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ORIGINAL RESEARCH ARTICLE

Binamorich-2: A new high yielding Chilli variety of Bangladesh

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ABSTRACT

Chilli is one of the most important spices as well as cash crop in Bangladesh. This study was undertaken at Bangladesh Institute of Nuclear Agriculture (BINA) to characterize the collected germplasm morphologically and select a desirable one for commercial cultivation in Bangladesh. More than fifty chilli germplasm were collected from local and exotic sources were put into evaluation to select desirable ones for directly use as varieties or for future usage as breeding materials. Through observation trials five germplasm were selected considering their better agronomic performance. Selected germplasm was evaluated through different trials at different chilli growing areas of Bangladesh during 2018 to 2020. Recommended cultural management for chilli cultivation was followed. The germplasm, IndoCF-25 produced significantly higher yield both green chilli and dried chilli than control varieties (Binamorich-1 and BARI Morich-1) in most of the trials. Over two years of advanced yield trial and on-farm trial, IndoCF-25 produced higher yield (32.00 t ha^{-1}) while BARImorich-1 produced (12.15 t ha^{-1}). IndoCF-25 was produced the longest plant height (78.8 cm), higher number of fruits (78.8) compared to Binamorich-1 (52.8), longer fruit size (13.95 cm), breadth (5.32 cm) and single fruit weight (11.38 g) compared to the check varieties. IndoCF-25 was found to be moderately tolerant to anthracnose, wilting and mosaic diseases, and also showed lower insect infestation than control varieties. Results of yield trials indicated that IndoCF-25-1 was suitable for cultivation in Bangladesh. Though check variety Binamorich-1 produced the highest yield (34.05 t ha^{-1}) among three tested genotype/varieties, due to the better pungency as well as other quantitative and qualitative performances, BINA has applied for registration of IndoCF-25-1 to the National Seed Board (NSB) of Bangladesh. Consequently, the NSB of Bangladesh registered IndoCF-25-1 as a high yielding better pungent chilli variety in 2020 as Binamorich-2 for commercial cultivation all over Bangladesh.

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INTRODUCTION

Chilli is cultivated worldwide and is an important spice and vegetable crop. It is an indispensable spice essentially used in every food for its pungency, taste, color and aroma. It is available and used in the form of green, dried and powdered. It has become an essential ingredient in Bangladeshi meals. Most of our households always keep a stack of fresh hot green chillies at hand, and use them to flavor most curries and dry dishes. It is typically lightly fried with oil in the initial stages of preparation of the dish. It has diversified uses. The peoples of Bangladesh are usually used chillies in all curry preparation like meat, fish, vegetables, pulses etc. for its typical color, taste and flavor. It is rich in proteins, lipids, carbohydrates, fibers, mineral salts (Ca, P, Fe) and vitamins like A, D, E, C, K, P, B2 and B12 with good medicinal properties. The fruits are an excellent source of health-related phytochemical compounds, such as ascorbic acid, carotenoids, tocopherols, flavonoids, and capsaicinoids that are

very important in preventing chronic diseases such as cancer, asthma, coughs, sore throats, toothache, diabetes and cardiovascular diseases (El-Ghoraba *et al.*, 2013).

Chilli is widely cultivated in Bangladesh in both the summer and winter seasons. Area under chilli cultivation was 98.86 thousand hectares producing about 118.65 thousand tons in the year of 2016-17 (BBS, 2018). The average yield of chilli pepper in the world is about 23.0 t ha^{-1} while it is only 6.64 t ha^{-1} in Bangladesh. In our country, chillies are grown in all the districts but plenty of chillies are produced in the district of Bogra, Rangpur, Kurigram, Jamalpur, Natore and Jessore. The chillies farmers cultivate local cultivars varieties like Balijuri, Bona, Bain, Saita, Suryamukhi, Paba, Halda, Dhani, Shikarpuri and Patnai which produce very low yields. There are many factors responsible for its lower acreage and yield, but the most important is the non-availability of high yielding varieties as well as their old cultivating practices with limited availability of irrigation facilities. Though the area and production have been raised but per unit yield of Chilli is very low. The yield of chilli can be increased through modern high yielding varieties with adopting improve production technology. It is therefore, imperative to develop high yielding varieties of chilli to increase the national production level.

Various strategies to increase chilli genetic variability can be pursued by such as seed introduction, hybridization, and mutation (Soeranto, 2011). Seed introduction through selection is a well-known breeding method to develop high yielding varieties of any crops. In any scenario, plant breeding through seed introduction has contributed to increased crop productivity by systematically creating new varieties with superior adaptation to the needs of society. Breeders continually need new and diverse germplasm from outside the utilized stock. They sometimes use exotic germplasm to find specific traits to maintain or improve yields. In short, the plant breeding process is a continual one, and diverse germplasm are a critical input in the agricultural production process. So, collection of germplasm is the critical first step in initiating any crop breeding programme and an excellent source of economically useful plant characters in forthcoming new varieties. According to Singh (2009) collected germplasm can also be a good source of new varieties for direct utilization. Although chilli is a major spice crop of Bangladesh, but its new high yielding variety development is still a great matter of concern. Therefore, high yielding chilli germplasm were evaluated in different chilli producing areas of Bangladesh through different trials to select a high yielding variety in favour of chilli farmers all over the country.

MATERIALS AND METHODS

A total of fifty-six local and exotic chilli germplasm was collected from home and abroad. Among them six were collected from Indonesian Spice and Medicinal Crops Research Institute, Indonesia. Main objectives of this collection were to evaluate them for selecting desirable germplasm for directly registration as varieties or for future usage as breeding materials. Through the observation trials during 2017, five germplasm namely IndoCF-25-1, IndoCF-28-5, IndoCF-29-8, ICF-13-2 and ICF-18-4 were selected on the basis of their higher yield potentiality along with other desirable morphological characters and yield attributes. Selected germplasm were evaluated through different replicated yield trials during 2018 to 2020. One popular variety of Bangladesh Agricultural Research Institute (BARI) namely BARImorich-1 and a newly released high yielding variety of Bangladesh Institute of nuclear Agriculture (BINA) namely Binamorich-1 were used as check variety. During rabi 2018-19, advanced yield trial was conducted at BINA farm; Kashiar char, Gouripur, Mymensingh; Sherpur Sadar, Sherpur and Melandaho, Jamalpur. During rabi season 2019-20, on-farm trial of promising genotypes of chilli with two check varieties were conducted at four locations (Farmers Field, Boyra, Mymensingh; Farmers Field, Gouripur, Mymensingh; Farmers Field, Sherpur and Farmers Field, Jamalpur). All the trials were laid out in randomized complete block design with three replications. Appropriate unit plot size was maintained for all the trials. Recommended doses of fertilizers were applied following the Fertilizer Recommendation Guide (BARC, 2005) during final land preparation. Recommended production packages with cultural and intercultural operations were followed to ensure normal plant growth and development. Data on various characters, such as plant height, fruit length, fruit diameter, number of fruits, fruit yield and average fruit weight were taken from each mutant. Data were compiled and analyzed through MSTAT-C software and the mean values were adjusted through DMRT at 5% level of significance following Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Performances of the selected genotype IndoCF-25-1 and check varieties on yield and yield attributing characters revealed significant variations for most of the characters in advanced yield trial (Table 1) and on-farm trial (Table 2) during 2018-19 and 2019-20 at different locations. Among the genotype and control varieties, performance of IndoCF-25 was found to be promising regarding yield and yield attributing characters where it produced the highest fruit length, average fruit $plant^{-1}$, yield $plant^{-1}$ and total yield (t ha^{-1}). Among these genotype and varieties, IndoCF-25-1 produced longer plant (66.8 cm) and also higher yield than the check variety (BARI Morich-1) at BINA HQ farm. Yield range was observed from 172 g $plant^{-1}$ to 825.50 g $plant^{-1}$. The highest yield per plant (825.5 g) was found from Binamorich-1 followed by the genotype IndoCF-25-1 (745.75 g) while the lowest yield per plant (172 g) was recorded from BARI Morich-1. Highest numbers of fruits (109.2) have found from BARI Morich-1 which was followed by the genotype IndoCF-25-1 (78.8) and lowest number of fruits was found from Binamorich -1 (61.5). The highest total fresh yield (34.05 t ha^{-1}) was produced from Binamorich-1 which was followed by the genotype IndoCF-25-1 (32.00 t ha^{-1}) which is statistically similar while the lowest yield was found from BARI Morich-1 (11.80 t ha^{-1}) (Table 1).

Table 1. Advanced yield trial of selected chilli genotype with check varieties Yield and yield contributing characters during Rabi, 2018-19.

Genotype/ Variety	Plant height (cm)	No. of fruits plant^{-1}	Fruit length (cm)	Fruit diameter (cm)	Average wt. (g fruit^{-1})	Yield (g plant^{-1})	Yield (t ha^{-1})	Taste/ Pungency
BINA HQ Farm								
IndoCF-25-1	66.8	78.8	13.75	4.99	11.28	745.75	32.00	High
Binamorich-1	44.6	61.5	14.50	5.58	12.36	825.50	34.05	Medium
BARIMorich-1	31.9	109.2	6.50	2.82	1.54	172.00	11.80	High
$LSD_{0.05}$	2.26	1.53	0.54	0.10	0.59	2.91	0.83	
CV	2.78	3.16	2.54	1.18	3.19	0.77	1.84	
Kashiar char, Gouripur, Mymensingh								
IndoCF-25-1	72.2	74.9	12.64	4.94	11.08	739.91	31.10	High
Binamorich-1	48.7	59.2	13.98	5.48	12.16	821.36	34.02	Medium
BARI Morich-1	39.7	104.8	6.12	2.69	1.61	163.29	11.51	High
$LSD_{0.05}$	2.13	1.64	0.48	0.08	0.54	2.80	0.76	
CV	3.14	3.54	2.79	1.31	3.35	1.02	2.04	
Sherpur Sadar, Sherpur								
IndoCF-25-1	69.8	72.5	11.95	4.42	10.22	732.48	30.18	High
Binamorich-1	45.4	56.5	13.18	5.18	12.05	788.02	32.79	Medium
BARI Morich-1	38.6	98.2	5.98	2.44	1.58	148.50	10.92	High
$LSD_{0.05}$	3.05	1.57	0.43	0.12	0.62	2.71	0.64	
CV	3.48	3.76	2.94	1.92	3.87	1.48	2.48	
Melandaho, Jamalpur								
IndoCF-25-1	70.8	76.5	12.82	5.20	11.10	780.32	31.78	High
Binamorich-1	51.5	63.8	14.10	5.68	12.75	842.50	34.68	Medium
BARI Morich-1	37.9	106.5	6.12	2.65	1.65	170.20	12.15	High
$LSD_{0.05}$	2.83	1.52	0.39	0.08	0.57	2.57	0.53	
CV	3.79	3.81	3.10	2.07	3.95	1.93	2.71	

Table 2. On-farm yield trial of selected chilli genotype with check varieties for yield and yield contributing characters during Rabi, 2019-20.

Genotype/ Variety	Plant height (cm)	No. of fruits plant^{-1}	Fruit length (cm)	Fruit diameter (cm)	Average wt. (g fruit^{-1})	Yield (g plant^{-1})	Yield (t ha^{-1})	Taste/ Pungency
Farmers Field, Boyra, Mymensingh								
IndoCF-25-1	76.2	78.2	13.95	5.25	11.38	784.85	31.58	High
Binamorich-1	54.1	65.4	15.68	5.77	13.02	848.50	34.46	Medium
BARIMorich-1	37.3	108.5	6.18	2.69	1.72	174.50	11.75	High
$LSD_{0.05}$	$LSD_{0.05}$	2.71	1.31	0.27	0.11	0.47	2.04	
CV	CV	4.12	4.12	3.53	2.65	4.34	2.57	
Farmers Field, Gouripur, Mymensingh								
IndoCF-25-1	68.9	73.4	11.83	4.90	10.65	755.50	30.25	High
Binamorich-1	40.2	60.4	14.05	5.22	12.20	818.50	32.18	Medium
BARI Morich-1	35.9	98.5	5.98	2.60	1.54	152.50	10.92	High
$LSD_{0.05}$	2.50	1.23	0.19	0.09	0.35	1.91	0.28	
CV	4.42	4.55	3.80	2.90	4.60	3.78	3.90	
Sherpur Sadar, Sherpur								
IndoCF-25-1	76.1	65.5	11.50	4.72	10.50	738.15	29.05	High
Binamorich-1	46.5	52.8	13.75	5.10	12.25	795.10	31.80	Medium
BARI Morich-1	38.2	90.5	5.60	2.48	1.58	143.50	10.75	High
$LSD_{0.05}$	2.56	1.20	0.16	0.07	0.30	1.82	0.22	
CV	4.52	4.80	3.78	3.15	4.52	3.90	4.12	
Farmers Field, Jamalpur								
IndoCF-25-1	78.8	80.5	14.50	5.32	11.28	784.10	31.80	High
Binamorich-1	45.6	67.8	16.15	5.78	12.44	855.50	33.12	Medium
BARI Morich-1	39.5	110.5	6.20	2.75	1.78	172.40	11.92	High
$LSD_{0.05}$	2.40	1.09	0.17	0.13	0.34	1.09	0.18	
CV	3.48	5.20	4.24	3.54	4.10	3.45	4.00	

At kashiar char, Gouripur, Mymensingh, the tallest plant height (72.20 cm) was recorded from IndoCF-25-1 genotype at Mymensingh which was followed by Binamorich-1 variety (48.7 cm). The maximum number of fruits per plant (104.8) was found from BARI Morich-1 followed by IndoCF-25-1 (74.9) where the minimum was found in Binamorich-1 (59.2). In case of total fresh yield of chilli, the highest yield (34.02 t ha^{-1}) was also found in Binamorich-1 which was followed by IndoCF-25-1 genotype (31.10 t ha^{-1}) (Table 1). At Sherpur, similar result was recorded where the tallest plant height (69.8 cm) was found from IndoCF-25-1 genotype. Highest fruit length (13.18 cm) was recorded from Binamorich-1 which was followed by the genotype IndoCF -25-1 (11.95) which is statistically similar. Highest yield per plant (788.02 g) was recorded from Binmorich-1 following IndoCF-25-1 (732.48 g) genotype. In case of total fresh yield of chilli, the highest yield (32.79 t ha^{-1}) was also found from Binamorich-1 which was followed by IndoCF-25-1 genotype (30.18 t ha^{-1}) (Table 1). At Jamalpur location, tallest plant height (70.8 cm) was found from IndoCF-25-1 genotype followed by Binamorich-1 (51.5 cm). Similar trend was observed in case of fruit length where highest fruit length (14.10 cm) was recorded from Binamorich-1 which was followed by IndoCF-25-1 genotype (12.82) which is statistically similar. Highest yield per plant (842.50 g) was recorded from Binamorich-1 followed by IndoCF -25-1 (780.32 g) (Table 1).

Chilli was significantly different from one cultivar to another in number of fruit (*Obidiebube et al*., 2012). The difference in yield of cultivars has been attributed to the genetic make-up (Odeleye *et al*., 2001 and Akinfosoye *et al*., 1997). Large varietal variations in yields were also reported by Rajput et al (1991). The results obtained in this study are in close agreement with those of Uddin *et al*., (2015), who recorded highly significant variability among different chilli genotypes in Bangladesh. The current results of morphological evaluation of chilli germplasm are supported by the study of Hill *et al*., (2013). The findings of Thul *et al*., (2009) and Ibiza *et al*., (2012) further strengthen the current findings, who also found valuable and highly significant and positive variability among their studied genotypes.

Farmers' field trials at different locations, significant differences were recorded in plant height among the chilli genotype/ varieties. Results of on-farm yield trial during 2019-20 showed that IndoCF-25-1 genotype performed better regarding fruit length, diameter as well as yield attributes than the BARI Morich-1 with the similarities of previous year result. Binamorich-1 was produced the highest yield (34.46 t ha^{-1}) which was closely followed by IndoCF-25-1 genotype (31.80 t ha^{-1}) at farmers field, Boyra, Mymensingh. Results of advanced yield trial at farmers' fields of different areas of Bangladesh showed that IndoCF-25-1 advanced line produced better plant height (78.8 cm), acceptable number of fruits $plant^{-1}$ (80.5), longer fruit (14.50 cm), higher fruit diameter (5.32 cm), higher single fruit weight (11.28 g), higher yield $plant^{-1}$ (885.50 g) as well as total yield (31.80 t ha^{-1}) compare to BARI Morich-1 (Table 2).

Though, IndoCF-25-1 produced lower number of fruits per plant but it gave the higher yield compared to BARI Morich-1 through considering its fruit length, fruit diameter, average individual fruit weight as well as yield per plant. This genotype also gave lower yield compared to Binamorich-1 but its pungency is much better than the tested variety. Genotypic variability considering different morphological and yield contributing characters, and yield among the different cultivars was also reported earlier by other researchers. The present results are in agreement with the earlier results. Differences found in different plant parameters among the population and control varieties are under genetic control. A little variation was observed in seed yield and yield attributes among the germplasm and control varieties within locations, seasons and also in years, and this phenomenon is attributed to the prevailing environmental factors. The incidence of anthracnose, wilting and mosaic diseases, and insect (thrips and aphid) infestation were also studied in different locations under field conditions (data not presented). The advance line IndoCF-25-1 was found to be tolerant to anthracnose, wilting and mosaic diseases and also showed lower infestation by insects. Overall infestation caused by leaf feeder insects like aphid and thrips were lower in IndoCF-25-1 genotype compared to the check varieties.

Generation of new plant type with improvement in yield attributes leading to produce high yield is the main plant breeding objective. IndoCF-25-1 showed superiority to check varieties in various cases as well as pungency in all the trials. Main distinguishing characteristics of IndoCF-25-1 genotype (new variety Binamorich-2) which makes the variety different from other varieties:

- High yielding, yield is 1.5 fold higher compared to traditional varieties.
- Plant type long, bushy and profusely branched.
- Fruits are dark green when it is green chilli and attractive red when it is properly ripen.
- Fruits are better pungent, fleshy and scented.
- Number of fruits per plant is 150-200, fruit length 10-15 cm and diameter 3-4.5 cm.
- Edible up to 8-10 days at ambient condition after harvesting of green chilli.

Conclusion

The overall performance of IndoCF-25-1 genotype in respect to total yield (32.00 t ha^{-1}) and yield components especially pungency was superior to check varieties (BARI Morich-1 and Binamorich-1). IndoCF-25-1, due to having high yield potential and other desirable agronomic performances, held promise for selection and registration as a high yielding chilli variety for the farmers of Bangladesh. So, BINA has decided to apply for the registration of this genotype as a high yielding variety proposed Binamorich-2 to the National Seed Board (NSB) of Bangladesh. Consequently, the NSB of Bangladesh registered IndoCF-25-1 as new variety Binamorich-2 in 2020 for commercial cultivation in Bangladesh.

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