of PSM-1 was 6.14g while it was 3.46g in case of Royal Wonder. It signifies that the Royal Wonder produced seed either of poor quality or without completely developed embryo which in turn results in lower seed weight and lesser germination than PSM-1. It was thus concluded that PSM-1 has high seed production potential than the check variety in the plains of Punjab.

*Reaction against diseases and insects:* PSM-1 (34.77%) was moderately susceptible to white rot (Table 3) as compared to other check varieties (83.49% Royal Wonder and 94.28% Indra). All the test enties were susceptible to root knot nematodes and leaf curl virus under artificial inoculation conditions. The number of aphids, thrips and white flies per 3 leaves were recorded under natural conditions and were found comparable for all the test entries.

Table 3: Reaction of bell pepper varieties against important diseases (under artificial inoculation conditions) and insect-pests (under natural conditions)*

| Variety/Hybrid | Root gall index, (0- 5 scale) *** | Leaf curl virus, % incidence | Number of aphids per 3 leaves | Number of thrips per 3 leaves | Number of white flies per 3 leaves |
|---|---|---|---|---|---|
| PSM-1 | 3.27 (S) | 100.00 | 2.64 | 5.88 | 1.27 |
| Royal Wonder (Check variety) | 3.32 (S) | 100.00 | 3.55 | 6.29 | 1.24 |
| Indra (Check hybrid) | 3.73 (S) | 100.00 | 3.08 | 7.14 | 1.14 |

*average of 2016-17 and 2017-18
**0-immune, 1-10: Highly resistant, 11-25: Resistant, 26-50: Moderately susceptible, 51-75: Susceptible and >75: Highly susceptible
***0: Immune, 0.1-1.0: Resistant, 1.1-2.0: Moderately resistant, 2.1-3.0: Moderately susceptible, 3.1-4.0: Susceptible and 4.1-5.0: Highly susceptible

## References

Anonymous (2017) *Horticultural statistics at a glance 2017*. Horticulture Statistics Divison, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt of India, pp 200.

Dhaliwal M S, Sharma S P, Jindal S K, Dhaliwal L K and Gaikwad A (2017) Growth and yield of bell pepper as influenced by growing environment, mulch, and planting date. Journal of Crop Improvement 31(6):830-846.

Dhaliwal M S and Jindal S K (2018) Punjab Gaurav and Punjab Sartaj: Tomato varieties for polynet house cultivation. Veg Sci 45(1):124-126.

Erickson A N and Markhart A H (2002) Flower developmental stage and organ sensitivity of bell pepper (*Capsicum annuum L*) to elevated temperature. Plant Cell Environ 25: 123-130.

Jindal SK, Dhaliwal MS and Chawla N (2015) Comparative performance of different tomato hybrids under naturally ventilated polyhouse. International Journal of Horticulture 5(14): 1-12.

Long S P and Ort D (2010) More than taking the heat:crops and global change. Curr Opin Plant Biol 13: 241-248.

Sato S, Peet M M and Thomas J F (2002) Determining critical pre and post anthesis periods and physiological processes in *Lycopersicon esculentum* Mill. exposed to moderately elevated temperature. J Exp Bot 53: 1187-95.

Sharma A, Jindal S K and Thakur H 2018. Phenotypic classes of leaf curl virus disease severity for nursery screening in chilli pepper. Pl Dis Res 33(1): 99-103.

Taylor A L and Sasser J N (1978) Biology, identification and control of root knot nematodes (*Meloidogyne spp.*). Coop Publ Dept Plant Pathol, North Carolina State Univ and the US Agency for 1st Div Raleigh, N.C. P 111.