Field Performance of F2 Generation Progenies of a Locally Developed Hybrid Chili (*Capsicum annuum* L.) Variety

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Abstract

Researchers and plant breeders have been consistently working to create improved chilli cultivars through hybridization. Because of the ability to thrive in specific niches and environmental conditions, locally produced hybrid chilli types have become well known. Hence, this study was conducted at the Field Crops Research and Development Institute (FCRDI) Mahailupallama, Sri Lanka to assess the field performances of F2 generation progenies obtained from a locally developed hybrid chilli variety MICH HY1. F1 Generation of MICH Hy 1 Chilli seeds (T1), F2 Generation of self-pollinated MICH Hy 1 Chili seeds (T2) and F2 Generation of open-pollinated MICH Hy 1 Chilli seeds (T3) were used as planting materials and the treatments were arranged in Randomized Complete Block Design having 20 replicates. Different vegetative and reproductive characteristics and yield parameters were recorded. The results showed that the F1 generation performed well compared to the F2 generations from both self-pollination and open-pollination in terms of plant height and canopy width, suggesting a genetic advantage defined by taller plants and broader canopies. Chilli plants in T3 took higher days for 1st flowering (65.3 days) while the T1 and T2 took 62.3 and 61.8 days respectively. Moreover, when compared to the F2 generation, the F1 generation produced more pods, higher total weights, and higher overall crop yields. These findings provide chilli farmers and breeders with practical assistance, allowing them to make informed decisions to increase chilli crop yield and success. Future study into the underlying genetic pathways promises more efficient and sustainable chilli cultivation approaches.

Keywords: Chilli, F2 Generation, Hybridization, MICH Hy 1, Open-Pollination, Self-Pollination

I. INTRODUCTION

Chilli (*Capsicum annuum* L.) is one of the world's most important vegetable crops, valued for its strong taste and widespread use in culinary traditions around the world (Hernández-Pérez *et al*., 2020). Chili is an essential condiment in most of the cuisines of Sri Lanka and people consume large quantities of chillies annually (Weerasekara *et al*., 2018). The cultivation extent of chilli in Sri Lanka is around 15,000 ha and production is about 75,000 Mt on a green chilli basis. However, due to insufficient production Sri Lanka imports large quantities of dry chili annually spending huge amounts of foreign exchange. Demand for chilli has increased in recent years, not only for culinary purposes but also for its pharmaceutical and therapeutic capabilities, making it a crop of major agricultural and commercial importance. To address this rising demand, high-yielding and disease-resistant chilli varieties must be developed (Hewage, Bandara and Rathnayake, 2022).

Plant breeders and researchers have been constantly engaged with producing superior chilli cultivars through hybridization. Locally created hybrids have received prominence among the numerous hybrid chilli types due to their suitability to unique ecological niches and tolerance to local diseases and pests (Rasco Jr, 2008). Sri Lanka has a diverse chilli collection, including Open Pollinated Varieties (OPVs) and newly released local hybrid chilli varieties (LHCVs). Despite the fact that LHCVs have only been on the market for around 5 - 6 years, they have quickly gained appeal among farmers due to increased production. However, only MICH HY1, released in 2015, is widely cultivated in various parts of the country, whereas MICH HY2 (issued in 2017) has not been as popular due to a lack of readily available seeds (Hewage, Bandara, and Rathnayake, 2022). MICH HY1 is a more

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appealing variety for chilli growers due to higher yields recorded by farmer fields, longer crop duration, less sensitivity to leaf curl complex, and significantly taller plants that make it easier for farmers to carry out specific agronomic procedures (Hewage, Bandara, and Rathnayake, 2022).

Further, the F2 generation, which is the self-pollination of F1 hybrids, is an important stage in the hybrid breeding process. It provides a unique chance to analyze the segregation of desirable features and identify the possibility for further development in future generations (Couto *et al*., 2019). Hence, the purpose of this research was to assess the field performances of F2 generation progenies obtained from a locally developed hybrid chilli variety MICH HY1. The findings of this study have the potential to contribute to the development of more resilient and high-yielding chilli cultivars for cultivation.

II. MATERIALS AND METHODS

A. Experimental Site

The study was conducted at the Field Crops Research and Development Institute (FCRDI) Mahailupallama, Department of Agriculture,Sri Lanka from May to October (one cropping cycle) during *Yala* season of 2022. The location represents DL_{lb} agroecological region of Sri Lanka. The average annual rainfall is 900 to 1100 mm and the temperature is around 27 – 29 ^{o}C. The soil type is Reddish Brown Earth with a moderate well-drained sandy clay loam texture (Panabokke, 1996).

B. Planting Materials

F1 and F2 generations of MICH Hy 1 Chilli seeds were used as planting materials in this study (Table 01). The F1 generation of MICH Hy 1 chilli plants was covered with isolation cages made of nylon fabric to obtain the F2 generation of self-pollinated seeds (T2) and other plants were allowed for open pollination to obtain the F2 generation of open-pollinated seeds (T3). Accordingly, seeds were extracted from 20 plants in each treatment separately by hand, and allowed to air-dry.

C. Nursery Preparation And Management

The extracted chilli seeds were treated with Captan fungicide and planted in black-coloured polythene bags (4” X 4”) with unsealed bottom. Bags were filled with a well-prepared potting mixture of Top soil: Organic matter: Sand at the ratio of 2:1:1 by volume leaving 2-3 cm from the top. Four seeds were planted in each bag and covered with soil. 2-3cm thickness straw mulch was placed to cover the pots and fungicide was applied after mixing with water. Bags were placed ensuring sufficient sunlight and drainage and the seedlings were maintained in a net house (50 % shade) and carefully protected from pests and diseases. Watering was done daily for good moisture conditions during the dry period. Seedlings were exposed to light sunlight gradually for hardening.

Table 01: Planting Materials Used in this Study

Treatment	Treatments
T1	F1 Generation of MICH Hy 1 Chili seeds
T2	F2 Generation of self-pollinated MICH Hy 1 Chili seeds
T3	F2 Generation of open-pollinated MICH Hy 1 Chili seeds

D. Land Preparation and Transplanting

Properly ventilated and well drained open field was selected for transplanting the chilli seedlings. The field was ploughed about 30 cm – 45 cm depth and the roots and stones were removed to make the soil finer. Thirty raised beds of 7.2 m² (1.2 m x 6 m) were prepared with 20 planting holes in each bed after getting the fine tilth. Four weeks old (28 days) healthy seedlings were selected for transplanting. Seedlings were transplanted with the spacing of 60 cm x 60 cm and two plants per hole. Weeding and watering were done as per the requirement during the experiment period.

E. Data Collection

All vegetative and reproductive characteristics and yield parameters were recorded according to the descriptor for chilli. Plant height (cm) and canopy width (cm) at 100 % flowering and at the 5th pick stages were collected from randomly selected 10 plants from each treatment using a meter scale. Flower Initiation – Days to first flowering and 50 % flowering were counted from the planting date. The average pod length (cm) and pod width (cm) of five green chillies from a single plant were recorded from 1st to 5th harvest using a cm scale. Pod thickness (mm) and pod breadth (mm) were measured using a vernier calliper and pod weight was measured using a weighing balance. In addition to these, number of pods per plot, total pod weight in each plot and total yield (t/ha) in each plot were recorded.

F. Statistical Analysis

The data were analysed using Analysis of Variance techniques and performed t-tests with 95% confidendce level using SPSS (SPSS 25.0, IBM, New York, USA) software.

III. RESULTS AND DISCUSSION

A.*Plant Height and Canopy Width*

Plant height was significantly ($p<0.05$) varied among different treatments at 100 % flowering and at 5th harvest. The highest plant height was observed in T1 compared to other treatments during both stages (47.8 cm and 59.1 cm respectively). Meanwhile, T1 also had a significantly higher canopy width (48.8 cm) at 5th harvest and no significant ($p>0.05$) differences were observed in the canopy width of chilli plants at 100 % flowering (Table 02). This observation shows that the F1 generation may have a genetic advantage, resulting in higher plant height.

B. Days to 1st Flowering and Days To 50% Flowering

In order to optimize planting times and crop management techniques, it is essential to comprehend the flowering patterns of various generations of chilli plants. Different treatments had significant ($p<0.05$) variation in the number of days taken to 1st flowering while no significant ($p>0.05$) variation was observed in the number of days taken to 50 % flowering. Chilli plants in T3 took higher days for 1st flowering (65.3 days) while the T1 and T2 took 62.3 and 61.8 days respectively (Table 03). When comparing T3 (F2 Generation of open-pollinated MICH Hy 1 Chili seeds) to T1 (F1 Generation of MICH Hy 1 Chili seeds) and T2 (F2 Generation of self-pollinated MICH Hy 1 Chili seeds), it is clear that T3 took the longest time to reach the first flowering. This finding shows that controlled breeding may cause the MICH Hy 01 Chili plants to flower earlier than they would by open-pollination.

C. Yield Parameters

There were no significant ($p>0.05$) differences observed in most of the pod characteristics of chilli plants (Table 04). However, the total number of pods per plot, total weight of pods per plot and total yield were significantly ($p<0.05$) varied among different treatments. Treatment T1 had the highest total number of pods per plot (272.5), the total weight of pods per plot (2725 g) and the total yield (17027 kg/ha) (Table 05). Further, no significant difference was observed in the yield parameters of T2 and T3. With its initial hybrid vigour, the F1 generation produces significantly more pods and yield overall than the F2 generation from both self-pollination (T2) and open-pollination (T3). Theses yield variations have important effects on chilli farming since better yields can boost farmers' profitability.

These yield performance differences between generations could be caused by both additive and dominant genes as well as their interaction effects, the most of which could be altered by recombination and selection (Perera *et al*. 2001). In a previous study, Marame *et al*. (2009) concluded that progeny generations (F1 and F2) outperformed their parents (P1 and P2) in terms of fruit characteristics in chilli plants. Furthermore, they stated that the superior performance of the segregating generations (F2) could indicate a higher frequency of their transgressive segregants while the improved performance of F1 could result from an accumulation of favourable dominant alleles. Kabilan *et al*. (2021) evaluated the performances of the F2 generation of Mundu Chili and recorded a range of 57.7 cm – 62.2 for plant height, 40 to 61 days for 50 % flowering, 57.4 – 70.5 for number of fruits per plant, 4.1 g – 4.5 g for individual fresh fruit weight and 236.7 g – 324.5 g for ripe fruit yield per plant.

IV. CONCLUSION

The results of this study offer important new understandings of the development, flowering, and yield parameters of MICH Hy 01 Chili plants of various generations. It is clear that the selection of seed generation and breeding procedures has a considerable impact on a number of chilli plant performance factors. In conclusion, the F1 generation's initial hybrid vigour is a crucial feature for producing exceptional growth and yields. These findings provide chilli farmers and breeders with practical assistance, allowing them to make informed decisions to increase the productivity and success of their chilli crop production initiatives. Further investigation into the genetic factors underlying these differences may lead to more effective and sustainable chilli growing strategies in the future.

Table 02: Plant Height and Canopy Width of Chili Genotypes at Two Growth Stages

Treatments	**At 100 % flowering**		**At 5th Harvest**	
	Plant height (cm)	**Canopy width (cm)**	**Height of plant (cm)**	**Canopy width (cm)**
T1	47.6 ± 0.8[a]	36.4 ± 0.6[a]	59.1 ± 1.7[a]	48.8 ± 1.6[a]
T2	40.9 ± 1.0[b]	36.2 ± 1.0[a]	52.6 ± 1.3[b]	43.0 ± 1.6[b]
T3	40.0 ± 0.8[b]	33.5 ± 1.1[a]	53.5 ± 1.9[b]	45.4 ± 1.4[b]
P value	0.01	0.06	0.01	0.03

Mean values followed by the same letters within a column are not significantly different at $p < 0.05$.

Table 03: Days Taken to 1st and 50% Flowering

Treatments	**Day to 1st flowering**	**Days to 50% flowering**
T1	62.3 ± 0.6[b]	69.0 ± 0.6[a]
T2	61.8 ± 0.5[b]	70.5 ± 0.6[a]
T3	65.3 ± 0.3[a]	71.3 ± 1.0[a]
P value	0.01	0.17

Mean values followed by the same letters within a column are not significantly different at p< 0.05.

Table 04: Pod Characteristics among Chilli Genotypes

Treatment	**Average pod weight (g/pod)**	**Average pod length (cm)**	**Average pod breadth (mm)**	**Average pod thickness (mm)**
T1	5.60 ± 0.26[a]	10.9 ± 0.2[a]	11.3 ± 0.1[a]	1.3 ± 0.02[a]
T2	5.04 ± 0.28[a]	10.5 ± 0.2[a]	10.7 ± 0.5[a]	1.3 ± 0.02[a]
T3	5.51 ± 0.14[a]	10.2 ± 0.1[a]	10.7 ± 0.2[a]	1.3 ± 0.03[a]
p value	0.22	0.10	0.29	0.118

Mean values followed by the same letters within a column are not significantly different at $p<0.05$.

Table 05: Yield Characteristics among Chilli Genotypes

Treatment	**Total no of pods/plot**	**Total weight of pods /plot(g)**	**Total yield (kg/ha)**
T1	272.5 ± 10.48 [a]	2725.50 ± 190.42[a]	17.27 ± 1.31[a]
T2	151.2 ± 7.22[b]	1421.50 ± 77.30[b]	7.97 ± 0.60[b]
T3	171.6 ± 9.18[b]	1873.75 ± 162.15[b]	9.16 ± 1.03[b]
p value	0.01	0.01	0.01

Mean values followed by the same letters within a column are not significantly different at $p<0.05$.

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