

Project ID 753

## Competitive Research Grant

# Sub-Project Completion Report

on

Induction of Somaclonal Variation in Non-Flowering  
Germplasm of Sugarcane through *In Vitro* Culture

Project Duration

May 2016 to Sept 2018

Breeding Division  
Bangladesh Sugarcrop Research Institute



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



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**Project Title: Induction of Somaclonal Variation in Non-Flowering Germplasm of Sugarcane through *In Vitro* Culture**

Project Implementation Unit  
National Agricultural Technology Program-Phase II Project (NATP-2)  
Bangladesh Agricultural Research Council (BARC)  
New Airport Road, Farmgate, Dhaka – 1215  
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## Acronyms

Somatic variant	:	Develop variant using somatic tissue
MS medium	:	Murashige and Skoog (1962) medium
MMS medium	:	Modified MS medium
Explant	:	Excised plant part
<i>In vitro</i>	:	Inside of glass
Ex vitro	:	Outside of glass (natural environment)
BSRI	:	Bangladesh Sugarcrop Research Institute
Brix%	:	Percentage of total soluble solid in sugarcane
2,4-D	:	2,4 dichlorophenoxy acetic acid
NAA	:	$\alpha$ -Naphthalene acetic acid
BA	:	6 -Benzyl adenine
IBA	:	Indol -3-butyric acid

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## Executive Summary

Bangladesh Sugarcrop Research Institute (BSRI) has a collection of 1130 germplasm, among them 800 does not flower, these huge number of germplasm can't be used for varietal improvement through conventional breeding approaches due to their non-flowering nature. Out of these 800 non-flowering germplasm, 20 including 5 varieties, 11 exotic, 2 indigenous and 2 institute bred germplasm were selected on the basis of tillering ability, sucrose content and yield (t/ha) characteristics to use as parent materials for the development of variant population through *in vitro* culture. Somatic tissues of the selected germplasm were cultured on medium *in vitro* to develop callus. After 15-20 days of culture callus was formed and sub-cultured on shooting medium for re-differentiation of unorganized tissue to form organ. Through this process variants were developed from the selected 20 germplasm and they were multiplied and rooted *in vitro*. The *in vitro* plantlets developed inside the glass tube under artificial environment need to adapt under natural condition. Thus, plantlets were transferred from *in vitro* to *ex vitro* condition under poly tunnel with high humidity for 20-25 days for hardening. Till to the reporting period about 1677 variants were acclimatized and maintained at nursery bed to attain at a height of 7-9 inches. Then they were transplanted in the research field and 1223 somatic variants were survived at field condition. Standard intercultural operations such as mulching, weeding, irrigation were done as and when required. Mechanical control measures were taken against the attack of diseases and insect pests of cane. Data on number of tiller per plant data was collected in the month of May 2018. Mill able canes per clump was recorded in the month of September 2018. Three variants produced higher number of mill able cane. In field condition nine (9) somatic variants from non-flowering genotypes showed flower and included in BSRI germplasm bank for further use in hybridization program to develop new variety.

# CRG Sub-Project Completion Report (PCR)

## A. Sub-project Description

1. Title of the CRG sub-project: Induction of somaclonal variation in non-flowering germplasm of sugarcane through *in vitro* culture

2. Implementing organization: Bangladesh Sugarcrop Research Institute (BSRI)

3. Name and full address with phone, cell and E-mail of

PI: Dr. Md. RahimulAlam, SSO, Breeding Division,  
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Co-PI: Dr. Md. Anisur Rahman, PSO and Head Breeding Division

BSRI, Ishurdi, Pabna, Phone: Office: 07326-64115

Cell phone: 01703488606 E-mail: [anis71@yahoo.com](mailto:anis71@yahoo.com)

4. Sub-project budget (Tk):

4.1 Total: 14,99,595/-

4.2 Revised (if any): 14,99,595/-

5. Duration of the sub-project:

5.1 Start date (based on LoA signed): May 2017

5.2 End date: 30 September 2018

6. Justification of undertaking the sub-project:

Bangladesh Sugarcrop Research Institute (BSRI) has a germplasm collection of 1136 clones of which 320 are flowering. There are some non-flowering clones which possess some desired agronomic traits (*e.g.* plant height, no. of millable cane, girth, yield etc.) and can withstand against biotic stresses *i.e.* shows tolerance to diseases and insect-pests as well as abiotic stresses such as salinity, drought, flood, waterlog etc. However, the fact is that, though having the target gene pool in the germplasm, we are not able to drag them into the desired clones for varietal improvement through conventional breeding approaches. As a result, we are lagging behind to exploit the existing geremplasm as a whole. However, somaclonal variation through plant tissue culture could be the probable gateway for utilizing those non-flowering clones in the breeding program by creation of genetic variability, which will surely widen the chance of getting desired varieties. BSRI has already developed a somaclonal variety (BSRI Akh 43) by exploiting Isd 18 which was red rot susceptible. Moreover, BSRI has a reputation of creating somaclones; but the non-flowering clones did not get the focus. In this time frame of the project, the focus will be on creating genetic variability through plant tissue culture of the non-flowering clones. If it is possible to develop superior somaclones than the non-flowering donor parents, then it will surely help the sugarcane breeders to develop climate resilience varieties with desired traits.

7. Sub-project goal: Development of superior somaclones from the non-flowering germplasm

8. Sub-project objective (s):

- i. Induction of somaclonal variants
- ii. Detection of somaclones with flowering habit
- iii. Enrichment of sugarcane germplasm bank

9. Implementing location (s): Tissue Culture Lab and Field of BSRI, Ishurdi, Pabna

10. Methodology in brief:

Twenty non-flowering, valuable and endangered sugarcane genotypes were selected from the germplasm bank of BSRI on the basis of desired agronomic and adaptive traits against different abiotic and biotic stresses for this research.

Table 1: Salient feature of selected non-flowering germplasm

Sl. No.	Selected genotypes	Source of collection	Importance	Reason of culture
1	Isd 2-54	BSRI released variety	1. High sugar and well adapted 2. Resistant to red rot disease	Due to non-flowering nature unable to use in hybridization program
2	Isd 27	BSRI released variety	1. High sugar content variety 2. Moderately tolerance to red rot disease	1. Varietal performance become deteriorated 2. Does not flower from last few years
3	Isd 34	BSRI released variety	1. High tillering with good rationing ability 2. Tolerance to waterlog condition	Due to non-flowering nature unable to use in hybridization program
4	Isd 37	BSRI released variety	1. Higher cane and sugar yielding variety, well adapted 2. Goor quality is very good	Due to non-flowering nature unable to use in hybridization program
5	BSRI Akh 42	BSRI released variety	1. Chewing type 2. Soft fiber and attractive stalk color 3. Susceptible to red rot disease	Due to non-flowering nature unable to use in hybridization program
6	GT 11	Exotic collection	1. High sucrose content 2. Soft fiber 3. Moderately resistant to red rot disease	Due to non-flowering nature unable to use in hybridization program Pipe observed inside the stalk
7	GT 17	Exotic collection	1. Higher cane and sugar yielding	Due to non-flowering nature unable to use in hybridization program Pipe observed inside the stalk
8	Co 433	Exotic collection	1. High yielding 2. Self-de-trashing	Due to non-flowering nature unable to use in hybridization program

Sl. No.	Selected genotypes	Source of collection	Importance	Reason of culture
9	Co 62-101	Exotic collection	1. High yielding 2. Self-de-trashing	Due to non-flowering nature unable to use in hybridization program
10	Co 6502	Exotic collection	1. High sucrose content 2. Profuse tillering ability	Due to non-flowering nature unable to use in hybridization program
11	CP 44-101	Exotic collection	1. High sucrose content 2. Self-de-trashing	Due to non-flowering nature unable to use in hybridization program
12	CP 48-103	Exotic collection	1. Sucrose content is high	Due to non-flowering nature unable to use in hybridization program Degenerating
13	CP 52-68	Exotic collection	1. Profuse tillering ability 2. Self-de-trashing	Due to non-flowering nature unable to use in hybridization program Degenerating
14	CP 53-33	Exotic collection	1. High sucrose content 2. Soft fiber	Due to non-flowering nature unable to use in hybridization program Susceptible to wilt disease
15	CP 55-30	Exotic collection	1. High sucrose content 2. Profuse tillering ability	Due to non-flowering nature unable to use in hybridization program
16	Q 69	Exotic collection	1. High cane and sugar yielding 2. Suitable for juice	Due to non-flowering nature unable to use in hybridization program
17	I 61-90 (Self)	Institute bred	1. High cane and sugar yielding 2. Suitable for juice	1. Huge wax in stalk inhibit juice preparation
18	I 131-10	Institute bred	1. High yielding 2. Suitable for ratoon	1. Bud sprout at maturity stage 2. Unable to use as seed
19	Hulekhali	Local collection	1. High yielding 2. Low management	Bud sprout standing cane hinder seed quality
20	Ranagon	Local collection	1. High sucrose content 2. Suitable for juice 3. Attractive stalk color	Due to non-flowering nature unable to use in hybridization program

Leaf sheath as explant was collected from field grown germplasm at the age of 6-8 months and prepared aseptically following plant tissue culture technique for *in vitro* culture. Murashigie and Skoogs (MS) medium and Modified MS (MMS) medium supplemented with auxin and cytokinin were used to develop somaclonal variants. The MMS medium supplemented with 2.0, 3.0 and 4.0 mg/L 2,4-D was used to develop callus from the explant. But shoot initiation from the callus and rooting of shoot was done on MS medium supplemented with auxin and cytokinin alone or in combinations. pH of the medium was adjusted to 5.7 and autoclaved at 121 °C temperature for 20 minutes. The cultures were incubated in an air conditioned culture room at 25±1°C condition and illuminated by white fluorescent tubes of intensity about 3000 lux. After development of *in vitro* completed plantlets the culture vessels were transferred from control to normal room condition and makes them unplugged for three days. Then the plantlets were pull-out from medium, thoroughly washed the roots under running tap water and pricked up at garden soil containing cel-u-pack to acclimatize at natural environment under transparent poly tunnel. After hardening the developed somatic variants were transplanted in the field for evaluation. After maturity somatic variants were evaluated and selected better ones were included in germplasm bank for use in hybridization program.

## 11. Results and discussion:

**Callus development:** Explant of 20 non-flowering sugarcane germplasm was cultured on MMS medium supplemented with 2.0, 3.0 and 4.0mg/l 2,4-D and incubated at *in vitro* culture room condition. After 15-20 days of incubation callus was developed from the explants on 2.0, 3.0 and 4.0 mg/L concentration of 2,4-D supplemented medium but quality callus was observed on 3.0 mg/l 2,4-D supplemented medium(Fig 1).

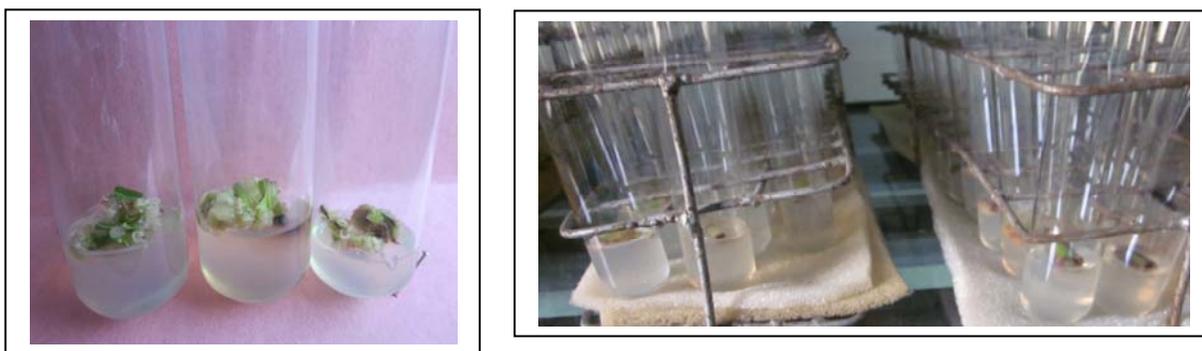
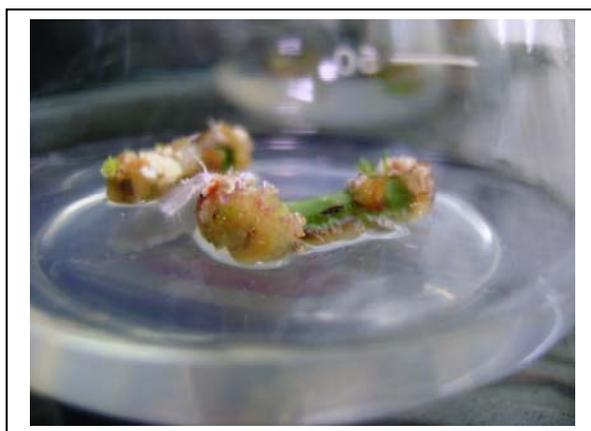
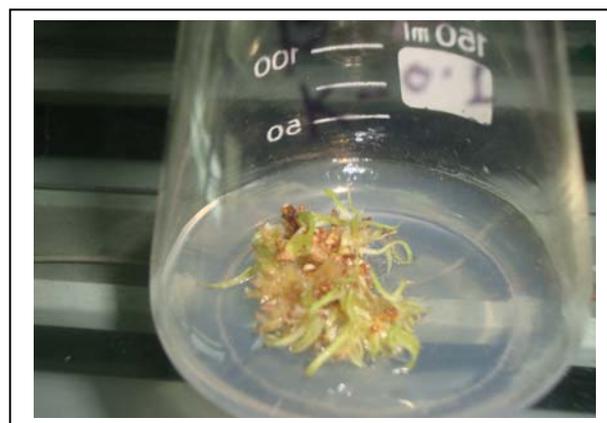


Figure 1: Development of callus from the explants of non-flowering sugarcane

**Shoot formation from the callus:** Callus was cultured on MS medium supplemented with BA (Benzyl adenine) and NAA (Naphthalene acetic acid) *in vitro* for the development of shoots. Within 20-25 days of culture callus of 14 germplasm initiated micro-shoots on this medium. Rest of the 6 genotypes initiated shoot on MS medium supplemented with BA (Benzyl adenine) and IBA (Indol Butyric Acid). They were incubated on the same medium to become 1.5-2.0 cm in shoot height. When the *in vitro* shoot reached in desired height, they were multiplied on liquid medium in side of glass vessel (Fig. 2).



A



B



C



D

Figure 2: A-B: Initiation of micro-shoot from callus; C-D: *In vitro* multiplication of shoots

***In vitro* root development from the micro-shoots:** When the micro-shoots attained about 3-5 cm height in shooting medium they were transferred to rooting medium for the development of roots from the cut end to form complete plantlets. About 90 percent of micro-shoots initiated roots in MS medium supplemented with NAA within 20-25 days of culture. After formation of sufficient roots, cultures were transferred from *in vitro* culture condition to *ex vitro* condition for acclimatization to natural environment.



A



B

Figure 3: A & B: Development of root from the cut-end of microshoot

### Acclimatization of the *in vitro* plantlets:

After 3-4 days of incubation at *ex vitro* condition the plantlets were pull-out from medium, thoroughly washed the roots under running tap water to free from medium and pricked up at soil media containing cel-u-pack to acclimatize at natural environment under transparent covered condition. It took about 1.5 to 2 months time to establish at soil condition then they were transferred from poly tunnel to nursery bed. Total 1677 numbers of somatic variants were developed and planted in the field in the month of January-February 2018 (Table 2).



A

B

Figure 4: A- Hardening of *in vitro* plantlets under covered condition  
B- *In vitro* developed plantlets are in nursery bed

Necessary intercultural operations such as mulching, weeding, irrigation were done as and when required. Mechanical control measures were taken against the attack of diseases and insect pests of cane. Number of tiller per plant data was collected in the month of May 2018 and presented in Table 2. The table revealed that the highest number of tiller per plant (6.48) was recorded by the variant of CP 53-33 followed by Isd 37 and I 61-90 (self) and lowest was produced by the variants of GT 17.

Table 2: Number of developed somatic variants from non-flowering sugarcane germplasm, its survivability in field and tillering ability per plant

Sl. no.	Name of germplasm	No. of somatic variants developed	No. of variants survived in field	No. of tiller/plant
1	Isd 27	52	33	2.8
2	Isd 34	107	81	4.64
3	Isd 37	88	65	6.45
4	CO 62-101	147	132	5.33
5	CO 6502	125	121	5.64
6	CP 44-101	49	31	4.99
7	CP 48-103	75	69	5.02
8	CP 53-33	35	20	6.48

Sl. no.	Name of germplasm	No. of somatic variants developed	No. of variants survived in field	No. of tiller/plant
9	CP 55-30	37	22	4.0
10	Q 69	105	70	3.53
11	GT 17	59	47	1.0
12	I 61-90 (self)	171	132	6.41
13	I 127-09	37	31	3.0
14.	Rangon	43	36	2.82
15.	Co 453	154	87	5.24
16	GT 11	166	123	2.34
17	CP 5268	65	42	1.33
18	Hulekhali	44	-	-
19	I 131-10	77	59	3.33
20	BSRI Akh 42	41	22	2.51
Total		1677	1223	

The variants of Hulekhali (local germplasm) did not survived in field condition. The Earthing up and tying of cane was performed in the month of July to August 2018. Different characters like leaf length, leaf breath and cane diameter was recorded in the month of August and summarized in Table 3.

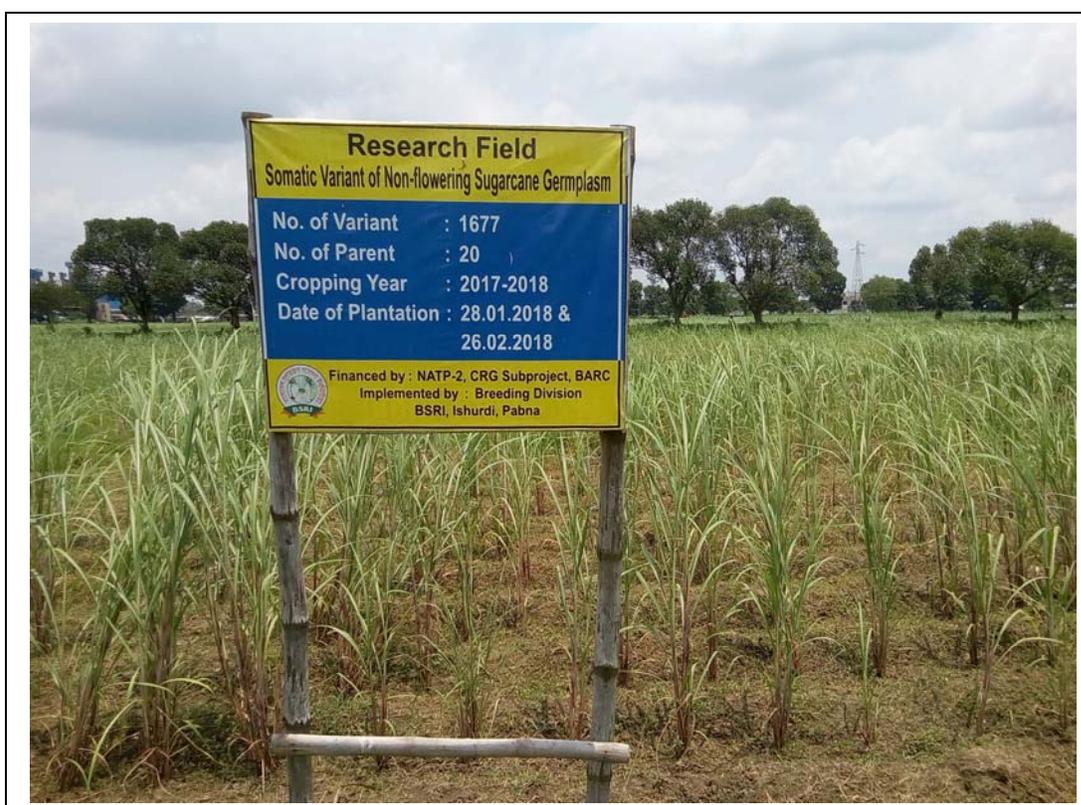


Figure 5: Research plot of somatic variants developed from 20 non-flowering sugarcane



Figure 6: Tillering of sugarcane somatic variants in the field

The variants Co 6502 showed the highest 134.44 cm leaf length and the lowest leaf length (73.00 cm) was recorded from the parent Isd 34. In case of leaf breadth the variant Co 62-101 revealed highest result (4.03 cm) and it was lower for the parent of Isd 34 (1.15 cm). Cane thickness depends on its diameter, for this the diameter of variants and parents was recorded (Table 3). The highest cane diameter (23.82 mm) was recorded from the variants I 61-90 (self) followed by Rangoan(21.83 mm). The lowest cane diameter was recorded by the parents Cp 48-101 (11.50 mm). In field condition the cane elongation rate was higher during July to October. The elongation rate of somatic variants and parents.

Table 3: Leaf length, Leaf breath and cane diameter of selected somatic variants in comparison with donor (parents)

Sl. no.	Variants	Leaf length (cm)		Leaf breath (cm)		Cane dia (mm)	
		Variant	Parent	Variant	Parent	Variant	Parent
1.	Co 6502	134.44	117.00	3.48	2.48	17.97	14.74
2.	I 61-90 (self)	115.40	106.50	3.30	2.35	23.82	15.00
3.	Q 69	101.80	110.00	2.02	2.32	14.34	18.20

Sl. no.	Variants	Leaf length (cm)		Leaf breath (cm)		Cane dia (mm)	
		Variant	Parent	Variant	Parent	Variant	Parent
4.	CP 55-30	124.50	100.00	2.34	1.80	16.21	15.11
5.	Co 62-101	104.00	95.00	4.03	3.40	18.19	11.75
6.	Isd 34	119.60	88.25	3.30	1.15	17.37	12.33
7.	Cp 48-103	105.00	97.00	2.54	1.70	16.97	14.88
8.	Cp 48-101	104.00	100.00	2.75	1.75	15.83	11.50
9.	Rangoan	118.20	90.50	2.60	1.95	21.83	16.00
10.	CP 53-33	122.50	97.00	2.00	1.51	16.50	14.18
11.	Co 453	105.30	76.00	2.48	1.65	15.17	14.50
12.	GT 11	100.00	97.00	2.70	2.45	15.00	12.50
13.	CP 52-68	98.00	84.10	2.35	1.98	14.75	13.65
14.	Isd 27	97.50	73.00	2.48	1.65	15.50	12.50
15.	GT 17	103.30	94.00	2.60	1.90	13.67	13.00
16.	Isd 37 (46T)	103.00	99.00	3.23	2.97	16.33	15.33

was recorded in the month of August to September 2018 and presented in the Table 4. The result showed that cane elongation in September was higher than August. Most of the variants showed higher elongation than the parent. In the month of August variants of Isd 34 showed the highest elongation per day (0.6 cm) than other variants but in the month of September the variants of Isd 34 and CP 48-103 had the highest elongation per day (0.8 cm) followed by CP 55-30 and Co 6502 (0.7 cm).

Table 4: Cane stalk elongation rate (per day) of somatic variants and parents for the month of August and September, 2018.

Sl no.	Variants	Growth rate(cm) / day			
		August		September	
		Variant	Parent	Variant	Parent
1.	Co 6502	0.4	0.3	0.7	0.5
2.	I 61-90 (self)	0.3	0.2	0.6	0.5
3.	Q 69	0.2	0.3	0.3	0.3
4.	CP 55-30	0.2	0.1	0.7	0.4
5.	Co 62-101	0.2	0.1	0.5	0.3
6.	Isd 34	0.6	0.1	0.8	0.7
7.	CP 48-103	0.5	0.3	0.8	0.5
8.	CP 48-101	0.3	0.2	0.2	0.3
9.	Rangoan	0.2	0.1	0.4	0.3
10.	CP 53-33	0.2	0.3	0.5	1.1
11.	Co 453	0.2	0.1	0.4	0.3
12.	GT 11	0.1	0.0	0.3	0.2
13.	CP 52-68	0.2	0.1	0.4	0.2
14.	Isd 27	0.3	0.4	0.7	0.8
15.	GT 17	0.3	0.1	0.3	0.3
16.	Isd 37 (46T)	0.3	0.1	0.5	0.2

In field condition out of the 1223 somatic variants, 9 variants showed flower (Fig.-7) and table 5, the flowering variants were selected and planted in BSRI germplasm bank for further use in hybridization program. The performances of flowering variants are given in Table 5. The variants I 61-90 (self), CP 53-33

and Isd 37 (46T) produced higher number of tiller, and millable canes per clump. In case of cane yield the variant I 61-90 (self) produced the highest (2.65 kg of five canes) yield followed by the variant of Isd 37 (46T) and Co62-101. The highest field brix (20.57) was recorded from the variant Co 6502 (Table 5).

Table 5: Field performance of flowering variants developed from non-flowering genotypes.

Sl No.	Variants	No. tiller/ Clump		No. Millable canes/ Clump		Field Brix%		Yield (kg) Weight of 5 canes	
		Variant	Parent	Variant	Parent	Variant	Parent	Variant	Parent
1.	Co 6502	5.64	2.18	5.10	2.0	20.57	17.15	2.12	1.89
2.	I 61-90 (self)	6.40	3.10	5.94	1.54	19.60	18.48	2.65	2.08
3.	CP 55-30	4.00	2.25	4.0	2.25	17.40	15.50	2.10	1.65
4.	Co 62-101	5.33	3.56	5.01	2.81	19.60	20.10	2.35	2.20
5.	Cp 48-103	5.02	2.36	4.12	1.75	14.30	13.20	2.00	1.20
6.	Cp 48-101	4.99	2.22	4.15	2.11	16.00	17.80	1.70	1.95
7.	CP 53-33	6.48	4.57	5.68	3.67	18.00	18.20	2.38	2.31
8.	Co 453	5.24	2.34	3.95	1.83	13.20	13.50	1.50	2.54
9..	Isd 37 (46T)	6.45	4.23	5.47	4.01	19.40	19.00	2.50	2.10



Fig 7: Flower in somatic variant developed from non-flowering genotypes through *in vitro* culture

### 13. Research highlight/findings:

- Twenty non-flowering sugarcane germplasm taken from BSRI germplasm bank were selected for *in vitro* culture under this project.
- Total 1677 somatic variants were developed through *in vitro* callus culture of the selected germplasm.
- A field experiment was set up with *in vitro* variant at BSRI farm following augmented design after hardening.

- Data on survivability of variants and number of tiller per plant was recorded after 30 and 140 days of plantation in the field. Out of 1677 variants, 1223 were survived in field.
- Highest number of tiller per plant (6.48) was recorded by the variant of CP 53-33 followed by Isd 37 and I 61-90 (self).
- In the month August cane elongation-rate of variant Isd 34 was the highest 0.6 cm per day in August but it was higher for Isd 34 and CP 48-103 (0.8 cm/day) in September.
- Most of the selected variants showed higher yield than the parents.
- Nine somatic variants from non-flowering genotypes showed flower and included in germplasm bank for further use in hybridization program.

## **B. Implementation Position**

### **1. Procurement:**

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment	10	2,22,500/-	10	2,22,500/-	
(b) Lab & field equipment	6	2,24,000/-	6	2,24,000/-	
(c) Other items (Chemical and apparatus)	37	3,91,500/-	37	3,91,500/-	

### **2. Establishment/renovation facilities:**

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Hardening shed	1	1			

### **3. Training/study tour/ seminar/workshop/conference organized:**

Description	Number of participant			Duration (Days/weeks / months)	Remarks
	Male	Female	Total		
(a) Training					
(b) Workshop					

## **C. Financial and physical progress**

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/unspent	Physical progress (%)	Fig in Tk
						Reasons for deviation
A. Contractual staff salary	2,34,517/-	2,34,135/-	2,34,135/-	-	100	-
B. Field research/lab expenses and supplies	6,46,980/-	5,79,740/-	5,79,740/-	-	89.61	Insufficient fund received

C. Operating expenses	71,798/-	71,666/-	68048/-	3618	94.78	
D. Vehicle hire and fuel, oil & maintenance	-	-	-	-		
E. Training/workshop/seminar etc.	-	-	-	-		
F. Publications and printing	60,000/-	35,000/-	35,000/-	-	58.33	Insufficient fund received
G. Miscellaneous	39,840/-	39,840/-	39,840/-	-	100	
H. Capital expenses	4,46,500/-	4,46,500/-	4,46,500/-	-	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)
1. Induction of somaclonal variants	<ol style="list-style-type: none"> <li>1. Selection of non-flowering sugarcane germplasm for the development of variation through <i>in vitro</i> culture</li> <li>2. Preparation of medium for <i>in vitro</i> culture of explants</li> <li>3. Explants culture for callus initiation</li> <li>4. Shoot initiation from the callus</li> <li>5. Root formation from the base of <i>in vitro</i> microshoots</li> <li>6. Hardening of <i>in vitro</i> plantlets from 20 germplasm</li> </ol>	Total 1677 somatic variants were developed	Somatic variant develop technique established
2. Detection of somaclones	<ol style="list-style-type: none"> <li>1. Field trial of somatic variants</li> <li>2. Data collection and analysis</li> </ol>	1223 variants were survived in field condition	
3. Enrichment of sugarcane germplasm bank	<ol style="list-style-type: none"> <li>1. Flowering somatic variant from non-flowering genotypes were included in germplasm bank for the use in hybridization programme.</li> </ol>	9 variants emerged flower and included in BSRI gerplasm bank.	Enrich BSRI germplasm bank

**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.	booklet		
Journal publication			
Information development			
Other publications, if any			

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

- Generation of technology (Commodity & Non-commodity)

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

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

- iv. **Policy Support**

#### **G. Information regarding Desk and Field Monitoring**

- i) **Desk Monitoring:**

Different report such as Inception Report, Quarterly Report, Half-yearly Report and Annual Report were submitted to Director PIU-BARC as per schedule and Statement of Expenditure (SoE) within 3<sup>rd</sup> days of every month.

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

Fieldmonitoring team of PIU-BARC, NATP-2 visited the lab and field work of this project on the 8<sup>th</sup> March, 2018. The team was satisfied to the project activities.

#### **I. Lesson Learned/Challenges (if any)**

- This project activity should be merged to core research program of BSRI.
- It is an annual crop which needs more than one year. For this study needs longer period for final results.
- Sugarcane setts may be irradiated for having flowering genotypes in addition to *in vitro* culture.

#### **J. Challenges (if any)**

- Sugarcane is an annual crop which needs more than one year. For this study needs longer period for final results.
- Natural calamity like early/over rain fall hampered intercultural operation which causes the poor yield of the crop.

Signature of the Principal Investigator  
Date .....  
Seal

Counter signature of the Head of the  
organization/authorized representative  
Date .....  
Seal