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Short Communication

Punjab Kheera Hybrid-11 (PKH-11): A new hybrid of parthenocarpic gynoecious cucumber (*Cucumis sativus* L.) for poly-net house cultivation

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Cucumber (*Cucumis sativus* L.) is one of the most important cucurbitaceous salad vegetable crops grown extensively in tropical and sub-tropical parts of India. Its primary centre of origin is India (Zeven and Deweb 1982) and secondary centre of diversification is China (De Candolle 1882). It is grown throughout the world and is the fourth most important vegetable crop after tomato, cabbage and onion (Tatlioglu 1993). Cucurbits production in India is primarily limited to the cultivation in open fields. In North India, it is cultivated in open field conditions during spring-summer season and in protected conditions during winter and rainy season to provide protection from cold in winters and virus infection and wilt in rainy season. Mostly gynoecious × monoecious and gynoecious × gynoecious based F_1 hybrids are cultivated in open field conditions due to high yields but parthenocarpic hybrids are mostly cultivated in poly-net houses. Parthenocarpy (seedless fruit) is an economically important yield attributing trait in cucumber (Sun et al. 2006). The role of parthenocarpic cucumber hybrids in increasing the production and productivity of poly-net house grown cucumber is well recognized in the world. The higher yield potential of parthenocarpic cucumber is often higher than that of conventional seeded varieties due to its association with gynoecious trait and also due to the fact that pollination is not a pre-requisite for fruit set as it is in seeded cucumber. Moreover, the energy required to produce seeds in conventional seeded cultivars is not needed in parthenocarpic hybrids as these hybrids are seedless and the conserved energy will be utilized to produce more fruits in parthenocarpic hybrids. However, cultivation of cucumber under protected conditions in India is restricted due to non-availability of suitable parthenocarpic gynoecious hybrids from public sector and high cost of the hybrid seeds developed by the private sector (Kumar et al. 2016). Moreover, parthenocarpic gynoecious hybrids available in the country usually become unstable, that is, gynoecism breaks down under high temperature conditions of protected structures (Cantliffe 1981). Consequently, development of high yielding stable parthenocarpic gynoecious hybrids for protected cultivation is immensely needed. In 2021, Punjab Agricultural University, Ludhiana has released parthenocarpic gynoecious cucumber hybrid "Punjab Kheera Hybrid-11" for commercial cultivation in poly-net house.

Present research work was conducted at Vegetable Research Farm, Punjab Agricultural University, Ludhiana, India, from 2017-18 to 2020-21. Ludhiana is situated at latitude of 30°55' N and longitude of 75°54' E and at a mean altitude of 247 meters above sea level. This place is characterized by very hot and dry summer (April to June) followed by a hot and humid monsoon period and cold winters during December- January. In the study, cucumber crop was sown twice in each year under poly-net house during 2017-18 to 2020-21. The first crop of cucumber was sown in first week of September and its seeds were directly sown in the soil on the raised beds. The second crop was sown in first week of January in the plastic plug trays and transplanted in first week of February. The rooting media used in plastic plug trays was soil-less and composed of cocopeat, perlite and vermiculite in the ratio of 3:1:1 respectively. The seeds were sown at the depth of 0.5 cm in these plug trays. The seedlings were transplanted at 2-3 true leaf stage on the raised beds. The beds were made 100 cm wide (from base) and 15 cm height. The two rows of cucumber have been sown/transplanted on each bed according to the season and the seeds/seedlings were sown/transplanted in a paired row pattern with row to row and plant to plant spacing of 50 cm and 30 cm respectively with zigzag way (means plants of second row was placed in the centre and parallel of the plants

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of the first row). The drip laterals of 20 mm diameter, 2.0 liter discharge/dripper/hour and 30 cm spacing between two drippers (20:2:30) were laid on beds before transplanting. Two drip lines on each bed were laid and washed before closing them from the ends with the help of end plugs. The standard package of practices recommended for the crop was followed to raise a healthy crop (Dhall 2019). The plants were trained upwards so that the main stem is allowed to climb to the overhead wire along a polythene twine. All the laterals and fruits were removed from the main stem up to 20 cm from the ground level. The eight parthenocarpic hybrid combinations and one commercial hybrid (Multistar of Rizak Jawan Seeds) and one variety Punjab Kheera-1 as checks were evaluated for estimation of various yield and quality traits along with their reaction to diseases from 2017-18 to 2020-21 but the results of only released hybrid "Punjab Kheera Hybrid-11" were discussed in this manuscript. The data were recorded for fruit weight (g), fruit length (cm), fruit diameter (cm), number of fruits per vine, total yield (q/ha), dry matter (%), ascorbic acid (mg/100g) and total soluble solids (%). The data recorded were subjected to analysis of variance to detect genotypic differences. The analysis was carried out using computer software CPCS1 statistical package. The screening for downy mildew and wilt diseases was undertaken under field conditions whereas the reaction to root-knot nematode incidence was observed under artificial conditions. The PDI of downy mildew were recorded by using 0-5 visual rating scale and categorized as resistant (0-25%), moderately resistant (26-40%), susceptible (41-60 %) and highly susceptible (>60%). The scoring for wilt was done using scale of 1-4 where 1= 1-5% moderately resistant, 2= 6-10% moderately susceptible, 3=11-20% susceptible, 4= >20-100% highly susceptible. The root–knot nematode was characterized using scale of 0-5 (Taylor and Sasser 1978).

Total yield (q/ha): Yield is a complex character which involves the interaction of several intrinsic and external factors. It largely depends upon the production and mobilization of carbohydrates, uptake of nutrients and water from the soil and the hormonal balance, in addition to several environmental factors to which plant is exposed during the growing period (Schaffer and Andersen 1994). In addition, cucumber yield depends not only on the accumulation of photo assimilates during the crop growth and development, but also on its partitioning in the desired storage organs (Jiang et al. 2012). It was evident from the data given in Table 1 that mean total yield of new hybrid 'Punjab Kheera Hybrid-11' from September sown crop was 799.7 q/ha which was 10.91% higher than the check hybrid 'Multistar' and 16.25% higher than the check variety Punjab Kheera-1 . However, January sown crop of 'Punjab Kheera Hybrid-11' gave mean total yield of 951.2 q/ha which was 7.23% higher than the check hybrid Multistar and 14.16% higher than check variety 'Punjab Kheera-1'. The lower yield in September sown crop was due to the fact its crop duration is less (First week of September to last week of December) than the January sown crop (First week of January to last week of May). In addition, the September crop was more infested with severe diseases like wilt and insect pest like white fly, which results into lower yields as compared to January sown crop. These results are in conformity with the findings of Dhall (2019) and Dhall and Dhillon (2021).

Number of fruits per vine: The mean number of fruits per vine in September sown crop of 'Punjab Kheera Hybrid-11' was 18.09 which was significantly less than both the check hybrid 'Multistar' (14.46%) and heck variety 'Punjab Kheera-1' (15.34%), which may be due to larger fruit size and weight of 'Punjab Kheera Hybrid-11' (table 2). However, mean number of fruits per vine in January sown crop of 'Punjab Kheera Hybrid-11' was 20.05 which were significantly less than the check hybrid 'Multistar' and check variety 'Punjab Kheera-1' by 17.76% and 18.23% per cent, respectively. Both the check variety and hybrid were at par for number of fruits per vine in both the seasons. It was observed that the time of planting affect the number of fruits per vine

Table 1: Total yield (q/ha) at PAU, Ludhiana

Variety/ Hybrid	Year								Mean		Percent increase (+) or decrease (-) over check	
	2017-18		2018-19		2019-20		2020-21					
	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown
PKH-11	845.6	964.8	792.0	935.1	802.5	995.8	758.5	909.0	799.7	951.2		
Multistar	684.8	881.4	749.8	883.8	747.4	902.4	720.6	880.5	725.7	887.0	+10.19	+7.23
Punjab Kheera-1	679.0	855.1	693.8	873.9	718.3	842.8	660.5	760.8	687.9	833.2	+16.25	+14.16
CD @ 5%	35.8	40.1	42.2	46.8	32.8	42.8	25.4	22.6				

Multistar as Check Hybrid; Punjab Kheera-1 as Check Variety

as more fruits per vine were observed in January sown crop. An increase in number of fruits per vine in January sown crop may further be attributed to the reason that plants remain physiologically more active to build up sufficient source for the developing flowers, ultimately leading to more number of fruits. These results are in conformity with the findings of Dhall (2019).

Fruit weight (g): From consumer acceptability point of view, higher fruit weight in seedless cucumber is not desirable character and average fruit weight of about 120-170 g is generally preferred by consumers. Among genotypes and years, the maximum average fruit weight (170.0 g) was observed in hybrid 'Punjab Kheera Hybrid-11' (January sown) during 2019-20 while minimum (110.0 g) in variety 'Punjab Kheera-1' (September sown) during 2017-18. The mean fruit weight in September sown crop of 'Punjab Kheera Hybrid-11' was 151.0 g which was significantly higher than both the check hybrid and variety by 26.67% and 31.07% respectively (Table 2). However, mean fruit weight in January sown crop of 'Punjab Kheera Hybrid-11' was 162.2 g which was at significantly higher than check hybrid 'Multistar' by 28.93% and also significantly higher than check variety 'Punjab Kheera-1' by 35.73%. Similar results were corroborated by Dhall and Singh (2016).

Fruit length (cm): Among genotypes and years, the maximum average fruit length (19.0 cm) was observed in hybrid 'Punjab Kheera Hybrid-11' (January sown) during 2018-19 while minimum (13.2 cm) in variety 'Punjab Kheera-1' (September sown) during 2020-21. The mean fruit length in September sown crop of 'Punjab Kheera Hybrid-11' was 16.2 cm which was significantly higher than both the check hybrid (Multistar) and check variety (Punjab Kheera-1) by 10.9% and 18.2% respectively (Table 2). However, mean fruit length in January sown crop of 'Punjab Kheera Hybrid-11' was 18.1cm which was also significantly higher than the check hybrid and check variety by 16.0% and 22.2%, respectively. Similar results for fruit weight in cucumber were reported by Kaur et al (2016) and Singh et al (2016).

Fruit diameter (mm): Higher fruit diameter is less desirable attribute for parthenocarpic cucumber. Among genotypes and years, the minimum average fruit diameter (30.1 mm) was observed in hybrid 'Multistar' during 2020-21 (September sown) while maximum (38.2 mm) in 'Punjab Kheera Hybrid-11' during 2018-19 (January sown). The mean fruit diameter in September sown crop of 'Punjab Kheera Hybrid-11' was 35.3 mm which was significantly higher than both the checks (Table 2). However, mean fruit diameter in January sown crop of 'Punjab Kheera Hybrid-11' was 37.2 mm which was also higher than both the checks (Multistar & Punjab Kheera-1). It was concluded that there were non-significant differences between the 'Punjab Kheera-1' and the check hybrid 'Multistar' for fruit diameter during both the sowing seasons. Similar results for fruit weight in cucumber were reported by Kaur et al (2016) and Singh et al (2016).

Quality characters: The dry matter content of 'Punjab Kheera Hybrid-11' was 3.29 % which is significantly higher than both the checks. The ascorbic acid content of 'Punjab Kheera Hybrid-11' was 6.5 mg/100g which

Table 2: Yield attributing traits

Variety/ Hybrid	Year								Mean		Percent increase (+) or decrease (-) over check	
	2017-18		2018-19		2019-20		2020-21					
	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown	Sept. Sown	Jan. Sown
	Number of fruits per vine											
PKH-11	18.60	20.50	18.05	19.50	18.10	20.80	17.60	19.40	18.09	20.05		
Multistar	21.06	24.70	21.5	24.26	22.04	25.50	20.01	23.05	21.15	24.38	-14.46	-17.76
Punjab Kheera-1	22.09	25.08	21.01	24.50	21.20	24.80	21.19	23.70	21.37	24.52	-15.34	-18.23
CD @ 5%	2.42	2.01	1.89	2.50	1.05	1.28	1.54	1.62				
	Fruit weight (g)											
PKH-11	160.5	165.0	155.5	168.4	152.3	170.0	135.5	145.5	151.0	162.2		
Multistar	116.3	125.7	124.0	128.3	120.6	124.5	116.0	124.5	119.2	125.8	+26.67	+28.93
Punjab Kheera-1	110.0	120.3	118.0	125.7	120.8	120.0	112.0	112.0	115.2	119.5	+31.07	+35.73
CD @ 5%	8.45	9.91	9.25	10.60	7.50	8.25	9.41	10.68				
	Fruit length (cm)											
PKH-11	15.8	18.2	16.4	19.0	16.5	17.2	15.9	18.0	16.2	18.1		
Multistar	15.0	15.8	14.5	16.0	14.5	15.5	14.4	15.1	14.6	15.6	+10.9	+16.0
Punjab Kheera-1	13.8	15.5	14.2	15.0	13.5	14.5	13.2	14.2	13.7	14.8	+18.2	+22.2
CD @ 5%	1.52	1.69	1.38	1.72	1.12	1.02	1.21	1.42				
	Fruit diameter (mm)											
PKH-11	35.7	36.6	34.9	38.2	35.9	37.1	34.7	36.9	35.3	37.2		
Multistar	30.5	31.6	32.1	33.4	31.8	35.9	30.1	31.2	31.1	33.0	+13.5	+12.7
Punjab Kheera-1	33.2	34.9	32.4	35.3	32.8	36.3	32.8	34.1	32.8	35.2	+7.6	+5.6
CD @ 5%	2.05	2.22	2.18	2.68	2.50	2.01	1.95	2.02				

Multistar as Check Hybrid; Punjab Kheera-1 as Check Variety

Table 3: Quality traits

Variety/ Hybrid	Dry matter (%)	TSS (%)	Ascorbic acid (mg/100 g)
PKH-11	3.29	3.9	6.5
Multistar	2.98	3.1	6.3
Punjab Kheera-1	2.82	2.8	5.5
CD @5%	0.12	0.10	0.30

is non-significantly different from the check hybrid 'Multistar' but significantly higher than the check variety ''Punjab Kheera-1'. The total soluble content (TSS) of 'Punjab Kheera Hybrid-11' was 3.9 per cent which was significantly higher than both the checks used in the experiment. Similar results were corroborated by Dhall and Singh (2016).

Reaction against diseases: The screening for downy mildew and wilt diseases was undertaken under field conditions whereas the reaction to root-knot nematode incidence was observed under artificial conditions. Upon screening against downy mildew, Punjab Kheera Hybrid-11 gave disease severity percent of 35.0 having moderately resistant reaction which was less than the check hybrid Multistar (72.5%, highly susceptible) but significantly at par with Punjab Khreea-1 (30.3%, moderately resistant) (Table 4). Upon screening against wilt incidence, Punjab Kheera Hybrid-11 gave disease severity percent of 4.5% having moderately resistant reaction which was less than both the checks 'Multistar' (15.0.0%, susceptible) and Punjab Kheera-1 (5.0%, moderately resistant) (Table 4). Root gall index were studied for root-knot nematode disease and observed that the Punjab Kheera Hybrid-11 along with both the checks were susceptible to root-knot nematode disease.

Table 4: Reaction to diseases (downy mildew, wilt, root knot nematodes)

Downy mildew under field conditions		
Variety/Hybrid	Downy mildew severity (%)	Reaction
PKH-11	35.0	Moderately Resistant
Multistar	72.5	Highly Susceptible
Punjab Kheera-1	30.3	Moderately Resistant
Wilt incidence under field conditions		
Variety/Hybrid	Wilt Incidence (%)	Reaction
PKH-11	4.5	Moderately Resistant
Multistar	15.0	Susceptible
Punjab Kheera-1	5.0	Moderately Resistant
Nematodes under artificial conditions		
Variety/Hybrid	Root gall Index (0-5) Scale	Reaction
PKH-11	3.33	Susceptible
Multistar	3.66	Susceptible
Punjab Kheera-1	3.56	Susceptible

Similar results were corroborated by Dhall and Dhillon (2021).

Important characters of Punjab Kheera Hybrid-11: The plants of Punjab Kheera Hybrid-11 bear 1-2 fruits per node; fruits are seedless, bitterness free, moderately ribbed, cylindrical in shape, dark green in colour, 16-18 cm long with average fruit weight of 150-160 g and do not require peeling. It takes 45 and 60 days for first fruit picking after sowing in September and January, respectively. Average total yield is 800 q/ha and 950 q/ha in September and January sown crop, respectively.

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