Project ID -479

Competitive Research Grant

Sub-Project Completion Report

on

Collection, Evaluation, Characterization and Bulb Preservation of Lilium in Bangladesh

Project Duration

May 2017 to September 2018

Floriculture Division
Horticulture Research Centre
Bangladesh Agricultural Research Institute (BARI)
Joydebpur, Gazipur-1701

Submitted to
Project Implementation Unit-BARC, NATP 2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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Acronyms

BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
Cm	Centimeter
PI	Principal Investigator
Co-PI	Co-principal Investigator
CRG	Competitive Research Grant
Fig.	Figure
g	Gram
HRC	Horticulture Research Centre
PCR	Project Completion Report
%	Percentage
°	Degree
DAS	Days After Storage
temp.	Temperature

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Executive Summary

Lilium is a high demanded flower in international flower trade and commercially it is grown as cut flower for its long lasting (12-15 days) majestic flowering sticks with wide range of color and attractiveness.It may also be grown as potted plants, herbaceous borders etc. This lucrative flower has recently been introduced in Bangladesh due to its high demand and profitability. Even to meet up the local demand this flower is being imported from other countries specially China. Very few farmers are trying to cultivate this flower in a small scale with minimum germplasm collecting from neighboring countries. Unavailability of Lilium germplasm is due to the high cost of bulb (60-80 BDT/bulb). Bangladesh Agricultural Research Institute has collected a few number of Lilium germplasm which are not sufficient for the research. Bulb preservation is an important issue for the continuation of the lilium cultivation. Moreover, lilium needs vernalization-the induction of a plant's flowering process by exposure to the prolonged cold of winter, or by an artificial equivalent. The lilium bulbs are normally preserved in cold storage (2-5^0c temp.) for 6-8 weeks which is little bit difficult to maintain at farmers level. Under Bangladesh climatic condition 6-8 weeks are not sufficient to keep the bulbs at storage due to the difference between bulb harvesting and the next winter is too long. The farmers are trying to preserve lilium bulbs in normal room condition for some time though it deteriorates the bulb quality. Besides, a certain level of postharvest rots of lilium bulbs is occurred due to its perishable nature. Preservation media is very much important to retain the moisture of bulb. Moist cocodust is being used widely for lilium bulb preservation. Sawdust may use as substitute of cocodust which needs systematic research. As germplasm collection, evaluation and characterization are the pre-requisite for the improvement of lilium flower, there is no technology related to proper preservation of lilium bulbs and also there is no systematic study in this regard hence this project has been proposed during May 2017 to September 2018.

Under the project two experiments entitled “Collection, evaluation, characterization and maintenance of lilium” and “Lilium bulb preservation influenced by various temperatures and storing media” were carried out. During this period development of lilium shed house with UV polyfilm and also lilium shed with Agro shade was established. Among the collected lilium germplasm, 19 attractive colored and two types of flowers viz. Asiatic lilium and Oriental liliumhave been found. Among them 14 germplasm are suitable for cut flower and 5 are suitable for pot culture. Considering bulb preservation, cool temperature (2.1-2.5^{0}c) with sawdust media is suitable for lilium bulb preservation.

Total fund release up to September 2018 is Tk. 1681674.00 (Sixteen lac eighty one thousand six hundred seventy four taka only) and expenditure during this time was Tk. 1660716 (Sixteen lac sixty thousand seven hundred and sixteen taka only). After completion of the project RPA refund was 10864.39/= (Ten thousand eight hundred sixty four taka & thirty nine paisa only) and GoB fund was 9174/= (Nine thousand one hundred seventy four taka only) and bank closing charge was 919.61/= (Nine hundred nineteen taka & sixty one paisa). Procurement has been completed according to the approved procurement plan.

A. Sub-project Description

1. Title of the CRG sub-project: **Collection, Evaluation, Characterization and Bulb Preservation of Lilium in Bangladesh**
2. Implementing organization: Bangladesh Agricultural Research Institute (BARI)
3. Name and full address with phone, cell and E-mail of PI/Co-PI (s):

Principal Investigator: **Dr. Farjana Nasrin Khan**
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4. Sub-project budget (Tk):
   4.1 Total: **1786415**.00 **(**Taka seventeen lac eighty six thousand four hundred fifteen only)
   4.2 Revised (if any): Not any

5. Duration of the sub-project:
   5.1 Start date (based on LoA signed): 9 May, 2017
   5.2 End date: 30 September 2018

6. Justification of undertaking the sub-project:

Lilies are high demanded cut flower in international flower trade due to its wide diversity of flower color, attractive flower shape, long multi-flowering stalk, and having long post-harvest vase life (Lucidos *et al.,* 2013). It is a genus of herbaceous flowering plants belongs to the family, *Liliaceae.* Commercially it is grown as cut flower for its long lasting (12-15 days) majestic flowering sticks with wide range of color and attractiveness. It may also be grown as potted plants, herbaceous borders etc. This lucrative flower has recently been introduced in Bangladesh due to its high demand and profitability. Even to meet up the local demand this flower is being imported from other countries specially China. Very few farmers are trying to cultivate this flower in a small scale with minimum germplasm

collecting from neighboring countries. Unavailability of Lilium germplasm is due to the high cost of bulb (60-80 BDT/bulb). Bangladesh Agricultural Research Institute has collected a few number of Lilium germplasm which are not sufficient for the research. Bulb preservation is an important issue for the continuation of the lilium cultivation. Moreover, lilium needs vernalization-the induction of a plant's flowering process by exposure to the prolonged cold of winter, or by an artificial equivalent. Shin *et al*. (2002) also showed that low temperature is necessary for the sprouting of lily bulbs after harvest. Vernalization is affected by the combination of the temperature and the duration of the storing period (Le Nard and De Hertogh, 1993). The lilium bulbs are normally preserved in cold storage (2-5^0c temp.) for 6-8 weeks which is little bit difficult to maintain at farmers level. In an experiment, Maddah *et al*. (2012) showed that after 10 weeks of vernalization most of the bulbs were stimulated which meant the last week of vernalization. But in Bangladesh climatic condition 10 weeks are not sufficient to keep the bulbs at storage due to the difference after bulb harvesting and the next winter is too long. The farmers are trying to preserve lilium bulbs in normal room condition for sometime though it deteriorates the bulb quality. Besides, a certain level of postharvest rots of lilium bulbs is occurred due to its perishable nature. Preservation media is very much important to retain the moisture of bulb. Moist cocodust is being used widely for lilium bulb preservation. Sawdust may be used as substitute of cocodust which needs systematic research. As germplasm collection, evaluation and characterization are the pre-requisite for the improvement of lilium flower and there is no effective technology related to proper preservation of lilium bulbs and also there is no systematic study in this regard hence this project has been proposed.

7. Sub-project goal: To introduce and popularize a new flower ‘Lilium’ as well as increase farmer’s income and livelihood.

8. Sub-project objective (s):
   8.1 . To collect Lilium germplasm from different sources
   8.2 . To evaluate the performance of Lilium under the climatic condition of Bangladesh and
   8.3 . To find out the suitable method for preserving Lilium bulbs.

9. Implementing location (s): Floriculture Division, Horticulture Research Centre, BARI, Joydebpur, Gazipur-1701.

10. Methodology in brief:

The study was carried out at Floriculture Research Field, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during the rabi season of 2017-18. Bulbs of Lilium germplasm were collected from various sources like farmer's field, flower exhibition, personal communication etc. After collection, the bulbs were sown under uv polyfilm structured shade house on 15 to 20 November, 2017. The experimental land was well prepared by adding cocodust (50:50 soil and cocodust), 10t cow dung/ha and fertilized @ 300kg urea, 375kg TSP and 300kg MoP/ha. Cow dung, TSP and MoP were applied as basal and urea was top dressed in two equal splits at one month after planting and spike initiation stage. No design was followed and spacing was maintained at 30cm from row to row and 15cm from plant to plant. When the lower most buds showed colour, the spikes were harvested. After collecting flowers, the plants with 3-4 leaves were kept in the field for bulb development. When the leaves were brown and more or less damaged the bulbs were lifted carefully and stored at cocodust at different storage temperature (2.1-2.5^{0}c, 6.5-7.5^{0}c & 8.0-10°c) for next planting (16-18 weeks). Various qualitative and quantitative data were recorded during the study period to see the performance of Lilium genotypes.

Plate 1. Lilium shade

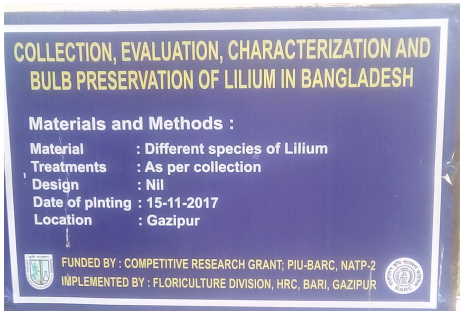


Plate 2. Signboard of lilium experiment

Plate 3. Bulbs of Lilium

Plate 4. Bed preparation with cocodust

For the study of bulb preservation, bulbs of Lil 001 (creamy white colour) were used as materials. There were two factors viz., storage temperature (2.1-2.5^{0}c, 6.5-7.5^{0}c & 8.0-10°c) in cold storage of BADC, Kashimpur, cool room of Postharvest Division, BARI & constant temperature and

humidity chamber, HRC, BARI, respectively) and storing media like cocodust (100%), sawdust (100%) & cocodust + Sawdust (50:50). The humidity of BADC cold storage was 85 to 91%, Cool room of Postharvest Division was 70 to 75% and constant temperature and humidity chamber was 75 to 90%. CRD factorial design was followed. ANOVA and mean comparison by LSD were followed using R-software.

Plate 5. Cold storage of BADC, Kashimpur (Temp. 2.1 to2.5^{0}c, Humidity 85 to 91%)

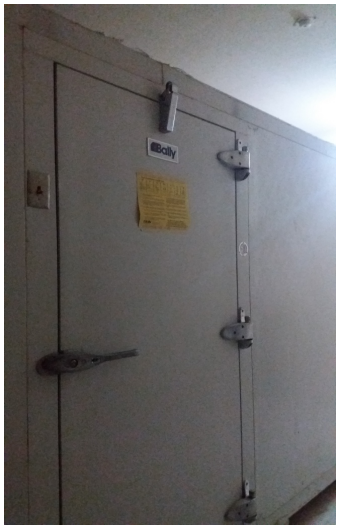


Plate 6. Cool room of Postharvest Division, BARI (Temp. 6.5 to 7.5^0 c, Humidity 70 to 75%)

Plate 7. Cons. Temp. & humidity chamber, HRC, BARI (Temperature 8-10^0 c Humidity 75 to 90%)

11. Results and Discussion

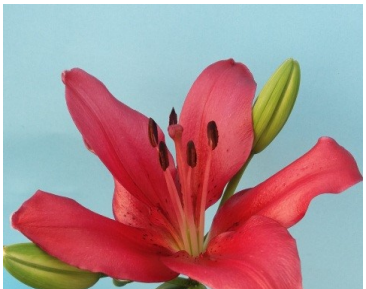
Expt. No. 01. Collection, Evaluation, Characterization and Maintenance of Lilium

Wide variations in terms of qualitative parameters were observed (Table 1 & 2). Among the collected lilium germplasm, 19 attractive colored and two types of flowers viz. Asiatic lilium and Oriental lilium have been found. Among them 14 germplasm are suitable for cut flower and 5 are suitable for pot culture. Attractive colour and variations were found in lilium petals and tepals (Plate 8 & 9). Various spots were originated by the tepals of 11 lilium genotypes and 8 genotypes did not show any spot in the tepal. Banba (1967) conducted an experiment where most of lilium hybrids had spots on their tepals due to the presence of anthocyanin. Regarding fragrance, Oriental type lilium produced strong scented flowers whereas Asiatic types have no fragrance. Each species in the genus *Lilium* possess great genetic diversity in its growth habit, flower color, form, shape, size, and as well as in persistence. This diversity in species of agronomic traits offers a

substantial germplasm and opportunities for the development of hardy and healthy varieties for variable climatic zones (Anderson *et al*., 2010).

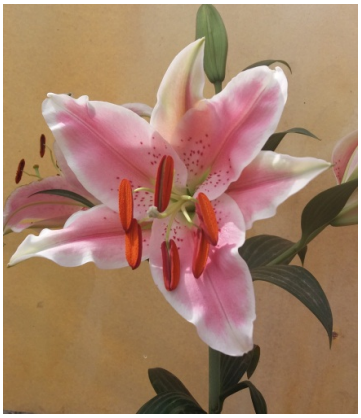
Table 1. Qualitative traits of some Lilium genotypes as cut flower

Genotypes	Type	Petal description	Anther colour	Fragrance
Lil-001	Asiatic	Creamy white, greenish yellow mid rib and sporadic dark spots are present at the base of the petal	Deep maroon	Absent
Lil-002	Asiatic	Light orange, deep orange mid rib is present at the base of the petal	Deep maroon	Absent
Lil-003	Asiatic	Deep orange, dark spots are present at the base of petal	Maroon	Absent
Lil-004	Asiatic	Deep Magenta	Brown	Absent
Lil-007	Asiatic	Deep orange, numerous dark spots are present at the base of the petal	Deep maroon	Absent
Lil-008	Asiatic	Reddish magenta, few dark spots are present at the base of the petal	Deep maroon	Absent
Lil-010	Asiatic	Yellow, no spots are present	Deep brown	Absent
Lil-011	Asiatic	Pink at petal tips, burnt orange in the lower half of the petals and yellow in the center with some dark spots.	Deep maroon	Absent
Lil-012	Asiatic	Light orange, no spots are present	Deep maroon	Absent
Lil-014	Oriental	White curly petals, no spots are present	Deep maroon	Present
Lil-016	Asiatic	Greenish cream, green mid rib and few maroon spots are present at the base of the petal	Maroon	Absent
Lil-017	Oriental	White centered deep pink curvy petals surrounded by white colour, no spots are available	Deep maroon	Present
Lil-018	Oriental	White broad petals, no spots are present	Maroon	Present
Lil-019	Oriental	Light pink curvy petals surrounded by white colour, numerous dark spots are present at the base of the petal	Orange	Present



Lil-017

Lil-018



Lil-019

Plate 8. Cut flowers of some lilium genotypes

Table 2. Qualitative traits of Lilium genotypes as pot plant

Genotypes	Type	Petal description	Anther colour	Fragrance

Genotypes	Type	Petal description	Anther colour	Fragrance
Lil-005	Asiatic	White, numerous pinkish red spots are present at the base of petal	Orange	Absent
Lil-006	Asiatic	Orange, numerous dark spots are present in the petal	Deep maroon	Absent
Lil-009	Asiatic	Orange, dark spots are present at the base of the petal	Deep maroon	Absent
Lil-013	Oriental	Deep magenta pink petals around a white center with dark spots	Deep orange	Present
Lil-015	Oriental	Thick white petals, white hair are present but no spots are available	Maroon	Present

Lil- 005 Lil- 013 Lil- 015

Plate 9. Pot flowers of some lilium genotypes

Various growth and flowering parameters were influenced by the lilium genotypes (Table 3). The longest plant (73.60cm) was produced by the genotype Lil 001. The plant height range of the cut flower was 32.80cm to 73.60cm. On the other hand the pot plant produced comparatively shorter plants (10.20cm to 18.60cm). Balode (2010) also reported the higher phenotypic variability for plant height in lilium genotypes. The maximum number of leaves was recorded in Lil-007 and Lil-008 (70.0) and the minimum in Lil-015 (24.0). The minimum days were required for bud initiation from planting in Lil-017 and Lil-019 (26.0days) whereas the maximum days in Lil- 001 (138.0days). The longest and the broadest bud were produced by the genotype Lil-017 (12.0cm) and Lil-014 (3.76cm), respectively. The shortest and the narrowest bud were produced by the genotype Lil 006 (5.72cm & 2.02cm, respectively).

Table 3. Vegetative and flowering parameters of different Lilium genotypes

Genotypes	Plant height (cm)	No. of leaves/plant	Days to bud initiation	Bud length (cm)	Bud diameter (cm)
Lil-001	73.60	47.0	138.0	10.42	3.30
Lil-002	43.0	40.0	135.0	10.50	3.20
Lil-003	33.0	45.0	70.0	8.0	2.50
Lil-004	34.0	48.0	65.0	7.50	2.70
Lil-005	15.50	48.0	52.0	5.98	2.18
Lil-006	16.60	41.0	27.0	5.72	2.02
Lil-007	34.20	70.0	30.0	8.44	2.54
Lil-008	43.40	70.0	27.0	7.98	2.74
Lil-009	16.80	45.0	30.0	6.50	2.20
Lil-010	50.10	64.0	33.0	9.94	2.72
Lil-011	45.10	65.0	30.0	8.56	2.46
Lil-012	46.0	60.0	32.0	8.90	2.54
Lil-013	18.60	33.0	52.0	9.30	3.32
Lil-014	36.60	37.0	37.0	11.48	3.76
Lil-015	10.20	24.0	40.0	6.40	2.66
Lil-016	32.80	48.0	34.0	8.80	2.50
Lil-017	39.10	51.0	26.0	12.0	3.50
Lil-018	48.40	37.0	27.0	10.70	2.98
Lil-019	40.20	36.0	26.0	9.76	3.34
Mean	**33.53**	**47.84**	**47.95**	**8.78**	**2.80**
CV (%)	**37.70**	**26.91**	**70.55**	**20.91**	**17.34**

The longest stalk and rachis (85.80cm and 26.0cm, respectively) were produced by the genotype Lil-018. The shortest stalk and rachis (18.0cm & 7.52cm, respectively) was recorded by Lil-009. The genotypes those are suitable as pot plant produced comparatively the shorter stalk (18.0cm to 28.90cm) and rachis (7.52cm to 10.0cm). The maximum number of florets per stick (10.50) was produced by the genotype Lil-001. The productivity of a cultivar is determined by the number of florets per flower stem. The more flowers on a stem, the more attractive are the plant with a longer flowering duration. Sheikh *et al.* (2015) also reported that wide range of variation was found regarding spike and rachis length (54.0-74.5cm and 14.9-17.4cm, respectively) and also florets number per flower stick (3.0-8.7).

The largest flower was produced by Lil-014 (21.90cm). Similar performance was found by De Hertogh (1996) where flower diameter ranged from 13.8 cm to 20.2 cm among some lilium varieties and significantly large sized flowers were recorded in Stargazer (20.6 cm) followed by Prato (20.2 cm) and PKLH-1 (19.3 cm) which could serve as a varietal trait. The vase life was recorded only for cut flower not for pot plants. The maximum vase life was observed in Lil-007 and Lil-010 (12.0 days) whereas the minimum in Lil 016 and Lil 019 (6.0 days).

Table 3. Vegetative and flowering parameters of different Lilium genotypes (Cont'd)

Genotypes	Stalk length (cm)	Rachis length (cm)	Florets/stick	Floret diameter (cm)	Vase life (days)
Lil-001	80.0	26.0	10.50	17.0	10.0
Lil-002	48.0	14.0	2.0	17.0	7.0
Lil-003	35.0	14.0	4.0	15.0	8.0
Lil-004	30.0	14.0	4.0	14.50	7.0
Lil-005	19.0	8.56	4.0	12.60	-
Lil-006	19.0	7.61	2.0	13.40	-
Lil-007	46.0	17.75	4.0	16.71	12.0
Lil-008	50.0	17.10	4.40	19.0	8.0
Lil-009	18.0	7.52	2.0	13.62	-
Lil-010	60.0	18.50	7.50	20.06	12.0
Lil-011	46.0	15.51	4.60	18.15	10.0
Lil-012	55.0	16.90	2.0	21.50	8.0
Lil-013	20.88	9.68	3.0	17.65	-
Lil-014	36.20	12.70	4.0	21.90	8.0
Lil-015	28.90	10.0	4.32	14.30	-
Lil-016	31.80	11.50	2.0	20.16	6.0
Lil-017	73.30	20.50	3.0	21.20	8.0
Lil-018	85.80	23.80	4.0	21.65	7.0
Lil-019	70.45	20.85	3.0	20.10	6.0
Mean	**44.91**	**15.08**	**3.91**	**17.66**	-
CV (%)	**47.52**	**35.54**	**53.21**	**17.48**	-

Like vegetative and flowering parameters, bulb and bulblet production were also influenced by the various lilium genotypes (Table 4). The maximum bulb weight (60g) was found in the genotypes Lil-007 and Lil-012 whereas the minimum bulb weight (15.35g) was found in Lil-002. Similarly, Lil-007 also produced the largest bulb (6.06cm). Maximum number of bulblet per plant

was produced by Lil-009 (8.00) and minimum was in Lil-013 (2.4). The heaviest bulblet per plant (7.52g) was produced by the genotype Lil-015. Similarly wide variation was also observed by Sheikh *et al*. (2015) where he reported that all lilium genotypes produced 1.0 daughter bulb per bulb and the range of bulblet production was 3.3-22.3 per bulb.

Table 4. Bulb and bulblet production influenced by Lilium genotypes

Genotypes	Single bulb wt (g)	Bulb diameter (cm)	Bulblet no./plant	Bulblet wt/plant (g)
Lil-001	16.25	3.45	4.0	5.60
Lil-002	15.35	3.50	3.0	1.9
Lil-003	18.9	4.0	5.0	2.68
Lil-004	20.0	4.50	4.0	3.40
Lil-005	20.0	3.62	7.0	10.0
Lil-006	40.5	4.74	4.0	5.0
Lil-007	60.0	6.06	5.41	2.46
Lil-008	34.0	4.81	4.30	2.84
Lil-009	30.0	4.0	8.0	12.0
Lil-010	30.0	4.54	3.0	2.30
Lil-011	38.0	4.74	4.30	2.84
Lil-012	60.0	5.50	4.0	3.20
Lil-013	49.0	4.96	2.4	1.64
Lil-014	26.0	4.66	3.0	3.0
Lil-015	50.0	5.38	3.63	7.52
Lil-016	33.0	4.80	4.50	6.0
Lil-017	40.0	5.32	6.0	5.56
Lil-018	48.0	5.68	2.64	1.70
Lil-019	48.0	5.38	3.84	2.10
Mean	**35.63**	**4.72**	**4.32**	**4.30**
CV (%)	**39.96**	**15.85**	**33.69**	**67.37**

Plate 11. Field view of different lilium genotypes

Conclusion

Lilium genotypes showed wide variation in all qualitative and quantitative parameters studied. Among the collected lilium germplasm, 19 attractive colored and two types of flowers viz.,

Asiatic lilium and Oriental lilium have been found. Among them 14 germplasm are suitable for cut flower and 5 are suitable for pot culture. Regarding fragrance, Oriental type lilium produced strong scented flowers whereas Asiatic types have no fragrance. The longest stalk and rachis (80.0cm and 26.0cm, respectively) and also the maximum number of florets per stick (10.50) were produced by the genotype Lil-001. The maximum vase life was observed in Lil-007 and Lil-010 (12.0 days) whereas the minimum in Lil 016 and Lil 019 (6.0 days). The heaviest and the largest bulb (60g and 6.06cm, respectively) were produced by the genotypes Lil-007.

Expt. No. 02. Lilium bulb preservation influenced by various temperature and storing media

Main effect of temperature and media on growth of lilium bulbs

During storage period lilium bulbs growth were significantly influenced by the various storage temperature and media (Table 1). Cool temperature (2.1-2.5^{0}c) showed significantly less sprout initiation (67.22%), the minimum number of root per bulb (9.75) and the smallest root and shoot (4.15 & 0.57cm, respectively). The higher temperature (8.0-10.0^{0}c) showed poor performance.

Considering storage media, sawdust showed the lower number of sprout initiation (75.0%), shorter root (7.80cm) and shoot (5.88cm). Though sawdust produced the maximum number of roots per bulb (12.93) followed by the mixture of sawdust and cocodust (50:50) but the overall good performance showed by sawdust till next year planting time.

Table 1. Main effect of temperature and media on growth of lilium bulbs during storage period

Treatments	Sprout	Root	Average root	Average shoot

	initiation (%)	no./bulb	length (cm)	length (cm)
Temperature				
2.1-2.5^{0}c (T_1)	67.22 b (56.81)	9.75 c	4.15 c	0.57 c
6.5-7.5^{0}c (T_2)	100.0 a (86.04)	12.69 b	11.42 b	10.0 b
8.0-10.0^{0}c (T_3)	100.0 a (86.04)	14.37 a	16.42 a	13.33 a
Level of significant	**	*	**	**
Media				
Sawdust (M_1)	75.0 c (66.98)	12.93 a	7.80 c	5.88 c
Cocodust (M_2)	98.89 a (84.15)	11.66 b	13.78 a	10.21 a
50% Sawdust+50% Cocodust (M_3)	93.33 b (77.76)	12.22 ab	10.41 b	7.82 b
Level of significant	**	*	**	**
CV(%)	4.51	6.23	13.44	11.35

Figures in parenthesis are transformed value
Means with the same letter(s) are not significantly different
** = Significant at 1% level of probability; *= Significant at 5% level of probability

Combined effect of temperature and media on growth of lilium bulbs during storage period

The combined effect of temperature and media showed significant variations on all the parameters of lilium bulbs during storage period except root number per bulb (Table 2). The cool temperature (2.1-2.5^{0}c) with sawdust produced the minimum sprout (25.0%), shorter root (3.29cm) and shoot (0.45cm). The two other temperature (6.5-7.5^{0}c and 8.0-10.0^{0}c) including all media produced 100% sprouting. The bulbs under high temperature (8.0-10.0^{0}c) with cocodust produced the longest root (20.46) and shoot (17.0cm).

Table 2. Combined effect of temperature and media on growth of lilium bulbs during storage period

Treatments	Sprout initiation (%)	Root no./bulb	Average root length (cm)	Average shoot length (cm)
T_1 M_1	25.0 c (28.87)	10.14 cd	3.29 c	0.45 d
T_1 M_2	96.67 a (80.37)	9.40 d	5.48 c	0.75 d
T_1 M_3	80.0 b (61.20)	9.70 d	3.69 c	0.50 d
T_2 M_1	100.0 a (86.04)	13.07 b	6.45 c	7.54 c
T_2 M_2	100.0 a (86.04)	12.17 bc	15.40 b	12.77 b
T_2 M_3	100.0 a (86.04)	12.83 b	12.40 b	9.71 c
T_3 M_1	100.0 a (86.04)	15.60 a	13.67 b	9.66 c
T_3 M_2	100.0 a (86.04)	13.40 ab	20.46 a	17.0 a
T_3 M_3	100.0 a (86.04)	14.12 ab	15.15 b	13.24 b
Level of significant	**	NS	**	**
CV(%)	4.51	6.23	13.44	11.35

Figures in parenthesis are transformed value

Means with the same letter(s) are not significantly different

** = Significant at 1% level of probability; NS = Non Significant

Where,

T_1= 2.1-2.5^{0}c M_1=Sawdust (100%)

T_2=6.5-7.5^{0}c M_2=Cocodust (100%)

T_3=8.0-10.0^{0}c M_3=Sawdust+cocodust (50:50)

Main effect of temperature and media on changes of weight of lilium bulbs during storage period

Changes of bulb weight (%) at various days after storage were significantly influenced by various temperatures (Fig.1). At 30 DAS, the minimum weight (3.02%) was increased by the temperature of 2.1-2.5^{0}c which gradually increased 8.89% up to 120 DAS. Whereas, the high temperature (8.0-10.0^{0}c) showed 10.25% increase of bulb weight at initial stage (30 DAS) which turned 23.80% at storage ending period (120 DAS). When considering media, sawdust significantly showed less increase in bulb weight at 30, 60, 90 and 120 DAS (3.45%, 4.78%, 6.31% & 9.32%,

respectively) (Fig. 2). In contrast, the lilium bulbs preserved by cocodust gained significantly the higher weight at various storage periods (9.37%, 12.36%, 17.33% & 26.81%, respectively).

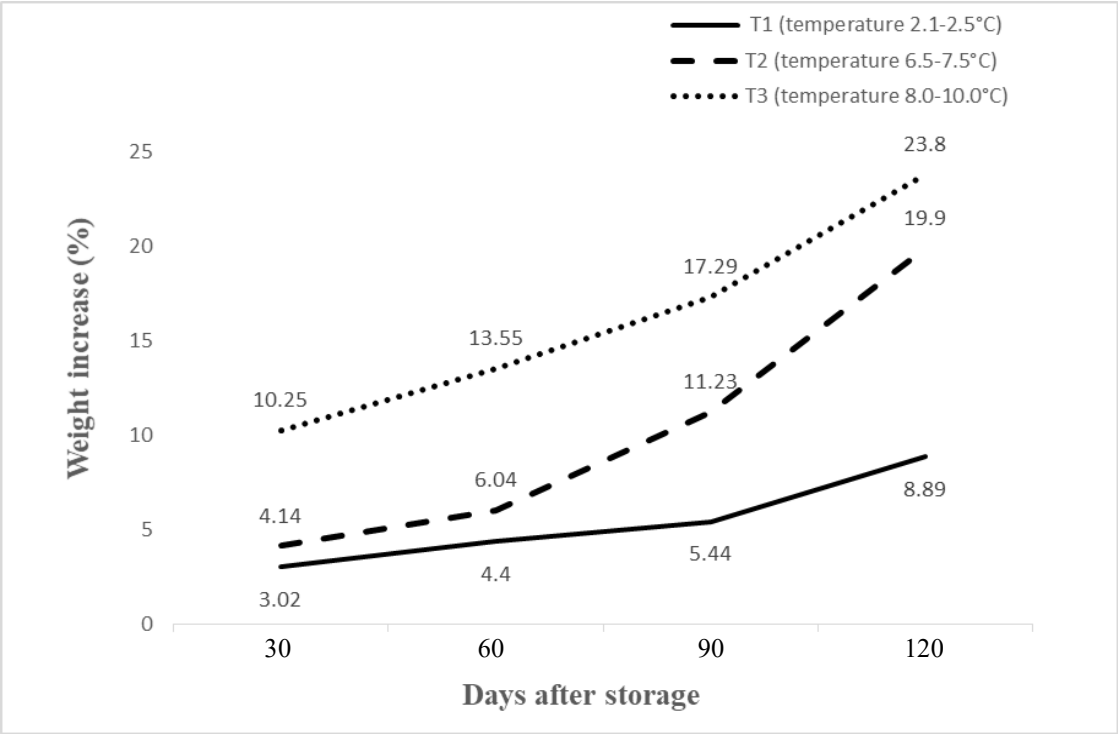


Fig.1 Increase of bulb weight (%) influenced by various temperature during storage period

Where, T_1= 2.1-2.5^{0}c T_2=6.5-7.5^{0}c T_3=8.0-10.0^{0}c

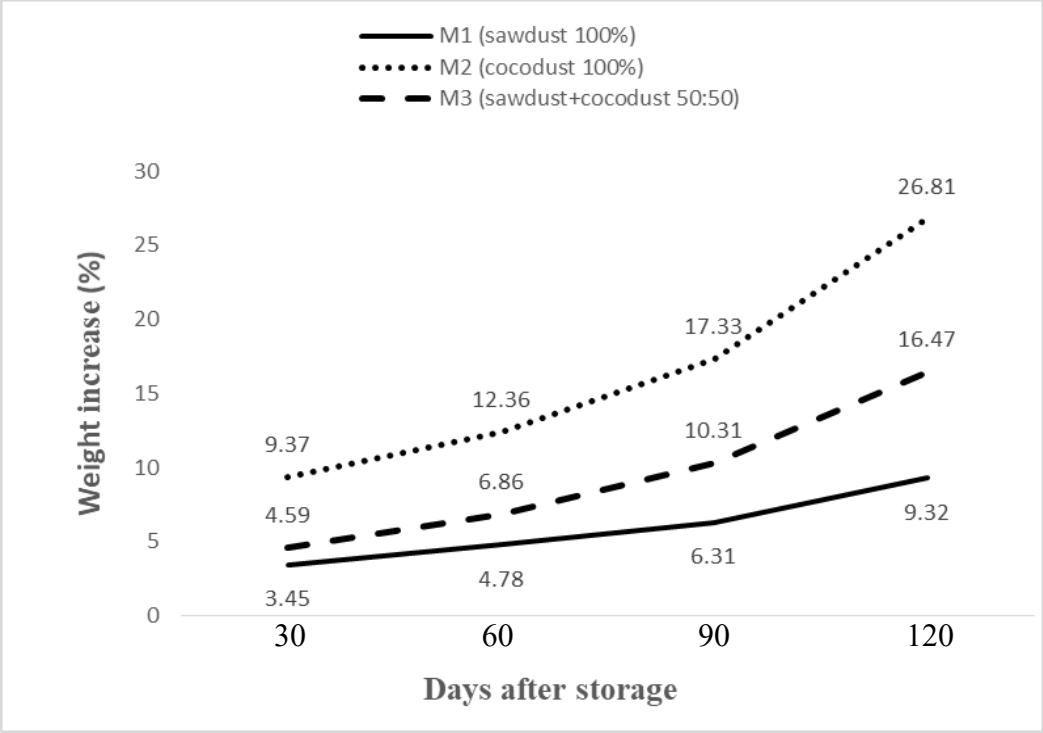


Fig.2. Increase wt. of bulb (%) influenced by various media during storage period

Where, M_1=Sawdust (100%) M_2=Cocodust (100%) M_3=Sawdust+cocodust (50:50)

Combined effect of temperature and media on changes of weight of lilium bulbs during storage period

Changes of bulb weight (%) at various storage dates were significantly influenced due to combined effect of temperature and media (Table 3). The lilium bulbs with sawdust preserved in low temperature (2.1-2.5^{0}c) gained the minimum weight during storage period (1.42%, 2.35%, 3.07% and 3.20%, respectively) which ultimately protected the bulbs from deterioration. Almost similar findings were presented by Maddah *et al*. (2012) where he reported that vernalization temperature of 3°C have preferred to 9°C for *Lilium ledebourii's* bulb preservation because in 9°C starch hydrolyzed and soluble sugar consumption were decreased. Whereas the bulbs in the high temperature (8.0-10.0^{0}c) with cocodust gained the maximum weight at 30, 60, 90, and 120 DAS (17.58%, 22.73%, 26.06% and 36.07%, respectively) which may be due to the higher sprout initiation, longer root and shoot produced during entire storage period.

Table 3. Combined effect of temperature and media on changes of weight of lilium bulbs during storage period

Treatments	Changes of weight (%)			
	30 DAS	60 DAS	90 DAS	120 DAS
T_1 M_1	1.42 d (1.12)	2.35 e (1.53)	3.07 e (1.73)	3.20 f (9.81)
T_1 M_2	4.99 bc (2.23)	6.65 bcd (2.58)	8.31 cd (2.88)	14.07 cd (21.25)
T_1 M_3	2.65 cd (1.62)	4.21cde (2.04)	4.94 de (2.2)	9.41e (17.22)
T_2 M_1	3.10 bcd (1.73)	4.14 de (2.02)	5.07 de (2.24)	11.92 de (19.47)
T_2 M_2	5.53 bc (2.34)	7.71bcd (2.76)	17.61 ab (4.18)	30.30 a (32.18)
T_2 M_3	3.79 bcd (1.92)	6.29 bcd (2.50)	10.99 bc (3.31)	17.48 bc (23.82)
T_3 M_1	5.85 bc (2.40)	7.85 bc (2.80)	10.79 bc (3.28)	12.83 cde (20.23)
T_3 M_2	17.58 a (4.18)	22.73 a (4.75)	26.06 a (5.09)	36.07 a (35.59)
T_3 M_3	7.33 b (2.69)	10.08 b (3.17)	15.0 b (3.87)	22.51b (27.32)
Level of significant	*	**	*	*
CV(%)	14.96	9.90	10.56	5.79

Figures in parenthesis are transformed value

Means with the same letter(s) are not significantly different

** = Significant at 1% level of probability; *= Significant at 5% level of probability

Where,

T_1= 2.1-2.5^{0}c M_1=Sawdust (100%)

T_2=6.5-7.5^{0}c M_2=Cocodust (100%)

T_3=8.0-10.0^{0}c M_3=Sawdust+cocodust (50:50)

Sawdust

Cocodust

Sawdust+Cocodust

Plate 12. Bulbs preserved at cold storage of BADC, Kashimpur
(Temp. 2.1 to 2.5^{0}c, Humidity 85 to 91%)

Sawdust

Cocodust

Sawdust+Cocodust

Plate 13. Bulbs preserved at cool room of Postharvest Division, BARI
(Temp. 6.5 to 7.5^0 c, Humidity 70 to 75%)

Sawdust

Cocodust

Sawdust+Cocodust

Plate 14. Bulbs preserved at constant temp. & humidity chamber, HRC, BARI
(Temperature 8 to 10^0 c, Humidity 75 to 90%)

Conclusion

Considering various parameters like sprout initiation, root and shoot length, weight changes of bulb (%), quality of bulb cool temperature (2.1-2.5^{0}c) with sawdust media is suitable for lilium bulb preservation under Gazipur condition.

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12. Research highlight/findings (Bullet point – max 10 nos.):

- It is possible to grow lilium flower under Bangladesh climate condition in the winter season.
- Among the collected germplasm, 19 attractive colored and two types of flowers viz., Asiatic lilium and Oriental lilium have been found in where 14 germplasm are suitable for cut flower and 5 are suitable for pot culture
- Oriental type lilium produced strong scented flowers whereas Asiatic types have no fragrance.
- The longest stalk and rachis (80.0cm and 26.0cm, respectively) and also the maximum number of florets per stick (10.50) were produced by the genotype Lil-001. The maximum vase life was observed in Lil-007 and Lil-010 (12.0 days) whereas the minimum in Lil 016 and Lil 019 (6.0 days). The heaviest and the largest bulb (60g and 6.06cm, respectively) were produced by the genotypes Lil-007.
- Cool temperature (2.1-2.5^{0}c) with sawdust media is suitable for lilium bulb preservation.

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment				100%	
1. Laptop	1	60000.00	1		
2. Scanner	1	10000.00	1		
3. Digital camera	1	25000.00	1		
4. Color printer	1	20000.00	1		
(b) Lab &field equipment	-	-	-	-	
(c) Other capital items	-	-	-	-	

C. Financial and physical progress (Fig in Tk)

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance / unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	342451	342451	342451	0.4	100	
B. Field research/lab expenses and supplies	1051257	1031913	996190	35723	94.8	
C. Operating expenses	118207	96207	117575	-21368	99.4	
D. Vehicle hire and fuel, oil & maintenance	54500	54500	54500	0	100	
E. Training/workshop/seminar etc.	0	0	0	0	0	
F. Publications and printing	90000	27342	20000	7342	22.22	PCR will be published by NATP
G. Miscellaneous	15000	14261	15000	-739	100	
H. Capital expenses	115000	115000	11500	0	100	

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	**Major technical activities performed in respect of the set objectives**	**Output (i.e. product obtained, visible, measurable)**	**Outcome (short term effect of the research)**
To collect Lilium germplasm from different sources	Information were collected regarding lilium flower growing area and therefore, communication was made to collect the bulbs	A good depository of lilium bulbs of different genotypes (19) has been developed	Lilium produced under Bangladesh climate condition
To evaluate the performance of lilium under the climatic condition of Bangladesh	After planting of lilium bulbs, various qualitative and quantitative data were recorded	19 attractive colored and two types of flowers viz. Asiatic lilium and Oriental lilium have been found.	
To find out the suitable method for preserving lilium bulb	After lifting of bulbs, a study conducted in combination with various storage temp. and media	Considering various parameters, cool temperature (2.1-2.5^{0}c) with sawdust media is suitable for bulb preservation	

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ **booklet**/leaflet/flyer etc.		1	লিলিয়াম: বানিজ্যিক ফুল চাষে নতুন সংযোজন- উৎপাদন কলাকৌশল ও সংগ্রহোত্তর ব্যবস্থাপনা (বাংলা)
Journal publication			-
Information development			-
Other publications, if any			-

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

- Production and postharvest management technology
- Production technology of propagating materials
- Preservation technique standardized to some extent

ii. **Generation of new knowledge that help in developing more technology in future**

- Sawdust is very much suitable for lilium bulb preservation but cocodust and the mixture of both media can be used to mitigate the availability of sawdust

iii. Technology transferred that help increased agricultural productivity and farmers' income

Production, postharvest and bulb preservation technology of lilium flower have been developed which are being transferred among the flower growers through training, demonstration, media, mobile apps etc.

iv. Policy Support

-Emphasis should be given to collect more lilium germplasm from abroad
-Cold storage facilities should be made available to preserve the bulbs for next year lilium cultivation

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.):

1. Review workshop held on 26 February, 2018 at BARC
2. Annual Review workshop held on 8-11 September, 2018 at BARC

ii) Field Monitoring (time & No. of visit, Team visit and output):

Visited two times at 16 January and 22 February 2018 by the following personnel;

- Dr. Md. Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist, NATP-2, BARC
- Dr. Md. Aziz Zillani chowdhury, Member Director (Crops) BARC, Dhaka
- Dr. Md. Abdus Salam, Director (SS), BARC, Dhaka
- Dr. Md. Kabir Uddin, CSO, BARC, Dhaka
- Md. Monirul Islam, NATP-2, BARC, Dhaka
- Mr. Abdul Mamun, NATP-2, BARC, Dhaka

Output: Monitoring team gave some valuable suggestions for the betterment of study.

Plate 15. Visit of Scientists, project personnel, guests etc





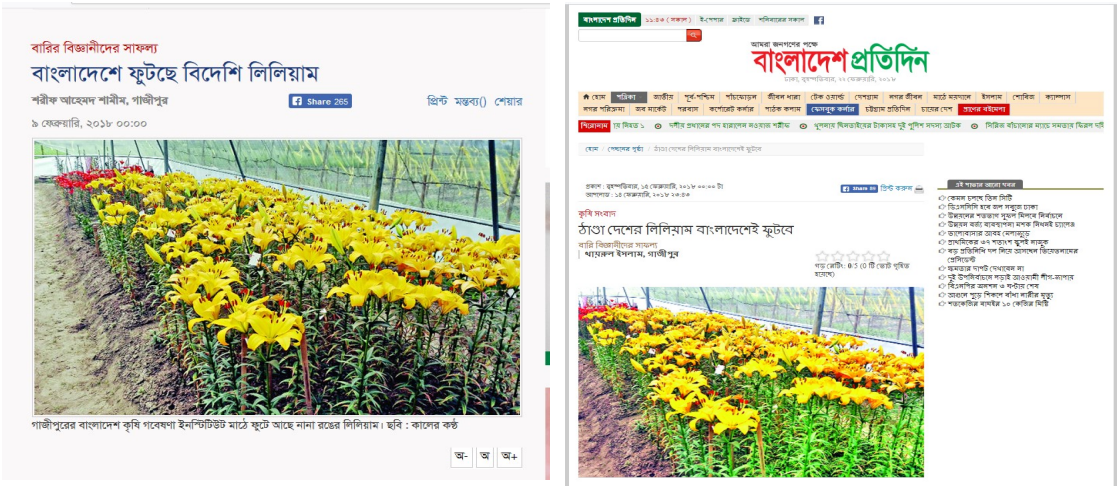

Plate 16. Article on lilium published in Newspapers

Plate 17. News on Lilium broadcasted by TV Channels

H. Lesson Learned/Challenges (if any)

Lilium bulb needs cool temperature for preservation. At least two “Constant Temperature and humidity chamber” are needed to minimize the preservation problem.

Signature of the Principal Investigator	Counter signature of the Head of the organization/authorized representative
Date ……	Date ……..