ANNUAL RESEARCH REPORT
2021-2022

Programme Leader

Dr. Md. Shamsur Rahman
Chief Scientific Officer

and

Dr. Mohammad Zulfiqur Ali Firoz
Chief Scientific Officer

Regional Agricultural Research Station
Bangladesh Agricultural Research Institute
Hathazari, Chattogram-4330

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EVALUATION OF SWEET ORANGE (KATA MALTA) LINE

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

An experiment was conducted at the citrusorchard of RARS, Hathazari, Chattogram during July 2020 to December 2021 in order to assess the yield potentialities of Katamalta.The plants were seven years old and same tree shape was obloid. Differences were observed in all the quantitative parameters studied. The plant height and canopy size were higher in Katamalta (2.88m and 1.58 x 3.47 m^2) than BARI Malta-1 (2.7m and 1.34x2.28 m^2) accordingly. Number of fruits/plant and individual fruit weight were higher in Katamalta (234 & 191g) than that of BARI Malta-1 (150 & 117g respectively). The fruit length and fruit diameter were higher in Katamalta (6.96 cm & 7.1 cm) than BARI Malta-1 (5.51 cm and 4.52 cm). The yield of fruits was higher in Katamalta (27.9 t/ha) which was higher than BARI Malta-1 (11.0 t/ha). The Juice content was higher in Katamalta (60 ml) than that of BARI Malta-1 (46.2 ml). The TSS was higher in Katamalta (8.5) than BARI Malta-1 (7.1).

Introduction

Citrus is widely grown in tropical and sub-tropical regions (Piccinelli *et al.*, 2008). Sweet orange (*Citrus sinensis*L. Osbeck) commonly called orange is a member of this family and a major source of vitamins, especially vitamin C, sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium (Angew, 2007). Orange is probablyoriginated from south East Asia, and were cultivated in China by 2500 BC (Nicolosi *et al.,* 2008), where it was referred to as "Chinese'' apple (Ehler, 2011). Today, it is grown almost all over the world as a source of food for humans because of its high nutritional values, source of vitamins and other uses. A sweet orange (Katamalta) germplasm collected from Chattogram hill tracts at the RARS, Hathazari. At present, these are bearing stage and it is important to evaluate sweet orange lines for developing a variety.

Materials and Methods

The investigation was carried out at RARS, Hathazari from July 2020 to December 2021. There were five sweet orange plants of Katamalta. Those were evaluated against BARI Malta-1 used as check. The experiment was laid out RCB design with 3 replications. The unit plot size was 1.75 × 20 m^2 and plant spacing was maintained at 4x4 m^2 accommodating 5 plants in each plot. The 7 years old plants were used in the study. The land was fertilized with Cowdung, urea, TSP, MoP, Gypsum (S), Zinc sulphate (Zn) and Boric acid (B) @ 15000, 450, 200, 200,100, 20 and 10 g/plant, respectively. The fertilizers were applied in three installments such as September 2020, March 2021 and May 2021. Besides this, other cultural practices like, weeding, watering, plant protection, mulching etc. were done as and when necessary. Data on tree shape, plant height, plant age, canopy size, leaf division, leaf lamina, flower type, fruits/plant, fruit weight, fruit length, fruit diameter, fruit shape, shape of fruit base, shape of fruit apex, color of fruit, texture of fruit surface, thickness of fruit rind, segments/fruit, segment uniformity, thickness of segments wall, fruit axis, pulp color, pulp firmness, fruit yield/hectare, juice content, seeds/fruit and TSS (%).

Results and Discussion

Variation was observed in all the studied parameters of Kata maltaas compare to BARI Malta-1. The plant height and canopy size were higher in Katamalta (2.88m and 1.58 × 3.47 m^2) in contrast BARI Malta-1 (2.7m and 1.34 × 2.28 m^2) accordingly, however, leaf division and flower type almost similar bi-foliate and hermaphrodite, respectively (Table 1). The number of fruits/plant and individual fruit weight were higher in Katamalta (117 & 191g, respectively) than that of BARI Malta-1 (75 & 117g, respectively). Moreover, the fruit length and fruit diameter of Katamalta was also higher (6.96 cm & 7.1 cm, respectively) than that of BARI Malta-1 (5.51 cm & 4.52 cm, respectively). Rind thickness of fruit and segments/fruit were also higher in Katamalta (0.53 cm & 10.9, respectively) than BARI Malta-1 (0.4 cm & 8.22, respectively). The fruit yield of Katamalta was higher (27.9 t/ha) than that of BARI Malta-1 (11.0 t/ha). The juice content was also higher in Katamalta (60 ml) than that of BARI Malta-1 (46.2 ml). Seeds/fruit was found almost similar in both the genotypes but TSS was found

higher in Katamalta (8.5%) than BARI Malta-1 (7.1%) (Table 2). For both the genotypes shape of fruit, fruit base and fruit apex were similar. Fruit shape was spheroid, and shape of fruit base and fruit apex was truncate were found in Katamalta and BARI Malta-1. In case of fruit color, Katamalta was light green while BARI Malta-1 was green. Surface texture of fruit was slightly rough in Katamalta but that was smooth for BARI Malta-1, respectively. In addition, segment uniformity and segments wall were similar for both the genotypes. Fruit axis and pulp color were solid and light yellow for both of them (Table 3).

Table 1: Morphological characters of Katamalta and BARI Malta-1

Genotypes	Tree shape	Plant height (m)	Plant age	Canopy size (m)	Leaf division	Leaf lamina (cm)	Flower type
Katamalta	Obloid	2.88	7	1.58x3.47	Bifoliate	9.8x4.1	Hermaphrodite
BARI Malta-1	Obloid	2.7	7	1.34x2.28	Bifoliate	9.1x4.2	Hermaphrodite

Table 2: Quantitatives characteristics of Katamalta and BARI Malta-1

Genotypes	Fruits/plant	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit rind thickness (cm)	Segments/fruit	Fruit yield/ hectare	Juice content (ml)	Seeds/fruit	TSS (%)
Katamalta	234	191	6.96	7.1	0.53	10.9	27.9	60.0	21	8.5
BARI Malta-1	150	117	5.51	4.52	0.4	8.22	11.0	46.2	20	7.1

Table 3: Qualitatives characteristics of Katamalta and BARI Malta

Genotypes	Fruit shape	Fruit base shape	Fruit apex shape	Fruit color	Fruit surface texture	Segment uniformity	Segments wall	Fruit axis	Pulp color	Pulp firmness
Katamalta	Spheroid	Truncate	Truncate	Light green	Slightly rough	Equal	Thin	Solid	Light yellow	Tight
BARI Malta-1	Spheroid	Truncate	Truncate	Green	Smooth	Equal	Thin	Solid	Light yellow	Tight

Conclusion

From the findings it can be summarized that the Katamalta was higher yielder as compare to BARI Malta-1.

EVALUATION OF LOCAL EGGPLANT (POTHA BEGUN) GERMPLASM

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

The experiment was carried out at the research field of HRC, RARS, Hathazari, Chattogram during the winter season of 2021-22 to find out superior local eggplant genotypes. In case of Potha Begun lines significant differences were observed in all the parameters studied except fruit length, fruit diameter and number of fruits per plant. The earliest 50% flowering was found in the genotype SM (P)-10 (61.0 days) followed by SM (P)-08 (67.0 days) and it was delayed in SM (P)-06 (91.0 days) and SM (P)-11 (90.6 days). The highest individual fruit weight containing genotype was SM(P)-14 (49.3g) and SM(P)-01 (49.0g) followed by SM(P)-04 (46.3g) and it was the lowest in SM(P)-06 (26.3g). The highest significant fruit yield/plant or yield/hectare observed in SM(P)-09 (1.38 kg/plant or 19.86 t/ha), followed by SM (P)-12 (1.20 kg/plant or 18.53 t/ha), SM (P)-04 (1.16 kg/plant or 18.40 t/ha) and it was the lowest in SM (P)-06 (0.52 kg/plant or 8.01 t/ha). The 1000-seed weight was the highest in SM (P)-08 (8.0g) followed by SM (P)-13 (7.0 g) and SM (P)-17 (7.0g).

Introduction

Eggplant is one of the most common, popular and important vegetable crops grown in India, Bangladesh and other parts of the world (Bose *et al.*, 2002). Eggplant is grown round the year in Bangladesh. The area and production of eggplant reached 1.09 lakh hectare and 28.89 lakh tons, respectively in the year 2021 at Bangladesh. It is cultivated all over the country. But yield of this vegetable is very low due to lack of high yielding varieties. To increase yield it is necessary to developed more high yielding as well as region specific varieties. There are several regional varieties of eggplant which are very popular in their respective regions. In Chattogram region, a local eggplant cultivar named Potha begun is very popular and farmers of this region are very interested to cultivar this cultivar. This variety has been cultivated in this region for a long time and its variety varies greatly This cultivar has been cultivated in this region for a long time and a wide range of variations are existed in respect of yield, size, quality, insect an diseases susceptibility. Hence enough scope to develope a regional variety from this variation. In this point of view, the study was conducted to collect and observe their yield potentialities for developing a new variety of this popular cultivar.

Materials and Methods

The investigation was carried out at RARS, Hathazari, Chattogram during winter of 2021-22. There were seventeenpotha begun lines viz. SM (P)-01, SM (P)-02, SM (P)-03, SM (P)-04, SM (P)-05, SM (P)-06, SM (P)-07, SM (P)-08, SM (P)-09, SM (P)-10, SM (P)-11, SM (P)-12, SM (P)-13, SM (P)-14, SM (P)-15, SM (P)-16 and SM (P)-17. The experiment was laid out at RCB design and with 3 replications. The unit plot size was 0.7×7.0 m^2 and plant spacing was maintained at 1.2×0.7 m^2. The 30 days old seedlings were transplanted in the main field on 06 December, 2021. The land was fertilized with Cowdung, urea, TSP, MoP, Gypsum, Zinc sulphate and Boric acid @ 10,000, 375, 250, 250, 100, 12 and 10 kg^{-ha}. Half quantity Cowdung, entire TSP, Zinc sulphate and Boric acid and half quantity MoP were applied during land preparation. Remaining half quantity Cowdung was applied during pit preparation at one week before planting. Rest of MoP and entire urea were applied in 20 days interval after transplanting. Besides this, other cultural practices like, weeding, watering, plant protection measures, mulching were done as and when necessary. Data on days to 50% flowering, plant height at 1st harvest, branches/plant, individual fruit weight (g), fruit length (cm), fruit diameter (cm), number of fruits/plant and fruit yield (kg/ha or t/ha) were recorded. Data were analyzed using Statistix 10 statistical software and differences among the means were compared following Tukey's honestly significant difference test at 5% level of significance.

Results and discussion

Significant difference was observed in all the eggplant genotypes (Potha begun) among the parameters studied except number of fruits/plant, fruit length and diameter (Table 1). The earliest 50% flowering was found in the genotype SM (P)-10 (61.0 days) followed by SM (P)-08 (67.0 days) and it was delayed in SM (P)-06 (91.0 days) and SM (P)-11 (90.6 days). The longest plant found at 1st harvest was SM (P)-16 (53.6 cm) followed by SM (P)-07 (53.0 cm), it was the lowest in SM (P)-06 (26.6 cm). The maximum branches found in SM (P)-04 (8.66) followed by SM (P)-07 (8.33) and minimum

branches containing genotype was SM (P)-15 (4.43), SM (P)-11 (4.9) and SM (P)-16 (5.0). The highest individual fruit weight containing genotypes were SM (P)-14 (49.3 g) and SM (P)-01 (49.0 g) followed by SM (P)-04 (46.3 g) and it was the lowest in SM (P)-06 (26.3 g). The highest significant fruit yield/plant or /hectare observed in SM (P)-09 (1.38 kg/plant or 19.86 t/ha), followed by SM (P)-12 (1.20 kg/plant or 18.53 t/ha), SM (P)-04(1.16 kg/plant or 18.40 t/ha) and it was the lowest in SM (P)-06 (0.52 kg/plant or 8.01 t/ha). The 1000-seed weight was the highest in SM (P)-08 (8.0g) followed by SM (P)-13 (7.0 g), SM (P)-17 (7.0g) and it was the lowest in SM (P)-05 (4.16g) and SM (P)-10 (4.0g).

Table 1: Phenological, yield and yield contributing characters of local eggplant lines

Lines	Days to 50% flowering	Plant height at 1st harvest	Brunches/ plant	Individual fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruits/ plant	Fruit yield/ (kg/plant)	Fruit yield/ (t/ha)	1000-seed weight (g)
SM (P)-01	88.0ab	45.3c	6.66a-c	49.0a	4.16	4.24	20.6	0.99a-c	15.28a-c	5.00de
SM (P)-02	82.6bc	46.3a-c	6.00a-c	36.3c-g	3.70	3.79	26.6	0.86a-c	13.30a-c	6.00b-d
SM (P)-03	84.0a-c	46.0bc	5.50bc	41.0a-e	3.83	3.90	25.3	0.90a-c	13.85a-c	6.83a-c
SM (P)-04	89.0ab	47.0a-c	8.66a	46.3ab	4.00	4.16	26	1.16ab	18.40ab	5.00de
SM (P)-05	70.0ef	44.0cd	6.66a-c	36.3c-g	3.96	3.46	24	1.02a-c	15.02a-c	4.16e
SM (P)-06	91.0a	26.6f	5.93a-c	26.3h	3.46	3.45	21.3	0.52c	8.01c	5.00de
SM (P)-07	88.6ab	53.0ab	8.33a-b	40.0b-f	4.00	3.66	28	0.87a-c	13.85a-c	5.00de
SM (P)-08	67fg	45.0c	6.00a-c	31.6f-h	3.54	3.60	30.6	0.81a-c	12.53a-c	8.00a
SM (P)-09	75.0de	45.6bc	6.00a-c	44.3a-c	4.13	4.06	30.6	1.38a	19.86a	6.00b-d
SM (P)-10	61.0g	47.6a-c	5.43c	31.2g-h	3.50	3.53	33.7	0.85a-c	13.20a-c	4.00e
SM (P)-11	90.6a	41.0cd	4.90c	42.0a-d	3.84	3.96	21.3	0.89a-c	13.76a-c	5.00de
SM (P)-12	78.3cd	47.0a-c	6.00a-c	44.3a-c	4.15	4.06	33.3	1.20ab	18.53ab	5.16c-e
SM (P)-13	73.6d-f	43.0cd	5.33c	34.1d-h	3.70	3.60	26.6	0.86a-c	13.20a-c	7.00ab
SM (P)-14	79.0cd	37.0de	5.66bc	49.3a	4.13	4.06	30.6	1.12a-c	17.20a-c	5.00de
SM (P)-15	77.6cd	33.0ef	4.43c	36.0c-g	3.70	3.90	32.4	0.94a-c	14.53a-c	6.00b-d
SM (P)-16	77.6cd	53.6a	5.00c	33.0e-h	3.44	3.36	22.6	0.66bc	10.25bc	6.00b-d
SM (P)-17	87.6ab	43.0cd	5.53bc	32.3e-h	3.41	3.36	25.7	0.77a-c	11.97a-c	7.00ab
F-test	**	**	**	**	ns	ns	ns	**	**	**
CV (%)	2.98	5.48	15.71	7.38	-	-	-	22.5	21.5	10.36

Conclusion

Considering all the characters the genotypes SM (P)-04, SM (P)-09 and SM (P)-12 were found promising and can be trial again in the next year.

Reference

Bose, T.K., J. Kabir, T.K. Maity, V.A. Parthasarathy and G. Som. 2002.Vegetable crops. Naya Prokash, Calcutta 700006, India. p- 265.

REGIONAL YIELD TRIAL OF SELECTED EGGPLANT HYBRIDS (SET- I, II)

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

A study on the regional yield trial of eggplant hybrid lines was conducted at RARS, Hathazari, Chattogram during winter, 2021-22 to find out high yielding hybrid lines.Significant differences were observed in all the parameters studied except days to last harvest.The earliest 1st flowering was observed in the genotype.The maximum fruit bearing green colored hybrids were F_1 11x353A (43.5) and F_1 21x11 (36) than other hybrids. The highest fruit yield per plant and per hectare observed in the $F_1$21x11 (3.3kg and 42.9 t/ha) and F_1 11×353A (3.1 kg/plant and 40.3 t/ha), whereas, check varieties F_1 Purbani (2.5 kg/plant and 32.5 t/ha) and BARI Hybrid Begun-5 (2.2 kg/plant and 28.6 t/ha) which were far lower than promising hybrids. The maximum fruit bearing purple colored hybrid was F_1 203×233 (37.6) but it was the lowest inF_1 203x5 (21.8) and BARI Hybrid Begun-6 (20.9). The highest fruit yield per plant and per hectare observed in the F_1 5x216 (2.96 kg/plant and 38.51 t/ha) followed by F_1 203×5 (2.6 kg and 33.83 t/ha) and F_1 203x233 (2.58 kg/plant and 33.54 t/ha) whereas, check varietiesBARI hybrid Begun-6 (2.22 kg/plant and 28.86 t/ha) and F_1 Purple king (2.19 kg/plant and 28.58 t/ha) which was far lower than promising hybrids.

Introduction

Eggplant or Brinjal (*Solanum melongena* L.) belongs to the family solanaceae and is the most important and widely-consumed vegetable in Bangladesh. It is cultivated all over the country. Yield of eggplant in Bangladesh is low as compared to that of other tropical countries might be due to lack of high yielding hybrid varieties.Production of this vegetable is very low due to lack of high yielding and superior quality of varieties. To increase yield hybrid variety should be developed. Some hybrid eggplant varieties were released by BARI. But those are not enough to meet the demand of the country. So, it is very important to develop a more hybrid eggplant varieties. Becausehigh yielding hybrid variety is an important factor for maximizing the production of eggplant. There is a great chance to get higher yield using hybrid exploitation in eggplant. Olericulture Division, HRC, BARI selected some winter hybrid eggplant lines. This study was undertaken to study the performance of yield potentialities of these hybrid lines at Chattogram region of Bangladesh and to develop high yielding hybrid eggplant variety.

Materials and Methods

The study was conducted at Regional Agricultural Research Station, Hathazari, Chattogram during winter, 2021-22. The seedlings of green colored eggplant lines viz. F_1 11x353A, F_1 21x11, F_1 12x253B and check varieties were F_1Purbani and BARI Hybrid Begun-5 as well as purple colored eggplant lines viz. F_1 5x216, F_1 203x233, F_1 203x5 and check varieties were F_1 Purple king and BARI Hybrid Begun-6. The 30 days old seedlings were transplanted on 03 December, 2020. The experiment was laid out in RCB design with 3 replications. Unit plot size was 7.0x0.7m^2 and plant spacing was 1.2 × 0.7 m accommodating 10 plants/plot. The land was fertilized with Cowdung, urea, TSP, MoP, Gypsum, Zinc sulphate and Boric acid @ 10,000, 375, 250, 250, 100, 12 and 10 kg^{-ha}. Half quantity Cowdung entire TSP, Zinc sulphate and Boric acid and half quantity MoP were applied during land preparation. Remaining half quantity Cowdung was applied during pit preparation at one week before planting. Rest of MoP and entire urea were applied in 20 days interval after transplanting. Besides, other cultural practices like, weeding, watering, plant protection measures, mulching were done as and when necessary. Data on days to 1st flowering, days to 50% flowering, days to 1st harvest, days to last harvest, individual fruit weight (kg), fruit length (cm), fruit diameter (cm), fruits/plant, fruit yield (kg/plant) and fruit yield/ha (t) were recorded. Data were analyzed using statistix 10 statistical software and differences among the means were compared following Tukey's honestly significant difference test at 5% level of significance.

Results and Discussion

Significant difference was observed in all the green colored eggplant genotypes among the parameters studied except days to last harvest (Table 1). The earliest days to 1st flowering observed in the hybridsF_1 12x253B (99 days),F_1 11x353A (100 days)and F_1 21x11 (100.7 days). Similarly, the earliest days to 50% flowering observed in the hybrids F_1 11x353A (107 days), F_1 12x253B (107 days)andF_1 21x11 (109

days). Moreover, the earliest days to 1st fruit harvest found in the hybrids $F_1$11x353A and F_1 21x11 (125 days for both). The days to last harvest was insignificant for all hybrids but ranged from 166.3 to 170.6 days. Maximum fruit bearing hybrids were F_1 11x353A (43.5) and F_1 21x11 (36) than other hybrids. The individual fruit weight was the highest in F_1Purbani (165.2g) followed by BARI Hybrid Begun-5 (151.0g) but it was the lowest in the F_1 11x353A (71.6g). The highest fruit length was observed in the F_1 11x353A (11.6 cm) followed by F_1 21x11 (9.9 cm) but the maximum fruit diameter was found in F_1Purbani (6.5 cm) and BARI Hybrid Begun-5 (6.4 cm).In addition, the highest fruit yield per plant and per hectare observed in the F_1 21x11 (3.3kg and 42.9 t/ha) andF_1 11x353A (3.1 kg/plant and 40.3 t/ha), whereas, check varieties F_1Purbani (2.5 kg/plant and 32.5 t/ha)and BARI Hybrid Begun-5 (2.2 kg/plant and 28.6 t/ha) which was far lower than promising hybrids. On the other hand, significant difference was also observed in all the purple colored eggplant genotypes among the parameters studied except days to last harvest (Table 2). The earliest days to 1st flowering were observed in the hybrids F_1 203x5 (84.3 days),F_1 203x233 (86.0 days), and BARI Hybrid Begun-6 (88.0 days). Similarly, the earliest days to 50% flowering observed in the hybrids F_1 203x5 (93.0 days), but it was the delayed in F_1 Purple king (104.6 days). Moreover, the earliest days to 1st fruit harvest found in the hybrids F_1 203x5 (118.0 days), but it was the delayed in F_1 Purple king (130.0 days). The days to last harvest was insignificant for all hybrids but ranged from 168.3 to 172.3 days. Maximum fruit bearing hybrid wasF_1 203x233 (37.6) but it was the lowest in F_1 203x5 (21.8)andBARI Hybrid Begun-6 (20.9).The individual fruit weight was the highest in F_1 203x5 (119.6 g) and F_1 5x216 (114.8 g) but it was the lowest in the F_1 Purple king (68.6g) and F_1 203x233 (68.4 g).The highest fruit length was observed in the F_1 Purple king (11.6 cm) but the maximum fruit diameter was found in F_1 203x5 (5.9 cm). In addition, the highest fruit yield per plant and per hectare observed in the F_1 5x216 (2.96 kg/plant and 38.51 t/ha) followed by F_1 203x5 (2.6 kg and 33.83 t/ha)andF_1 203x233 (2.58 kg/plant and 33.54 t/ha), whereas, check varieties BARI Hybrid Begun-6 (2.22 kg/plant and 28.86 t/ha) and F_1 Purple king (2.19 kg/plant and 28.58 t/ha) which was far lower than promising hybrids.

Table 1: Morphological and yield contributing characters of green eggplant hybrids (Set-I)

Treat	Days to 1st flowering	Days to 50% flowering	Days to 1st harvest	Days to last harvest	Fruits/ plant	Individual fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Yield/ plant (kg)	Yield/ha (t)
F_1 11x353A	100.0c	107.0c	125.0b	170.6	43.5a	71.6e	11.6a	3.2c	3.1a	40.3a
F_1 21x11	100.7c	109.0c	125.0b	169.6	36.0a	92.3d	9.9b	4.8b	3.3a	42.9a
F_1 12x253B	99.0c	107.0c	128.3a	169.3	21.8b	116.2c	9.1bc	5.1b	2.5ab	32.5ab
F_1Purbani	114.3a	120.0a	129.0a	166.3	14.9b	165.2a	8.4cd	6.5a	2.5ab	32.5ab
BARI Hybrid Begun-5	109.0b	113.0b	129.3a	166.3	14.6b	151.0b	7.6d	6.4a	2.2b	28.6b
F-test	**	**	**	ns	**	**	**	**	*	*
CV (%)	1.74	1.06	0.75	-	12.03	1.53	5.38	4.6	11.6	11.6

Table 2: Morphological and yield contributing characters of purple eggplant hybrids (Set-II)

Treat	Days to 1st flowering	Days to 50% flowering	Days to 1st harvest	Days to last harvest	Fruits/ plant	Individual fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Yield/ plant (kg)	Yield/ ha (t)
F_1 5x216	98.3a	101.3ab	126.0ab	171.3	25.8c	114.8a	11.1b	5.1b	2.96a	38.51a
F_1 203x233	86.0b	98.0b	123.0b	169.3	37.6a	68.4c	10.6b	3.8c	2.58ab	33.54ab
F_1 203x5	84.3b	93.0c	118.0c	168.3	21.8c	119.6a	8.4b	5.9a	2.60ab	33.83ab
F_1Purple king	97.0a	104.6a	130.0a	172.3	32.0b	68.6c	20.4a	2.2d	2.19b	28.58b
BARI Hybrid Begun-6	88.0b	100.0b	125.0b	170	20.9c	106.1b	11.2b	4.8b	2.22b	28.86b
F-test	**	**	**	ns	**	**	**	**	**	**
CV (%)	3.9	3.5	3.22	-	7.02	4.48	9.1	2.62	7.1	7.1

Conclusion

The results of the present study revealed that the green colored hybrid F_1 11x353A and F_1 21x11 as well as purple colored hybrid F_1 5x216 found promising than check varieties.

REGIONAL YIELD TRIAL OF EGGPLANT LINES FOR WINTER (SET- I, II, III)

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

Significant difference was observed in all the green, purple and white colored eggplant genotypes among the parameters studied to find out the best performing lines. In case of green colored eggplantsignificant differences were observed in all the parameters studied except days to 50% flowering, days to 1st harvest, fruit length and days to last harvest. The highest fruit bearing genotype was SM-332 (17) and ISD-35 (16.3) while BARI Begun-6 contains 12 fruits/ plant. The maximum fruit yield per plant and per hectare found in ISD-35 (1.99 kg/plant and 23.76 t/ha) followed by BARI Begun-6 (1.85 kg/plant and 22.12 t/ha) and it was the lowest in SM 275 (1.34 kg/plant and 16.06 t/ha). The highest purple colored fruit bearing genotype was SM-233 (33.5) and SM-216 (32.3) and it was the lowest in SM-42 (8.3). The maximum fruit yield per plant and per hectare found in SM-233 (1.99 kg/plant and 23.76 t/ha) and SM-216 (1.88 kg/plant and 22.4 t/ha) and it was the lowest in BARI Begun-6 (0.81 kg/plant and 9.6 t/ha). In between two white colored lines, the earlier flowering and harvest was found in SM-23A (87/94 and 125 days) as well as number of fruits/ plant and fruit yield was higher in the same genotype (21 and 16.75 t/ha).

Introduction

Eggplant (*Solanummelongena*L.) is one of the most common, popular and important vegetable crops grown in India and other parts of the world (Bose *et al.*, 2002). It is also major vegetable in Bangladesh. Eggplant was grown round the year in Bangladesh. It is popular, nutritious and commercial vegetables have high demand. The production volume of eggplant reached 28.89 lakh tons in the year 2021 on 1.09 lakh hectare of land in Bangladesh. It is cultivated all over the country. But production of this vegetable is very low due to lack of high yielding varieties. To increase yield it is necessary to developed more high yielding as well as region specific varieties. BARI already developed numbers of eggplant varieties. But it is not sufficient to meet the country demand. So, it is very important to develop more high yielding varieties. In this point of view, the olericulture Division of HRC, BARI selected some advance winter eggplant lines, they are green, purple and white colored lines. The study was conducted to observe their yield potentialities and other performances. The present investigation was a part of that program.

Materials and Methods

The investigation was carried out at RARS, Hathazari, Chattogram during winter of 2021-22. There were three type of colored winter eggplant lines viz. green colored (Set-I)ISD-35, SM-275, SM-332; purple colored(Set-II) SM-42, SM-216, SM-233 and white colored (Set-III) SM- 312 and SM-23A where BARI Begun-4 and BARI Begun-6was used as check. The experiment was laid out at RCB design and replicated 3 times. The unit plot size was 0.7 m x 7.0 m and plant spacing was maintained at 1.2 m X 0.7 m. The land was fertilized with Cowdung, urea, TSP, MoP, Gypsum, Zinc Sulphate and Boric acid @ 10,000, 375, 250, 250, 100, 12 and 10 kg^{-ha}. Half quantity Cowdung entire TSP, Zinc sulphate and Boric acid and half quantity MP were applied during land preparation. Remaining half quantity Cowdung was applied during pit preparation at one week before planting. Rest of MoP and entire urea were applied in 20 days interval after transplanting. Besides this, other cultural practices like, weeding, watering, plant protection measures, mulching were done as and when necessary. Data on days to 1st flowering, days to 50% flowering, days to 1st harvest, days to last harvest, individual fruit weight (g), fruit length (cm), fruit diameter (cm), fruits/plant, fruit yield (kg/plant) and fruit yield (t/ha) were recorded. Data were analyzed using Statistix 10 statistical software and differences among the means were compared following Tukey's honestly significant difference test at 5% level of significance.

Results and discussion

Significant difference was observed in all the green colored eggplant genotypes among the parameters studied except days to 50% flowering, days to 1st harvest and fruit length (Table 1). The earliest days to 1st flowering was observed in the line SM-332 (104 days) whereas BARI Begun-6 required 122.6 days. The lines showed delayed last harvest than check variety. The highest fruit bearing genotype was SM-332 (17)and ISD-35 (16.3) while BARI Begun-6 contains 12 fruits/ plant. The highest individual

fruit weight containing genotype was BARI Begun-6 (154.6 g) followed by ISD-35 (122.3 g) and it was the lowest in SM 332 (95.0 g). The maximum fruit diameter found in the genotype BARI Begun-6 (6.86 cm) followed by ISD-35 (6.05 cm). The maximum fruit yield per plant and per hectare found in ISD-35 (1.99 kg/plant and 23.76 t/ha) followed by BARI Begun-6 (1.85 kg/plant and 22.12 t/ha) and it was the lowest in SM 275 (1.34 kg/plant and 16.06 t/ha). On the other hand, significant difference was observed in all the green colored eggplant genotypes among the parameters studied except days to 1st and 50% flowering, days to last harvest and fruit length (Table 2). The earliest 1st harvest was observed in the line SM-233 (139 days) and BARI Begun-4 (136 days). The highest fruit bearing genotype was SM-233 (33.5) and SM-216 (32.3) and it was the lowest in SM-42 (8.3). The highest individual fruit weight containing genotype was SM-42 (112.3 g). Maximum fruit diameter found in the genotype SM-42 (4.2 cm). Maximum fruit yield per plant and per hectare found in SM-233 (1.99 kg/plant and 23.76 t/ha) and SM-216 (1.88 kg/plant and 22.4 t/ha) and it was the lowest in BARI Begun-6 (0.81 kg/plant and 9.6 t/ha).In addition, in between two white colored lines, the earlier flowering and harvest was found in SM-23A (87/94 and 125 days) as well as number of fruits/ plant and fruit yield was higher in the same genotype (21 and 16.75 t/ha). However, individual fruit weight higher in SM-312 (102.0 g) shown in (Table 3).

Table 1: Phenological, yield and yield contributing characters of green coloredeggplant OP lines (Set-I)

Lines	Days to 1st flowering	Days to 50% flowering	Days to 1st harvest	Days to last harvest	Fruits/ plant	Individual fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit yield (kg/plant)	Fruit yield (t/ha)
ISD-35	112.3ab	117.3	138	169.0a	16.3a	122.3b	6.82	6.05ab	1.99a	23.76a
SM-275	107.3ab	110.6	138	170.0a	13.5b	99.67c	7.79	5.07b	1.34c	16.03c
SM-332	104.0b	109.0	138	166.3a	17.0a	95.0c	7.99	4.99b	1.61bc	19.22bc
BARI Begun-6	122.6a	125.0	140	145.6b	12.0b	154.6a	7.4	6.86a	1.85ab	22.12ab
F-test	*	ns	ns	**	**	*	ns	*	**	**
CV (%)	5.5	-	-	1.82	5.81	19	-	9.6	7.52	7.52

Table 2: Yield and yield contributing characters of purple colored eggplant OP lines (Set-II)

Lines	Days to 1st flowering	Days to 50% flowering	Days to 1st harvest	Days to last harvest	Fruits/ plant	Individual fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit yield (kg/plant)	Fruit yield (t/ha)
SM-42	114.3	117.7	144.3a	166.3	8.3c	112.3a	9.7	4.2a	0.94b	11.2b
SM-216	114.0	116.7	143.6a	170.7	32.3a	51.4b	10.7	2.9ab	1.66a	19.8a
SM-233	113.3	116.3	139.0b	172.3	33.5a	56.2b	11.9	2.8ab	1.88a	22.4a
BARI Begun-4	101.3	114.0	136.0b	171.0	17.0b	47.1b	10.1	2.7b	0.81b	9.6b
F-test	ns	ns	**	ns	**	**	ns	*	**	**
CV (%)	-	-	1.06	-	8.67	11.88	-	15.19	18.46	18.46

Table 3: Yield and yield contributing characters of white colored eggplant OP lines (Set-III)

Lines	Days to 1st flowering	Days to 50% flowering	Days to 1st harvest	Fruits/ plant	Individual fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit yield (kg/ plant)	Fruit yield (t/ ha)
SM- 312	109	119	138	8	102	11.4	4.5	0.82	9.71
SM-23A	87	94	125	21	67	5.2	4.8	1.41	16.75

Conclusion

Considering all the characters in three types of eggplant linesISD-35 (green), SM-216, SM-233 (purple) andSM-23A (white)performed best as compare to check varieties BARI Begun-4 and BARI Begun-6.

Reference

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REGIONAL YIELD TRIAL OF HYBRIDS OF TOMATO IN WINTER

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

The trial was conducted at the research field of Horticulture Research Centre, RARS, Hathazari, Chittagong during the winter season of 2021-22. Significant differences were observed in all the parameters studied except locule number. The earliest fruit harvest was observed in the Unnayan (108.6 days) followed by BARI Hybrid Tomato-8 (110.3 days) and Hybrid-53 (115.0 days) was the delayed than other hybrids. The highest number of fruits was observed in the Hybrid-53 (44.6) followed by Unnayan (38.6) and Hybrid-75 (38.0),and it was the lowest in BARI Hybrid Tomato-8 (30). The marketable yield per plant and per hectare were the highest in Hybrid-76 (3.34kg/plant and 100.4 t/ha) followed by Hybrid-53 (3.21 kg/plant and 96.5 t/ha) but it was the lowest in BARI Hybrid Tomato-8 (1.81 kg/plant and 54.2 t/ha).

Introduction

Tomato (*Solanumlycopersicum*) is a popular vegetable crop in the world and grown over 4 million hectares of land. It is one of the sources of vitamins and minerals. Available winter varieties of tomato in the country are not sufficient to meet the consumers demand.They are looking for diversified tomato varieties and BARI developed a few open pollinated and hybrid varieties for winter tomato.The national average of tomato yield is 14.64 t/ha (BBS, 2020)which is far below than our developed varieties. Farmers demand for winter hybrids is increasing day by day. It is reported that high yielding varieties of tomato is resulted in increased yield of 20-50% (Choudhury*et.al.,* 1965). Hybrids of tomato show considerable heterosis for yield, yield contributing characters and qualities. Therefore, from that evaluation, we had selected five promising hybridsto test at different locations. The objective was to select suitable winter hybrids with high yield, better quality and wide adaptability across the country.

Materials and Methods

The investigation was conducted at RARS, Hathazari, Chattogram during winter of 2021-22.The study consisted of four winter hybrids viz. Hybrid-50, Hybrid-53, Hybrid-75 and Hybrid-76. BARI Hybrid Tomato-8 and commercial hybrid Unnayan were use as check. Seeds were sown in seed bed on 04 November, 2021. Twenty eight days old seedlings were transplanted in the main field. The experiment was laid out in RCB design with three replications. The plant spacing maintained 60 cm between rows and 40 cm between plants within the bed. The land was fertilized with Cowdung, urea, TSP, MoP, Gypsum and Zinc sulphate @ 5000,550,450,250,100 and 12 kg/ha, respectively. Half of Cowdung and MoP; entire amount of TSP, Gypsum and Zinc sulphate were applied as basal dose during final land preparation. The remaining amount of Cowdung was applied in pit. Urea and the rest of MoP were applied the three equal installments as top dressing at 20, 40, 60 days of transplanting. Intercultural operations were done as and when necessary. Data on include days to 50% flowering, Days to 1st harvest, marketable fruits/plant, marketable yield/plant, marketable yield/ha, individual fruit weight, TSS (%) and fruit locule number were recorded.Analysis of variance (ANOVA) and meanseparation of genotypes were done using Statistix 10 software.

Results and Discussion

Performance of hybrid tomato genotypes are presented in Table 1. The earliest flowering observed in the Unnayan (55.6 days) followed by BARI Hybrid Tomato-8 (57.3 days) and Hybrid-53(62.0 days) was the delayed than other hybrids. Likewise, the earliest fruit harvest was observed in the Unnayan (108.6 days) followed by BARI Hybrid Tomato-8 (110.3 days) and Hybrid-53 (115.0 days) those were delayed than other hybrids. The highest number of fruits was observed in the Hybrid-53 (44.6) which was statistically similar toUnnayan (38.6) and Hybrid-75 (38.0) and it was the lowest in BARI Hybrid Tomato-8 (30). Individual fruit weight was the highest in Hybrid-76 (126.2g) and Hybrid-50 (114.3g), while the lowest in BARI Hybrid Tomato-8(78.7 g).The marketable yield per plant and yield per hectare were the highest in Hybrid-76 (3.34kg/plant and 100.4 t/ha, respectively) which was statistically identical to Hybrid-53 (3.21 kg/plant and 96.5 t/ha, respectively) but it was the lowest in BARI Hybrid Tomato-8 (1.81 kg/plant

and 54.2 t/ha, respectively). The locule number of fruit was varied from 3.33 to 4.33. Total soluble solids (TSS %) of fruits of studied hybrids ranged from 4 to 5%.

Table 1: Morphological and yield contributing characters of tomato hybrids

Hybrids	Days to 50% flowering	Days to 1st harvest	Fruits/ plant	Individual fruit weight (g)	Fruit yield/ plant (kg)	Fruit yield/ha (t)	Locule number	TSS (%)
Hybrid-50	58.6bc	111.6bc	32.0bc	114.3a	2.74a-c	82.4a-c	3.33	5.0a
Hybrid-53	62.0a	115.0a	44.6a	95.8b	3.21ab	96.5ab	4.33	4.7a
Hybrid-75	59.0b	112.0b	38.0ab	79.5b	2.26cd	67.8cd	3.33	4.8a
Hybrid-76	58.0bc	111.0bc	35.3bc	126.2a	3.34a	100.4a	3.33	4.0b
Unnayan	55.6d	108.6d	38.6ab	92.6b	2.68bc	80.4bc	4.33	4.0b
BARI Hybrid Tomato-8	57.3c	110.3c	30.6c	78.7b	1.81d	54.2d	3.33	5.0a
F-test	**	**	**	**	**	**	ns	**
CV (%)	0.81	0.42	6.82	6.22	8.68	8.68	-	4.66

Conclusion

From the findings it can be summarized that the genotypes Hybrid-76 and Hybrid-53 were the highest yielder as compare to check varieties.

REGIONAL YIELD TRIAL OF SWEET PEPPER LINES

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

The investigation was carried out at RARS, Hathazari, Chattogram during winter season of 2021-22 to observe the yield performance of sweet pepper lines. The earliest 1st 50% flowering observed in the BARI Mistimorich-2 (81.6 days) and the highest individual fruit weight was found in CA0026 (93.0 g), BARI Mistimorich-2 (90.0 g) and CA0040 (85.5 g). The highest fruit bearing genotype was CA0031 (14.3) and fruit yield per plant or per hectare was BARI Mistimorich-2 (0.612 kg or 32.6 t/ha) and the genotype CA0035 showed minimum fruit yield (0.325 kg or 17.3 t/ha).

Introduction

Sweet pepper (*Capsicum annuum* L.) belongs to the family solanaceae and native to tropical South America. Sweet pepper fruits are used as vegetable, spices and medicinal purpose. There are wide range of variation in fruit shape, size and color. Some advanced lines were selected for adaptive trial in different parts of Bangladesh. The purpose of this study was to find out suitable lines for developing a new variety.

Materials and Methods

The investigation was carried out at RARS, Hathazari during winter season of 2021-22. There were four sweet pepper lines viz. CA0026, CA0031, CA0035 and CA0040 BARI Mistimorich-2 was used as check. The experiment was laid out RCB design with 3 replications. The unit plot size was 3.0x1.0m^2 and plant spacing was maintained at 50x40cm^2 accommodating 10 plants in each plot. The 30 days old seedlings were transplanted in the main field on 14December, 2021. Low height tunnel with 60 mesh nylon net with polythene sheet was used for proper growth of the plants. The land was fertilized with Cowdung (CD), urea, TSP, MoP, Gypsum (S), Zinc sulphate (Zn) and Boric acid (B) @ 10000, 220, 330, 200,100, 12 and10 kg/ha, respectively. The one third of the CD and half of TSP and full of S, Zn and B were applied during final land preparation. The remaining CD, TSP and 1/3rd of MoP were applied during pit preparation. One fifth of urea and MoP were applied 20 days of transplanting in the main field. After that, rest of urea and MoP were applied in equal four installments at 20 days interval. Besides this, other cultural practiceslike weeding, watering, plant protection, mulching, etc. were done as and when necessary. Data on days to 1st, 50% flowering, fruit length (cm), fruit diameter (cm), individual fruit weight (g), number of fruits/plant, yield/plant (kg) and yield/ha (t) were recorded. Data were analyzed using Statistix 10 statistical software.

Results and discussion

Significant differences observed in all the parameters studied in sweet pepper lines except days to 1st flower open (Table 1). The earliest 1st 50% flowering observed in the BARI Mistimorich-2 (81.6 days) and it was delayed in CA0035 (87.3 days)and CA 0031 (87.6 days). The highest individual fruit weight was found in CA0026 (93.0 g), BARI Mistimorich-2 (90.0 g) and CA0040 (85.5 g) and it was the lowest in CA0031 (39.0 g). The highest fruit bearing genotype was CA0031 (14.3) than the other genotypes. The fruit yield per plant or per hectare was BARI Mistimorich-2 (0.612 kg or 32.6 t/ha) and the genotype CA0035 showed minimum fruit yield (0.325 kg or 17.3 t/ha).

Table 1: Yield and yield contributing characters of different sweet pepper lines

Lines	Days to 1st flower open	Days to 50% flower open	Individual fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruits/ plant	Fruit yield/ plant (kg)	Fruit yield/ha (kg)
CA 0026	80	83.3b	93.0a	8.1ab	6.6a	7.3b	0.542ab	28.9ab
CA 0031	82	87.6a	39.0c	9.6a	3.7d	14.3a	0.504ab	27.5ab
CA 0035	81.6	87.3a	55.0b	6.8b	5.2c	6.6b	0.325b	17.3b
CA 0040	78.3	82.3bc	85.5a	7.8ab	6.1ab	7.0b	0.500ab	26.6ab
BARI Mistimorich-2	78.6	81.6c	90.0a	9.3a	5.9b	9.6b	0.612a	32.6a
F-test	ns	**	**	*	**	**	*	*
CV (%)	-	1.98	4.53	9.38	4.09	7.33	6.47	6.87

Conclusion

From the findings it can be summarized that the genotypes CA 0026, CA 0031 and CA 0040 were higher yielder which was close to check variety.

REGIONAL YIELD TRIAL OF BOTTLE GOURD HYBRIDS

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

An experiment was conducted at the research field of RARS, Hathazari, Chattogram during winter of 2021-22 in order to assess the regional yield potentialities of four winter bottle gourd hybrids.Significant differences observed in all the parameters studied in winter bottle gourd hybrids except days to last harvest and number of fruits/plant.The earliest 1st female flowering obtained from the hybrid $F_1$4x231 (76.0 days),closely followed by F_1 4x3 (77.0 days) and Dina (77.6 days), while that was delayed in F_1 4x3 (82.3 days). Among the hybrids $F_1$4x3 (106.0 days) and $F_1$1x2 (106.6 days)were found early, while $F_1$4x231 (115.6 days) was late. The highest individual fruit weight was observed in F_1 3x4 (2.7 kg) followed by F_1 4x3 (2.5 kg) which was higher than commercial check variety Diana (2.0 kg). The highest fruit yield per hectare was found in F_1 3x4 (101.6 t) closely followed by F_1 4x3 (98.0 t), while the hybrid F_1 1x2 (57.5 t) and Diana (64.7 t) exhibited lowest fruit yield/ha.

Introduction

Bottle gourd has been credited with a wide bi-hemispheric distribution (Bose *et al.*, 2002). Bottle gourd (*Lagenariasiceraria*) is an important and popular vegetables of Bangladesh (Rashid, 1999). It is a popular nutritious vegetables and high demand in Bangladesh and other countries. There are about 50 thousand tons bottle gourd produce every year in Bangladesh. It is cultivated all over the country. Production of this vegetable is very low due to lack of high yielding and superior quality of varieties. To increase yield hybrid variety should be developed. Some bottle gourd varieties were released by BARI. But all of them are OP varieties. Hence those are not sufficient to meet the country demand. So, it is very important to develop a hybrid bottle gourd variety. In this point of view, vegetable division of HRC, BARI had selected some advance winter bottle gourd hybrids. The study was conducted to observe their yield potentialities in different locations. The present investigation is a part of that program.

Materials and Methods

The investigation was carried out at RARS, Hathazari during winter season of 2021-22. There were four winter bottle gourd hybrids viz. F_1-1x2,F_1-3x4, F_1-4x3, F_1-4x231 and commercial hybrid Diana was used as check. The experiment was laid out RCB design with 3 replications. The unit plot size was 2mx10m and plant spacing was maintained at 3 mx2 m accommodating 5 plants in each plot. The 20 days old seedlings were transplanted in the main field on 01 December, 2021. The land was fertilized with Cowdung, urea, TSP, MoP, Gypsum (S), Zinc sulphate (Zn) and Boric acid (B) @ 10000, 375, 250, 250,100, 12,10 kg/ha, respectively. The one third of the cowdung and half of TSP and full of S, Zn and B were applied during final land preparation. The remaining cowdung and TSP and 1/3rd of MoP were applied during pit preparation. One fifth of urea and MoP were applied 20 days of transplanting in the main field. After that, rest of urea and MoP were applied in equal four installments at 20 days interval. Besides this, other cultural practices like, weeding, watering, plant protection measures, mulching were done as and when necessary. Data on days to 1stmale flowering, Days to 1stfemale flowering, Node number at 1st male flowering, Node number at 1st female flowering,Days to 1st and last harvest, Fruit length (cm), Fruit diameter (cm), Individual fruit weight (g), Number of fruits/plant, Yield/plant (kg) and Yield/ha (t) were recorded. Data were analyzed using Statistix 10 statistical software.

Results and discussion

Significant differences wasobserved in all the phonological parameters studied in winter bottle gourd hybrids except days to last harvest (Table 1). The earliest 1stmale flowering was observed in the hybrid F_1 4x231 (76.0 days) statistically similar withhybridF_1 4x3 (77.0 days) and check variety Diana (77.6 days) while delayed1stmale flowering observed in$F_1$3x4 (82.3 days). Likewise, the earliest 1st female flowering was observed in the hybrid $F_1$4x231 (81.0 days) closely followed by $F_1$3x4 (81.3 days) and Diana (82.6 days) while that was delayed in F_1 4x3 (86.3 days). Minimumnode numberat 1st male floweringwas recorded in thecheck variety Diana (9) closely followed by hybrid F_1 1x2 (9.3), F_1 4x231 (9.6) andF_1 4x3(10), in contrast maximum node number at 1st male flowering was found in the hybrid $F_1$3x4 (13.6)as well as minimum node number was recordedat 1st female flowering in the hybrid F_1 1x2 (14.6) and maximum node number at 1stfemale flowering wasin hybrid F_1 4x3 (17.6).The hybrid $F_1$4x3 (106.0 days) closely followed by$F_1$1x2 (106.6 days) showed earliest 1stfruit harvest while the delayed 1stfruit harvest was in F_1 4x231 (115.6 days). In case of last harvest, there was no significant difference was found among the studied hybrids (Table 1).Significant variation was observed in yield and yield contributing characters of different bottle gourd hybrids except number of fruits/plant (Table 2).Maximum fruit length was found in hybrid F_1 3x4 (43.6 cm) and it was minimum inthecheck variety Diana (30.3 cm),hybrid F_1 4x3 (32.0 cm). The highest fruit diameter was exhibited by the hybridF_1 4x231 (12 cm), closely followed byF_1 3x4 (11.8 cm) and that was the lowest in $F_1$1x2 (8.0 cm). The heaviest fruit was found in F_1 3x4 (2.7 kg) followed by F_1 4x3 (2.5 kg) and it was the lightest in commercial check variety Diana (2.0 kg). The number of fruits/plant was found insignificant among the hybrids. The fruit yield/plant was found significant and that was the highest in F_1 3x4 (40.7 kg) closely followed by and F_1 4x3 (39.2 kg), in contrast the hybrid F_1 1x2 (23.0 kg) and Diana (25.9 kg) showed the minimum fruit yield. The fruit yield per hectare was also significant and that was maximum in F_1 3x4 (101.6 t) at par with F_1 4x3 (98.0 t), on the other hand the hybrid F_1 1x2 (57.5 t) and Diana (64.7 t) exhibited minimum fruit yield/ha.

Table 1: Phenological characters of different bottle gourd hybrids

Lines	Days to 1st male flowering	Days to 1st female flowering	Node number at 1st male flowering	Node number at 1st female flowering	Days to 1st harvest	Days to last harvest
F_1 3x4	82.3a	81.3c	13.6a	16.6ab	108.0bc	157.6
F_1 1x2	81.0a	85.0ab	9.3b	14.6b	106.6c	158.0
F_1 4x3	77.0b	86.3a	10.0b	17.6a	106.0c	158.0
Diana	77.6b	82.6bc	9.0b	16.6ab	110.0b	159.0
F_1 4x231	76.0b	81.0c	9.6b	17.3ab	115.6a	157.6
F-test	**	**	**	*	**	ns
CV (%)	1.11	1.53	9.35	5.92	1	-

Table 2: Yield and yield contributing characters of different bottle gourd hybrids

Lines	Fruit length (cm)	Fruit diameter (cm)	Individual fruit weight (kg)	Fruits/ plant	Fruit yield/ plant (kg)	Fruit yield/ ha (t)
F_1 3x4	43.6a	11.8a	2.7a	14.6	40.7a	101.6a
F_1 1x2	40.0b	8.0c	1.5d	14.6	23.0c	57.5c
F_1 4x3	32.0cd	11.5b	2.5ab	14.6	39.2a	98.0a
Diana	30.3d	11.5b	2.0c	13.0	25.9c	64.7c
F_1 4x231	34.3c	12.0a	2.4b	13.6	32.7b	81.8b
F-test	**	**	**	ns	**	**
CV (%)	2.75	1.9	4.2	-	4.9	4.8

Conclusion

From the findings it can be concluded that the hybridsF_1 3x4 and F_1 4x3 were the highest yielder as compare to commercial check variety Diana.

References

Bose, T. K., J. Kabir, T.K. Maity, V. A. Parthasarathy and G. Som. 2002.Vegetable crops.NayaProkash, Calcutta 700006, India. P. 504.

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REGIONAL YIELD TRIAL OF WINTER BOTTLE GOURD LINES

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

An experiment was conducted at the research field of RARS, Hathazari, Chattogram during winter season of 2021-22 in order to assess the regional yield potentialities of four winter bottle gourd lines.Significant differences observed in all the parameters studied except individual fruit weight.The earliest 1st flowering was observed in the genotype LS 154 (78.6 days) and LS 171 (78.6 days). Similarly, the line LS 154 (113 days) closely followed by LS 171 (114 days) showed earliest fruit harvest. The longest fruit was found in LS 154 (49.3 cm) followed by LS 171 (32 cm) and the line LS 154 (12 cm) and LS 171 (11.2 cm) exhibited highest fruit diameter. The highest fruit bearing line was LS 231 (7.5 fruit/plant) and LS 154 (7.3 fruit/plant) followed by LS 171 (6.9 fruit/plant). The highest yield per hectare was found in LS 154 (59.5 t) and the line LS 232 (26.4 t) exhibited the lowest yield.

Introduction

Bottle gourd has been credited with a wide bi-hemispheric distribution (Bose *et al.*, 2002). Bottle gourd (*Lagenariasiceraria*) is an important vegetable of Bangladesh (Rashid, 1999). It is a popular, nutritious and commercial vegetables possess high demand in Bangladesh. There are about 50 thousand tons bottle gourd produce every year in Bangladesh. It is cultivated all over the country. Production of this vegetable is very low due to lack of high yielding and superior varieties. To increase yield it is necessary to developed more varieties. As well as region specific varieties should be needed. BARI already developed six varieties of bottle gourd. But it is not sufficient to meet the country demand. So, it is very important to develop more high yielding varieties. In this point of view the vegetable division of HRC, BARI has selected some advance winter bottle gourd lines. The study has conducted to observe their yield potentialities. The present investigation is a part of that program.

Materials and Methods

The investigation was carried out at RARS, Hathazariduring winter season of 2021-22. There were four winter bottle gourd lines viz. LS 146, LS 154, LS 171,LS 231 and LS 232 were evaluated BARI Lau-3 was used as check. But due to heavy rain and storm the line LS 146 and BARI Lau-3 have destroyed. The experiment was laid out in RCB design with 3 replications. The unit plot size was 2x10m^2 and plant spacing was maintained at 3 mx2 m that accommodating 5 plants in each plot. The 22 days old seedlings were transplanted in the main field on 19 November, 2021. The land was fertilized with Cowdung, urea, TSP, MoP, Gypsum (S), Zinc sulphate (Zn) and Boric acid (B) @ 10000, 375, 250, 250, 100, 12 and 10

kg/ha, respectively. The one third of the cowdung and half of TSP and full of S, Zn and B were applied during final land preparation. The remaining cowdung and TSP and 1/3rd of MoP were applied during pit preparation. One fifth of urea and MoP were applied at 20 days of transplanting in the main field. After that, rest of urea and MoP were applied in equal four installments at 20 days interval. Besides this, other cultural practices like, weeding, watering, plant protection measures, mulching, etc. were done as and when necessary. Data on days to 1st flowering, days to 1stand last harvest, fruit length (cm), fruit diameter (cm), individual fruit weight (g), number of fruits/plant, yield/plant (kg) and yield/ha (t) were recorded. Data were analyzed using Statistix 10 statistical software.

Results and discussion

Significant differences have observed in all the studied parameters in winter bottle gourd lines except individual fruit weight (Table 1). The earliest 1st flowering was observed in the line LS 154 (78.6 days) and LS 171 (78.6 days) and it was delayed in LS 232 (82 days). Likewise, the line LS 154 (113 days) and LS 171 (114 days) showed earliest fruit harvest. In case of last harvest, earlier lines were recorded LS 154 (156 days) and LS 232 (156 days) at per with LS 231 (157 days), while delayed was LS 171 (159 days). Maximum fruit length was found in LS 154 (49.3 cm) followed by LS 171 (32.0 cm) and the line LS 154 (12.0 cm) and LS 171 (11.2 cm) exhibited the highest fruit diameter. The individual fruit weight was not significant among studied lines. The highest fruit bearing genotype was noted LS 231 (7.5 fruits/plant) closely followed by LS 154 (7.3 fruits/plant) while that was lowestin LS 232 (6.5 fruits/plant). The fruit yield per plant was the highest in LS 154 (23.8 kg) followed by LS 171 (12.2 kg) and that was thelowest from LS 232 (10.5 kg). Likewise, the highest yield/ha was found in LS 154 (59.5 t) followed by LS 171 (30.5t) and the line LS 232 (26.4 t) exhibited lowest fruit yield/ha.

Table 1: Yield and yield contributing characters of different bottle gourd lines

Lines	Days to 1st flowering	Days to 1st harvest	Days to last harvest	Fruit length (cm)	Fruit diameter (cm)	Individual fruit weight (kg)	Fruits/ plant	Fruit yield/plant (kg)	Fruit yield/ ha (t)
LS 154	78.6b	113.0c	156.0b	49.3a	12.0a	2	7.3ab	23.8a	59.5a
LS 232	82.0a	124.0a	156.0b	26.6c	10.4b	1.7	6.5c	10.5c	26.4c
LS 231	80.0ab	117.3b	157.0b	23.3d	10.9b	1.5	7.5a	10.9bc	27.2bc
LS 171	78.6b	114.0c	159.0a	32.0b	11.2ab	1.4	6.9b	12.2b	30.5b
F-test	**	**	**	**	**	ns	**	**	**
CV (%)	1.04	1	1	2.87	3	-	1.72	3.51	3.5

NB: The lines LS 146 and BARI Lau-3 were destroyed due to disease infestation

Conclusion

From the findings it can be summarized that the genotypes LS 154 were the highest yielder as compare to other lines.

References

Bose, T. K., J. Kabir, T.K. Maity, V. A. Parthasarathy and G. Som. 2002.Vegetable crops. Naya Prokash, Calcutta 700006, India. P. 504.

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ADVANCED YIELD TRIAL OF STEM AMARANTH GERMPLASM

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

The investigation was carried out at RARS, Hathazari during winter season of 2021-22 to observe yield performance of two stem amaranth lines for winter.Significant differences were observed in all the parameters studied except individual stem weight. The highest stem height was observed in the line AT Nar 005 (102.3 cm) than check BARI Danta-1 (74.6 cm). The stem yield per hectare was the highest in AT Nar 005 (59.6 t/ha) and it was the lowest in BARI Danta-1 (53.3 t/ha).

Introduction

Stem amaranth (*Amaranthus tricolor*) is a popular summer vegetable in Bangladesh. It is quick growing, succulent, easily available in all over the country. It is considered as a potential subsidiary food crop (Teutonico and Knorr, 1985). Thus, amaranth plays a predominant role both in nutrition and food security. It is more profitable than that of rice, wheat and other vegetables (Das, 1988) because of its short duration and both summer and winter season cultivation. However, nowadays there is not any recognized variety for winter season developed by BARI. The aim of this study to develop a high yielding stem amaranth variety for winter season.

Materials and Methods

The investigation was carried out at RARS, Hathazari during winter season of 2021-22. There were two winter stem amaranth lines viz. AT Nar 004, AT Nar 005 and BARI Danta-1 was used as check. The experiment was laid out RCB design with 3 replications. The unit plot size was 3.0m x 1.0m and plant spacing was maintained at 30cm X 10 cm in each plot. The seeds were sown in the main field on 15 December, 2021. The land was fertilized with Cowdung, urea, TSP, MoP, Gypsum, Zinc sulphate and Boric Acid @ 10000, 250, 100, 150, 75, 12,10 kg/ha, respectively. The one third of the cowdung and half of TSP and full of S, Zn and B were applied during final land preparation. The remaining cowdung and TSP and 1/3rd of MoP were applied during pit preparation. One fifth of urea and MP were applied 20 days of sowing in the main field. After that, rest of N and K were applied in equal four installments at 15 days interval. Besides this, other cultural practices like, weeding, watering, plant protection measures, mulching were done as and when necessary. Data on plant height (cm), plant diameter (cm), individual stem weight (g), stem yield/plot (kg) and yield (t/ha) were recorded. Data were analyzed using Statistix 10 statistical software.

Results and discussion

Significant differences observed in all the parameters studied in stem amaranth lines except individual stem weight (Table 1). The highest stem height was observed in the line AT Nar 005 (102.3 cm) than check BARI Danta-1 (74.6 cm). However, the maximum stem diameter was observed in BARI Danta-1 (1.67 cm) than the germplasm. The individual stem weight was not significant among genotypes. The stem yield per plot and per hectare was the highest in AT Nar 005 (17.9 kg/plot and 59.6 t/ha) and it was the lowest in BARI Danta-1 (16.1 kg/plot and 53.3 t/ha).

Table 1: Yield and yield contributing characters of stem amaranth germplasm

Genotypes	Stem height (cm)	Stem diameter (cm)	Individual stem weight (g)	Stem yield/plot(kg)	Stem yield (t/ha)
AT Nar 004	84.0b	1.5ab	187.0	17.2ab	57.0ab
AT Nar 005	102.3a	1.46b	195.0	17.9a	59.6a
BARI Danta-1	74.6b	1.67a	175.6	16.1b	53.3b
F-test	**	*	NS	*	*
CV (%)	5.29	4.32	3.87	3.88	3.76

Conclusion

From the findings it can be summarized that the genotype AT Nar 005 were the highest yielder as compare to other lines.

REGIONAL YIELD TRIAL OF FRENCH BEAN LINES (SET-I)

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

The experiment was carried out at the research field of HRC, RARS, Hathazari, Chattogram during the winter season of 2021-22 to find out superior French bean genotypes. Significant differences were observed in all the parameters studied except days to 50% flowering, pods/panicle, pod weight, seed length and seed diameter. The number of pods per plant was higher in PV Rai 005 (17.2) than that of PV Pah 001 (15.5) and BARI Jharsheem-3 (13.3). The 100-seed weight was higher in PV Rai 005 (58.0g) whereas PV Pah 001 (47.6g) and BARI Jharsheem-3 (47.6g). The highest seed yield was found in PV Rai 005 (39.8 g/plant and 6.7 t/ha) followed by PV Pah 001 (36.9g/plant and 6.2 t/ha), whereas, BARI Jharsheem-3 (29.7 g/plant and 5.0 t/ha).

Introduction

French bean (*Phaseolus vulgaris*) under the family Leguminosae is one of the most important and widely grown vegetables in the world as well as in Bangladesh. Unlike other beans, French beans along with their cover are rich in nutrients and vitamins.It is rich in protein, iron, carotene, thiamine and riboflavin. They offer many health benefits like improving heart, gut, and bone health. They may also prevent congenital disabilities in pregnant women; prevent anemia, and even cancer. The pods are eaten whole, including the immature seeds, when they are still young and tender. They have a delicate texture and taste. In this stage they are eaten with the pods and the seeds. The seeds of the mature pod are knows as flageolets (khaishya) and can be eaten and used in curry. Seeds of French beans are high in vitamin B, K, and calcium. These nutrients are important for maintaining strong, healthy bones and reducing risk of fractures. The B vitamin is also important for reducing depression.In Chittagong region consumers usually choose the bold seeded bean. Bangladesh Agricultural Research Institute has released khaishya variety but it is not pole type. Pole bean is very popular to the Chittagong region especially in hilly areas because of its nutritious value and attractive spotted seeds rather than pod and its market demand is also very high. The present investigation has undertaken with a view to find out suitable pole bean genotypes as a khaishya variety.

Materials and Methods

The experiment was carried out at the research field of HRC, RARS, Hathazari, Chattogramduring the winter season of 2021-22. Two advanced lines of French bean PV Rai 005 and PV Pah 001 where BARIJharsheem-3 used as check. The seeds of threegermplasm were sown in main field on 29November, 2021. The experiment was set under RCB design and replicated 6 times. The unit plot size was 6 m x 1.2m and plant spacing was maintained at 30 cm x 15 cm. The land was fertilized with CD, Urea, TSP MP and Gypsum @ 10,000, 330, 625, 200 and 275 kg^{-ha}. Half quantity CD entire TSP and half quantity MP were applied during land preparation. Remaining half quantity CD was applied during pit preparation at one week before planting. Rest of MP and entire urea were applied in 3 equal installments at 15, 30 and 45 days after transplanting. Besides this, other cultural practices like, weeding, watering, plant protection measures, mulching were done as and when necessary. Data on different physio-morphological, yield and yield contributing characters were recorded. Data were analyzed using Statistix 10 statistical software.

Results and discussion

Significant difference among the genotypes in different physio-morphological and yield contributing parameters studied except days to 50% flowering,pods/panicle, pod weight (g),seed length (cm), seed diameter (cm) (Table 1). The plant height at 1st and last harvest was higher in PV Rai 005 (133.2and 159.3 cm, respectively) than PV Pah 001 (35.3and 38.1 cm, respectively) and BARI Jharsheem-3 (32.3and 37.8 cm, respectively). The number of pods per plant was higher in PV Rai 005 (17.2) than that of PV Pah 001 (15.5) and BARI Jharsheem-3 (13.3). Likewise, the pod length was found maximum in PV Rai 005 (14.3 cm) andPV Pah 001 (14.0 cm)but pod diameter was higher in PV Rai 005 (1.45 cm). The 100-seed weight was the highest in PV Rai 005 (58.0g) whereas that was the lowest in PV Pah 001 (47.6g) and BARI Jharsheem-3 (47.6g). The highest seed yield was found in PV Rai 005 (39.8 g/plant and 6.7 t/ha) followed by PV Pah 001 (36.9g/plant and 6.2 t/ha) whereas, it was

the lowest in BARI Jharsheem-3 (29.7 g/plant and 5.0 t/ha). Seed color also varied among the studied French bean linesand that was spotted straw in PV Rai 005, and light brick in BARI Jharsheem-3.

Table 1: Yield and yield contributing characters of French bean lines

Treatments	Days to 50% flowering	Plant height at 1st harvest (cm)	Plant height at last harvest (cm)	Pods/ panicle	Pod length (cm)	Pod diameter (cm)	Pods/ plant
PV Rai 005	48.0	133.2a	159.3a	3.0	14.3a	1.45a	17.2a
PV Pah 001	47.0	35.3b	38.1b	3.0	14.0a	1.18b	15.5ab
BARI Jharsheem-3	46.0	32.3b	37.8b	2.0	9.7b	1.16b	13.3b
F-test	ns	**	**	ns	**	**	*
CV(%)	-	8.22	6.17	-	4.89	5.2	13.52

Table 1: (Continued)

Treatments	Pod weight (g)	Seeds/ pod	Seed length (cm)	Seed diameter (cm)	100-seed weight (g)	Seed yield/ plant (g)	Seed yield/ha (t)	Seed color
PV Rai 005	5.2	5.0a	1.3	1.2	58.0a	39.8a	6.7a	Spottedstraw
PV Pah 001	5.0	4.7a	1.9	0.9	47.6b	36.9ab	6.2ab	
BARI Jharsheem-3	5.0	4.0b	1.9	0.8	47.6b	29.7b	5.0b	Light brick
F-test	ns	**	ns	ns	**	*	*	
CV (%)	-	6.54	-	-	5.18	7.45	7.45	

Conclusion

Considering all the parameters the genotype PV Rai 005was found promising.

REGIONAL YIELD TRIAL OF FRENCH BEAN LINES (SET-II)

M. R.ISLAM, M. M. RAHMAN AND Z.A. FIROZ

Abstract

The experiment was conducted at the research farm of HRC, RARS, Hathazari, Chattogram during the winter season of 2021-22 for finding out superior French bean genotypes. Significant differences were observed in all the parameters studied except pods/plant andpod weight. The number of pods per plot was the highest in PV Rai 004 (21.8) followed by BARI Jharsheem-2 (20.8) and PV Rai 001 (19.8) accordingly. The highest pod yield per hectare was in PV Rai 004 (30.4 t/ha) among the genotypes. The highest seed yield was found in PV Rai 001 (4.68 kg/plot and 6.52 t/ha) whereas, BARI Jharsheem-2 (4.32 kg/plot and 6.04 t/ha) among the genotypes.

Introduction

French bean (*Phaseolus vulgaris*) belongs to the family Leguminosae is one of the most important and widely grown vegetables in the world as well as in Bangladesh. It is rich in protein, iron, carotene, thiamine and riboflavin. It is also a rich source of vitamins A, C, and K, and of folic acid and fiber.It is important to rinse and drain canned beans to reduce sodium content. Many studies have suggested that including French beans in the diet decreases the risk of obesity, diabetes, heart disease, and overall mortality.The pods are eaten whole, including the immature seeds, when they are still young, and tender at that stagethe part eaten are the pods and the seeds. Some cultivars of French beancontained bold seeds and the seeds of the mature pod are knows as flageolets (Khishya) and can be eaten and usedincurry.Mature seeds of these varieties are more popular than pods and farmers cultivate these beans for seeds.Consumers of Chittagong region usually choose the bold seeded bean. Bangladesh Agricultural Research Institute has released Khaishya variety but it is not pole type. French bean is very popular to the Chattogram region especially in hilly areas because of its nutritious value and attractive spotted seeds rather than pod and its market demand is also very high. The present investigation was undertaken with a view to finding out suitable French bean genotypes as a khaishya variety.

Materials and Methods

The experiment was conducted at the research farm of HRC, RARS, Hathazari, Chattogram during the winter season of 2021-22. Three advanced lines of French bean PV Rai 001, PV Rai 003, PVRai 004 where BARI Jharsheem-2 used as check. The seeds of germplasm were sown in main field on 29November, 2021. The experiment was set under RCB design and replicated 3 times. The unit plot size was 6 m x 1.2m and plant spacing was maintained at 30 cm x 15 cm. The land was fertilized with CD, Urea, TSP MP and Gypsum @ 10,000, 330, 625, 200 and 275 kg^{-ha}. Half quantity CD entire TSP and half quantity MP were applied during land preparation. Remaining half quantity CD was applied during pit preparation at one week before planting. Rest of MP and entire urea were applied in 3 equal installments at 15, 30 and 45 days after transplanting. Besides this, other cultural practices like, weeding, watering, plant protection measures, mulching were done as and when necessary. Data on different physio-morphological, yield and yield contributing characters were recorded. Data were analyzed using Statistix 10 statistical software.

Results and discussion

Significant difference among the genotypes in different physio-morphological and yield contributing parameters studied except number of pods/plant and individual pod weight (Table 1). The plant height was the highest in PV Rai 001at flowering (152.6 cm) and harvest (180 cm) among the genotypes. The earliest 50% flowering observed in BARI Jharsheem-2 (46.6 days) than rest of the genotypes. The number of pods per plot was the highest in PV Rai 004 (21.8) followed by BARI Jharsheem-2 (20.8) and PV Rai 001 (19.8) accordingly. Likewise, the pod length and diameter was maximum in PV Rai 001 (16.0 cm and 1.36 cm). The highest pod yield per hectare was in PV Rai004 (30.4 t/ha) among the genotypes. Moreover, seed length and diameter was the highest in PV Rai 001 which was (1.5 cm and 0.85 cm) among the genotypes. The 100-seed weight was the highest in PV Rai 001 (31.3g) and PV Rai 004 (30.0g) whereas BARI Jharsheem-2 (18.6g). The highest seed yield was found in PV Rai 001 (4.68kg/plot and 6.52 t/ha) whereas, BARI Jharsheem-2 (4.32 kg/plot and 6.04 t/ha)among the genotypes. Greycolor seeds were found in PV Rai 001 and PV Rai 003, whereas blakish-brown seeds were found from linePV Rai 004.

Table 1: Yield and yield contributing characters of French bean lines

Treatments	Plant height at flowering (cm)	Plant height at harvest (cm)	Days to 50% flowering	Pods/ plant	Pod length (cm)	Pod diameter (cm)	Pod weight (g)
PV Rai 001	152.6a	180.0a	49.3a	16.3	16.0a	1.36a	7.43
PV Rai 003	23.0b	31.6b	48.3a	12.3	12.4b	1.06c	6.33
PV Rai 004	34.0b	44.6b	48.6a	16.3	13.3b	1.20b	7.20
BARI Jharsheem-2	33.0b	40.6b	46.6b	16.0	12.9b	1.00c	5.56
F-test	**	**	**	ns	**	**	ns
CV (%)	8.9	8.3	1.25	-	5.9	5.7	-

Table 2: (Continued)

Treatments	Pod yield/ plot (kg)	Pod yield (t/ha)	Seed length (cm)	Seed diameter (cm)	100-seed weight (g)	Seed yield/ plot (kg)	Seed yield (t/ha)
PV Rai 001	19.8ab	27.6ab	1.5a	0.85a	31.3a	4.68a	6.52a
PV Rai 003	18.4b	25.5b	1.2c	0.53c	18.0b	3.44b	4.76b
PV Rai 004	21.8a	30.4a	1.5a	0.74b	30.0a	3.60b	5.00b
BARI Jharsheem-2	20.8ab	28.9ab	1.3b	0.52c	18.6b	4.32ab	6.04ab
F-test	*	*	**	**	**	*	*
CV (%)	6.5	6.6	2.03	4.9	5.23	6.2	6.3

Conclusion

Considering all the parameters the line PV Rai 001 performed best along with BARI Jharsheem-2 among the genotypes.

EVALUATION OF LOCAL CHILLI (HALDA MORICH) GERMPLASM

M. R. ISLAM, M. M. RAHMAN AND Z. A. FIROZ

Abstract

The experiment was carried out at the research field of HRC, RARS, Hathazari, Chattogram during the winter season of 2021-22 to find out superior local chilli (Haldamorich) genotypes. The maximum fruit bearing genotypes were SA (H)-20 (122.6), SA (H)-09 (121.5) and SA (H)-03 (120.6) as well as SA (H)-17 (21.2) was found the lowest fruit bearer. The highest green fruit yield per plant and per hectare observed in SA (H)-20 (585.0 g/plant and 15.6 t/ha), SA (H)-09 (583.5 g/plant and 15.5 t/ha) followed by SA (H)-01 (504.8 g/plant and 13.4 t/ha) and it was the lowest in SA (H)-17 (81.3 g/plant and 2.20 t/ha). The maximum dry fruit yield per plant and per hectare observed in SA (H)-09 (172.6 g/plant and 4.60 t/ha), SA (H)-20 (168.0 g/plant and 4.48 t/ha) followed by SA (H)-01 (155.1 g/plant and 4.13 t/ha) and it was the lowest in SA (H)-17 (25.6 g/plant and 0.68 t/ha).

Introduction

Chilli is one of the most common, popular and important spices crops grown in Bangladesh and other parts of the world. Every day we use chilli for making curry and green chilli contained high amount of vitamin C. Chilligrown round the year in Bangladesh. It is cultivated all over the country. But production of chilli is very low due to lack of high yielding varieties. To increase yield it is necessary to developed more high yielding as well as region specific varieties. In Chattogram region, a local chilli cultivar named Halda morich is very popular and farmers of this region are very interested to cultivate this cultivar. Halda morich also vary popular for dry purpose in Chattogram region. Because it's pungency is very low and possess very attractive red color. This cultivar has been cultivated in this region for a long time and a wide range of variations are existed in respect of yield, size, quality, insect a diseases susceptibility, etc. Hence enough scope to develop a regional variety. On the other hand, high yielding variety is essential for obtaining higher yield of chilli. The present investigation was done to observe their yield potentialities and other performances.

Materials and Methods

The investigation was conducted at research farm of RARS, Hathazari, Chattogram during winter 2021-22. There were twenty winter local chilli lines viz. SA (H)-01,SA (H)-02,SA (H)-03,SA (H)-04,SA (H)-05,SA (H)-06,SA (H)-07,SA (H)-08,SA (H)-09,SA (H)-10,SA (H)-11andSA (H)-12, SA (H)-13,SA (H)-14,SA (H)-15,SA (H)-16,SA (H)-17,SA (H)-18,SA (H)-19,SA (H)-20. The experiment was set under RCB design with 3 replications. The unit plot size was 1.0 m x 7.0 m and plant spacing was maintained at 1.50m x 50cm. The land was fertilized with CD, Urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid @ 5000, 210, 330, 200, 110, 12 and 10 kg^{-ha}. Half quantity CD entire TSP, Zinc sulphate and Boric acid and half quantity MP were applied during land preparation. Remaining half quantity CD was applied during pit preparation at one week before planting. Rest of MP and entire urea were applied in 20 days interval after transplanting. Besides this, other cultural practices like, weeding, watering, plant protection measures, mulching were done as and when necessary. Data on days to 50% flowering, plant height at 1st harvest, branches/ plant, number of fruits/ plant, individual fruit weight (g), fruit length (cm), fruit diameter (cm)and green & dry fruit yield (g/plant and t/ha) and 1000-seed weight (g) were recorded. Data were analyzed using Statistix 10 statistical software and differences among the means were compared following Tukey's honestly significant difference test at 5% level of significance.

Results and discussion

Significant difference was observed in all the local chilli genotypes (Halda morich) among the parameters studied except individual fruit weight for both green and dry condition (Table 1). The earliest 50% flowering observed in the genotype SA (H)-04 (63.0 days) followed by SA (H)-02 (68.0 days) and it was delayed in SA (H)-08 (86.3 days). Maximum fruit bearing genotypes were SA (H)-20 (122.6), SA (H)-09 (121.5) and SA (H)-03 (120.6), in contrast SA (H)-17 (21.2) was found minimum fruitbearer. The maximum fruit length found in the genotype SA (H)-04 (8.71 cm) followed by SA (H)-06(7.96 cm) and it was the lowest in SA (H)-17 (5.27 cm).The maximum fruit diameter found in the genotype SA (H)-08 (1.24 cm) and SA (H)-13 (1.24 cm) and SA (H)-19 (1.23 cm).

Table 1: Morphological and yield contributing characters of local chilli (Halda morich) lines

Line	Days to 50% flowering	Plant height at 1st harvest	No. of fruits/plant	Individual fruit weight (green)	Individual fruit weight (dry)	Fruit length (cm)	Fruit diameter (cm)	No. of branches/ plant	1000-seed weight (g)
SA (H)-1	77.6b-d	64.4i-k	110.0b	4.58	1.4	7.49bc	0.88c-e	13.0a	3.43b
SA (H)-2	68.0fg	67.9g-k	100.2c	4.8	1.2	7.00cd	0.78de	9.5a-c	2.53e
SA (H)-3	71.3d-f	75.6c-f	120.6a	3.92	1.1	6.41d-f	0.71e	7.6bc	3.06cd
SA (H)-4	63.0g	69.0f-j	95.1d	4.1	1.16	8.71a	1.0bc	8.7a-c	3.46b
SA (H)-5	76.0c-e	76.0c-e	94.0d	4.46	1.56	7.00cd	1.1ab	8.4bc	2.93d
SA (H)-6	70.0ef	72.0d-h	78.4e	4.56	1.4	7.96ab	1.08ab	10.4ab	3.06cd
SA (H)-7	84.0ab	62.1k	40.8k	3.96	1.2	6.58de	1.02bc	5.8c	3.36bc
SA (H)-8	86.3a	70.3e-j	41.3jk	3.95	1.2	5.7f-h	1.24a	8.0bc	3.40b
SA (H)-9	77.0cd	77.0c-e	121.5a	4.8	1.5	6.62de	0.98bc	10.0a-c	3.03d
SA (H)-10	79.6bc	68.0g-k	71.3f	4.45	1.16	7.56bc	1.12ab	10.0a-c	3.50b
SA (H)-11	76.6cd	66.0h-k	52.6gh	4.66	1.23	5.98e-h	1.04bc	8.2bc	3.46b
SA (H)-12	79.3bc	92.0a	30.3l	4.77	1.56	6.04e-h	1.02bc	7.77bc	3.50b
SA (H)-13	82.0a-c	73.0c-g	52.6gh	4.96	1.2	5.43gh	1.24a	7.33bc	3.90a
SA (H)-14	81.0a-c	49.0l	29.7l	4.26	1.2	5.58f-h	0.95b-d	5.89c	2.96d
SA (H)-15	81.0a-c	84.0b	48.6hi	4.66	1.23	5.42gh	1.02bc	9.0a-c	2.53e
SA (H)-16	78.0bc	79.0bc	56.6g	5.49	1.56	6.63de	0.96bc	8.33bc	3.0d
SA (H)-17	79.0bc	63.8jk	21.2m	3.84	1.21	5.27h	1.11ab	7.1bc	2.93d
SA (H)-18	79.6bc	73.0c-g	46.0ij	4.18	1.2	5.92f-h	1.08ab	8.2bc	2.56e
SA (H)-19	79.0bc	78.0b-k	53.3gh	4.53	1.36	5.85f-h	1.23a	9.3a-c	2.46e
SA (H)-20	76.0c-e	71.0e-i	122.6a	4.77	1.36	6.14e-g	0.94b-d	8.0bc	2.96d
F-test	**	**	**	ns	ns	**	**	**	**
CV(%)	2.67	3.04	2.29	-	-	4.25	5.72	9.7	3.37

Table 2: Green and dry yield performance of local chilli (Halda morich) lines

Line	Green fruit yield/plant (g)	Dry fruit yield/ plant (g)	Green fruit yield/ ha (t)	Dry fruit yield/ ha (t)
SA (H)-1	504.8ab	155.1b	13.4ab	4.13b
SA (H)-2	476.9a-c	121.2d	12.7a-c	3.23d
SA (H)-3	472.3a-c	132.7c	12.5a-c	3.50c
SA (H)-4	390.2b-e	104.2e	10.4b-e	2.78e
SA (H)-5	419.5a-d	149.1b	11.1a-d	3.97b
SA (H)-6	358.0b-f	109.8e	9.5b-f	2.92e
SA (H)-7	162.2g-j	49.3ij	4.3g-j	1.31ij
SA (H)-8	163.3g-j	49.3ij	4.3g-j	1.31ij
SA (H)-9	583.5a	172.6a	15.5a	4.60a
SA (H)-10	317.4c-g	82.9f	8.4c-g	2.21f
SA (H)-11	245.4e-j	62.9gh	6.5e-j	1.67gh
SA (H)-12	144.5h-j	46.2jk	3.8h-j	1.23jk
SA (H)-13	260.8d-i	63.7gh	6.9d-i	1.69gh
SA (H)-14	126.6i-j	35.6jk	3.3ij	0.95kl
SA (H)-15	227.2e-j	58.2hi	6.1e-j	1.55hi
SA (H)-16	311.4c-h	86.1f	8.3c-h	2.29f
SA (H)-17	81.3j	25.6l	2.2j	0.68l
SA (H)-18	191.6f-j	54.5h-j	5.1f-j	1.45h-j
SA (H)-19	241.8e-j	72.0g	6.4e-j	1.92g
SA (H)-20	585.0a	168.0a	15.6a	4.48a
F-test	**	**	**	**
CV(%)	7.5	3.87	7.5	3.87

The genotype SA (H)-13 (3.90 g) showed maximum 1000-seed weight and it was the lowest in SA (H)-19 (2.46 g), SA (H)-16 (2.53 g) and SA (H)-18 (2.56 g). Highly significant yield was found among the studied germplasm (Table 2). The highest significant green fruit yield per plant and per hectare observed in SA (H)-20 (585.0 g/plant and 15.6 t/ha),SA (H)-09 (583.5 g/plant and 15.5 t/ha)followed by SA (H)-01(504.8 g/plant and 13.4 t/ha)and it was the lowest in SA (H)-17 (81.3 g/plant and 2.20 t/ha).The maximum significant dry fruit yield per plant and per hectare observed in SA (H)-09 (172.6 g/plant and 4.60 t/ha),SA (H)-20 (168.0 g/plant and 4.48 t/ha) followed by SA (H)-01 (155.1 g/plant and 4.13 t/ha) and it was the lowest in SA (H)-17 (25.6 g/plant and 0.68 t/ha).

Conclusion

Considering all the characters the genotypes SA (H)-01, SA (H)-09 and SA (H)-20 were found promising and can be trial again in the next year for confirmation.

INTERCROPPING OF VEGETABLES AND SPICES WITH CHILLI IN CHATTOGRAM REGION

M. M. ALAM AND Z. A. FIROZ

Abstract

The experiment was conducted at Regional Agricultural Research Station, Hathazari, Chattogram during December 2021 to April 2022 to assess the performance of radish, carrot, onion and garlic with chilli as intercrop. All intercrop combinations performed better under chilli field. Onion gave the highest equivalent yield (8.76 t/ha) with chilli. The maximum net returns and benefit cost ratio was achieved from chilli and onion intercrop.

Introduction

Inter-cropping provide several major advantages namely; diversification reduces risk associated with crop failure, offers greater yield stability and utilizes the available growth resources more efficiently and sustainably. Usually plants differing in grow duration, height, rooting systems and nutrient requirements are considered to growth together in inter-cropping systems. Better inter-crop production could be achieved with the choice of the appropriate crops, population density and planting geometry of component crops. Therefore, the present study was undertaken to evaluate the performance of the inter-cropping system of vegetables with chilli for higher productivity and economic return.

Methods and materials

The experiment was carried out at Regional Agricultural Research Station, Hathazari, Chattogram during December 2021 to April 2022 to assess the performance of radish, carrot, onion and garlic with chilli for higher productivity and economic return. The treatments were T_1= Sole chilli, T_2= Chilli + radish, T_3= Chilli+ carrot, T_4= Chilli + onion and T_5= Chilli + garlic. The experiment was laid out in RCB design with three replications. The unit plot size was 5m × 4m. Radish and carrot seeds; onion and garlic bulbs and 30 days old chilli seedlings were sown/transplanted on 15 December, 2021. The land was fertilized at the rate of 97- 66-100-1 kg ha^{-1} NPKS, respectively. Half of N and all other fertilizer was applied as basal. Rest N was applied at 30 DAS. Chilli and radish were harvested during February to April 2022 but carrot, onion and garlic were harvested on 2nd week of March, last week of March and 1st week of April 2022, respectively.

Results and discussion

The yield of chilli and component crops ate presented in Table 1. The results revealed that the highest chilli yield was obtained from treatment T_1 (sole chilli). Maximum chilli equivalent yield (8.76 t/ha) was obtained from treatment T_4 (Chilli + onion). The highest net return (1,48,300tk/ha) and benefit cost ratio (1.74) was obtained from T_4 (Chilli + onion) inter-cropping system.

Table 1: Yield of different spices with chilli during 2021-22

Treatment	Yield of chilli (t/ha)	Yield of spices (t/ha)	Equivalent yield of chilli (t/ha)	Gross margin (Tk/ha)	Total variable cost (Tk/ha)	Net return (Tk/ha)	BCR
T_1	12.05 a	-	-	2,41,000	1,80,000	61,000	1.34
T_2	9.48 b	16.20 a	3.86 d	2,70,600	1,85,000	85,600	1.46
T_3	8.34 c	7.88 b	7.52 b	3,24,400	1,88,000	1,36,400	1.73
T_4	8.24 c	7.34 c	8.76 a	3,48,300	2,00,000	1,48,300	1.74
T_5	8.76 c	2.27 d	4.33 c	2,66,000	2,20,000	46,000	1.21
CV (%)	5.21	4.43	3.51	-	-	-	-
Lev. of sig	**	**	**	-	-	-	-

T_1= Sole chilli, T_2= Chilli + radish, T_3= Chilli+ carrot, T_4= Chilli + onion and T_5= Chilli + garlic
Price: Chilli= 20 Tk/kg, Radish= 5 Tk/kg, Carrot= 20 Tk/kg, Onion= 25 Tk/kg, Garlic 40 Tk/kg

Conclusion

From the results it may be concluded that cultivation of chilli with onion was more profitable than sole cropping of chilli. For further confirmation of the result, the experiment may be repeated in the next year.

YIELD PROCESS AND CROP COMPETITION OF LEAFY VEGETABLES INTERCROPPING SYSTEM WITH CHILLI

M. M. ALAM AND Z. A. FIROZ

Abstract

The experiment was conducted at Regional Agricultural Research Station, Hathazari, Chattogram during December 2021 to April 2022. Five inter-cropping combinations such as sole chilli, Chilli+two row spinach, Chilli+two row red amaranth, Chilli+two row coriander and Chilli+two row raddish were investigated. The highest green chilli fruit yield of 11.76 t ha^{-1} in sole chilli which was very close to chilli+two row red amaranth (10.8 t ha^{-1}) combination. The chilli yield was lowest (9.38 tha^{-1}) in chilli+two row radish combinations. The highest BCR (2.39) was found from Chilli+two row spinach treatment combination.

Introduction

Inter-cropping is a traditional practice in Bangladesh and it increases total productivity per unit area through maximum utilization of land, labour and growth resources (Crauford, 2000; Mahfuza*et al.*, 2012). By judicious choice of compatible crops and adopting appropriate planting geometry, inter/intra specific competition may be minimized resulting higher total productivity (Umrani*et al.,* 1994). Canopy architecture of tall stature crop regulates the availability of light on under storied crop (Faruque*et al.,* 2000). Leafy vegetables such as spinach and red amaranth, radish, mustard etc. are a short duration and short stature vegetable. On the other hand, chilli is comparatively tall and long duration crop. Chilli is one of the major spices crop in Bangladesh cultivated in 2, 49,748 acres of land (both winter and summer) with a production of 1,41,177 metric tons (BBS, 2018). It is usually grown as sole and in some cases inter-crop at farmer's field in various parts of Bangladesh. Chilli is generally grown with wide row spacing of 60cm, which makes it suitable for inter-cropping. Therefore, this experiment will be conducted to find out suitable crop combination for higher productivity and economic return.Therefore, this experiment was conducted to find out optimum chilli leafy vegetables combination for higher productivity and economic return and study the effect of inter-cropping on component crops.

Materials and Methods

The experiment was conducted at RARS, Hathazari, Chattogram during December 2021 to April 2022. Five inter-cropping such as sole chilli (60cm × 50cm), Chilli+two row spinach, Chilli+two row red amaranth, Chilli+two row coriander and Chilli+two row radish were investigated. The experiment was laid out in Randomized Complete Block Design with three replications. The unit plot size was 3.6m × 3m. The fertilizer dose was 96-45-75-15-1.5-1.4 kg/ha N P K S Zn B. Half of N and all other fertilizers was applied as basal during final land preparation. Remaining N was applied in three equal splits at 25, 50 and 70 DAT. Cowdung @ 10 t/ha was applied as a blanket dose during final land preparation. Thirty days old seedlings of chilli (var. BARI Morich-1) was planted in the field on 13 November, 2020. Seeds of spinach, red amaranth (var. BARI Lalshak-1), coriander and radish were sown on the same day as per treatment. Weeding, irrigation and crop protection measures were taken as and when necessary. Spinach, red amaranth, coriander and raddishwere harvested at 40, 35, 45 and 60 days after sowing (DAS), respectively. First harvest of green chilli was done at 109 days after planting (DAP) and continued up to 138 DAP. Yield was calculated for green chili and inter-crops in ton per hectare considering the whole plot as harvest area. Five plants of chili from each plot were selected randomly to collect data on yield components. Collected data were analyzed statistically with the help of MSTATC program (Gomez and Gomez, 1984) and mean separation was done as per Least Significant Difference (LSD) test at 5% level of significance. Benefit cost analysis was performed considering the prevailing price of green chili, spinach, red amaranth, coriander and radish at the harvesting period in the local market.

Results and discussion

The yield of chilli was found to be affected significantly by the inter-crops (Table 1). All the yield parameters in sole chilli showed better performance over different inter-cropping combination except plant height. The number of branches per plant showed significant differences due to the effect of treatments. The sole chilli produced the highest number of branches (12) while it was the lowest in chilli+two row radish at final

harvesting stage. It might be due to the fact that sole chilli had minimum inter-specific competition for space and growth resources compared to inter-cropped chilli. Significantly the highest number of fruits plant^{-1} was observed in sole chilli (244) and the lowest was in chilli + two row radish (220) combination. This was might be associated with the number of branches per plant. Maximum weight of fruits per plant was obtained from sole chilli (342.78 g) whereas the lowest was also in chilli+two row radish (312.21 g) inter-cropping system. Yield of green chilli varied from 9.38 to 11.76 t ha^{-1} due to influence exerted by different treatments. Sole chilli produced significantly the highest fruit yield that was 11.76 t ha^{-1} which was very close to chilli + two row red amaranth (10.80 t ha^{-1}) combination. The chilli yield was the lowest (9.38 t ha^{-1}) in chilli+two row radish combinations. The highest BCR (2.39) was found from Chilli + two row of spinach treatment combination (Table 2).

Table 1: Yield and yield contributing characters of chilli under different inter-cropping system

Treatments	Plant height (cm)	Branch per plant (no.)	Chilli per plant (no.)	Wt. of green chilli per plant (g)	Green chilli yield (t/ha)
Chilli (sole)	38.89	12	244	342.78	11.76
Chilli + two row spinach	37.42	9	224	318.23	9.9
Chilli + two row red amaranth	37.7	10	225	325.17	10.8
Chilli + two row coriande	38.43	10	227	322.47	9.44
Chilli + two row raddish	39.7	8	220	312.21	9.38
LSD (0.05)	Ns	0.936	3.28	3.71	1.13
CV (%)	4.65	3.64	6.37	7.28	8.32

Table 2: Equivalent yield and cost benefit analysis under different inter-cropping system

Treatments	Chilli yield (t/ha)	Inter-crop yield (t/ha)	Chilli equ. yield (t/ha)	Gross return (Tk./ha)	Total cost (Tk./ha)	Gross margin (Tk/ha)	BCR
Chilli (sole)	11.76	-	11.76	294000	150000	144000	1.96
Chilli + two row spinach	9.9	9	18.9	382500	160000	222500	2.39
Chilli + two row red amaranth	10.8	8	14.64	366000	165000	201000	2.22
Chilli + two row coriander	9.44	6	16.64	416000	190000	226000	2.19
Chilli + two row raddish	9.38	25	17.38	434500	195000	239500	2.23

Price: spinach 15tk/kg, red amaranth 12tk/kg, coriander 30tk/kg, raddish8tk/kg and green chilli 25 tk/kg.

Conclusion

Among the treatments it was found that alternate row of chilliand two row spinach exhibited maximum chilli equivalent yield as well as BCR and it was concluded that this combination economically profitable. The experiment might be repeated next year for finalize the result.

EFFECT OF NITROGEN ON GROWTH AND YIELD OF SUNFLOWER UNDER CHATTOGRAM REGION

M. M. ALAM AND Z. A. FIROZ

Abstract

The experiment was conducted at Regional Agricultural Research Station, Hathazari, Chattogram during December 2021 to April 2022 to evaluate the effect of nitrogenous fertilizer management on growth and yield performance of sunflower. Five treatment combinations viz. T_1= 0 kg/ha, T_2= 60 kg/ha, T_3= 120 kg/ha, T_4= 180 kg/ha, T_5= 240 kg/ha urea were tested. The experiment was laid out in a randomized complete block design with 3 replications and BARI Sunflower-3 was used as test crop.The nitrogenous treatments are significantly different in terms of yield and yield attributes. Application of additional urea significantly increased all of the parameters such as the plant height, head diameter, number of seed per head, 1000 seed weight and seed yield. The significantly highest seed yield (1.21t/h) was recorded in treatment T_5while the lowest seed yield (0.64 t ha^{-1}) was observed in absolute control treatment (T_1). The overall results indicated that application of 180 kg/ha urea was more effective than other fertilizer management packages in respect of yield and yield attributes for sunflower cultivation in the Chattogram region of Bangladesh.

Introduction

Sunflower (*Helianthus annuus* L.) is an important oil seed crop which ranks 3rd after soybean and peanut along with other oil seed crops like (canola, and cotton) which contributes considerably to edible oil in the world (Thavaprakash*et al.*, 2002). In Bangladesh, sunflower occupies an important place in oil seed crops because of short duration, having ability to adapt wide range of climate and soil conditions as well as containing omega 3. Although, this crop has ideal place in the present cropping system but due to some constraints the average yield is much lower than world's average. The low productivity is mainly due to poor fertility of soils, lack of proper production technology, unavailability of inputs, and marketing problems. Nitrogen play an imperative role in maximization of crop yields (Massignam *et al.*, 2009) and improves the yield as well as quality of all crops (Bell *et al.*, 1995; Dreccer *et al.*, 2000; Ullah *et al.*, 2010). Additionally, higher rates of N increases photosynthetic processes, leaf area production, leaf area duration as well as net assimilation rate (Ahmad *et al.*, 2009; Munir *et al.*, 2007). The development of individual leaf area and total leaf area of crop plant and ultimately contributing towards higher grain yield (Cheema *et al.*, 2001; Tsialtas &Maslaris, 2008; Rafiq *et al.*, 2010). Many researchers (Miralles *et al.*, 1997; Bange *et al.*, 2000) concluded that N increases grain yield by affecting the growth and development of sunflower. There is lack of advanced production technology and farmers are facing acute problems in growing sunflower crop in Bangladesh. Therefore, the present study was undertaken to evaluate the effect of different nitrogen rates on growth and grain yield of sunflower under ecological conditions of Hathazari, Chattogram and to find out the optimum and economic fertilizer dose for sunflower.

Materials and Methods

The experiment was conducted at RARS, Hathazari, Chattogram during December 2021 to April 2022to evaluate the effect of integrated nutrient management for better yield of sunflower. The experiment was laid out in a RCB design with three (03) replicates. The unit plot size was 4m×3m and BARI Sunflower-3 was used as the test crop. Treatments were randomly distributed within the blocksas follows: T_1= 0 kg/ha, T_2 = 60 kg/ha, T_3= 120 kg/ha, T_4= 180 kg/ha, T_5= 240 kg/ha. The seeds were sown @ 10 kg ha^{-1} in line with the spacing of 50cm × 25cm on 18 December, 21. Different intercultural operations and plant protection measures were taken as and when necessary to raise healthy crops.The crop was harvested on 28 March 2022. Data were collected on an individual plant basis from five (5) randomly selected plants of each plot in such a way that the border effect was avoided for high precision. Data on yield and yield contributing parameters were recorded and statistically analyzed with the help of statistical package statistix 10 (Analytical Software. Tallahassee, Fla, USA) and mean separation was tested by Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1960).

Results and Discussion

The effect of nitrogen on the yield and yield parameters of sunflower are summarized in the Table 1. Seed yield, stover yield and yield attributes like plant height, head diameter, number of seeds head^{-1} and thousand seed weight of sunflower were significantly influenced by different nitrogen dose in this study. Significantly the highest plant height (82 cm) was observed in T_5 treatment which was statistically identical with T_4 treatment. The lowest plant height (70 cm) was obtained from absolute control treatment (T_1).The result related to plant height was similar to the findings of Vedpathak and Chavan (2016) who observed that application of vermi-compost along with chemical fertilizers increased plant height significantly in sunflower. Significantly the maximum head diameter (15.8 cm) was recorded (T_4) which is statistically identical with T_5 (15.3 cm). The minimum head diameter (96 cm) was observed in absolute control treatment (T_1). The highest number of seeds per head (600) was produced by the treatment T_4 which statistically identically with treatment T_5 (580). The minimum number seeds per head was produced by the treatment T_1 (240). The maximum weight of seeds per head was observed in Treatment T_5 (42.4 g) and the minimum was found in control treatment (17.5g). The highest seed yield (1.21 t/ha) was obtained from Treatment T_5 which was statistically similar with treatment T_6. The lowest seed yield (0.64 t/ha) was obtained from control treatment (T_1).

Table 1: Yield and yield contributing characters of sunflower as influenced by different urea fertilizer during 2021-22

Treatment	Plant height (cm)	Stem girth (cm)	No. of leaves (nos.)	Diameter of head (cm)	No. of seeds / head (nos.)	Weight of seeds/ head (gm)	Yield (t/ha)
T_1	70 c	2.3 c	14 c	9.6 c	240 c	17.5 c	0.64 c
T_2	73bc	2.8 b	18 b	12.7bc	480 b	33.6 b	0.85 b
T_3	75 b	3.5ab	20ab	14.2 b	550ab	38.5ab	1.04ab
T_4	80ab	3.7 a	24 a	15.5 a	600 a	42.4 a	1.21 a
T_5	82 a	3.6 a	23 a	15.3 a	580 a	41.6 a	1.15 a
CV (%)	4.61	3.47	4.51	6.45	9.45	2.48	3.48
Lev. of sig	**	**	**	**	*	*	*

T_1= 0 kh/ha, T_2 = 60 kg/ha, T_3= 120 kg/ha, T_4= 180 kg/ha, T_5= 240 kg/ha

Conclusion

From the results it may be concluded that the recommendation of urea fertilizer is 180 kg/ha for cultivation of sunflower in Chattogram region. For further confirmation of the result the experiment may be repeated in the next year.

PERFORMANCE OF COWPEA INTERCROPPING WITH MAIZE AT CHOTTOGRAM REGION

M. M. ALAM AND Z. A. FIROZ

Abstract

The experiment was conducted at Regional Agricultural Research Station, Hathazari, Chattogram during December 2021 to April 2022 to evaluate the performance of maize-cowpea inter-crop as influence by planting arrangement for higher productivity.Three treatment combinations viz.T_1= One row maize (60cm × 20cm) + one row cowpea, T_2= One row maize (60cm × 20cm) + two row cowpea and T_3= One row maize (60cm × 20cm) + cowpea broadcast was tested. The experiment was laid out in a randomized complete block design with 3 replications and BARI Hybrid Maize-9 and BARI Felon-2 were used as test crop.The different inter-crop combination is significantly different in terms of yield and yield attributes. The significantly highest maize grain yield (8.25t/ha) was recorded in treatment T_1wher the treatment combination was one row maize with one row cowpea while the lowest maize grain yield (6.81t/ha) was observed in treatment T_3wher the treatment combination was one row maize with cowpea broadcast. The low yield in treatment T_2 and T_3 might be due to high competition for the limited growth resources. The overall results indicated that cultivation of maize with one row cowpea was more effective than other intercrop combinations.

Introduction

Maize (*Zea mays* L.) is a priority crop of modern farmers as a staple food in many rural communities of Bangladesh and is one of the most important cereal crops grown in Bangladesh. It is an important dual purpose crop used in human diet and animal feed in Agro industries (Atunewa and Afolbi 2001). Cowpea is also another most important food leguminous crops in north south region. It is well adapted to the drier region of the tropics. It has the ability to fixed atmospheric nitrogen through its root nodules and it grow well in a poor soil with more than 85% and with less than 0.2% organic matter (Scott, 2008). In addition, it is shade tolerant, so is compatible as an inter-crop with maize, millet sorghum sugarcane and cotton. The use of inter-cropping by small holder farmers is a common practice (Ofuso-Amin J and N.V. Limbani, 2007).Seran and Brimtha 2010 reported that inter-cropping offer several advantages is small scale farmers, by inter-cropping with appropriate crop at an appropriate planting arrangement, these may benefit from improved soil fertility, increase productivity and reduced risk of total crop failure. In most cases local maize is grown in mixture with local cowpea which result in poor yield, this may be attributed to improper crop mixture. The beneficial effects of inter-cropping maize-cowpea have not been fully exploited correct combination of inter-cropping, planting pattern that will enhance growth and yield of the two components in inter-crop. Hence, the experiment was conducted to evaluate the performance of maize-cowpea inter-crop as influence by planting arrangement for higher productivity.

Methods and Materials

The experiment was carried out during 2021-2022 at Regional Agricultural Research Station, Hathazari, Chattogram. Maize cultivar BARI Hybrid Maize-9 and cowpea cultivars BARI Felon-2 were evaluated in this study. The experiment was laid out in a randomized complete block design. The treatments were T_1= One row maize (60cm × 20cm) + one row cowpea, T_2= One row maize (60cm × 20cm) + two row cowpea and T_3= One row maize (60cm × 20cm) + cowpea broadcast. The experiment had three replications with 4m × 4.8 m individual plot size. Maize seeds were sown on 23 December in 2021. Three maize seeds were sown per hole and later thinned to one plant per stand at two weeks after planting (WAP). Cowpea seeds were sown at two weeks after maize was sown. Sole Maize was fertilized by 250-55-120-50-5-1 N-P-K-S-Zn-B kg/ha, respectively. Sole cowpea was fertilized by 20-20-25 NPK $kgha^{-1}$, respectively and inter-crop was fertilized by250-55-120-50-5-1 N-P-K-S-Zn-B $kgha^{-1}$, respectively. In case of sole maize 1/3 N and all other fertilizers as basal. Rest N will be applied at 35 and 55 DAS. In case of sole cowpea all fertilizers will be applied as basal at the time of final land preparation. In case of Inter-crop 1/3 N and all other fertilizers as basal. Rest N will be applied at 25 & 45 DAS. Additional N (30kg/ha) will be applied in 2 split at 20 and 35 DAS as side dressing to cowpea. Plots were kept weed-free using hand hoes. During vegetative, flowering and podding stages, cowpea plants were sprayed with Karate (50 g L^{-1}). This was applied at a rate of 1.0 L ha^{-1} at the time the first few insects were noticed.Cow pea was harvested during 3rdweak of March to

2nd week of April 2022. Maize was harvested during 3rdweak of April to 2nd week of May 2022. Data were collected on an individual plant basis from five (5) randomly selected plants of each plot in such a way that the border effect was avoided for high precision. Data on yield and yield contributing parameters were recorded and statistically analyzed with the help of statistical package statistix 10 (Analytical Software. Tallahassee, Fla, USA) and mean separation was tested by Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1960).

Results and discussion

The results of yield and yield attributes of different inter-crop combination are present in table 1. Plant height, number of grains per cob, 1000 grain weight and yield were significantly influenced by different inter-crop combinations in this study. The significantly highest plant height of maize (209.7cm) was recorded in treatment T_3 while the lowest plant was observed in treatment T_1 (202.5 cm). The highest number of seeds per cobs (763.4) was found in T_1 and the lowest number grains per cob was observed in T_3. The maximum 1000 grain wt. (342 g) was produced by the treatment T_1 and lowest was found in T_3 treatment. The highest maize grain yield (8.45 t/ha) was observed in T_1 and lowest grain yield (6.86 t/ha) was found in T3 where s per combination was one row maize with one row cowpea while the lowest maize grain yield (6.81t/ha) was observed in treatment T_3wher the treatment combination was one row maize with cowpea broadcast. The low yield in treatment T_2 and T_3 might be due to high competition for the limited growth resources. The highest gross return (201000 tk/ha) and BCR (1.68) was found in the inter-crop combination of Maize with one row cowpea (Table 2). The overall results indicated that cultivation of maize with one row cowpea was more effective than other inter-crop combinations.

Table 1: Yield and yield attributes of cowpea in maize inter-cropping with cowpea at Chattogram region during2021-2022

Treatment	Plant height (cm)	No. of grains cob^{-1}	1000 seed wt. (g)	Grain yield (t/ha)	Maize equivalent yield (t/ha)
T_1	202.5 c	763.4 a	342 a	8.45 a	1.80
T_2	205.8 b	750.8 b	317 b	7.21 b	2.13
T_3	209.7 a	746.1 b	338 c	6.86 c	1.95
CV (%)	12.87	11.94	6.84	3.48	
Lev. of sig.	**	**	**	**	

T_1= One row maize (60cm × 20cm) + one row cowpea, T_2= One row maize (60cm × 20cm) + two row cowpea and T_3= One row maize (60cm × 20cm) + cowpea broadcast.

Table 2: Yield and economic analysis in cowpea inter-cropping with maize at Chattogram region during2021-2022

Treatment	Yield of Maize (t/ha)	Yield cowpea (t/ha)	Gross Return (tk/ha)	TVC (tk/ha)	BCR
T_1	8.25 a	0.72b	201000	120000	1.68
T_2	7.12 b	0.85a	184900	122000	1.52
T_3	6.81 b	0.78b	175200	123000	1.42
CV (%)	3.48	2.49	-	-	-
Lev. of sig.	**	**	-	-	-

T_1= One row maize (60 cm × 20 cm) + one row cowpea, T_2= One row maize (60 cm × 20 cm) + two row cowpea and T_3= One row maize (60 cm × 20 cm) + cowpea broadcast.
Prize: Maize 20tk/kg, Felon 50tk/kg.

Conclusion

The overall results indicated that cultivation of maize with one row cowpea was more effective than other inter-crop combinations.It was the first year result, it should be repeated for next year for final recommendation.

INTERCROPPING COWPEA WITH SORGHUM UNDER DIFFERENT PLANTING SYSTEM

M. M. ALAM AND Z. A. FIROZ

Abstract

The experiment was conducted at Regional Agricultural Research Station, Hathazari, Chattogram during December 2021 to April 2022 to evaluate the performance of sorghum cowpea inter-crop as influence by planting arrangement for higher productivity. Five treatment combinations viz. T_1= sorghum normal row+one row cowpea, T_2= sorghum normal row+two row cowpea and T_3= sorghum normal row+cowpea broadcast T_4= Sole sorghum and T_5= Sole cowpea were tested. The experiment was laid out in a randomized complete block design with 3 replications and BARI Sorghum-1 and BARI Felon-2 were used as test crop.The different inter-crop combination is significantly different in terms of yield and yield attributes. The significantly highest sorghum grain yield (2.85 t/h) and cowpea seed yield (1.25 t/ha) was obtained from treatment T_4 and T_5 where the practice as a sole cropping. Highest sorghum equivalent yield and land equivalent ratio were observed in sorghum+ two row cowpea inter-cropping system.

Introduction

Sorghum is an unbranched and erect cereal crops with wide spacing. Sorghum is used as food, feed, fodder and fuel. Recently it is getting the special importance by the government of Bangladesh due to huge demand in medicine industry and low water required for cultivation. On the other hand, cowpea is also another most important food leguminous crops in north south region. It is well adapted to the drier region of the tropics. It has the ability to fixed atmospheric nitrogen through its root nodules and it grow well in a poor soil with more than 85% and with less than 0.2% organic matter (Scott, 2008). By judicious choice of compatible crops and adopting appropriate planting geometry, inter/intra specific competition may be minimized resulting higher total productivity (Alom*et al.*, 2013). But literature is meager regarding sorghum+cowpea inter-cropping under different planting systems in Bangladesh condition. By adopting appropriate planting geometry in the inter-cropping system, the total productivity of the crops can be enhanced (Umrani*et al.*, 1984). So, this experiment was conducted to find out suitable planting systems of sorghum and cowpea as inter-cropping for higher productivity, economic return and national nutritional food security.

Methods and Materials

The experiment was carried out during 2021-2022 at Regional Agricultural Research Station, Hathazari, Chattogram. Sorghum cultivar BARI Sorghum-1 and cowpea cultivars BARI Felon-2 were evaluated in this study. The experiment was laid out in a randomized complete block design. The treatments were T_1= Sorghum normal row (100%) + 1 row cowpea in between two rows of sorghum. T_2= Sorghum normal row (100%) + 2 rows cowpea in between two rows of sorghum. T_3= Sorghum (100%) + cowpea broadcast (100%) in between sorghum lines T_4= Sole sorghum and T_5= Sole cowpea (40 cm × 10 cm). The experiment had three replications with 5m × 4.8 m individual plot size. Sorghum seeds were sown on 22 December in 2021. Three maize seeds were sown per hole and later thinned to one plant per stand at two weeks after planting (WAP). Cowpea seeds were sown at two weeks after sorghum was sown. Sole sorghum was fertilized by 120-48-75-30-3-1 kg/ha N-P-K-S-Zn-B, respectively. Sole cowpea: 20-20-25 NPK $kgha^{-1}$, respectively Inter-crop: 120-48-75-30-3-1 kg/ha N-P-K-S-Zn-B Sole sorghum: 1/3 N and all other fertilizers as basal. Rest N will be applied at 25 & 45 DAS.Sole cowpea: All fertilizers will be applied as basal at the time of final land preparation. Inter-crop: 1/3 N and all other fertilizers as basal. Rest N will be applied at 25 & 45 DAS. Additional N (30 kg/ha) will be applied in 2 split at 20 and 35 DAS as side dressing to cowpea. Plots were kept weed-free using hand hoes. During vegetative, flowering and podding stages, cowpea plants were sprayed with Karate (50 g L^{-1}). This was applied at a rate of 1.0 L ha^{-1} at the time the first few insects were noticed. Cow pea was harvested during 3rdweak of March to 2nd week of April 2022. Sorghum was harvested during 3rdweak of April to 2nd week of May 2022. Data were collected on an individual plant basis from five (5) randomly selected plants of each plot in such a way that the border effect was avoided for high precision. Data on yield and yield contributing parameters were recorded and statistically analyzed with the help of statistical package statistix 10 (Analytical Software. Tallahassee, Fla, USA) and mean separation was tested by Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1960).

Results and discussions

Grain and stover yield of both sorghum and cowpea were higher in sole cropping than the intercropped mixtures irrespective of the planting patterns (Table 1), presumably due to the absence of competition from companion crop. The stover yield of both crops in inter-cropping followed similar trend as in grain yields. This observation thus reflects an inter-specific relationship of mutual inhibition in which both crops in their mixtures at the various planting patterns yielded less than their potential (expected) yields in monoculture.The effect of different planting arrangements on land equivalent ratio (LER) are presented in Table 1. As expected, the partial LER of both crops increased as their proportions increased in the inter-cropping mixtures at the different planting patterns. The total LER was highest at one row sorghum with two roe cowpea (T_2), where sorghum and cowpea achieved 79% and 68% of their sole yields respectively, indicating a higher biological and economic efficiency.

The average relative crowding coefficient (K) value of sorghum was higher than cowpea, thus indicating its dominance in the mixture and such result is not unexpected since cereals are usually more competitive than legumes. Aggressively (A), competitive ratio (CR) and monetary advantage index (MAI) of sorghum-cowpea mixture in 3 planting patterns are presented in Table 2.

The competitive ability of the component crops in an inter-cropping system is determined by its aggressively value. Regardless of the planting patterns, there was a positive sign for sorghum and a negative sign for the inter-cropped cowpea, indicating that sorghum was dominant while cowpea was dominated. Results showed positive aggressively for sorghum at one row sorghum+one row cowpea and one row sorghum+cowpea broadcast combinations while it proved less competitive and was dominated by cowpea at one row sorghum + two row cowpea combination. The monetary advantage index (MAI) values were positive in all the planting combinations. The result showed definite yield and economic advantages in sorghum-cowpea inter-cropping over sole cropping. The highest MAI (42363.95) was obtained in the one row sorghum with two row cowpea inter-cropping, which implied that the planting pattern was highly economical and advantageous for this combination.

Table 1: Grain and Stover yields, Equivalent yield (EY), and Land equivalent ratio (LER) of sorghum-cowpea inter-cropping systems during 2021-22

Treatment	Grain yield (t/ha)		Stover yield (t/ha)		Equivalent yield(t/ha)		Land equivalent ratio		
	Sorghum	Cowpea	Sorghum	Cowpea	Sorghum	Cowpea	Sorghum	Cowpea	total
T_1	2.31	0.76	5.24	1.42	0.95	1.85	0.81	0.61	1.42
T_2	2.25	0.85	5.18	2.28	1.06	1.88	0.79	0.68	1.47
T_3	2.12	0.78	5.18	2.34	0.98	1.70	0.74	0.62	1.37
T_4	2.85	-	5.36	-					
T_5	-	1.25	-	2.45					
CV (%)	3.46	2.85	4.67	3.86	-	-	-	-	-
Lev. of sig.	**	**	**	**	-	-	-	-	-

T_1= Sorghum normal row+1 row cowpea, T_2= Sorghum normal row+2 rows cowpea, T_3= Sorghum+cow pea broadcast T_4= Sole sorghum and T_5= Sole cow pea. Prize: Sorghum 40tk/kg, Cowpea 50 tk/kg

Table 2: Aggressively (A), competitive ratio (CR) and monetary advantage index (MAI) relative crowding coefficient (K) of sorghum-cowpea inter-cropping systems during 2021-22

Treatment	Competitive ratio (CR)		Aggressively (A)		Monetary advantage index (MAI)	Relative crowding coefficient (K)	
	Sorghum	Cowpea	Sorghum	Cowpea		Sorghum	Cowpea
T_1	1.33	0.75	0.405	-0.96	38569.01	1.71	0.79
T_2	0.58	1.72	0.22	-0.84	42363.95	1.32	0.61
T_3	1.19	0.84	0.24	-0.81	33435.04	1.08	1.17

T_1= Sorghum normal row+1 row cowpea, T_2= Sorghum normal row+2 rows cowpea, T_3= Sorghum+cow pea broadcast T_4= Sole sorghum and T_5= Sole cowpea. Prize: Sorghum 40tk/kg, Cowpea 50 tk/kg

Conclusion

From the above findings we concluded that optimum and sustainable productivity and profitability of sorghum+cowpea inter-crop combinations, a planting pattern comprising of one rows of sorghum to two row of cowpea may be practiced in Chattogram region to increase land use efficiency. It was the first year results; it should be repeated for next year for final recommendation.

STUDY OF PROPICONAZOLE DEGRADED BACTERIA SPP. FOR SUPPRESSING STEM ROT IN MANGO

M. T. HOSSAIN, M. M. RAHMAN AND Z. A FIROZ

Abstract

Stem end rot of mango caused by *Lasiodiplodia theobromae* is the major economical devastating postharvest and field disease in mango growing areas. Still to date there is no successful eco-friendly remedy to control the disease. Our farmers had been using Triazole fungicide, propiconazole group especially, Tilt-250 EC during the last decade. But, Tiazole fungicide, which inhibits the demethylation, is serious harmful in human body. Now-a-days, it is a demand to be safe and enjoy with the safe agriculture. Endophytic *Bacillus* species with plant growth promoting activities have been used during the last decade for safe agriculture as an eco-friendly bio-control measures. Therefore, in lieu of propiconazole the basic experiment has been conducted having with the eco-friendly antagonistic endophytic novel *Bacillus velezensis* GL6 at Regional Agricultural Research Station, Hathazari, Chattogram to control the stem end rot as well as degrade the propiconazole properties. Out of three antagonistic species, *Bacillus velezensis* GL6 is the best to degrade the propiconazole properties. Three concentrations of *Bacillus velezensis* GL6 were used compared with Tilt-250 EC. The concentration (1×10^7 CFU/ml) of *Bacillus velezensis* BARI/HAT/GL6 could change the color of Tilt within 6 hr. It also showed -.68 ±0.01 to 0.48 ± 0.01 absorbance by 600 nm web length by deleting the concentration of Tilt-250 EC in without media and with media condition respectively. It seems strain BARI/HAT/GL6 has positive effect to degrade the propiconazole.A very clear and distinct inhibition zones were observed at *in vitro* cell bio-assay, indicating strong antagonistic strain GL6. It revealed significantly (Tukey HSD, $P<0.01$) lower disease severity by 1.5 ± 0.3, than the control, Tilt-250 EC and hot water by 4.0 ± 0.5, 1.75 ± 0.2 and 3.0± 0.4, respectively in the mango fruit (postharvest condition) after pathogen inoculation. However, strain GL6 showed significantly consistent disease suppression 2.67 times to stem end rot compared to control.

Introduction

Postharvest losses of fresh mango fruits have been reported to average 69%-100% under disease-favorable condition (Johnson, 2008; Sakalidis *et al.*, 2011). The disease, stem end rot (SER) of mango is economically damaging due to rendering the fruit unmarketable (Bally *et al.*, 2009). SER etiology is complex, with multiple fungal pathogens reported to be involved before and after harvest. Symptoms appear after fruit ripen; a soft brown decay begins from the stem end of the fruit and rapidly involves the whole fruit. *Lasiodiplodia theobromae* is considered to be the most important SER pathogen causing severe losses in fruit quality and marketability (Ambreen *et al.*, 2014).

To control the SER, farmers of Bangladesh mainly have been using Triazlole fungicide ($C_{15}H_{17}Cl_2N_3O_2$). This fungicide inhibits the demethylation in the eukaryotic cell like fungus. Demethylation in c-14 during Ergosterol of fungus is biological process for cell division and well growth. As Triazlole fungicide inhibits the demethylation process, ultimately fungal cell is disrupted and it will die. But, it affects the human liver and skin also. Therefore, as an alternative, we have to search powerful triggered novel microbes that degrade the propiconazole after spraying to the mango.

Biological control using antagonistic bacteria would be environmentally sound and can be implemented as an integrated disease management tool as well as to increase the yield. Various bacterial genera, such as *Bacillus*, *Burkholderia*, *Lysobacter*, *Pantoea*, *Pseudomonas*, and *Streptomyces*have been used as bio-control agents for controlling diseases and increasing the PGPR performance of many crops. Several *Bacillus* species have been developed as commercial bio-pesticides, because *Bacillus* species can produce endospores and persist successfully in natural environments for a long period after treatment (Hu *et al.*, 2011). *Bacillus* species widely used for biological control of many plant diseases in different hosts include *Bacillus amyloliquefaciens*, *Bacillus subtilis*, *Bacillus pasteurii*, *B. cereus*, *Bacillus pumilus*, *Bacillus mycoides*, and *Bacillus sphaericus*(Kloepper *et al.*, 2004). Diverse species of *Bacillus* have been isolated from various terrestrial and halophytic plants and some of them have been shown to be endophytic. In this study, to find out the novel endophytic isolates, we highlighted only the endophytic *Bacillus* strains to degrade the propiconazole properties as well as to control the SER of mango.

Materials and methods

The purely isolated bacterial strainGL6 was sub-cultured on one-tenth strength tryptic soy agar (1/10 TSA) media and stored at - 70 °C for further use. For preparation of the bacterial suspension, the strain was cultured in 1/10 tryptic soy broth (1/10 TSB) at 28° C overnight on a rotary shaker (180 rpm) and bacterial cells were harvested after centrifugation at 5,000g for 15 min. The collected cell pellets were then suspended in buffer solution (10mM $MgSO_4$) and its concentration was adjusted to about 1 × 10^7 colony forming unit (CFU) mL^{-1}.

Degradation Test: One ml Tilt-250 EC of 100 ml was diluted to the 1 liter distilled water. From that stock solution, only 200 ml Tilt-250 EC was kept in the different volumetric flask and then only one ml different bacterial suspension was mixed in there and finally the mixture was kept for 6 hr in the shaker by 160 rpm.

Antagonistic activity against stem end rot fungal pathogen: The endophytic bacteria were tested against important plant fungal pathogen *Lasiodiplodia theobromae*. The antagonistic activity of bacterial strains was determined by measuring the inhibition zone of mycelial growth of the fungal pathogen on potato dextrose agar (PDA) medium using *in vitro* confrontation bioassay. The antagonistic activity was determined by *in vitro* confrontation bioassay using Cell method by one line streaking or point inoculation were conducted against the pathogens which were set in the middle of the petri plate. Inhibition distance was measured from the outer part of the antagonistic microbe to the opposite outer part of the pathogen. The activity was estimated after 5-7 days incubation at 28 °C by mycelial growth inhibition: +, <3 mm; ++, between 4 to 5 mm; +++, between 6 to 8 mm and ++++, 8-10 mm. *Mean long time (more than 30 days). Different compositions were used for measuring the good compatible anti-fungal media. pH was adjusted to 7 for each media. The composition of the mew media MM2: Yeast extract-10g, NH_4Cl-4g, $MgSO_4$-4g, Dextrin-019123-8g.

Absorbance Test: Sample was run by the spectrophotometer Shimadzu UV-1900 of using the 600 nm web length.

Results and Discussion

Out of many isolates, only GL6 isolate were selected as a strong endophytic *Bacillus* species. The newly isolated endophytic bacteria have strong antagonistic approach to devastating plant fungalpathogen *Lasiodiplodia theobromae*. A very clear and distinct inhibition zonewas observed at *in vitro* cell and culture filtrate bioassay. Many studies showed the *Bacillus* species showed good performance in plant growth promotion as well as plant disease protection (Hossain *et al.*, 2016, Kahan, 2015). Strain GL6 showed ++++ reaction to inhibit the fungal pathogen.On the contrary, it showed -.68 ±0.01 to 0.48 ± 0.01 absorbance by 600 nm web length by deleting the concentration of Tilt-250 EC in without media and with media condition respectively, indicating the degradation of propiconazole properties. Out of three antagonistic species, *Bacillus velezensis* GL6 is the best to degrade the propiconazole properties Strain BARI/HAT/GL6 could also change the color of Tilt-250 EC within 6 hr. It seems strain BARI/HAT/GL6 has positive effect to degrade the propiconazole properties (Table 1). In addition, it revealed significantly (Tukey HSD, $P<0.01$) lower disease severity by 1.5 ± 0.3, than the control, Tilt-250 EC and hot water by 4.0 ± 0.5, 1.75 ± 0.2 and 3.0± 0.4 respectively in the mango fruit (post-harvest condition) after pathogen inoculation However, strain GL6 showed significantly consistent disease suppression 2.67 times to stem end rot compared to control.

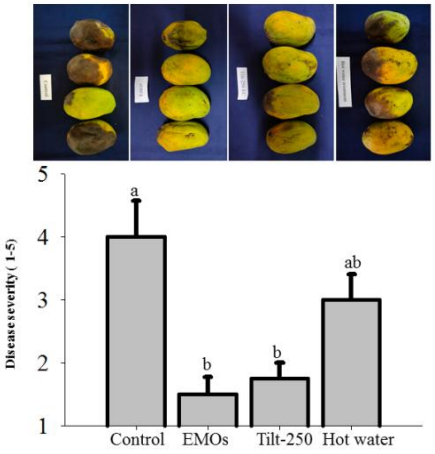

Fig. Data represent severity for mean values ± SE consisting of 10 mangoes by four replicates that have been analyzed at the 3 DAI (Days after inoculation) before treatment Different letters indicate statistically significant differences ($P < 0.01$) by Tukey's HSD test.

Table 1: Color reactions by the different isolates

Isolates	Color Reaction	[a]Absorbance without Media	[b] Absorbance without Media	[c] Absorbance With media	[d] Absorbance With media
GL6+Tilt	+++	0.37±.01 c	-.68 ±0.01 d	2.72±.01 a	0.48 ± 0.01 a
YC7012+Tilt	++	0.44±.02 c	-.54 ±0.01 c	2.62±.01 ab	0.38 ± 0.01 b
YC7007+Tilt	+	0.71±.01 b	-.33 ±0.01 b	2.57±.03 b	0.37 ± 0.01 b
Tilt-250 EC	-	1.06±.03 a	0.0 ±0 a	2.22±.01 c	0.0 ± 0.0 c

[a]Absorbance was conducted by 600 nm by the Shimadzu UV-1900 machine. Samples were mixed into the distilled water where distilled water might be zero as a control in spectrophotometer.

[b] Absorbance was conducted by 600 nm by the Shimadzu UV-1900 machine. Samples were mixed into the distilled water where the suspension Tilt might be zero as a control inspectrophotometer.

[c]Absorbance was conducted by 600 nm by the Shimadzu UV-1900 machine. Samples were mixed into the 1/10 th TSB media water where TSB broth might be zero as a control in spectrophotometer

[d]Absorbance was conducted by 600 nm by the Shimadzu UV-1900 machine. Samples were mixed into the 1/10 th TSB media water where the suspension Tilt might be zero as a control in spectrophotometer.

Conclusion

Bacillus velezensis BARI/HAT/GL6 was selected as a strong endophytic bacterium that degrades the propiconazole as well as to control the post-harvest SER of Mango by suppressing the pathogen *Lasiodiplodia theobromae*. Strain GL6 showed significantly consistent disease suppression 2.67 times to stem end rot compared to control.

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THE EFFICACY TEST OF *BACILLUS* BASED PRODUCTS (EMOs) FOR CONTROLLING GREENING DISEASE OF SWEAT ORANGE

M. T. HOSSAIN, M. M. RAHMAN AND Z. A FIROZ

Abstract

Greening disease for sweet orange is a serious threat over the world. Generally, the chemical pesticides have been being used for controlling the vector, insects. But still no date, there is no successful findings to control the greening pathogens *Liberibacter* sp. as well as greening disease. However, from the last decade, *Bacillus* species and their formulated products have been being used in agriculture for many aspects over the world. This approach is totally rudimentary in our country. The activity using the endophytic novel *Bacillus* species to control greening disease of sweet orange, BARI Malta-1 is the first study in our country. The *in vitro* and *in vivo* study had been conducted successfully at the Regional Agricultural Research Station, Hathazari, Chattogramto get the successful grafting projection without infection of greening disease by the *Bacillus oryzicola* YC7007 and *B. siamensis* YC7012 since 2017. YC7007 (2.0×10^7 CFU/ml) revealed significantly *($P<0.01$*) lower greening disease severity by 1.4 ± 0.1 and 0.9 ± 0.2 than the control by 2.86 ± 0.3 and 2.1 ± 0.2 in the BARI Malta-1 by root stocks with rough lemon and kalamunchi respectively. In the Pumelo root-stock, *Bacillus siamensis* YC7012 showed the best performance in respect to free infection of greening disease by 1.56 ± 0.2 scaling compared with control by 2.69 ± 0.2. In the seedling stage at nursery bed, YC7007 revealed significantly *($p < 0.01$*) lower greening disease index by 0.78 ± 0.14 compared with control by 3.8 ± 0.12.Depending on our data, EMOs made by the strain YC7007 and GL6 revealed significantly *($P<0.01$*) lower greening disease severity by 1.26 ± 0.2, than the control by 2.52 ± 0.3 in the BARI Malta-1 by root stocks with rough lemon at 3 years old plant.

Introduction

Grafting is an old plant propagation practice, is still widely used with fruit trees and in recent decades also with vegetables. Long term successful grafting is an important tool to get fruitful results, but still somewhat it is difficult. Reunion of two parts viz. scion and root-stock, wound healing and vascular regeneration are considerable thinking to get the successful grafting (Goldschmidt 2014). Cellulose, hemicellulose and lignin were scratched in the scion and root-stock to make a good adjustment. Using different grafting practices viz. cleft grafting, bark graft grafting, veneer grafting, splice grafting were considered depending on the host cells. Cellulase enzyme that degrades the cellulose, helps to accelerate the grafting. Some endophytic bacteria have strong cellulase enzymes viz, endo-glucanase, xylanase etc. to colonize the inner cell and induced auxin (Ajmal and Hossain 2016). By using the bacterial interaction, it is our first report so far we know. In this study, we highlighted the bacterial interaction for making the good grafting projection and the application of EAMOs (Effective microbial organisms) to control the greening disease. Citrus greening disease is a serious microbial disease affecting major citrus-growing areas and spreading to new citrus-growing regions. It is caused by a gram-negative bacterium named *Liberibactersp.*, spread by the psyllids, *Trioza erytrea* and *Diaphorinacitri*, acting as natural vectors. The disease is also propagated by grafting. Three species of the bacterium are known like *Liberibacter asiaticus*, *L. africanus*, and *L. americanus* (Bové, 2006). The pathogen penetrates the phloem and attack the vascular system, clogging the veins and drastically reduces the transport of water and nutrients. The disease has been described in China, already in 1929. In summary, there is a good reason for defining HLB as the most serious citrus disease in Florida today. Huanglongbing is a Chinese word meaning the “yellow dragon disease”.Probably due to the appearance, yellow shoot isone of the first symptoms of that disease. Another early symptom is yellowing of the leaf veins. Other symptoms include yellowing and mottling,eventually fall of the leaves, loss of fibrous rootlets, and ultimately death of the plant. Sick trees produce few small and deformed fruits. The three species of *Liberibacter* differ in their reaction to temperature. *L. asiaticus* is heat-tolerant and can survive at temperatures superior to 30°C, while *L. africanus* is thermo-labile and prefers temperatures in the range of 22–25°C. Detection of the pathogen in the infected plant or in the vector is difficult (Manjunath *et al.*, 2008). At present, there are no known methods for curing HLB. Therefore, the current study has been conducted to control the greening disease by the novel *Bacillus* sp. YC7007 and YC7012 that species already was patented and novel species (Hossain *et al.*, 2016 and 2019).

Materials and Methods

The experiment had been conducted at the Regional Agricultural Research Station, Hathazari, Chattogram from 2016-2022 to get the free greening disease by grafting projection for successful BARI Malta-1 garden. The experiment by the three stages viz. grafting, seedling and field condition, had been conducted. Grafting projection was done on 10 November 2016 and thereby grafted on root stock of one year old rough lemon and kalamanchi seedlings, respectively, were transplanted on 1 November 2017 in the hilly area of RARS, Hathazari which were under treated by the *Bacillus oryzicola* YC7007 and maintained to date. The bacterial suspension of YC7007 made with 10 mM $MgSO_4$ was drenched three times at 16 DAT by the 20 days interval subsequently and then maintained to date i.e. three time sprayings by each year. On the contrary, the seedlings grafted by root stock Pumelo by the BARI Malta-1 were transplanted on 1 November 2018 that was under subjected by the *Bacillus siamensis* YC7012. Three times sprayings were conducted by the 20 days interval from 1 January 2019 at Pumelo grafted BARI Malta-1. This set up also was conducted at Moyorkhil in Khagraschari to control the greening disease. YC7007 (2 .0 × 10^7CFU/ml) mixed with 10 mM $MgSO_4$ was inoculated at the part of scion cut and rootstock cut and then attachment by the veneer grafting has been conducted. Representative samples at least 20-50 were subjected under the treatment. On the contrary, the seedlings grafted by root stock Pumelo by the BARI Malta-1 were transplanted on 12 July 2019 that was under subjected by the EMOs (YC7007 +YC7012). Three times sprayings were conducted by the 20 days interval from 20 September 2021 to date.The data of greening disease of sweet orange (BARI Malta-1) were generated by the following rating scales with levels 0, 1, 2, 3, 4 and 5 corresponding to 0, 20, 40, 60, 80 and 100% of the canopy section area with HLB symptom (Bassanezi *et.al*., 2011). Data were analyzed by the student's t test and HSD Tukey at 1% level having with three replications.

Results and Discussion

Novel species *Bacillus* sp. YC7007 was subjected to regenerate the reunion of scion and root stocks. Strain YC7007 showed the good grafting projection almost free from nursery diseases especially, greening disease. The bacterial treatment at the different stages viz. seedling, field condition by the suspension of YC7007 (2.0 × 10^7 CFU/ml) had been used through one time drenching and three time sprayings bioassays. This approach with the novel *Bacillus* sp. YC7007 revealed significantly (P<0.01) lower greening disease severity by 0.78 ± 0.14, than the control by 3.80 ± 0.12 in the BARI Malta-1 (Fig. 1) in the pumelo grafting projection at nursery level. The bacterial treatment at field condition that was grafted with the pumelo by BARI Malta-1 by the suspension of YC7012 (2.0 × 10^7 CFU/ml) was subjected through one time drenching and three time sprayings bioassays. This approach with the novel *Bacillus siamensis* YC7012 revealed significantly *(P<0.01)* lower greening disease severity by 1.56 ±0.2 compared with control by 2.69 ± 0.2.in the BARI Malta-1 (Fig. 2). BARI Malta-1 that was granted by the rough lemon and Kalamanchi root stocks respectively, was treated by the bacterial suspension of YC7007 (2.0 × 10^7 CFU/ml) by one time drenching and three time sprayings inoculation. This approach with the novel *Bacillus* oryzicola YC7007 revealed significantly (P<0.01) lower greening disease severity by 1.4 ± 0.1 and 0.9 ± 0.2 than the control by 2.86 ± 0.3 and 2.1 ± 0.2 in the BARI Malta-1 by root stocks with rough lemon and kalamunchi respectively. Depending on our data, EMOs made by the strain YC7007 and GL6 revealed significantly *(P<0.01*) lower greening disease severity by 1.26 ± 0.2, than the control by 2.52 ± 0.3 in the BARI Malta-1 by root stocks with rough lemon at 3 years old plant.

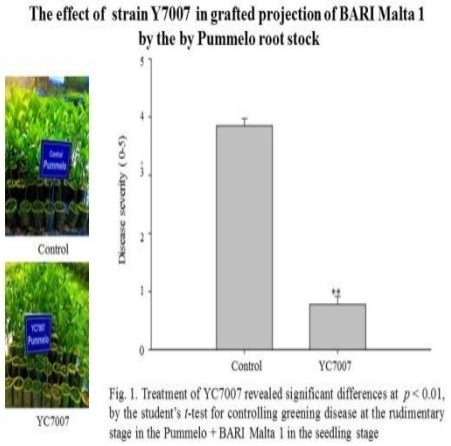

Fig. 1. Treatment of YC7007 revealed significant differences at $p < 0.01$, by the student's *t*-test for controlling greening disease at the rudimentary stage in the Pummelo + BARI Malta 1 in the seedling stage

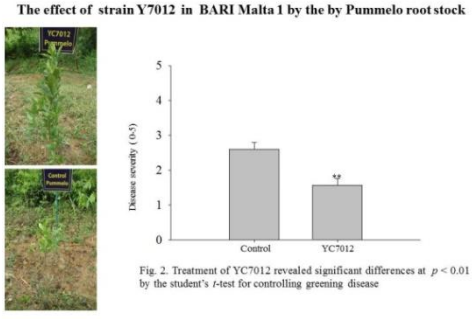

Fig. 2. Treatment of YC7012 revealed significant differences at $p < 0.01$ by the student's *t*-test for controlling greening disease

Endophytic bacteria YC7007 and YC7012 have been reported as a good source for controlling the plant diseases and they showed the good suppressive activities against all major plant pathogens (Chung and Hossain et at., 2015; Hossain *et al.*, 2016, Hossain *et al.*, 2019). As they are endophytic and colonize into the plant cell without the disturbance, they did good grafting projection and controlled the greening disease. In field of Khagrachari and RARS, Hathazari, strain YC7007 controlled 85% and 73% respectively, diseased reduction over the control. Many bacteria produce auxin and degrade the cellulose by cellulase enzyme (Ajmal and Hossain 2016). On the contrary, *Bacillus siamensis* YC7012 has been reported as a Plant growth promoting bacterium very recently (Hossain *et al.*, 2019). This bacterium YC7012 also showed the suppressive activities to greening disease. Therefore, the formulation product called EMOs by strain YC7007 and YC7012 have made as it is now burning issues to control the greening disease

The effect of strain Y7007 in BARI Malta 1 by the by Rough lemon and Kalamanchi root stock

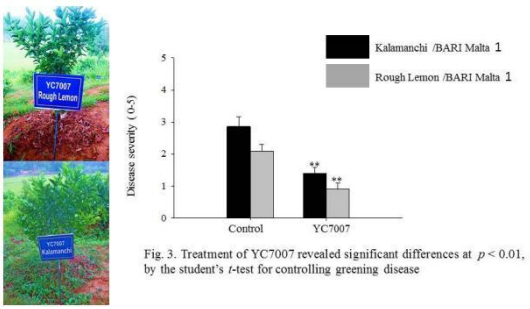

Fig. 3. Treatment of YC7007 revealed significant differences at $p < 0.01$, by the student's *t*-test for controlling greening disease

The effect of EMOs in BARI Malta 1 by the by Pummelo root stock

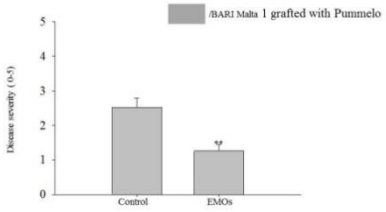

Fig. 4. Treatment of EMOs revealed significant differences at $p < 0.01$, by the student's *t*-test for controlling greening disease. Data have collected from 5 plants and 50 leaves for each plant under one each treatment by three replicates

Conclusion

Strain YC7007and YC7012 showed the good grafting projection almost free from nursery diseases especially greening disease. Therefore, the formulation products called EMOs by them is very antagonistic to greening disease that revealed 2 time less disease compared to control.

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THE EFFICACY TEST OF EMOS FOR CONTROLLING BACTERIAL WILT IN SOLANACEOUS VEGETABLE

M. T. HOSSAIN, M. ALAM AND Z. A. FIROZ

Abstract

Bacterial wilting of solanaceous crops like eggplant, tomato and pepper is a serious threat over the world. Still there is no successful remedy for controlling the bacterial wilt in solanaceous crops. However, probiotic *Bacillus* species and their formulated products had been being used to the agriculture with the many aspects over the world from the last decade. This approach is very rudimentary in our country. The activity of the formulated EMOs (Effective Microbial Organisms) by using the endophytic novel *Bacillus oryzicola* YC7007 and *B. velezensis* GL6 to control bacterial wilt in solanaceous crops is the first study in Bangladesh to our knowledge. The *in vitro* antagonistic activities by formulated product of EMOs and their active inocula levels had been scrutinized against the bacterial pathogen *Ralstonia solanacearum* for controlling bacterial wilt since 2016 in very susceptible BARI *Bt* Begun-2, Strain YC7007 and GL6 did quorum having with the 2.0×10^7 CFU/ml or CFU/gminocula that suppressed the wilt and promoted the plant growth compared with control. Bacterial wilt of the solanaceous crops especially on eggplant (very susceptible variety BARI *Bt* Begun-2), tomato (BARI Tomato-15) and chili pepper (very susceptible variety Haldamorich) was successfully controlled *in vibo* at RARS, Hathazari. Granular EMOs were scrutinized by one time drenching as a basal dose and formulated powder EMOs were conducted by three time sprayings to the rhizosphere till to droplet. There were no diseases at 2-MAT (Months after transplanting) in the treated plot. Granular form for basal application, EMOs (1×10^8 CFU/g) and powder form formulated bacterial product (1×10^9 CFU/g) together revealed significantly (Tukey HSD, $P<0.05$) lower disease severity by 1.2 ± 0.3, than the control by 2.59 ± 0.3 in the BARI *Bt* Begun-2 at 3-MAT. However, EMOs revealed significantly (Tukey HSD, $P<0.05$) lower disease severity by 0.56 ± 0.07 and 0.3 ± 0.3 than the control by1.03 ± 0.1 and 1.83 ± 0.1 at BARI Tomato-15 and Halda morich respectively at 4-MAT out of 0-5 disease rating scales. EMOs showed significantly consistent disease suppression 70-84% in the BARI *Bt* Begun-2 and BARI Tomato-15respectively at 4-MAT to bacterial wilt compared to control. At the same time 4-MAT, the resistance to wilt of BARI *Bt* Begun-2 impaired and turned into HS (Highly susceptible) in the untreated plot almost. We concluded that EMOs products are key vital biological products to *Ralstonia solanacearum* for controlling bacterial wilt in solanaceous crops.

Introduction

Solanaceous crops like eggplant or Brinjal (*Solanum melongena* L.), tomato (*Solanum lycopersicum*) and pepper plants (Halda morich) are the most important and widely-consumed vegetables in Bangladesh. Their yields were declining due to the wilting that is serious threat in our economy. Bacterial wilt, caused by *Ralstonia* (=*Pseudomonas*) *solanacearum* (E.F. Smith) is a major constraint in solanaceous crops production. The disease is widely distributed in tropical, subtropical and some warm temperate regions over the world. The pathogen is difficult to control, since it is soil-borne and has a wide host-range. Infection is through root-to-root transmission, movement of soil and dissemination by farm implements and water irrigation. A combination of high temperature and poor drainage favor development of the disease which causes 75 to 81% yield loss during summer in India (Rao *et al,* 1976). Generally, bacterial wilt in solanaceous crops is being managed by application of bactericides, copper fungicides and by crop rotation, with no adequate successful control measures to date to our knowledge. However, it is challenging to control the bacterial wilt having with bio-control approach. Therefore, an alternative control measure, biological agent or integrated agents of *Bacillus* sp. called EMOs, is being launched in Chattogram division, Bangladesh led by Regional Agriculture Research Station, BARI, Hathazari.

Bacillus is the current burning bio-control agent that can control many diseases. Endophytic rhizobacteria are efficient and reliable in inducing defense responses. These bacteria can grow in adverse environments and are well-adapted to the plant system (Khan *et al.,* 2016, Hossain *et al.*, 2019). Endophytic rhizobacteria play prominent and beneficial roles in plant defenses against pathogens and growth promotion during the interaction, such as direct suppression of phytopathogens or solubilization of the fixed nutrients to the available form or ISR, induced systemic resistance (Chung *et al.,* 2015; Hossain *et al.,* 2016). Many endophytic bacteria, several *Bacillus* species stimulate the plant immune system through ISR to control plant diseases (Kloepper *et al.,* 2004). *Bacillusoryzicola* YC7007 and$YC7010^T$, which are two novel endophytic strains isolated from rice

roots, were reported to induce systemic resistance against *F. fujikuroi*, *Burkholderia glumae* and *Xanthomona soryzae*pv. *oryzae* in rice by their produced metabolites (Chung *et al.,* 2015, Hossain *et al.*, 2016). To evaluate the efficacy of novel stain *Bacillus oryzicola* YC7007 and *B. velezensis* GL6 and their products EMOs, the validation trial over the Chattogram division including hilly areas had been done successfully in BARI *Bt* Begun-2 from 2019 to 2021 under the program of MoA. In the current year 2, the study has been undertaken in the solanaceous crops having with the formulation products like granular and powder from by the *B. oryzicola* YC7007 and *B. velezensis* GL6 to control the bacterial wilt of solanaceous crops like BARI *Bt* Begun-2, BARI Tomato-15 and local Halda Morich which were very susceptible variety.

Materials and Methods

The experiment was conducted at Plant Pathology laboratory of Regional Agricultural Research Station, Hathazari, Chattogram from 2021-2022 to find out the efficacy of EMOs produced from *Bacillus oryzicola* YC7007, and *B. velezensis* BARI/HAT/GL6, to study its effectiveness against wilt of Solanaceous crops Validamysin was used as check. Three solanaceous crops viz. BARI*Bt* Begun-2, BARI Tomato-15 and Halda morich were used for this study. Strain YC7007 and GL6 were found effective through Pinprick, stem clipping and root clipping bioassay were conducted to inoculate the pathogen *in vitro* for screening test in the previous year for pot experiment in BARI *Bt* Begun-2. In the field trial, artificial inoculation has been omitted. Beneficiary bacterial suspension was made with the buffer of 10 mM $MgSO_4$ having with different sterilized/autoclaved carrier materials to make the bacterial formulated powder (1×10^9 CFU/g). Finally, EMOs were made by the cell pellets of *Bacillus oryzicola* YC7007 and *B. velezensis* GL6. Basal dose of EMOs, granular form 100 gm/m^2 was done at the land preparation and then land was wrapped by the black plastic paper. Black plastic was unwrapped at 21 days. In the current year the experiment was conducted only at RARS, Hathazari. Bacterial drenching was done one time and three times sprayings by the EMOs formulated powder were conducted till to droplet in the rhizosphere by 20 days intervals subsequently from 20 days after planting. Fertilizers and irrigation were maintained accordingly in homogenous condition to all plots (Azad *et al.,* 2017, Café-Filho*et al.,* 2019). The data of bacterial wilt of eggplants were generated by the following rating scales. 0-Highly Resistant (HR) with no wilt symptom; 1-Resistant (R), with 1-10% wilted plants; 2-Moderately Resistant (MR) with 11-20% wilted plants; 3-Moderately Susceptible (MS), with 21-30% wilted plants; 4-Susceptible (S) with 31- 40% wilted plants, and, 5-Highly Susceptible (HS) with >40% wilted plant at 2-MAT, 3-MAT, 4-MAT and 5-MAT. Data were analyzed by the HSD Tukey at 1% level having with three replicates for basic research and 5% level by three replicates for field research

Results and Discussion

Quorum sensing bioassay: Plate bioassay was conducted to scrutinize the quorum sensing by the *Bacillus* sp. YC7007, *B. velezensis* BARI/ HAT/ GL6 and powder formulated EMOs made by two strains of YC7007 and GL6. Strain YC7007 and GL6 did quorum having with the 2.0×10^7 CFU/ml inocula that promoted the plant fresh weight compared with the other concentrations. Out of the three concentrations viz. 2×10^5, 2×10^7, 2×10^8 CFU/ml, the concentration, 2.0×10^7 CFU/ml of YC7007 and GL6 revealed the good quorum sensing for promoting the plant growth in the plate bioassay. Strain YC7007 and GL6 (2.0×10^7 CFU/ml) revealed significantly (P<0.01) higher plant fresh weight by 0.7 ± 0.05 and 0.6 ± 0.05 g/plate respectively, than the other concentrations 2.0×10^5 and 2×10^8 CFU/ml by 0.48 ± 0.01 g, 0.4 ±0.05 g/plate and 0.49 ± 0.05, 0.48 ± 0.01 g/plate respectively, in the plate bioassay (Fig. 1). Strain YC7007 (2.0×10^7 CFU/ml) promoted 2.59 time more productions compared with control. Strain YC7007 and GL6 did quorum having with the 2.0×10^7 CFU/ml inocula that promoted the plant fresh weight. Individually, each strain colonized at the rhizosphere for quorum sensing by the (1 ×

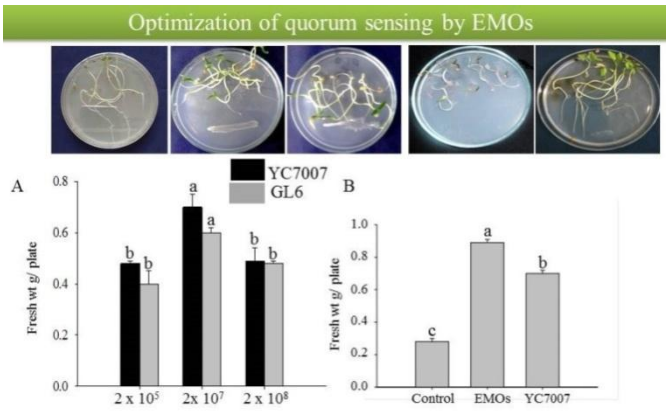

Fig. 1 A. Data represent mean values ± SE of three replicates, each contains 3 plates and each plate contains 10 seedlings. Different letters indicate statistically significant differences ($P < 0.01$) by Tukey's HSD test. B. Asterisks show significant differences among treatments by Tuke 's HSD test ($P < 0.01$). All experiments were repeated three times with similar results.

10^7CFU/g or CFU/ml). EMOs that made by two strains revealed significantly (P<0.01) higher plant fresh weight by 0.0.89 ± 0.02 g/plate followed by the YC7007 and control by 0.7 ± 0.02 g/plate and 0.28± 0.02 respectively.

Wilting control by the EMOs: The suppressive bioassay by the EMOs of novel species *Bacillus oryzicola* YC7007 and B. *velezensis* GL6 had been conducted against bacterial wilt of solanaceous crops like BARI *Bt* Begun-2, BARI Tomato-15 and local HaldaMorich in the natural field condition. EMOs revealed significantly (Tukey HSD, P<0.05) lower disease severity by 1.2 ± 0.3, than the control and Validamycinby 2.59 ± 0.3and 1.85± 0.1 in the BARI *Bt* Begun-2 respectively at 3-MAT. EMOs controlled 70% bacterial wilt of BARI *Bt* Begun-2 compared with control at 4-MAT especially in the RARS, Hathazari, there was no diseases of bacterial wilt of BARI *Bt* Begun-2 in the treated plot of EMOs at the 2- MAT whereas untreated plot showed the disease by 0.83± 0.2 at 2 MAT in the BARI *Bt* Begun-2. So, EMOs might control 100% wilt compared the control in the all locations at 2-MAT (Fig.2).

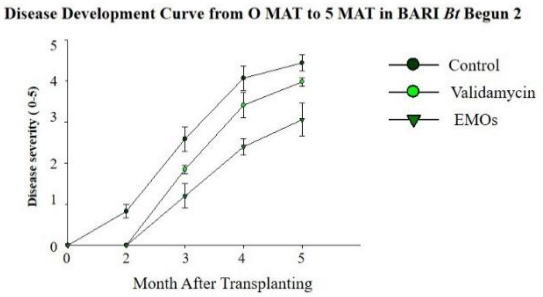

Fig. 2 Data represent mean values ± SE of six replicates, each consisting of 18 plants. Different lines indicate statistically significant differences (P < 0.05) by Tukey's HSD test regarding the severity depending on the different time frames from 0 MAT to 5 MAT in Sigma Plot 10.

EMOs revealed significantly (Tukey HSD, *P<0.05*) lower disease severity by 0.56 ± 0.07, than the control and Validamycin by 1.03 ± 0.1 and 0.83± 0.1 in the BARI Tomato-15 respectively at 4-MAT. EMOs controlled 84% bacterial wilt of BARI Tomato-15 compared with control at 4-MAT especially in the HRC, RARS, Hathazari, On the contrary, EMOs revealed significantly (Tukey HSD, *P<0.05*) lower disease severity by 0.3 ± 0.3, than the control and Validamycin by 1.83 ± 0.1 and 1.3± 0.4 in the local HaldaMorich respectively at 4-MAT. EMOs revealed 6 times low level of disease severity compared with control at 4-MAT in local Morich (Fig. 3). EMOs revealed significantly (Tukey HSD, *P<0.05*) higher yield by 24.3 ± 1.2 ton/h than the control and Validamycin by 1.63 ± 1.18 and 15.0 ± 0.5 in the BARI *Bt* Begun-2 respectively. On the contrary, EMOs revealed insignificantly (Tukey HSD, *P<0.05*) higher yield by 77.0 ± 1.5 ton/h than the control and Validamycin by 68.33 ± 4.40 and 72.0 ± 1.7 ton/hain the BARI Tomato-15 respectively.

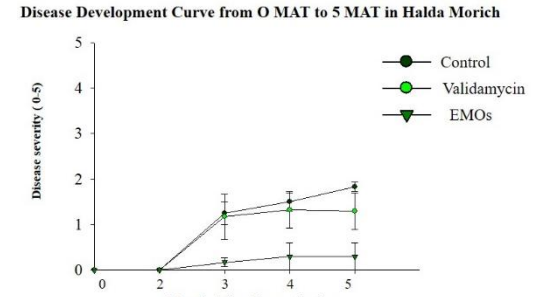

Fig. 3 Data represent mean values ± SE of six replicates, each consisting of 20 Plants. Different lines indicate statistically significant differences (P < 0.05) by Tukey's HSD test regarding the severity depending on the different time frames from 0 MAT to 5 MAT in Sigma Plot 10.

Disease severity was lower in the treated plot individually at any location from 2-MAT to 5-MAT compared to control.In the treated plot, the plant triggered highly resistance (HR) in the experiment plot. On the contrary, the colonization test of EMOs in the rhizosphere areas were subjected in the different locations to know their self-life in the nature as they produced endospore. The inocula (CFU/g) of EMOs was different in the different locations. In average, it was almost 2×10^6 CFU/g till to 4-MAT in the rhizosphere of BARI *Bt* Begun-2. The inocula for quorum sensing by the novel strain YC70007 is 2×10^7 CFU/ml. In the same way, other some novel strain, *Bacillus velzensis*BARI/HAT/GL-6 was subjected in the lab setting experiment against wilting to the BARI *Bt* Begun-2. *Bacillus velzensis* BARI/HAT/GL-6 showed the lower disease severity. It was similar to strain YC7007, therefore, the product made by the two strains of YC7007 and GL6. Endophytic bacteria YC7007 has been reported as a good source for controlling the plant diseases and it showed the good suppressive activities against all major plant pathogens (Chung and Hossain et at., 2015; Hossain *et al.*, 2016). Biological control using antagonistic bacteria and fungi would be an environmentally sound option, and can be an alternative to agrochemicals in the management of plant diseases. During the last decades, many *Bacillus* species have been used for controlling plant diseases with

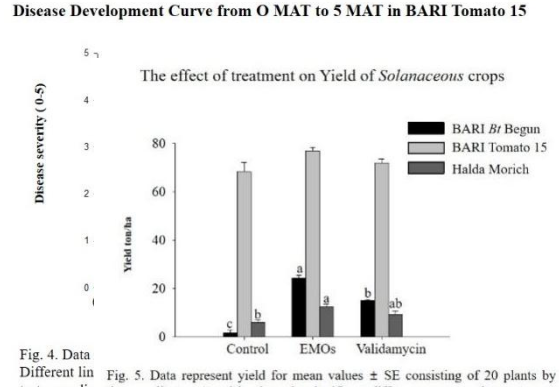

Fig. 4. Data
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Fig. 5. Data represent yield for mean values ± SE consisting of 20 plants by three replicates. Asterisks show the significant differences among the treatments using the HSD Tukey's (P < 0.05).

some success, but only a few have been developed for the practical use in commercial farms (McSpadden Gardener 2010; McSpadden Gardener 2004). EMOs products are key vital biological products to *Ralstonia solanacearum* for controlling bacterial wilt in all types of solanaceous crops.

Conclusion

The inocula for quorum sensing of EMOs is 2×10^7 CFU/ml. Strain YC7007 and BARI/HAT/GL are strong antagonistic endophytic bacterium of *Ralstonia solanacearum*. The very susceptible eggplant varieties (BARI *Bt* Begun-2 to bacterial wilting were successfully controlled *in vitro* and *in vibo* in RARS, Hathazari. In current year (2021), EMOs are used over the Chattogram division in the 16 locations.There was no diseases at 2-MAT (Months after transplanting) in the treated plot. Granular form for basal application, EMOs (1×10^8 CFU/g) and powder form formulated bacterial product (1×10^9 CFU/g) together revealed significantly (Tukey HSD, $P<0.05$) lower disease severity compared with control and Validamycin in the BARI *Bt* Begun-2, BARI Tomato-15 and Local Halda morich out of 0-5 disease rating scales. EMOs showed significantly consistent disease suppression 70-84% in the BARI *Bt* Begun-2 and BARI Tomato-15 respectively at 4-MAT to bacterial wilt compared to control. At the same time 4-MAT, the resistance to wilt of BARI *Bt* Begun-2 impaired and turned into HS (Highly susceptible) in the untreated plot almost. EMOs revealed 6 times low level of disease severity compared with control at 4-MAT in local Morich. EMOs products are key vital biological products to *Ralstonia solanacearum* for controlling bacterial wilt in *Solanaceous* crops.

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EFFECT OF IRRIGATION ON MANGO FRUIT CRACKING IN CHATTOGRAM REGION

M. P.HAQUE, Z. A. FIROZ, M.A. HOSSAIN, AND S.K. BISWAS

Abstract

The study was conducted at existing HRC Mango Orchard of Regional Agricultural Research Station, Hathazari, Chattogram during the Rabi season of 2019-20, 2020-21 and on-going (2021-22) to explore the optimal period of irrigation to mitigate mango fruit cracking. Five treatments were applied: T_1 (rain-fed i.e. local practice), T_2 (irrigation at full bloom), T_3 (irrigation at fruiting setting), T_4 (irrigation at full bloom and fruit setting), and T_5 (irrigation at 2 weeks interval),). The highest yield (76.5Kg plant^{-1} and 74.6 Kg plant^{-1} in successive years) was found at higher frequency irrigation (T_5). The maximum irrigation (average 1926 liters plant^{-1}) was applied at two weeks interval irrigation (T_5). In rain-fed condition (T_1), yield was lowest (56.8Kg plant^{-1} and 55.2Kg plant^{-1} in first and second years). The lowest number of fruits dropping (21 and 19no.fruits) was occurred in irrigation at full bloom and fruit setting (T_4). The lowest number of cracking (15 and 13no.fruits) as well as the highest sweetness (average TSS=24%) occurred irrigation at fruit setting (T_3) and the benefit-cost ratio was also higher in this treatment.

Introduction

Mango (*Mangifera indica*) is one of the most popular fruits in Bangladesh. Mango belongs to the family Anacardiaceae is a tropical to sub-tropical fruit, originated in the Indian sub-continent (Indo-Burma region) in the prehistoric times. Bangladesh is the world's eighth largest mango producing country as it produces about 1,047,850 tons of mangos every year which accounts for 3.9 percent of the world total mango production.

Mango production increases day by day in Chattogram region e.g. 71459 M.ton.in 2015 and 81112 M.ton in 2016 (BBS, 2017). Irrigation is one of parameters besides nutrition management that increases the yields and improves the quality of mango (W. Spreer *et al.*, 2007). In this region, farmers are still empirically applying water based upon experiences, without technical criteria. As a result, chances are that the mango crop cannot uptake enough water for its development and production due to soil water stress or excess. This kind of irrigation management may also lead to an increase in production costs due to excess amount of water applied that affects the sustainability of water resources. Therefore, irrigation management for the mango crop should follow technical criteria, so that water is applied at the right time and at the right amount.

Alam *et al.*, (2017) found that the fruits dropping and cracking of mangoes causes four reasons-diseases, insects, nutrient deficiency, water scarcity in Bangladesh. Mango fruit cracking occurs in Chattogram region during dry season (Nov-March). The cracked fruits lose keeping quality and unsuitable for transportation and consumption. The scarcity of soil moisture and also excess of soil moisture cause fruit cracking (Saran *et al.*, 2008). There is also water scarcity during this period in Chattogram region. So, Optimal stages of irrigation in mango production may save water and boost up quantity and quality (fruit cracking) of mango. The aim of this experiment is to find out the critical stage of irrigation to mitigate mango fruit cracking of mango.

Materials and Methods

A field experiment was conducted at existing HRC Mango Orchard (BARI Aam-4, Age 5-7 years), Hathazari, Chattogram during the rabi season of 2019-20as well as 2020-21and also on-going (2021-22). The design of a randomized complete block was performed with three replication and five treatments.

The five irrigation treatments are:

1) Rain fed condition i.e. Local practice (T_1)
2) Irrigation at full bloom (T_2)
3) Irrigation at fruit setting (T_3),
4) Irrigation at full bloom and fruit setting (T_4)
5) Irrigation at 2 weeks intervals (T_5)

Fertilizer dose and methods of application were Manure (35 kg/plant), Uea (875 gm/plant), TSP (437 gm/plant), MOP (350 gm/plant), Zn (350 gm/plant), Zn-SO4 (17 gm/plant), and Boric acid (35 gm /plant) (FRG, 2012).

Amount of water to be applied, during each irrigation event, was estimated by measuring soil moisture depletion from the field capacity. The water was applied by hose pipe with ring basin method.

Water content was calculated gravimetrically or volumetrically. Gravimetric soil water content is the mass of water divided by the mass of dry soil. It was measured by weighing a mass of wet soil, drying the soil for 24 hours at 105 ^{0}C in Oven, and then reweighing the sample(Waller & Yitayew, 2016).

$$\Theta_{grav}\ (gm/gm) = \frac{Mass\ of\ water(gm)}{Mass\ of\ dry\ soil\ (gm)} = \frac{Mass\ of\ wet\ soil\ (gm) - Mass\ of\ dry\ soil\ (gm)}{Mass\ of\ dry\ soil} \quad (1)$$

$$\Theta_v\ (cm^3/cm^3) = \theta_{grav} \times \text{soil bulk density}\ (gm/cm^3) \quad (2)$$

The depth of irrigation water requirement was estimated with the guideline of Michael (2007) as follows in equation (3).

$$d_{IR} = \frac{(FC - RL) \times A_s \times D}{100} \quad (3)$$

where, d_{IR} = depth of irrigation water requirement (mm), FC= field capacity (%) which measured byponding water method on the soil surface (Michael, 2007), RL= residual moisture content (%) which measured before irrigation gravimetrically, A_s = apparent specific gravity of soil, D= depth of effective root zone to be irrigated (mm).

The time, required to be irrigation, was calculated following equation (4).

$$t = \frac{d_{IR} \times A}{Q \times 1000} \quad (4)$$

where t = time to be irrigated (min), d_{IR} = depth of irrigation water requirement, A = area of plot (m^2), Q= discharge (m^3/min).

The data were analyzed with "agricolae" R version 4.0.0 software package (Mendiburu, 2020).

Results and Discussion

The highest yield (76.5Kg plant^{-1} and 74.6Kg plant^{-1} in first and second years) was obtained at two weeks interval irrigation (T_5) and the lowest yield (56.8 Kg plant^{-1} and 55.2Kg plant^{-1} in first and second years) was in rain-fed condition (T_1). The fruit weight per plant was also highest (526 gm/plant and 511.7gm/plant) and lowest (355 gm/plant and 335gm/plant) in irrigation at two weeks interval and rain-fed condition respectively. The more frequent irrigation was more response to yield. One irrigation event occurred at both full bloom and fruit setting. The fruiting stage irrigation was responsive to yield which was more yield than full bloom irrigation (Table 1).

The fruits' cracking at two weeks interval irrigation (T_5**)** was also the highest level (39 and 37 no. fruits in successive years) than any other treatments. The lowest number of fruits cracking (15 and 13 nos. Fruits in successive years) was occurred at fruiting stage irrigation. The results revealed that the less irrigation and excessive irrigation than a certain level may cause more fruit cracking which was similar findings to Saran *et al.*, (2008) .However, this study was found that irrigation at fruiting stage was more critical stage of irrigation.

The highest number of fruits' dropping (38 and 33 no. Fruits in two years) was obtained at rainfed condition (T_1) which was control treatment in comparison to other treatments. The lowest number of fruit dropping (21 and 16no.Fruits in successive years) was occurred in irrigation at flowering stage plus fruiting stage (T_4). So, irrigation at both flowing stage and fruiting stage were crucial for reduction of fruits dropping. Spreer *et al.*, (2009) also had evidence that fruits dropping without irrigation were higher.

The percentage of TSS at rainfed condition (T_1) was less than irrigation at fruiting stage (T_3). The sweetness (TSS) was the lowest (average 20.5%) in two weeks interval irrigation (T_5) and the highest sweetness (24%) was at fruiting stage irrigation (T_3).Therefore, the more frequent interval irrigation decreased the sweetness of mango. Léchaudel*et al.*, (2005) also showed that the frequent irrigation water supply reduced the sugar or sweetness of mango. This study revealed that irrigation at fruit setting (T_3) was the optimal stage of irrigation to maintain the level of higher sweetness.

Irrigation at two weeks interval was required more water (average 1926liters/plant) than any other irrigation treatments (Table 2). The cost and benefit of this irrigation treatment (T_5) was higher although the benefit-cost ratio was lowest (average BCR=1.5). The benefit-cost ratio of irrigation at fruiting stage was highest (average BCR about to 3). Rahman *et al.*, (2019) also found that the benefit-cost ratio of mango production at farmer's level in Bangladesh was 3.00.

However, with respect to economic return and fruits cracking, the irrigation at fruiting stage was the more beneficial and suitable stage of irrigation (T_3).

Table 1: Irrigation effect on Mango production

Treatment	No of fruits per plant	Weight per fruit (gm)	Yield per plant (kg)	No of fruits drop	No of fruit cracks	TSS (%)
2019-2020						
T_1	160.0	355.0	56.8	38.3	32.7	23.0
T_2	142.3	410.0	58.4	37.7	25.7	22.3
T_3	147.0	458.3	67.4	24.7	15.0	24.0
T_4	145.7	485.0	70.6	21.0	25.0	21.7
T_5	145.3	526.7	76.5	31.0	39.0	19.3
CV (%)	3.8	2.8	4.3	10.8	11.6	4.3
LSD	10.7	23.8	5.4	6.2	6.0	1.8
2020-2021						
T_1	165.0	335.0	55.2	33.3	30.3	23.1
T_2	145.7	440.0	64.2	32.7	23.7	22.5
T_3	148.0	456.7	67.6	19.7	13.0	24.0
T_4	146.3	489.0	71.6	16.0	23.0	21.2
T_5	145.7	511.7	74.6	26.0	37.0	22.0
CV (%)	4.3	4.8	6.9	12.8	12.7	5.7
LSD	12.2	40.6	8.7	6.2	6.0	2.4
Combined analysis of 2019-20 and 2020-21						
T1	162.50	345.00	56.04	35.83	31.50	23.00
T2	144.00	425.00	61.29	35.17	24.67	22.33
T3	147.50	457.50	67.47	22.17	14.00	24.00
T4	146.00	487.00	71.10	18.50	24.00	21.67
T5	145.50	519.17	75.53	28.50	38.00	20.67
CV (%)	4.08	3.96	5.80	11.71	12.10	5.10
LSD	7.45	21.65	4.71	4.02	3.92	1.39
2021-2022						
The experiment is on-going.						

Note: T_1=Rain fed , T_5= Irrigation at 2 weeks interval, T_2= Irrigation at full bloom, T_3= Irrigation at fruit setting, T_4= Irrigation at full bloom and fruit setting

Table 2: Irrigation event, amount of irrigation, and Profitability analysis of mango production

Treatment	Irrigation no.	Amount of irrigation (Liters/plant)	Effective rainfall (Liters/m2)	Yield per plant (Kg)	Benefit (Tk/plant)	Cost (Tk/plant)	Benefit-Cost Ratio
2019-2020							
T_1	0	0	28.7	56.8	2272	780	2.91
T_2	1	1000	28.7	58.4	2336	900	2.60
T_3	1	1200	28.7	67.4	2696	900	3.00
T_4	2	1300	28.7	70.6	2824	1300	2.17
T_5	10	2000	28.7	76.5	3048	2000	1.52
2020-2021							
T_1	0	0	50.2	55.2	2210	800	2.8
T_2	1	950	50.2	64.2	2568	950	2.7
T_3	1	1130	50.2	67.6	2702	950	2.8
T_4	2	1270	50.2	71.6	2862	1400	2.0
T_5	10	1852	50.2	74.6	2982	2200	1.4
Mean of two seasons (2019-2020 and 2020-2021)							
T_1	0	0	39.5	56.04	2241.5	790	2.84
T_2	1	975	39.5	61.29	2451.6	925	2.65
T_3	1	1165	39.5	67.47	2698.8	925	2.92
T_4	2	1285	39.5	71.10	2844.16	1350	2.11
T_5	10	1926	39.5	75.53	3021.3	2100	1.44
2021-2022							
The experiment is on-going							

Note: *T_1=Rain fed, T_5= Irrigation at 2 weeks interval, T_2= Irrigation at full bloom, T_3= Irrigation at fruit setting,*

T_4= Irrigation at full bloom and fruit setting. Assume labor per day Tk550 and selling price per Kg at farm gate Tk40.

Conclusion

From the previous two year experiment, Irrigation at fruit setting of mango (T_5) was the more profitable, sweetness, and lower fruits cracking although its yield was lower than the highest frequency irrigation (T_5) at two weeks intervals.

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EFFECT OF IRRIGATION ON THE YIELD AND QUALITY OF BLACK PEPPER

M. P. HAQUE, Z. A. FIROZ, M.A. HOSSAIN, AND S. K. BISWAS

Abstract

The black pepper is generally cultivated in Chattogram region with rainfed condition for the lack of available water in dry season. The main objective of this experiment is that there is any effect of irrigation in black pepper's yield and further to find out the critical stages of irrigation for water saving. The experiment was started from November, 2021 and it's on-going. The status of black pepper is pre-spiking stage.

Introduction

Black pepper (*Piper nigrum* L.), the 'king of spices', originated in the tropical evergreen forests of the Western Ghats of India (Sivaraman *et al.*, 1999), and is one of the oldest spices known to humankind. Global black pepper production is led by Vietnam, with 216,432 ton per year, followed by Indonesia, India, Brazil, and China, with 82,167; 55,000; 54,425; and 34,587 ton per year, respectively (*FAOSTAT*, 2016) whereas, the production of it in Bangladesh is about 10 ton per year. The cause of lower production rate might be poor policy and cultural practice like fertilizers and water management as well as the promising varieties.

Black pepper grows successfully between 20° north to 20° south of the equator and from 0 to 1,500 m above sea level. It is a plant of the humid tropics, requiring 1,250-2,000 mm of rainfall, tropical temperatures and high relative humidity with little variation in day length throughout the year (Sivaraman *et al.*, 1999). Black pepper grows well on soils ranging from heavy clay to light sandy clays rich in humus with porous friable nature, well drained, but still with ample water retention. Soils with near neutral pH, high organic matter and high base saturation with calcium (Ca) and magnesium (Mg) were found to enhance black pepper productivity (Mathew *et al.*, 1995). Black pepper plants are more susceptive to water stress and recovery of water deficit for economical yield (Ambrozim *et al.*, 2022).

In Bangladesh, usually farmer cultivates black pepper with supportive trees in medium high land areas. This type of high land is susceptible to water deficit in dry season (from November to April). Therefore, the supplementary irrigation could be mitigating the water stress and increase the water productivity of black pepper. This experiment was conducted for the determination of critical stages or period of irrigation and increase of black pepper production.

Materials and methods

Experimental Site: The experimental site was the research field of the Regional Agricultural Research Centre of Bangladesh Agricultural Research Institute at Hathazari in Chittagong, Bangladesh, which was located at 22º33'08.85'' N, 91º47'39.14'' E and elevation of 12.5m above the mean sea level (Figure1). The site was laid on the agro-ecological zone (AEZ) number 23, described as Chittagong coastal plain. The soil of research was silt clay loam and the pH level remained between 5.5 and 6.5 (mildly acidic). The average bulk density of soil from 0 to 60cm was 1.5gm cm^{-3}. The research was performed 2021-2022. Temperature, relative humidity, and rainfall were shown in Figure 2.

Crop selection: The most popular variety of black pepper i.e. BARI Golmorich-1 in Bangladesh was selected for this experiment. The average yield of this variety is 4-5 kg per plant per year and it is slightly bushy with supportive tree.

Agronomic Practices: The standard practice was performed from 2021. Fertilizer recommendation guide (2012) suggested for black pepper N: 100gm, P: 40gm, K: 140gm. The prescribed dose was divided two equal portions. The first portion was applied at April 22, 2022 by ringing 30cm as well as depth 15cm and the remainder portion will be applied in September, 2022.

Experimental Design: The experiment was designed with a randomized complete block design (RCBD). Spiking, flowering and fruit set stages are sensitive to irrigation and water management for humid tropics in India (Varadan, 2002).So, there were eight treatments taken. The following treatments were as below:

1. Irrigation at spiking stage (T_1)
2. Irrigation at flowering stage (T_2)
3. Irrigation at fruit set stage (T_3)
4. Irrigation at spiking stage plus flowering stage (T_4)
5. Irrigation at spiking stage plus fruit set stage (T_5)
6. Irrigation at flowering stage plus fruit set stage (T_6)
7. Irrigation at 10 day's intervals (T_7)
8. Rain fed condition (Check) (T_8)

Every treatment was replicated three times following the procedure of Gomez and Gomez (1994).

Estimation of irrigation water and time: Amount of water to be applied, during each irrigation event, was estimated by measuring soil moisture depletion from the field capacity. The water was applied by hose pipe with ring basin method.

Water content was calculated gravimetrically or volumetrically. Gravimetric soil water content is the mass of water divided by the mass of dry soil. It was measured by weighing a mass of wet soil, drying the soil for 24 hours at 105 ^{0}C in Oven, and then reweighing the sample(Waller & Yitayew, 2016).

$$\Theta_{grav}\ (gm/gm) = \frac{Mass\ of\ water(gm)}{Mass\ of\ dry\ soil\ (gm)} = \frac{Mass\ of\ wet\ soil\ (gm) - Mass\ of\ dry\ soil\ (gm)}{Mass\ of\ dry\ soil} \quad (1)$$

$$\Theta_v\ (cm^3/cm^3) = \theta_{grav} \times \text{soil bulk density}\ (gm/cm^3) \quad (2)$$

The depth of irrigation water requirement was estimated with the guideline of Michael (2007) as follows in equation (3).

$$d_{IR} = \frac{(FC - RL) \times A_s \times D}{100} \quad (3)$$

where, d_{IR} = depth of irrigation water requirement (mm), FC= field capacity (%) which measured by ponding water method on the soil surface (Michael, 2007), RL= residual moisture content (%) which measured before irrigation gravimetrically, A_s = apparent specific gravity of soil, D= depth of effective root zone to be irrigated (mm).

The time, required to be irrigation, was calculated following equation (4).

$$t = \frac{d_{IR} \times A}{Q \times 1000} \quad (4)$$

Where, t = time to be irrigated (min), d_{IR} = depth of irrigation water requirement, A = area (m^2), Q= discharge (m^3/min).

Economic benefit: The economic benefit will be analyzed with the benefit-cost ratio (BCR) shown in equation (9). When BCR is greater than unity, the irrigation practice would be profitable. There is considered two types of cost which are fixed cost and variable cost. The land rental is the fixed cost. The variable costs are land preparation, pesticide, insecticide, human labor, fertilizers, irrigation(equation (5). The sum of two types of costs was the total cost (equation (6)). Net return was estimated using equations (7) and (8). The unit production cost is calculated as total cost dividing by yield.

$$VC = \sum_{i=1}^{n} X_i C_i \quad (5)$$

$$Total\ Cost = Fixed\ cost + VC \quad (6)$$

$$Gross\ return = Yield \times Selling\ price \quad (7)$$

$$Net\ return = Gross\ return - Total\ Cost \quad (8)$$

$$Benefit\ Cost\ Ratio(BCR) = \frac{Grossreturn}{TotalCost} \quad (9)$$

Statistical Analysis: The data will be analyzed with "agricolae" R version 4.0.0 software package (Mendiburu, 2020).

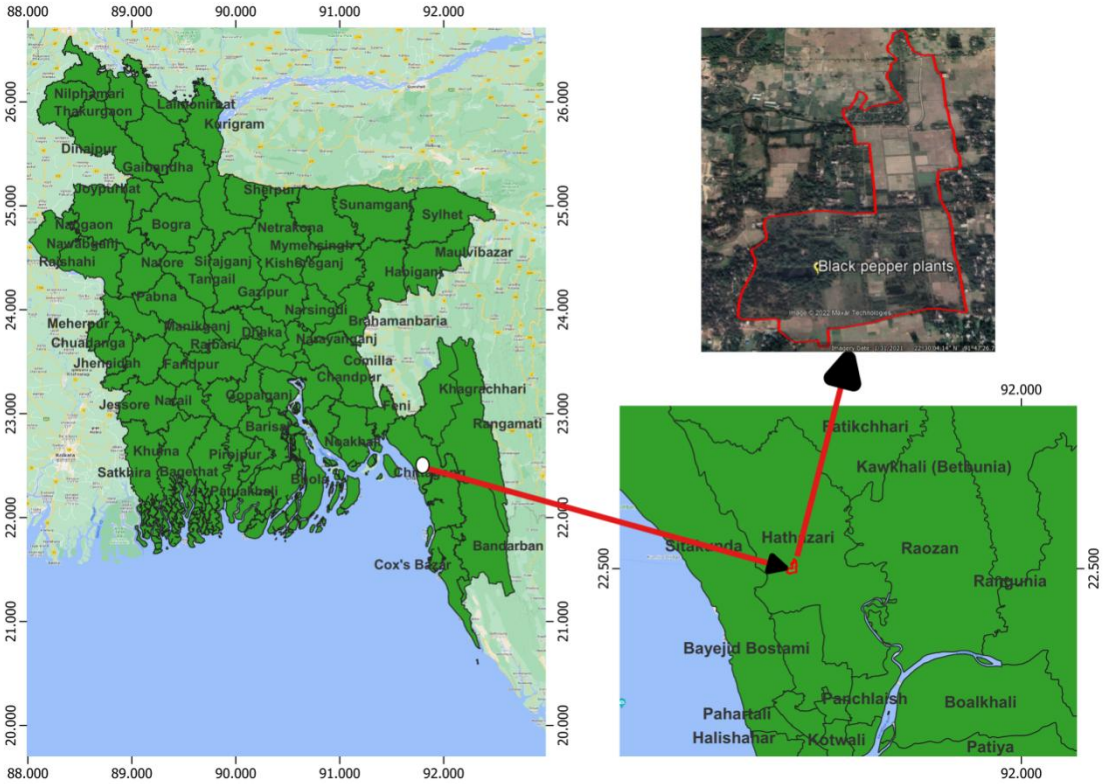

Figure1. Location of experimental site (green sign) at Chittagong in Bangladesh

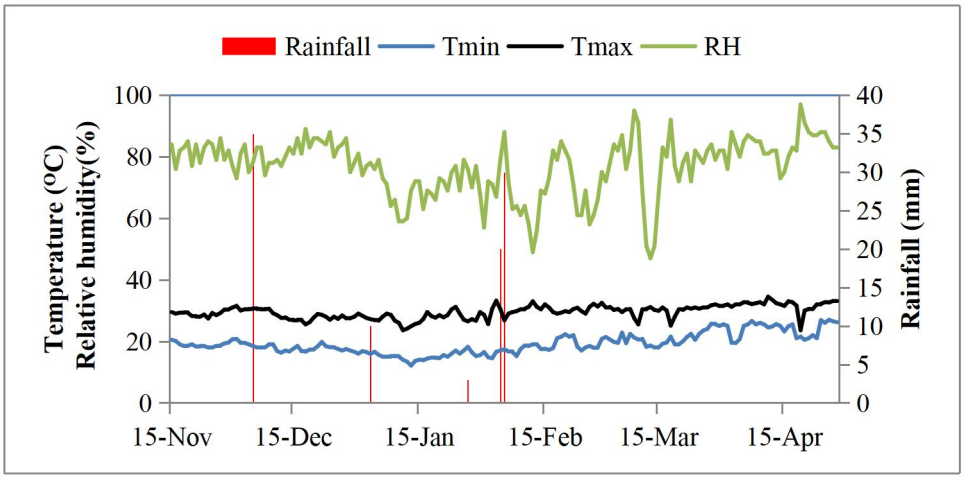

Figure 2.Maximum temperature, minimum temperature (°C), rainfall (mm) and relative humidity (%)

Figure 3.Present status (pre-spiking stage) of experiment at 21 April, 2022.

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BASELINE STUDY ON CASHEW NUT PRODUCTION PROCESSING AND MARKETING IN BANDARBAN HILL DISTRICT

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Abstract

The study was carried out in 17 paras/villages under four Upazilas in Bandarban hill district with view to document current status of cashew nut production processing and marketing covering 105 samples household for data collection. Multi-stage sampling technique was followed for selecting the specific locations. Results revealed that farmers used less inputs particularly fertilizer during whole production period. The yield was obtained at 0.425 tons/ha irrespective of all locations which are lower than that of global average of cashew nut production (0.750 ton/ha). The gross margin was calculated at Tk.1,48,76.36/ha. The BCR was found to be 2.03 irrespective of all locations indicating that the cashew nut production is profitable. Productivity will increase if the improved production technologies can be adopted and common diseases and pests are controlled. Cultivating more productive varieties in new places the production will be increased manifold. Resulting export opportunities will be increased. Simultaneously, the number of processing factories needs to be increased locally in line with the increase in production. Currently, farmers need hands on training on improved production technologies, post-harvest management, storing and marketing facilities for ensuring fair prices of their produces.

Introduction

Cashew nut is one of the most well-known crops of the hilly areas. This is one of the main sources of income for them. His value is increasing day by day. It has been cultivated in the hills for a long 20-30 years in a state of neglect. But now its demand is huge in the international market. As a result, there is an immense potential for export. But in order to export to the world market, its quality must be considered first and foremost. There is a need for research for that. Export is possible only through research, innovation of improved varieties, production and processing of quality nuts. The present government is quite sincere about the research, development, expansion and export of cashew nut. As a result, a new project entitled ‘’Cashew nut and Coffee Research, Development and Extension’’ project is being implemented by BARI & DAE with the kind support of the Ministry of Agriculture in nine districts including hill districts over the country.

Cashew nut is on the list of potential export products of the country. This crop has economic importance as well as nutritional value which are quite amazing for health. The hilly region can be called a gateway for expansion and development of cashew nut. This hilly region covers one tenth of the country. The climate and soil of the region are all suitable for cashew nut cultivation. Half of the cashew nuts produced in the country come from the Bandarban Hill District. It is widely cultivated especially in Thanchi and Ruma upazilas. As cashew is not perishable, there are opportunities to cultivate them in remote areas of the hills. Experts are of the opinion that the oil produced from the peel of cashew nut can be used to make high quality organic pesticides, vinegar and alcohol. Juice can be made from the top fruit adjacent to the nuts. This cashew apple fruit contains 70 percent juice. It is rich in many nutrients. This juice contains 6 times more vitamin C than oranges. It is possible to earn extra income by selling these processed juices. For every 3.5-4.0 kg of peeled nuts, 1 kg of processed nuts is available. Generally, improved varieties or high yielding almond trees are economically suitable for collection of nuts only when they are three years old. When the tree is 10-15 years old, it starts giving maximum yield. Depending on the age of the plant, natural environment and management, on an average 0.5 kg to 25.0 kg nuts are obtained from each tree. It is possible to collect nuts ranging from 10.0 kg to 25.0 kg in trees of eight years or more. In case of high yielding varieties, it is possible to get 3.0 to 5.0 ton nuts per hectare through improved management. The world average yield of cashew nut is about 0.750 metric tons per hectare (Daily Sangbad, 2021). At present the average productivity (yield) of cashew per hectare is known to be 1.5-1.8 tons. However, it is possible to increase its productivity through research (the daily observer, 2022).

According to Additional Director Office, DAE, Rangamati region, 2022 reported that in 2020-21 financial year the total cashew nut production was 4 metric tons under 2027 hectares of land in three hill districts. The average yield of raw nut was estimated at 1.97 ton/ha. The monetary values of this total production was accounted at Tk. 1,60,000 (as per Tk. 40,000/ton) in three hill districts. According to same source, in Bandarban the total production of cashew nut was 0.5 ton under 1909 hectares of land. Here, per hectare yield was accounted at 0.262 ton while same production was found in Rangmati in 100 hectares of

land (average yield 200.0 kg/ha) and in Khagrachari the total production of cashew nut in 2020-21 was reported at 3 metric ton under 18 hectares of land (The average yield 166.67 ton/ha). The word average of cashew nut production per hectare was at 0.750 ton/ha (Daily Sangbad, 2021). There is severe dearth of field level data/information on this crop. The baseline data is a reference value/data that can helps to evaluate the project impact in future. This type information will understand the results and know how to use them for further action (Uddin at, al, 2014). Therefore, the study was undertaken with the following specific objectives such as (i) to document socio-demographic profile of the respondents; (ii) to know the current status of input use, productivity, profitability, processing and marketing of cashew nut; (iii) to identify the existing problems/constraints for cashew nut production, processing and marketing; and (iv) to derive policy implications and recommendations.

Methodology

Selection of the study area: A multi-stage sampling technique was followed to select the study area. In the first stage, Bandarban hill district was selected purposively to address the cashew nut production scenario of the hill district. In the second stage Upazila also selected purposively as there one wide area of cashew nut cultivation. Therefore, in total 17 paras/villages were selected in four Upazilas for data collection. Of them, two paras/villages such as Khamtang Para, Thoyambo Para in Ruma Upazila, three paras namely Paoching para, Tongkhong para, Boding Para in Thanchi Upazila; nine paras such as Sualung Para, Wabraing para, Sonupara, Kossoptoli, Owabraing Para, Shoanru para, Rowangchori Para, Ujani Para, Sollopara in Rowangchari Upazila; and three upazila Kraong Amtoli Para, Dolupara, Chinlung Para in Bandarban Sadar Upazila were selected purposively for data collection. Based on the availability of cashew nut growers, specific locations were selected in consultation with Upazila Agriculture Officer (UAO) and Sub-Assistant Agriculture Officer (SAAO) in the respective Upazilas.

Sample size and sampling technique: There is no safe general rule as to how large sample size must be for use of the normal approximation in computing confidence limit (Cochran, 1999). When the population size is known and the researchers are careful of the heterogeneity problem, any number (equal to or) greater than the statistically large sample (of 30 sample units) may be appropriate (Freund and Williams (1983). Proportionate random sampling technique was adopted for selecting the sample size in each location. In this process, a sampling frame was constructed by 50 cashew growers for each location except Bandarban Sadar. In Bandarban Sadar the sampling frame was constructed by 30 cashew nut growers. After that, the proportionate sampling (60%) was done considering the minimum number of 30 households required for statistical analysis in each location. By applying this technique, due to resource limitations a total of 105 sample households were selected for the study. Uddin et al. (2021) followed the same sampling procedures for their study.

Data collection procedure and period of data collection: Both primary and secondary data were used in the study. The primary data were collected by pre-tested semi-structured survey questionnaire. The secondary data were collected from published reports, internet and BBS sources. Face to face interview with cashew growers was done by field level officials and researcher himself. Moreover, the respective DAE personnel facilitated for selecting the respondents in all locations. In each Upazila, the project Scientific Assistant was engaged for collecting the necessary data. The data collection period was February to April, 2022.

Analytical techniques: Descriptive statistics such as mean, standard deviation, percentage were used to analyze the primary data. The mean comparison and significance test were done by One-Way ANOVA using SPSS. In the ANOVA technique, the F-value was used to judge whether there is a significant difference or not among the locations and samples. The productivity was measured by the average yield of this crop per hectare basis and multiplied average farm-gate price. Profitability of crop production was analyzed based on gross return, gross margin, and benefit-cost ratio. Land use cost was calculated based on the per hectare value of leased land for four months.

Gross return, $GR_{ij} = Y_{ij}P_{ij}$

Where,

GR_{ij}= Gross return (Tk/ha) of j^{th} crop for i^{th} farmer

Y_{ij}= Quantity of j^{th} crop produced (kg/ha)for i^{th} farmer

P_{ij}= Price of j^{th} crops (Tk/kg) received by the i^{th} farmer

Gross margin= Gross return- Total variable cost

Results and Discussion

Socioeconomic profile of cashew nut growers: The respondents were found to be average age of 46.28 years. It was certain that irrespective of locations all the respondents were able to adopt new technologies for agricultural development due to belonging from young to mature ages. The mean differences of the age of respondents varied insignificantly ($F=1.113$; $p \leq 0.213$) among the locations. In the case of education of the respondents, average years of schooling were found to be 3.33 years indicating that the low level education is persist. The major occupation of the respondents was agriculture 98.9% irrespective of all locations. Occupations of the respondents may influence adopting new technologies.The average household size was 4.99 persons per family which was slightly lower than that of national average of 5.0 (BBS, 2018).The mean difference of the household size varied insignificantly among the locations ($F= 1.513$; $p \leq 0.106$). The average experience of cashew nut cultivation was recorded to be 8.6 years irrespective of all locations (Table 1).

Table 1: Socioeconomic profile of cashew nut growers (respondents)

Sl. No.	Particulars		Locations			All (average) (n=105)
			Rowanchari + Sadar (n=45)	Ruma (n=30)	Thanchi (n=30)	
1.	Average age of respondents (years)		48.5	50.5	39.8	46.3
2.	Education of the respondents (year of schooling)		4.5	3.4	2.4	3.4
3.	Occupation (%)	Agriculture	100.0	96.7	100.0	98.9
4.	Family size (person per family):	Male	1.9	2.8	2.7	2.5
		Female	2.2	2.4	2.8	2.5
		Total	4.2	5.2	5.6	4.9
5.	Having experience of cashew nut cultivation (years)		9.6	9.7	6.5	8.6

Contextual information of Cashew nut cultivation: It can be seen in Table 2 that the average distance of garden to home was recorded to be 1.47 km. It is important to carry the input and harvested product to home. Average cultivable land per household was estimated at 2.15 ha irrespective of all locations. Among the location this figure was found to be higher in Ruma Upazila followed by Thanchi. Fellow land is an important factor to create opportunity for establish new garden of cashew nut. It is estimated that per household average fellow land was 0.56 ha irrespective of all locations. Among them it was the highest in Rowanchari and Sadar Upazila followed by Ruma Upazila. Types of land owner are an important for operating the land smoothly. In the study most of the respondents opined that they owner cultivator. It was found that the land use cost was accounted at Tk. 18,525 per hectare.

Table 2: Contextual information of Cashew nut cultivation

Sl. No.	Particulars		Locations			All (average)
			Rowanchari + Sadar	Ruma	Thanchi	
1.	Average distance of garden to home (km)		2.17	0.78	1.45	1.47
2.	Average cultivable land per household (ha)		1.92	2.41	2.11	2.15
3.	Average fellow land per household (ha)		0.70	0.59	0.38	0.56
4.	Types of land owner (%):	Owner cultivator	97.8	100.0	96.7	98.2
		Owner cum tenant	2.2	-	3.3	2.8
5.	Average lease value of land (Tk/ha)		18,525	18,525	18,525	18,525

Production related information on cashew nut: Age of cashew nut orchard is an important for accounting their productivity. Among the respondents, it was reported to 1st establishment orchard was in 2012 for Ruma and Rowanchari/Sadar and 2015 for Thanchi indicating that the orchard is mid age. Per household average area of orchard was recorded to be 1.03 ha irrespective of all locations where total number of plants exist 371.67 no. Irrespective of all locations, the mortality rates was found to be 13.1%. Lack of irrigation, draught, weak plants and lack of take care were the main causes of mortality reported by the growers (Table 3a).

Table 3a: Production related information on cashew nut cultivation

Sl. No.	Particulars		Locations			All (average)
			Rowanchari + Sadar	Ruma	Thanchi	
1.	1st establishment year of cashew nut orchard (year)		2012	2012	2015	-
2	Average age of tree (years)		9.84	9.90	6.0	8.58
3	Average area of cashew nut orchard (ha)		0.78	1.11	1.21	1.03
4	Having total number of plants in the orchard (no.)		321	1167	1427	371.67
5	Source of plants (%) Own source (only)		44	30	29	34.33
6	Number of plants cultivated in the orchard		382	1379	1542	1101
7	Mortality rate (%) of the plants		16.09	14.32	8.89	13.10
8	Causes of mortality (in% of respondents):	Lack of irrigation	31	10	5	15.33
		Drought	17.8	13.3	40.0	23.7
		Plants were weak	8.9	3.3	0.0	4.1
		Lack of take care	2.2	20.0	3.3	8.5

Most of the cashew nut growers planted their sapling as scattered way. The average distance of plant to plant was found to be 10.92 meter and row to row 10.76 meter irrespective of all locations. The size of pit on an average was 0.20 x 0.20x 0.52m. Most of the grower's didn't use basal dose of fertilizer. Very fewer amounts of fertilizer were applied after planting the sapling (Table 3b).

Table 3b: Production related information on cashew nut

Sl. No.	Particulars		Locations			All (average)
			Rowanchari + Sadar	Ruma	Thanchi	
1.	Methods followed for planting (In%):	Scattered	57.7	33.3	23	76.7
		Maintain row	40.0	66.7	23.3	43.3
		Triangular	2.2	-	-	2.2
2.	Distance maintained (meter):	Plant to plant	11.1	9.8	11.87	10.9
		Row to row	11.3	9.8	11.13	10.7
3.	Size of pit (m):	Length	0.17	0.3	0.17	0.20
		Width	0.17	0.3	0.17	0.20
		Depth	0.50	0.6	0.50	0.5
4.	Basal dose used in pit (%)	Yes	2.2	3.3	-	2.7
		No	97.8	96.7	100.0	98.1
5.	After planting fertilizer used (kg):	Urea	6.7	4.3	-	5.5
		TSP	10.0	7.3	-	8.6
		MoP	8.4	4.2	-	6.3

Lack of money and lack of knowledge about fertilizer requirements for cashew nut were the major causes not or less use of fertilizer. It can be seen in Table 3c that on an average number of spraying for controlling pest and disease control was found to be 5.67 time in whole production period. Mulching use in dry season is very important for sustaining soil moisture of cashew tress. In the study, only 9.33% of the respondents used this practice. The soil type of cashew nut is mostly loam to sandy loam. The irrigation facilities of the cashew orchard are very scares.

Table 3c: Production related information on cashew nut

Sl. No.	Particulars		Locations			All (average)
			Rowanchari + Sadar	Ruma	Thanchi	
1.	Number of spraying in the orchard (times)		9.3	4.5	4.2	6.0
2.	Mulching used in dry season (In% of respondents):	Yes	20.0	90.0	-	55.0
		No	80.0	10.0	100.0	63.3
3.	Pruning practiced in a cashew tree (In% of respondents):	Yes	20.0	96.7	6.7	41.1
		No	80.0	3.3	93,3	58.9
4.	Soil type of cashew orchard (In% of respondents):	Loam	37.8	3.3	100.0	16.0
		Sandy-loam	62.2	96.7	0.0	84.0
		Clay-loam	-	-	-	-
5.	Having irrigation facilities in the orchard (In% of respondent):	Full	-	-	-	-
		Partial	-	-	3.3	3.3
		Rain-fed	100.0	100.0	96.7	98.9

Extension personal contact is very much important for booting the production of cashew nut. In the study, three magnitudes i.e., low, medium and high were articulated into the questionnaire. The highest percentages of the respondents opined that the extension contact with them was low due to remoteness of production places. No ICT technology was found to be used in the respondents. Level of knowledge on cashew nut cultivation was said as medium of the respondents. Irrespective of all location, only 5% of the respondent cultivated intercrop in the cashew nut orchard before the age of trees 3/5 years (Table 3d).

Table 3d: Production related information on cashew nut

Sl. No.	Particulars		Locations			All (average)
			Rowanchari + Sadar	Ruma	Thanchi	
1.	Magnitude of extension personal contact (In% of respondents):	Low	64.8	100.0	100.0	88.3
		Medium	19.9	-	-	19.9
		High	15.6	-	-	15.6
2.	Having practice to use ICT for getting information on Cashew nut (%):	Yes	-	-	-	-
		No	100.0	100.0	100.0	100.0
3.	Level of knowledge on cashew nut cultivation (%):	Low	2.2	19.9	-	7.4
		Medium	91.2	56.6	100	82.5
		High	6.6	23.5	-	10.1
4.	Having intercrop in the cashew nut orchard during 3/5 years of plants (%)	Yes	15.6	16.7	10.0	14.1
		No	84.4	83.3	90.0	85.9

Productivity and profitability of cashew nut cultivation: The average yield of cashew nut was recorded to be 0.425 tons/ha irrespective of all locations. Among the locations, the highest yield was obtained in Thanchi Upazila (0.579 ton/ha) and the lowest in Rowanchari plus Bandarban. The average yield per tree of 8.58 years old was accounted at 1.39 kg nut only in all locations. But in the location of Rowanchari plus Bandarban was found to be 2.28 kg. The average farm gate price of raw nut was estimated at Tk. 68.8 irrespective of all locations. The gross margin was calculated at Tk. 14876.36. The BCR was found to be 2.03 in all locations implies that the production of cashew nut is profitable (Table 4). The mean difference of the yield of cashew nut varied significantly at 1% level of probability among the locations ($F= 5.213$; $p \leq 0.00113$).

Table 4. Productivity and profitability analysis of cashew nut cultivation (Per hectare basis)

Sl. No.	Particulars	Locations			All (average)
		Rowanchari + Sadar	Ruma	Thanchi	
1	Average yield of cashew nut (ton)	0.329	0. 368	0. 579	0.425
2	Average yield per tree cashew nut (kg)	2.28	0.96	0.93	1.39
3	Average farm-gate price of per kg cashew nut	65.3	70.0	70.2	68.5
4	Gross return (Tk.)	21470.64	25760.0	40631.76	29287.47
5	Total variable cost*	12333.33	16733.33	14166.67	14411.11
6	Gross margin (Tk.)	9137.31	9026.67	26465.09	14876.36
7	BCR (Undiscounted)	1.74	1.54	2.87	2.03

Note: Total variable cost includes weeding cost, insecticide cost, spraying cost, fertilizer cost and fertilizer application cost for one year 2021.

Harvesting/collecting storing and processing of cashew nut: Farmers are indifferent and inexperienced in collecting, drying and storing cashew nut. It falls from the tree when ripe. Due to the farmer not collecting it from the soil at the right time, it becomes black when it comes in contact with the soil or gets wet in rain water and the quality is lost. As a result, the market price goes down a lot. In this case, the fallen nuts need to be collected and dried quickly and stored properly. In the study it was observed that farmers generally collected/harvested matured nut and it was naturally dropped nut in most of cases. They are used to drying in spreading polythene in the backyard or on the mate or on the concrete floor. Most of the farmers stored the nut in polythene bag (Table 5).

Table 5. Harvesting drying storing and processing related information of cashew nut

Sl. No.	Particulars		Locations			All (average)
			Rowanchari + Sadar	Ruma	Thanchi	
1.	Harvesting stage of cashew nut? (In% of respondents)	Matured stage	100.0	100.0	100.0	100.0
		Immature stage	-	-	-	-
2.	Harvesting method of cashew nut followed by farmers (In% of respondents):	Picking up cashew nuts that fall naturally	97.8	95.4	96	96.4
		Climb the tree with own hands	2.2	3.3	2.2	2.6
		With the shaking of the tree	-	1.3	1.8	1.0
3.	Used to drying place of cashew nuts (In%):	Spreading polythene in the backyard	100.0	90.0	93.3	94.4
		On the concrete floor	-	3.3	-	1.1
		On the mate	-	6.7	6.7	4.4
4.	Storing method followed by farmers (In%):	In polythene bag	100.0	86.7	100.0	95.6
		In Drum	-	10.0	-	3.3
		In earthen jars or pots	-	3.3	-	1.1

Marketing of cashew nut: Marketing of agro-product in hilly areas is still traditional. There are no organized marketing systems. Carrying agro-product from one place to another is very difficult in the hilly areas due to shortage of transportation and remote production places. It was observed that the most of the farmers carried their product own-self or sometimes used jeep and truck for large volume of products. Cen percent farmers sold their product after drying. But they have no knowledge on scientific ways of drying of cashew nut, Resulting the carnal of cashew nut was deteriorated in most of the cases. In the study areas, the buyer of raw cashew nut was observed as faria, wholesaler and representative of commission agents (Aratder). The satisfaction level of farmers is lower to moderate for selling their product (Table 6).

Table 6: Mode of transportation and marketing of cashew nut in Bandarban

Sl. No.	Particulars		Locations			All (average)
			Rowanchari + Sadar	Ruma	Thanchi	
1.	Transportation mode from orchard to home (In%):	Carrying own-self	97.8	96.7	100.0	98.1
		Jeep	2.2	3.3	-	1.9
2.	Transportation mode from home to market (In%):	Carrying own-self	22.3	6.7	46.7	25.2
		Jeep	67.7	86.7	53.3	69.2
		Truck	-	4.6	-	1.5
3.	Selling of cashew nut (In%):	Before drying	-	-	-	-
		After drying	100.0	100.0	100.0	100.0
4.	Buyers of cashew nut (%):	Faria	-	-	-	-
		Bepari	66.7	-	46.7	37.8
		Wholesaler	33.3	96.7	53.3	61.1
		Aratder	-	3.3	-	1.1
5.	Satisfaction to sale price of cashew nut (In% of respondents)	Low	17.8	96.7	-	38.1
		Medium	82.2	3.3	100.0	61.9
		High	-	-	-	-

Training received by the cashew farmers: Training is an important for increasing efficiency of the farmers. Only 13.4% farmers received traing on cashew nut production reported by the sample farmers. Main training provider was DAE. The effectiveness of training is seems to be medium level as per respondents responses (Table 7).

Table 7: Training received on cashew nut cultivation in Bandarban

Sl. No.	Particulars		Locations			All (average)
			Rowanchari + Sadar	Ruma	Thanchi	
1.	Training received (In%):	Yes	33.3	6.6	-	13.4
		No	66.7	93.4	100.0	86.6
2.	Training provider (In% of responses):	DAE	2.22	6.6	-	2.9
		NGO	-	3.4	-	3.3
3.	Effectiveness of training (In% of responses)	Low	15.6	36.7	-	26.2
		Medium	84.4	63.3	-	73.8
		High	-	-	-	-

Problems/constraints of cashew nut cultivation: In the study the following problems/constraints has been identified through questionnaire survey and open discussion with cashew nut growers and relevant stakeholders. The problems are stated bellow:

 # Production related problem

- Drought/lack of irrigation
- Lack of training on cashew nut cultivation
- Pest & diseases attack
- Lack of cash for orchard management
- Flower drop
- Excessive weed during Kharif-2 season in the orchard
- Lack of seedlings
- Labour shortage

 # Harvesting/collection, drying, storing and processing related problems

- Lack of knowledge on proper harvesting method
- Collection problem during rainy season
- Drying problem due to lack of available open space
- Lack of knowledge on proper storing method
- Carrying problem of nuts from orchard to home
- Lack of storage facilities
- Labour shortage
- Lack of training on post-harvest management including sorting, grading, drying, storing etc
- Lack of local processing center

 # Marketing related problems:

- Higher marketing cost due to insufficient transportation facilities;
- Shortage of wholesaler or limited number of buyer
- Lower selling price
- Network problems for connectivity for market linkage
- Lack of training on modern marketing systems.

Conclusion and recommendations

Based on results it might be concluded that the cost of cultivating cashew nut is comparatively much less. This crop does not require much fertilizer and irrigation. It is important to determine the recommended fertilizer level for high yielding cashew trees. It needs research. It goes without saying that insects and spiders do not attack as much. Productivity will increase if the common diseases and pests are controlled. The main challenge in cashew nut cultivation in the hills is to ensure fair price to the farmers by increasing the productivity of the existing varieties. For this, it is to cultivate more productive varieties. If quality nuts are supplied by grading in the processing factory, higher price will be ensured. At the same time, if we can produce quality cashew nut by following the Good Agricultural Practices (GAP), the export opportunities will increase manifold. Simultaneously, the number of processing factories needs to be increased locally in line with the increase in production.

Acknowledgement

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SOCIOECONOMIC STUDY ON LOCAL CULTIVAR DUHAZRI ALUIN CHATTOGRAM DISTRICT

M. JAMAL UDDIN AND Z. A. FIROZ

ABSTRACT

The local cultivar of potato (Dohazari Alu) is very much popular for its distinct features. It has high market demand in the study areas. But scientists and policy makers are unknown to this promising cultivar. That's why the study was carried out in nine villages covering 55 farmers under Chandanish Upazila in Chattogram district to examine the input use pattern, productivity and profitability of this crop at the farm level. In addition, farmers' and consumers' perceptions of this cultivar were also assessed in this study. Multi-stage sampling technique was followed for selecting the specific study area for data collection. Proportionate random sampling was used for determining the sample size and descriptive statistics was employed for analysing the collected data. Results revealed that farmers used less input, particularly fertilizer doses during its production. The yield was recorded at 13.752 tons/ha. The gross margin was calculated at Tk. 1,71,466/ha. The BCR was found to be 1.83 on a variable cost basis. The cost of production per kg of potato was calculated at Tk.17.91. As farmers' response, the market demand of this cultivar is high because of its good taste. The consumers of local potato cultivar opined that its buying price is high, its gives a different taste to the curry, the keeping quality is high in normal temperatures, it is available in the local market and it does not rot easily if kept at room temperatures. Regular training of farmers on fertilizer and pest & disease management will increase the productivity and profitability of this crop. If the management practices could be improved, the way of income of the farmers will be easier.

Introduction

Potato is one of the major food crops in the world. It is one of the staple foods of people in at least 40 countries of the world. In terms of production, potato is in fourth place after paddy, wheat, and maize. It is an important tuber crop in Bangladesh. It is widely cultivated in some districts for favorable weather and marketing. It is a short-term high yielding crop that can help increase food production in Bangladesh due to scarcity of land. According to BBS (2022), the total production of potatoes in the country in 2020-21 is 9887242 MT where 9090810 MT (91.95%) of high-yielding varieties and the rest 796432 MT (8.05%) of local cultivars. In that year, the total production of local cultivars of potato in the district was 25772 MT with a cultivable area of 2175 hectares. The average yield per hectare is 11.848 MT of local variety. On the other hand, in the Chittagong district, only 22032 MT of high-yielding potato was produced in that year in an area of 1206 hectares in 2020-21. The average yield per hectare is 18.263 MT of HYV potato. According to the data, the area under local cultivars of potatoes is more than the area under high-yielding variety potatoes in the Chittagong district.

Dohazari variety of potato called Dohazari Alu is a local improved cultivar in the Chandnais Upazila of Chattogram district. The yield of this early variety of potato is good everywhere in this region including on the banks of the river Shangu. It is well known in the Chandnaish region as the cash crop of the Rabi season. According to the statistics of Upazila Agriculture Office, potato is cultivated in a total area of 580 hectares. There are only two cold storages at Chandnaish Upazila. Sometimes potato farmers get frustrated as they do not get the right price of their produce due to inefficient market. .Bangladesh has formulated a draft roadmap with a target of exporting 2.5 million MT of potatoes by 2025. It is learned that 18 varieties of potatoes suitable for export have been registered.

Hundreds of varieties of potatoes are cultivated in the world. These differ in appearance, tuber structure, size, and color, maturation time, cooking, and marketing qualities, yield and resistance to diseases and insects. A variety suitable for one area may not be suitable for another. Potato varieties cultivated in Bangladesh can mainly be divided into two categories, local and high yielding (HYV). The so-called indigenous varieties are not, in fact, completely indigenous. In the distant past, they were brought to this part of the subcontinent and in the absence of a variety development effort; they gradually became degraded as a resulting lower yield. Bangladesh Agricultural Research Institute (BARI) has so far developed 100 HYV potato varieties.

About 28 varieties of local potatoes are cultivated in different parts of the country (daily Jaijaidin, 2021). They have familiar local names. Despite being low yielders, some local cultivars are still

cultivated across the country for various reasons. Dohazari Alu is one of them. It is mainly cultivated in the Chandnaish area of Chattogram district. It is round and pale, each weighing about 25 grams (daily Jaijaidin 2021). This potato is highly demanded locally as it has a high storage capacity at normal temperature and is very tasty. It is possible to increase its current productivity to some extent through improved management. Research initiative for developing improved production practices needs some basic information about this cultivar. Therefore, the present study was undertaken to provide necessary information for commencing on-farm research. The specific objectives of the study were as follows: (i) to document the socioeconomic and contextual information of the growers and cultivar; (ii) to estimate the input use, productivity, and profitability of the local potato cultivar (Dohazari Alu); (iii) to know the farmers and consumers perceptions to this cultivar; and (iv) to derive some policy recommendations.

Methodology

Study area selection: A multi-stage sampling technique was followed to select the study area. In the first stage of sampling, the Chattogram district was selected purposively to address the local cultivars scenario in the district. In the second stage, Chandanish Upazila was selected purposively as the targeted local potato cultivar is widely/extensively cultivated in this area. In the third stage, nine villages were selected purposively from the aforementioned Upazila for data collection. Based on the availability of local cultivars, specific locations were selected in consultation with Upazila Agriculture Officer (UAO)and Sub-Assistant Agriculture Officer (SAAO).The selected villages were Moddhom Hasimpur, Dakkin Joara, Fatorkul, Chagachar, Jamijori, Diakul, Purbo Dohazari, Hazipara, and Purbo Hasandondi.

Sampling techniques: There is no safe general rule as to how large the sample size must be for the use of normal approximation in computing the confidence limit (Cochran, 1999). When the population size is known and the researchers are careful of the heterogeneity problem, any number (equal to or) greater than the statistically large sample (of 30 sample units) may be appropriate (Freund and Williams, 1983).However, a proportionate random sampling technique was adopted for selecting the sample size. In this process, a sampling frame was constructed by 100 growers of Dohazari Alu. After that, the proportionate sampling (55%) was done equally for this crop. By applying this technique, due to resource limitations, a total of 55 sample households were selected for the study. Uddin et al. (2010) followed the same sampling procedures for another study.

Data collection procedure: Both primary and secondary data were used in this study. Secondary data and information were collected through reviewing related literature, relevant documents/reports,BBS, and the internet. Primary data were collected from sample households using a semi-structured survey schedule. Five experienced SAAO's were engaged for data collection. Before starting data collection, a discussion meeting on the survey schedule was held among data collectors for better understanding of the survey schedule. The data collection period was from February to April 2022. The researcher himself and Upazila Agriculture Officer monitored data collection so that the actual growers of local cultivar (Dohazari Alu) were interviewed.

Analytical techniques: Descriptive statistics such as mean and percentage were used to analyze the primary data. The mean comparison and significance test were done by One-Way ANOVA using SPSS. In the ANOVA technique, the F-value was used to judge whether there is a significant difference or not among the locations and samples. The productivity was measured by the average yield of this crop per hectare basis. The average farm-gate price of potato was used for estimating the gross return. The profitability of crop production was analyzed based on gross return, gross margin, and benefit-cost ratio. Land use cost was calculated based on the per hectare value of leased land for four months. The following equations were used for working out gross return, net return and gross margin.

$GR_{ij} = Y_{ij}P_{ij}$ ---------- (1)

Where,

GR_{ij}= Gross return (Tk/ha) of j^{th} crop for i^{th} farmer

Y_{ij}= Quantity of j^{th} crop produced (kg/ha) by the i^{th} farmer

P_{ij}= Price of j^{th} crop(Tk/kg) received by the i^{th} farmer

Net return= Gross return – Total cost (total variable cost+ total fixed cost) ---------- (2)

Gross margin= Gross return- Total variable cost ---------- (3)

Results and Discussion

Socioeconomic characteristics of the respondents

The socioeconomic characteristics of the respondent farmers are presented in Table 1. The average age of the respondent of Dohazari Alu was 45.95 years indicating that farmers involved in local cultivar production were fairly young. A similar result was obtained by Uddin et al. (2020) who reported an average age of 45.4 years for farmers in Hathazari, Chattogram. The average education level of the respondent was found to be 6.09 years of schooling. This might enhance their adoption of local cultivars. Kehinde (2005) noted that education was the key to enhancing productivity among farming households as it promotes their understanding of modern technologies. The major occupation of the respondents was agriculture (100%) in the study areas. Occupations of the respondents may influence the adoption of new technologies. The secondary occupation was reported to be business (15%) and service (2%) for all locations. The average household size was 6.75 persons per family which were higher than the national average of 5.0 persons (BBS, 2018).The mean difference the household size varied insignificantly among the locations (villages) ($F= 1.131$; $p \leq 0.203$). The average cultivated land per household was recorded as 0.927 hectares irrespective of locations. The highest51% of farmers were found to be tenants followed by owner cultivators 45% in all locations (Table 1).

Table 1. Socioeconomic and demographic characteristics of the respondents

Sl. No.	Particulars	
1.	Average age of the respondents (years)	45.95
2.	Level of education [year of schooling]	6.09
3.	Occupational status (%): (multiple response) - Agriculture - Business - Service - Day labour	 100.0 14.5 1.8 -
4.	Family size (person/family)	6.75
5.	Cultivated land (ha/household)	0.927
6.	Farmer's category (%): - Owner cultivators - Tenants - Owner cum tenant	 45.5 50.9 3.6

Production-related information

Production-related information includes plot size, seed used, sources of seed, seed treatment, sowing period, number of spraying, harvesting period, duration of harvests, and yield (Table 2). Results revealed that the average plot size of the cultivar was found to be 0.379 ha which was (40.88%) of the total cultivated land of the respondent. The use of seed rate is an important issue for raising the productivity of the crop. The average seed used was 1046.9 kg/ha. Most of the seeds (52.7%) were bought from local bazaar(market) and some portions were kept themselves (40.0%). Farmers did not maintain recommended spacing for this cultivar. Table 2 shows that the highest 87.3% of respondents did not treat seeds before sowing. The prevalence of diseases and pests in cultivars is a common phenomenon particularly late/early blight and cut worm at the seedling stage. Controlling these problems, farmers usually spray different types of pesticides. The frequency of sprayed pesticides as per recommended SAAO's and dealer shopkeepers was 2.41 times for controlling pests & diseases.The average duration of crops was estimated at 96.21days. The period of harvest of Dohazari Alu were ranged from February to March.

Table 2. Production-related information aboutlocal cultivar Dohazari Alu

Sl. No.	Particulars	Amount
1.	Average plot size (ha/farm)	0.379
2.	Seed used(kg/ha)	1046.9
3.	Sources of seeds (%): - Own source - Neighbors - Local bazaar - Dealer's shop	 40.0 5.5 52.7 1.8
4.	Whether the seeds are treated before sowing (%)? -Yes - No	 12.7 87.3
5.	Number of sprayingper season	2.41
6.	Crop duration (days)	96.21

Input use pattern in Dohazari Alu production

The rationale and efficient use of inputs are prerequisites for enhancing the productivity of crops. Respondent farmers applied cowdung (as organic fertilizer), chemical fertilizer (i.e. Urea, TSP, MoP & Gypsum), and pesticides to the potato crop. The applied amounts of inputs were found to be lower than the recommended doses for HYV Potato (BARI, 2019).Farmers used a lower amount of fertilizers due to a lack of capital and unknown the effect of recommended doses of fertilizer (Table 3).

Table 3. Quantity of inputs used in producing Dohazari Alu

Sl. No.	Type of Inputs	Amountused in local potato(kg/ha)	Amount used in HYV potato (kg/ha)*
1.	Seed	1047	1500-2000
2.	Cowdung	4032	10,000
3.	Urea	162.4	325-350
4.	TSP	321.7	200-220
5.	MoP	161.8	250-300
6.	Gypsum	86.6	100-120
7.	Boron	-	6-9

- *Source: BARI, 2019

Production cost of local cultivar (Dohazari Alu)

The cost of production included both variable costs and fixed cost in the process of Dohazari Alu production. The variable costs included human labour used for land preparation, tractor use, cost of seeds, weeding cost, manure & fertilizer cost, insecticide cost, irrigation, and harvesting cost. The study found that the total variable cost of this local cultivar was estimated at Tk. 205463 per hectare which was 83.4% of the total cost of production. The leased value of land was considered as the fixed cost of production of the local cultivar. The land-use cost was estimated at Tk. 22344per hectare which is9.1% of the total cost (Table 4).

Table 4.Cost of production of Dohazari Alu in the study areas

Sl. No.	Cost items	Amount (Tk/ha)	
		Taka	% of total
A.	Total Variable Cost		
1.	Labour cost for land preparation	20182	8.2
2.	Cost of tractor use	19983	8.1
3.	Seed cost	52638	21.4
4.	Weeding cost	20091	8.2

5.	Fertilizer cost: - Cowdung - Urea - TSP - MoP - Gypsum	 5121 3616 11177 2893 1264	 2.1 1.5 4.5 1.2 0.5
6.	Insecticide cost	15396	6.3
7.	Irrigation cost	12733	5.2
8.	Harvesting cost	40370	16.4
	Total Variable Cost (TVC)	**205463**	83.4
10.	Interest on operating capital @9%	18492	7.5
B.	Fixed Cost (land use rent for potato season)	22344	9.1
C.	Total Cost [A+B]	246299	100

***Note**: Seed cost @ Tk 50.27/kg, Cowdung= Tk.1.27/kg, Urea =Tk.22.26/kg; TSP= Tk.34.74/kg; MoP= Tk. 17.88/kg; and Gypsum= Tk.14.58/kg. Labour wages= Tk. 550/man-day*

Productivity and profitability of local cultivar (Dohazari Alu)

The average marketable yield of *Dohazari Alu* was recorded to be 13.75 tons/ha which is very much lower than that of HYV potatoes (BARI, 2016). The average farm-gate price of Dohazari alu was Tk.27.4/kg. The gross return, gross margin, and net return were calculated at Tk. 3,76,929, Tk.1,71,466, and Tk. 1,30,631respectively for this local cultivar. The BCR of this crop was found to be 1.53 and 1.83based on total cost and variable cost, respectively. It implies that the production of this crop is comparatively profitable at the farm level. However, the average cost of production per kilogram of this cultivar was estimated at Tk. 17.91 (Table 5). The daily JaiJaidin (2021) reported that the yield of Dohazari Ali was 80-85 mounds per 40 decimal lands and per kg potato was sold at a Tk. 21.25 per kg at farm-gate level in 2021. But in the year2022, the yield was found to be lower than in the year 2021 hence the farm-gate price was higher compared to the previous year. The mean difference in yields varied significantly at a 5% level among the locations ($F= 5.237$; $p \leq 0.0513$).

Table 5.Productivity and profitability of the local cultivar (Dohazari Alu)

Sl. No.	Particular	Amount (Tk/ha)
1	Marketable yield (ton/ha)	13.75
2	Gross return	3,76,929
3	Total variable cost	2,05,463
4	Total fixed cost	22,344
5	Total cost [3+4]	2,46,299
6	Gross margin[2-3)	1,71,466
7	Net return[2-5]	1,30,631
8	Benefit-cost ratio (BCR) Total cost basis Variable cost basis	 1.53 1.83
9	Cost of production per kg	17.91

Note: Average farm-gate price of Dohazari Alu isTk.27.4/kg

Farmer's perceptions for cultivating Dohazari Alu

Respondent farmers stated various reasons for cultivating this local cultivar in the study areas (Table 6). According to the farmer's opinion, the market demand of this cultivar is high because of its good taste. The price is higher than the other varieties of potatoesdue to its higher demand. But the yield is medium to low due to poor management and less use of fertilizers.The infestations of diseases and insects are high. The storage capacity of this cultivar is also goodat normal temperatures.

Table 6.Reasons for cultivating local cultivar (Dohazari Alu)

Sl. No.	Type of response	% of responses			
		Very high	High	Medium	Low
1.	Higher local demand	16.4	83.6	-	-
2.	Market price is high	10.0	72.7	17.3	-
3.	Very tasty	40.1	50.9	9.0	-
4.	High pest &disease infestation	52.7	27.1	20.2	-
5.	Storability at room temperature	-	76.4	23.6	-
6.	Poor to medium yield	-	-	63.7	36.3

Consumer's perceptions to Dohazari Alu

The consumers of local potato cultivar opined that its buying price is high due to market demand. This potato gives a different taste to the curry. The potato quality is highinterms of storing at normal temperatures. It is available in the local market. It does not rot easily if kept at room temperatures.The level of consumers' responses regarding this local cultivar is shown in Table 7.

Table7.Consumer's responses to the local cultivar (Dohazari Alu)

Sl. No.	Type of response	In % of responses			
		Very high	High	Medium	Low
1.	Very high price	66.2	73.8	-	-
2.	Tasty	20.0	72.3	7.7	-
3.	Attractive colour	-	40.0	49.1	10.9
4.	High storage capacity at room temperature	52.7	67.1	32.9	-
5.	Availablein the local market	-	76.2	23.8	-

Problems of Dohazari Alu cultivation

The highest percentage of respondents opined that they faced the problems of different pests and diseases attacked in the potato field. For example, viruses, blight, and fungus are the main diseases. In the case of pest attack, cutworm, etc most of the respondents claimed that they paid the high price of fertilizer i.e TSP. The other problems were stated by the respondents as lack of irrigation and lower yield of the local cultivar (Table 8). Farmers attributed to the low yield of this cultivar to low fertilizer application and disease attacks.

Table 8. Problems faced by the respondent farmers during cultivation of local cultivar (Dohazari Alu)

Sl. No.	Types of Problems	In % of respondents
1.	Infection of virus diseases	72.7
2.	Occurrence of blight disease	67.3
3.	Attack of cut worm	52.7
4.	High price of fertilizer	63.3
5.	Lack of irrigation facility	52.7
6.	Lower yield	36.3

Conclusions and recommendations

There is a lot of demand for this cultivar in the study areas. Its market price is often higher, so farmers cultivate it more than other potatoes. Due to the higher prevalence of diseases and the use of less amount of fertilizer, the yield is a little less. It can be stored longer than other potatoes at normal temperatures. It tastes pretty good to eat. Due to these characteristics, the farmers of the area are very interested in cultivating this potato. If farmers are made accustomed to disease and pest control management and the application of balanced doses of fertilizers, their yield and productivity will be increased manifolds. Concerned scientists may consider whether it is possible to conduct research on transforming it into an improved variety or maintain it as a breeding material as a long-term step. It is hoped that this potential crop will emerge as a source of income for the farmer through proper intervention.

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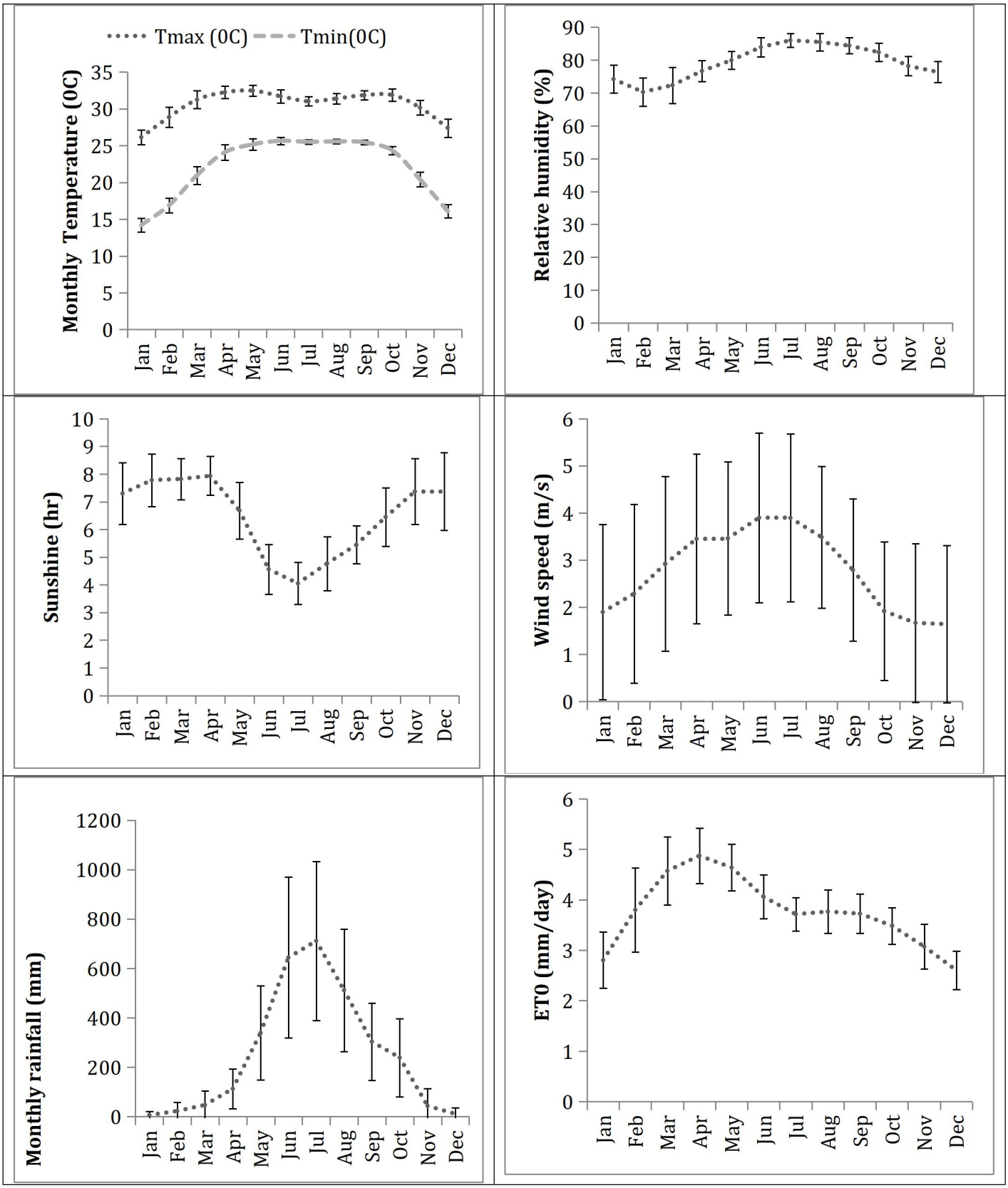
Appendix I. Breeder seed production of vegetables from RARS, Hathazari, Chattogram, 2021-22

Sl. No.	Varieties	Amount (kg)
01	BARI Sheem 1	12.00
02	BARI Sheem 3	12.00
03	BARI Sheem 6	9.00
04	BARI Sheem 7	1.00
05	BARI Lalshak 1	20.00
06	BARI Mistikumra 2	2.00
07	BARI Jharsheem 2	35.00
08	BARI Motorshuti 3	35.00
09	BARI Tomato 16	1.50
10	BARI Tomato 21	0.50
11	BARI Begun 7	0.25
12	BARI Begun 9	1.20
13	BARI Mula 1	3.50
	Total=	**133.00**

Appendix II. Annual Performance Agreement, 2021-2022

	1	1 *
	1	1
	5	5
	5	5
	1	1
	0.40	0.45
/ /	12000	27000
	0.35	0.35
/ /	10000	10000

Appendix III. Meteorological Information of Hathazari, Chattogram during 2021-22



Appendix IV. Scientists working at RARS, Hathazari, Chattogram during 2021-22

SL No.	Name	BARI Ide.	Designation	Discipline	Remarks
01.	Dr. Md. Z.A. Firoz	BARI0135	CSO	Horticulture	Up to 14-07-2022
02.	Dr. Md. Shamsur Rahman	BARI0185	CSO	Agronomy	01-08-2022-till to date
03.	Dr. Md. Moshiur Rahman	BARI0230	PSO	Horticulture	
04.	Dr. Md. Muktadir Alam	BARI0274	PSO	Agronomy	
05.	Dr. Md. Mahbubur Rahman Salim	BARI0307	PSO	Horticulture	
06.	Dr. Md. Jamal Uddin	BARI0309	PSO	Agril. Economic	
07.	Dr. Md. Rabiul Islam	BARI 0425	SSO	Horticulture	
08.	Dr. Mohammad Tofajjal Hossain	BARI0450	SSO	Plant Pathology	
09.	Shahadat Hossain	BARI0606	SO	Plant Breeding	Deputation for higher studies
10.	Md. Panjarul Haque	BARI2757	SO	Agril. Eng.	
11.	Sujan Mahmud	BARI3122	SO	Agronomy	Deputation for higher studies

Appendix V. Officers and Scientific Assistants working at RARS, Hathazari, Chattogram, 2021-22

SL No.	Name	BARI Ide.	Designation	Discipline/Posting	Remarks
01.	Md. Kamruzzaman	BARI2997	Sub-Assistant Eng.	Sivil	
02.	Md. Showkal Alam Chowdhury	BARI0800	Senior Scientific Assistant	Nursery/Fruit	
03.	Tulshi Das Baishna	BARI0823	Senior Scientific Assistant	Fruit	
04.	Md. Mojibur Rahman	BARI0919	Scientific Assistant	OFRD	
05.	Md. Iyear Hossain	BARI0948	Scientific Assistant	Overseer/General	
06.	Mohammad Shahajahan Mia	BARI1060	Scientific Assistant	Fruit	
07.	Md. Main Uddin	BARI1129	Scientific Assistant	Agronomy	
08.	Mohammad Ataur Rahman	BARI1196	Scientific Assistant	Agronomy	
09.	Rina Akter	BARI2787	Scientific Assistant	Agronomy	
10.	Alauddin Al Azad	BARI2975	Scientific Assistant	Vegetable	

Appendix VI. Farm Attendant, Lab Technician, Gardener and Staff working at RARS, Hathazari, Chattogram, 2021-22

SL No.	Name	BARI Ide.	Designation	Posting	Remarks
01.	Md. Shofiuddin Molla	BARI1397	Head assistant	Adeministration	
02.	Md. Yahiya	BARI1412	Steno graffer	Stor (Res.)	
03.	Ummeaira Khatun	BARI1432	Computer operator	CSO Office	
04.	Md. Zakir Hosen	BARI1470	Higher assistant	Stor (Stationary)	
05.	Uzzal Barua	BARI1521	Computer typist	CSO Office	
06.	Tinu Barua	BARI3322	Data entry operator	CSO Office	
07.	Md. Yousuf Mia	BARI1668	Mechanic	Maintanence	
08.	Md. Younus Mia	BARI1629	Driver	CSO Office	
09.	Md. Abul Kasem	BARI2323	Power Pump operator	Pump operator	
10.	Md. Abul Kader	BARI3340	Power Pump operator	School	
11.	Mohammad Mamun Rashid	BARI1822	Lab assistant	Stor	
12.	Md. Anwar Hossain	BARI1838	Lab assistant	Pathology Lab	
13.	Md. Mofizor Rahoman	BARI2387	Tractor mate	Office	
14.	Md. Ansur Ali	BARI2390	Tractor mate	Guard	
15.	Md. Baelal Hossen	BARI2105	Guard	Guard	
16.	Md.Monjur Alam	BARI2008	Office support staff	MLSS	
17.	Milon Mazumdar	BARI3365	Office support staff	MLSS	
18.	Md. Jahangir	BARI 2429	Cattle keeper	Guard	
19.	Md. Abdul Mannan	BARI2195	Gardener	Nursery	
20.	Sre Sibo Kumar Malli	BARI2199	Gardener	Nursery	
21.	Md Abul Kalam	BARI2206	Gardener	Nursery	
22.	Md Abul Khai	BARI2207	Gardener	Nursery	
23.	Md. Mahabum Alam	BARI2209	Gardener	Nursery	
24.	Md. Mahabobour Rahman	BARI2211	Gardener	Nursery	
25.	Md. Lokman	BARI2217	Gardener	Nursery	
26.	Md. Firuz	BARI2227	Gardener	Nursery	
27.	Md. Norul Abser	BARI2229	Gardener	Nursery	
28.	Jannatul Ferdous Sheuli	BARI2240	Gardener	CSO Office	
29.	Md. Mubarok Hossain Patwary	BARI 2251	Gardener	Nursery	
30.	Mohammad Abdul Ali	BARI2260	Gardener	Nursery	
31.	Md. Khadem	BARI2261	Gardener	Nursery	
32.	MD Mamunur Ronid	BARI2269	Gardener	Nursery	
33.	Nurul Islam Mojumdar	BARI2281	Gardener	Cash section	
34.	Md. Juwel Islam	BARI2290	Gardener	Nursery	