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## Breeding single cross hybrids of maize for Rainfed mid hill regions

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### Abstract

Maize improvement will directly impact the food, feed and industry sector and significantly, to the employment sector also. Raising maize production will therefore overcome the problem of low productivity of maize (20 ql/ha) and create a positive all round impact for farmers of hill zones of Jammu and Kashmir (India), where maize is staple and traditionally cultivated crop. Considering the facts, a maize breeding research project was started since 2010 to develop high yielding single cross hybrids most suitable for prevailing climate. The hybrids thus produced were identified by evaluations through different agencies over years was of immense value. Out of the several station hybrids, PHM 11, PHM 12 and PHM 34 showed consistent performance for grain yield over years and locations. The hybrid PHM 12 and PHM 34 showed 21.9% and 22.2% yield superiority, respectively over national check in zone I, India, where as the hybrids performed 43.3 to 48.2 ql/ha grain yield at farmers field under farmers management practices which was more than double of average production of the region. One of the hybrid, PHM 12 has been recommended and approved for release by the state varietal release committee of state government. Considering the performance, the hybrids may be recommended for commercial cultivation to expeditiously meet the challenge of maize productivity and production economy of this region.

**Keywords:** Maize, Single cross hybrid, Yield evaluation

### 1. Introduction

Maize (*Zea mays* L.) is the most widely distributed crop of the world being grown in tropical, sun-tropical and temperate regions under irrigated to semi-arid conditions. Being a versatile crop, it adopts easily to a wide range of production environments (Sain Dass *et al.* 2009) [6]. Maize being an important crop of the intermediate hill (Rainfed) zone, perhaps because of it is hardy nature and tolerance to drought compared to wheat & rice and as a result has integrated in the socio-economic set up as staple food in the region. Mostly, farmer use to grow maize for food, feed and commercial values. The average yield of maize in mid hill regions of Jammu and Kashmir, India is 20 ql/ha which is higher than the average yield of the state 15 ql/ha and less than the average maize production of the country 24 ql/ha [1]. Most of the area in the region is Rainfed as only 13% of area is having assured irrigation. It has varied climate depending upon altitude of the place [2]. Annual average precipitation of the area is 1000 mm, which is very erratic for time and distribution. The region is totally hilly and mountainous bearing few low values and majority of crop fields are situated across the hilly slopes. Maize is cultivated mainly as sole crop, start with sowing in June-July and harvesting in October-November in the region. The average size of land holding is quite low as it is only 0.2 ha in the district.

Maize has acquired a well deserved reputation as a poor man's cereal owing to which it occupies the highest area under cultivation in the state of the country. The agriculture practices in this hill zone are mostly dependent on natural precipitation causing annual fluctuation in maize productivity. The gap between demand and production of maize in the region are rapidly increasing. One of the reasons behind the gap and low productivity of maize in the region is lack of high yielding variety of farmer choice suitable to this intermediate hill zone under Rainfed condition. As per the growing demand of maize, the emphasis should be given towards the development of high yielding single cross hybrids for prevailing agro climatic region, since no maize hybrid has been developed so far in this region. This should be duly supported by development of vigorous, productive and genetically diverse inbred lines that have good performance per se as well as in cross combination. Considering the above facts, a research project on "Development of hybrids in maize suitable for intermediate hill (Rainfed) zone Jammu and Kashmir (India) 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). Several high yielding single cross hybrids have been

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developed at this station, and identified as most promising hybrid suitable for the prevailing agro climatic region through different levels of evaluations. The present investigation is confined with the comprehensive evaluation of station hybrids since I have joined the station in 2010. However, the details of development and evaluation of parent inbreds of the hybrid have equal importance during the process.

## 2. Material and Method

The single cross hybrid maize development programme are carried out at MBRSS, Poonch through the study of combining ability of elite inbred lines available at this station. There are 523 inbred lines along with 360 germplasm of diverse genetic base are available at this station, which includes 30 promising inbred lines showing superiority for yield and combining ability. Identified inbred lines and their combinations with high SCA and GCA values are used for hybrid development every year. Under such activities a number of hybrids are developed every year and evaluated under different evaluation trial for their agronomical traits and suitability in prevailing agro climatic region.

The experiment trials were conducted in Randomized Block Design with three replications, following the recommended agronomical practices for raising and maintenance of plants. 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 parent lines of identified hybrids were maintained by sib matting. Every year, the required seeds of promising hybrids and their parents were produced. The female and male parents were grown in 2:1 ratio under time isolation to prevent any other pollen source. However, seed production through distance isolation is not feasible due to mono cropping pattern in the region. Thus, the hybrid produced was evaluation by different agencies. Multilocation trials were conducted at four different locations i.e. Poonch, Chatha, Udhampur and Rajouri of the state through Division of Plant Breeding, SKUAST-J; Minikit trials at group of farmers field were conducted by State Department of Agriculture, Government of Jammu and Kashmir; Zonal trials were conducted at different research stations i.e. Bajoura, Barapani, Kangra, Udhampur, Poonch of zone-1(India) through All India Coordinated Research Project (AICRP) on Maize under Indian Council of Agricultural Research (ICAR), On farm trial at farmers field were conducted by *Krishi Vigyan Kendra*, (A programme of ICAR) and Station Hybrid Evaluation Trials were conducted at MBRSS, Poonch.

## 3. Result and Discussion

Maize improvement will directly impact the food, feed and industry sector 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 cereal crop like maize (Joshi *et al.* 2005) [4] Identification of maize hybrid with high grain yield over the years is of immense value. The hybrids 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). Different numbers of hybrids were evaluated every year under the trial depending on the numbers of inbred combinations identified in combining ability analysis in previous years. Every year, 25-35 new single cross hybrids have been developed during the period. Table 1 showed that the hybrids maintained their high yield performance over the years with more than 20% yield superiority over local check hybrid in station hybrid evaluation trials. Consistent high yielding of this hybrid in station hybrid evaluation trials over years suggested its suitability in prevailing agro climatic region of the region. 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). Every year, 4 to 5 station hybrids were tested under multilocation trials, where the hybrids showed significantly superior performance for grain yield over locations (Table 2). The hybrids PHM11 (20.7% to 24.5%), PHM12 (13% to 27.3%) and PHM34 (14% to 45.3%) showed consistent yield superiority over check and locations. Stable performance of maize hybrids in multi environment trials is critical to sustain food production (Fan *et al.* 2007 and Khalil *et al.* 2011) [3, 5]. The four station hybrids were also evaluated in AICRP Zonal trial during 2012 (Table 3), where the hybrids PHM 12 and PHM 34 showed 21.9% (rank 8<sup>th</sup>) and 22.2% (rank 7<sup>th</sup>) grain yield superiority, respectively over national check and over locations. Due to outstanding yield performance of the hybrids, these were submitted for next level of evaluation under AICRP trials. The station hybrids showed 30.13 to 51.4 ql/ha average grain yield at farmers field under complete farmers management practices, which is much higher than the average production of the region (20 ql/ha) (Table 4). 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 maize grain for their food. Process of farmer's participation and their reaction gained through different agencies suggested that farmers were ready to adopt these hybrids for commercial cultivation. Besides having higher in yield, the hybrids also possess the favorable trait of farmer viz. white and yellow flint grain as staple food. However, the yield of yellow hybrids is slightly higher than white hybrids. However, farmers use to grow both types of grain maize for food, feed and commercial values. The hybrids may be promoted as solution for problem of low productivity 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, these hybrids will be suitable for intensive cropping in irrigated conditions as shown in multilocation trials. In addition, the hybrids also possess high adoptability in prevailing agro-climatic regions as their one or both parents was derived from local high yielding germplasm. The high yielding character of

**Table 1:** Performance of station hybrids in station hybrids evaluation trials conducted at maize breeding research substation, Poonch

| Year | No. of station hybrids/entries | No. of station hybrids superior over check | Yield superiority range |
|------|--------------------------------|--|-------------------------|
| 2008 | 8                              | 8  | 30-41 %                 |
| 2009 | 15                             | 10   | 15-28 %                 |
| 2010 | 31                             | 21   | 28-65 %                 |
| 2011 | 26                             | 20   | 11-38 %                 |
| 2012 | 30                             | 22   | 12-39 %                 |
| 2013 | 35                             | 18   | 08-35%                  |

**Table 2:** Performance of station hybrids in Multilocational trial conducted at four research stations of the university

| Station hybrids | Grain yield superiority (%) over local check hybrid and locations |      |      |      |
|-----------------|---|------|------|------|
|                 | 2010  | 2011 | 2012 | 2013 |
| PHM 11          | 20.78   | 21.3 | 24.5 |      |
| PHM 12          | -   | 13.5 | 27.3 | 25.3 |
| PHM 13          | 25.02   | -    | -    | -    |
| PHM 14          | 8.16  | -    | 0.6  | -    |
| PHM 15          | 16.9  | -    | -    | 14.7 |
| PHM 17          | 35.5  | -    | -    | 21.3 |
| PHM 34          | -   | 45.3 | 14.4 | 21.6 |
| PHM 35          | -   | 6.0  | -    | -    |

**Table 3:** Performance of station hybrids in AICRP Zonal trial conducted at four research stations of Zone I, India during 2012

| Hybrid         | Grain Yield q/ha & % superiority over N. check |      | Days to 75% dry husk |
|----------------|--|------|----------------------|
|                | Zonal Mean                                     | Rank |                      |
| PMH 11 W       | 61.75 (7.7)                                    | 13   | 102.9                |
| PMH 12 Y       | 69.86 (21.9)                                   | 8    | 103.3                |
| PMH 14 W       | 57.72 (0.7)                                    | 18   | 103.5                |
| PMH 34 W       | 70.03 (22.2)                                   | 7    | 102.0                |
| National Check | 57.32  | 19   | 101.6                |
| Local Check    | 54.73  | 21   | 101.5                |

(Source: Annual Report 2012, Directorate of Maize Research, New Delhi, India)

**Table 4:** Average grain yield performance of station hybrids at farmers field conducted by different agencies

| Year | Minikit Trial<br>(State Govt. Agril. Deptt.) |            | Farmer participatory. Trial<br>(MBRSS) |            | On Farm Trial<br>(KVK, ICAR) |            | Front Line Demonstration<br>(KVK, ICAR) |            |
|------|--|------------|--|------------|------------------------------|------------|---|------------|
|      | Station Entry                                | Yield q/ha | Station Entry                          | Yield q/ha | Station Entry                | Yield q/ha | Station Entry                           | Yield q/ha |
| 2010 | PHM 14                                       | 30.13      | -                                      | -          | -                            | -          | -                                       | -          |
| 2011 | -  | -          | PMH 12                                 | 45.22      | PHM 14                       | 38.12      | -                                       | -          |
| 2012 | -  | -          | PMH 12                                 | 48.18      | -                            | -          | PHM 14                                  | 37.66      |
| 2013 | PMH 12                                       | 43.7       | PMH 12                                 | 51.4       | -                            | -          | -                                       | -          |
|      | PMH 34                                       | 43.3       | -                                      | -          | -                            | -          | -                                       | -          |

(Source: Department of Agriculture, Government of Jammu and Kashmir, India; Annual Report, *Krishi Vigyan Kendra*, ICAR.

female parents of PHM12 and PHM 34 will facilitate the low cost hybrid seed production. Considering the performance of one of the station hybrid PHM 12 in and region and over locations, the hybrid was recommended and approved for release by state varietal release subcommittee, Govt. of Jammu and Kashmir, India. Formal seed production of these hybrids has not been possible because of lack of their notification by government of India. However, MBRSS has under taken their small scale dissemination through on farm seed production for only local farmers and these varieties are becoming very popular.

#### 4. Conclusion

The single cross hybrids developed at MBRSS have not only high grain yield potential but it also found adoptable in the prevailing agro climatic condition. This hybrid may expeditiously meet the challenge of productivity, production economy, resource conservation, industrial utilization and employment generation in the region. The hybrid may be recommended for commercial cultivation in the intermediate hill regions. The targeted seed requirement may be achieved through seed village programme of the state government once they notify and release by central seed committee.

#### 5. Acknowledgement

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