



P-ISSN: 2349-8528

E-ISSN: 2321-4902

IJCS 2018; 6(4): 3374-3377

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Received: 27-05-2018

Accepted: 29-06-2018

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## International Journal of *Chemical Studies*

# SJPC 1: A promising popcorn composite suitable for maize growers of Jammu province

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**Abstract**

Popcorn as cash crop has direct impact on socio economic status of farmers and significantly to the employment sector also. Raising popcorn production will therefore overcome the problem of low productivity of maize and create a positive all round impact for farmers of hill zones of Jammu and Kashmir, where maize is staple and traditionally cultivated crop. Grain quality is a major concern for the improvement of popcorn. The composite SJPC1 developed at MBRSS, Poonch, showed yield superiority both at research farm and farmers field. Consistent high yielding of this composite in multi location trials ranged between 22 to 35 ql/ha over years. The composite showed 25.56% yield superiority over best check variety even under farmers practices with very high cost benefit ratio. Considering the performance, composite SJPC1 may be recommended for commercial cultivation to expeditiously meet the challenge of agriculture income and production economy of this region.

**Keywords:** Maize, popcorn, composite, yield evaluation

**1. Introduction**

The high demand/high margin popcorn business can induce a major change in India's agriculture. Traditional Indian corn, used mostly in poultry and starch industries, is deemed unsuitable for popping kernels (Dass *et al.*)<sup>[1]</sup>. But farmers are responding to the market. Total area under maize cultivation is 8.5 million hectare. Around 25% of corn produce goes to the food industry, but the share of popcorn-worthy corn (small-kernelled, flinty type corn with very low starch content) is still small. But acreage devoted to popcorn-worthy corn is growing fast. Popcorn is unlike most other snacks— it's healthy, and recommended for weight-watchers. It's got more protein than any other grain, more iron than eggs and meat, and more fiber than potato. But all this has changed little for the farmer growing popcorn varieties of maize. But the main problem is yields, which at 20-25 quintal per hectare for popcorn maize, is half that of normal maize varieties. The same reason also accounts for research in popcorn maize not progressing much beyond development of the few major publicly-bred varieties. Research ultimately is demand-led. Till date in the state no high yielding popcorn is available. Thus the produce has less uniformity, which in turn affects their market acceptance, particularly in multiplex market. Therefore, there is a need to develop popcorn varieties for the state. Second problem associated with local popcorn cultivars is less popping percentage. Best popcorn variety should have popping percentage of more than 80%. Thus there is scope to breed for popcorn cultivars with enhanced popping ratio and with a soft texture and bigger volume. During breeding, scheme selection is to be made towards kernels with thick pericarp, hard coating with a soft starch cavity inside. For this purpose efforts may be made in the screening of germplasm and their utilization in breeding schemes. One variant of the inbreeding method, is the possibility of recombining a fairly large number of selected inbreds into a composite or synthetic variety that might be better than the original variety and which, because of the number of component lines, could be continued by open pollination without serious reduction of vigor and yield. Although in field corn composite variety of outstanding yielding ability has yet been produced, it should be possible, by rigid selection of the inbred lines on the basis of popping expansion, to produce in popcorn a composite of high quality. Selection of the best variety or hybrid of popcorn to be grown and processed for the kind of popcorn to be sold is critical to the raw materials comprising popcorn. In some forms of popcorn, the corn itself is the only raw material. For other methods of marketing popcorn such as microwave popcorn, soybean oil, salt, and flavouring are also needed.

Considering the above facts, a specialty corn research programme was started at Maize Breeding Research Sub-station (MBRSS), Poonch, a research station of Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu (SKUAST-J). Out of several high yielding popcorn genotypes developed at this station, a composite SJPC1 was identified as most promising and suitable for the prevailing agro climatic region through different levels of evaluations. The present study is confined with the comprehensive evaluation of SJPC1. However, the details of development and evaluation of parent inbreds and the composite have equal importance during the process.

## 2. Material and Method

Maize being a staple food of the district Poonch, an intermediate hill zone of Jammu and Kashmir state of India, cultivated over an area of 24,000 ha. The district falls between 33° 25' to 34° 01' N latitude and 73° 58' to 74° 35' E longitude, and bounded by Kashmir valley in north-east and Pakistan Occupied Kashmir (POK) in north-west. Poonch is situated at a height of 3300 m above mean sea level and spread over 1674 sq km <sup>[2][3]</sup>. Most of the area in the district is ranged as only 13% of the area is having assured irrigation. The district is totally hilly and mountainous bearing few low values and majority of crop fields are situated across the hilly slopes. It has varied climate depending upon the altitude of the place. Annual average precipitation of the area is 1000 mm, which is very erratic for time and distribution in the district. Maize is cultivated mainly as sole crop, start with sowing in June-July and harvesting in October-November in the region, whereas wheat as winter crop are cultivated only in 1000-1200 ha. The average size of land holding is quite low as it is only 0.2 ha in the district.

The popcorn composite development programs are carried out at MBRSS, Poonch through the identification of elite popcorn inbred lines available at this station. There are 75 inbred lines of popcorn of the diverse genetic base are available at this station, which includes 30 promising inbred lines showing superiority for yield evaluations. Identified inbred lines and their combinations values are used for composite development every year. Under such activities a number of improved genotypes are developed and evaluated under station hybrid evaluation trial for their agronomical traits and

suitability in prevailing agro climatic region.

The experiment, trial was conducted in Randomized Block Design with three replications, plant to plant spacing 20-25 cm, row to row distance of 60 cm with recommended dose of fertilizer per ha (80 kg N, 60 kg P and 40 kg K) during 2014 to 2016 at MBRSS, Poonch. The recommended agronomical practices were followed for raising and maintenance of plants. The average of five random plants from each replication were considered for yield attributing data. The grain yield per plot was recorded at 15% moisture content and converted into quintal per hectare (ql/ha). For maintenance, breeding of inbred lines, two random plants from each line were selfed, while rest of the plants in each line allowed to open pollinate. The composite SJPC1 was first made in 2012 and since then the composite has been under evaluation. Every year, the required seed of such composite was produced following recommended practices. However, seed production through distance, isolation (300-400 m) is not feasible due to mono cropping pattern in the region. Thus, the composite produced was evaluated by different agencies, *i.e.* station trials, multilocational trials conducted by All India Coordinated Research Project on Maize under Indian Council of Agricultural Research (ICAR) and trial at farmers field conducted by Krishi Vigyan Kendra, Poonch.

## 3. Results

### 3.1. Evaluation through station hybrid evaluation trial conducted at MBRSS, Poonch

Different numbers of experimental improved genotypes were evaluated every year under the trial depending on the numbers of inbred identified in previous years. The yield and yield attributing performance of SJPC1 during the last three years are illustrated in Table 1. The table showed that the popcorn composite maintained their high yield performance over the years. The composite showed more than 20% yield superiority over the check variety and years with a high of 44% in 2014. The composite SJPC1 also found superior over check variety for popping percentage which is the most desired trait of a popcorn genotype. The popping percentage of the composite ranged between 85% to 90%. The other important traits of a popcorn genotype are volume expansion. The composite showed at par with the best check variety for the trait.

**Table 1:** Performance under station varietal evaluation trials over years.

S. no	Traits	2014		2015		2016	
		SJPC1	Check	SJPC1	Check	SJPC1	Check
	Grain yield (ql/ha)	38.13	26.42	32.73	24.00	40.51	31.65
	Volume expansion (ratio)	1:28	1:27	1:30	1:32	1:30	1:25
	01	90	88	86	92	88	85
	02						
	03						

### 3.2. Evaluation through all India coordinated research project on maize under Indian Council of Agricultural Research (ICAR) at different zonal research station of India

The composite SJPC1 was evaluated in specialty corn trial PCI and PCII during kharif 2015 and kharif 2016, respectively. The trials were conducted in the different research centers of all five zones of India. In trial PCI, the composite showed 30.10 to 42.50 ql/ha mean grain yield over all the five zones (Table 2). The composite was ranked first at NEPZ zone followed by rank second at rest of the zones except zone CWZ. And it was found significantly superior

over a national check variety at all the zones. Due to outstanding yield performance of the composite in trial PCI, it was promoted for the next level of evaluation *i.e.* PCII under AICRP trials. In trial PCII, the composite showed a maximum grain yield of 39.23 ql/ha. at zone PZ and minimum at zone CWZ during kharif 2016. The composite was again found significantly superior over a national check variety at all zones except at Zone IV. In addition to outstanding performance for grain yield, the composite was also found superior for popping quality traits. In trial PCI, the composite showed maximum popping percentage of 92% at Bajoura center (Table 3) during kharif 2015. It was found significantly

superior over national check variety at all the centres except at Udaipur for the trait. Volume expansion defines the size of popped corn, which is a ratio of volume of popcorn before popping and volume of popcorn after popping. The composite

was found maximum of volume expansion ratio of 1:18.4 at zone-I. The size of popped corn was slightly smaller than the national check variety.

**Table 2:** Grain yield performance in multilocal trials under AICRP on maize.

Year	Trial	Entry	Zone wise mean grain yield ql/ha									
			NHZ	Rank	NWPZ	Rank	NEPZ	Rank	PZ	Rank	CWZ	Rank
2015	PCI	SJPC1	31.05	2	41.86	2	35.47	1	42.50	2	30.10	4
		Check	27.69		30.28		30.12		39.59		22.36	
2016	PCII	SJPC1	34.96	7	33.59	6	27.44	12	39.23	7	19.35	9
		Check	32.26		31.04		24.82		30.82		20.08	

**Table 3:** Estimation of quality traits in multilocal trials under trial PCI of AICRP on maize during kharif 2015.

S. no	Popping traits	Entry	Almora	Dholi	Udaipur	Bajoura	Godhra
01	Popping percentage (%)	SJPC1	81.5	63.0	67	92	59
		Check	66.5	54.0	77	76	53
02	Volume expansion (ml)	SJPC1	19/350	14/250	18/300	18/300	14/200
		Check	14.5/340	11/250	16/300	23/520	12/190

### 3.3. Evaluation through farmer's participatory trials.

The composite SJPC1 was also evaluated at farmers field under farmer's participatory trials during kharif 2014 and 2015 under farmer's management system. Where the

composite was found 18 to 20 ql grain yield per hectare (Table 4). The composite was evaluated at one kanal of land per farmer under rainfed condition with minimum or no use of fertilizer.

**Table 4:** Yield performance at farmer's field under farmer participatory trial

Year	No. of farmer	Seed issued	Area covered	Date of sowing	Irrigation	Fertilizer			Mean Yield ql/ha
						N (Urea)	P (DAP)	K (MOP)	
2014	04	6.0 kg	2,000 m <sup>2</sup>	7 <sup>th</sup> June	Rainfed	2 kg	3 kg	Nil	16.0
2015	05	7.5 kg	2,500 m <sup>2</sup>	9 <sup>th</sup> June	Rainfed	Nil	Nil	Nil	14.0

The cost benefit analysis of the composite was also done at farmers field (Table 5). Where, farmers are producing traditionally normal corn with an average production of 30.12 ql/ha. The cost of cultivation, including ploughing charges and cost of seed is ranged between Rs. 400 to 600 per kanal which tune to average of Rs. 10,000 per hectare. The price of normal corn in local market ranged between Rs. 1000-1200 per ql which tune to Rs. 36,144 per hectare. In contrast, the

farmer can get average production of 15 ql/ha popcorn grain yield under their production system as per result obtained in farmers participatory trial. It requires the same input cost of Rs. 10,000 per hectare. The price of popcorn grain ranged between Rs 6,000 to 8,000 per ql in local market which can tune gross income of Rs. 90,000 per ha. The cost benefit ratio of popcorn cultivation is much higher than the farmers practicing normal corn cultivation.

**Table 5:** Performance of SJPC1 in economics assessment

Technology Assessed	Average yield (ql/ha)	Net return profit (Rs/ha)	Cost-Benefit ratio
Farmer Practice (Normal corn hybrids)	30.12	26,144	2.61
SJPC1	19.00	80,000	8.0

### 4. Discussion

Popcorn improvement will directly impact the socio-economics and significantly, to the employment sector also. Raising maize production will therefore create a positive all round impact for farmers. Grain yield is a major concern for the improvement of any cash crop like popcorn [2]. Identification of improved popcorn genotype with high grain yield over the years is of immense value. Most agronomically and economically important traits such as grain yield are quantitative in nature and routinely exhibit genotype environment interaction. This necessitates genotype evaluation across multiple locations (called multilocation trial). Stable performance of genotype in multi environment trials is critical to sustain food production [4, 5]. The composite developed at Maize Breeding Research Sub-station, Poonch, have been intensively evaluated for four years by various agencies and showed yield superiority both at research farm (under agriculture scientist) and farmers field (Farmer practices). Consistent high yielding of this hybrid in station

hybrid evaluation trials and multilocation trials over years suggested its suitability in prevailing agro climatic region of the state. Maize cultivation is a way of life for most farmers in this hill zone. It is a traditional crop cultivated as food, feed, and fodder on slopping land (rainfed) in the hills [6]. The maize production scenario in this region is different from rest part of the state. It is grown under rainfed condition during summer (June-July) as a single crop per year or relayed with millets later in the season. So, high yielding popcorn with good popping quality like SJPC1 may also be recommended, particularly for this region as the popcorn genotype had excellent performance for grain yield in trial conducted by AICRP on maize. However, the composite was promoted to next level of evaluation due to its quality and grain yield. Maize yields fluctuate annually, especially in rainfed hills [7]. Although, maize yields increased slightly over the last years, there has been still less productivity when compared to national productivity. This is probably due to lesser use of fertilizer and improved seed and the sluggish adoption of

improved management practices. A similar investigation was also carried out by [8]. However, the composite SJPC1 showed 14 to 16 ql/ha yield potential under such farmer practices which is much similar to the average production of the region (15-17 ql/ha). More than two third of the maize produced in this intermediate hill is used for direct human consumption at the farm level and the ratio of human consumption to total production is higher in less accessible areas. Farmers of this region preferred white grain maize for their food. Process of farmers participation and their reaction gained through KVK, Poonch suggested that farmers were ready to adopt this technology for commercial cultivation. Beside having higher in yield, the composite also possess the favorable trait of farmer *viz.*, popping % and volume expansion. However, the yield of normal corn is higher than popcorn SJPC1, but, it has best commercial value than normal corn. The composite may be promoted as solution for problem of low farm income of the region which will impact over all development of farming community in the prevailing agro climatic region. Moreover, besides being suitability for rainfed condition, this popcorn composite will be suitable for intensive cropping in irrigated conditions as shown in multilocational trials.

## 5. Conclusion

The composite SJPC1 has not only high grain yield potential, but it also found adoptable in the prevailing agro climatic condition. This composite may expeditiously meet the challenge of productivity, production economy, resource conservation, industrial utilization and employment generation in the region. The composite may be recommended for commercial cultivation in the Jammu province of the state. The targeted seed requirement may be achieved through seed village programme of the state government, where a village or group of village is selected for specific seed production under required isolations.

## 6. Acknowledgement

The author is thankful to Directorate of Research, SKUAST-J, All India Coordinated Research Project on Maize under Indian Council of Agricultural Research (ICAR) and Krishi Vigyan Kendra, Poonch (A programme of ICAR) for facilitating and conducting the station trials, Multilocational trials, Zonal trial and FPTs, respectively. The scientific and non scientific staffs of MBRSS, Poonch are duly acknowledged for their contribution in development of SJPC1.

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