

SHORT COMMUNICATION

Co 15002: A potential fifth generation inbred derivative developed through inbreeding followed by hybridization and selection for sugarcane improvement

A. Anna Durai*, G. Hemaprabha, K. Mohanraj and Bakshi Ram

ICAR-Sugarcane Breeding Institute, Coimbatore, India.

*Corresponding author: Email :ayyadu@gmail.com

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ABSTRACT

Among 129 clones evaluated along with standard varieties CoC 671 and Co 86032 in Pre-zonal varietal trial (PZVT) during 2014-15, the clone PZVT 13-175 recorded the highest cane yield of 143.52 t/ha which was significantly superior to both the standards. Consequently the clone was given Co status i.e. Co 15002 and was included in Initial Varietal Trial of All India Co-ordinated research Project on Sugarcane in Peninsular Zone along with 25 other test entries and four standards at 15 test locations during the year 2018-19. Co 15002 registered significantly higher sucrose content (19.43%) than the commercially released sugarcane variety CoSnk 05103 (18.96 %) and on par with the ruling variety Co 86032 (19.63 %) at 10th month crop maturity. Cane yield of Co 15002 (96.27 t/ha) was found to be on par with the recently released CoSnk 05103 (97.23 t/ha) and CoC 671 (99.30 t/ha). Co 15002 was screened for red rot, smut and yellow leaf diseases under natural and artificially inoculated conditions at Coimbatore, Pune, Kolhapur and Navsari. Under natural conditions, smut and yellow leaf diseases were not observed. Co 15002 was resistant or moderately resistant to red rot by both plug and nodal methods in all the test locations. In artificial inoculated conditions, Co 15002 showed resistance to moderately resistant reaction to smut. It recorded 20 % flowering intensity and low pollen fertility of 30 % with peak flowering during the first fortnight of November and can be used as a pistil parent in hybridization programmes.

Keywords: Co 15002; Inbreeding; Red rot; Resistance; Selfs; Smut; Yellow leaf disease

Selfing in sugarcane aids in identifying the genotypes that are able to transmit the traits of interest to its offspring with conviction. Stevenson (1953) demonstrated that some populations derived from inbreeding in interspecific hybrids did not show any appreciable loss of vigour and they behaved like wild ancestors. Further, it is promising to segregate different traits in a particular variety without loss of vigour by means of selfing and to find disease resistant lines from susceptible parents in sugarcane (Cassalett et al. 1996). The polyploidy condition of sugarcane masks some favorable genes within a variety and inbreeding eliminates the undesirable genes and helps to generate genotypes that can be reliable donors with predictable performance.

India exploited the potentiality of selfing in their breeding programmes since 1930's and some of

the inbreds like Co 229, Co 317, Co 348, Co 508 etc were released as Co varieties (Ethirajan et al. 1977). Studies, to critically assess the utility of inbreeding as a breeding strategy in sugarcane for building up elite foundation donor stocks were initiated at ICAR-Sugarcane Breeding Institute, Coimbatore with eight commercial varieties during the year 1972. Some of the selfs of Co 775, Co 1148 CP 44/101 exhibited normal growth vigour and the results indicated the usefulness of elite inbreds as parents for improving the chances of obtaining early maturing high quality progenies.. The crosses involving inbreds of good x good and poor x poor general combining ability produced better specific combiners for different economic traits in sugarcane (Durai and Hemaprabha 2016). Considering the above authenticities, the present effort was made to identify a high quality and stress tolerant sugarcane genetic stock with ear-

ly sugar accumulation by exploiting inbreds as female parents and other promising Co canes as male parents.

Fifth generation inbred 1148-S4-242-4 was developed through repeated selfing of Co 1148. During the year 2009 flowering season 13 poly-crosses were made involving inbreds as female parent and high yielding, high sugared and disease resistant Co canes as pollen parents. Three thousand nine hundred and forty seedlings of inbred crosses were evaluated for economic traits in ground nursery in 2010-11. After evaluating the progenies in ground nursery, 80 clones were selected for clonal trial evaluation in Augmented design. Among them four clones viz., 2010-202 (1148-S4-242-4 x Co 94008, Co 99006, Co 8371, Co 06027), 2011-403 (1148-13-11-2-240 x CoC 671), 2011-663 (1148-13-11-2-237 x Co 2000-12) and 2011-667 (1148-13-11-2-237 x Co 2000-12) were forwarded for further testing under pre-zonal varietal trial (PZVT) at ICAR-SBI, Coimbatore.

During 2014-15, a set of 129 clones in PZVT including four inbred cross derivatives were evaluated in Augmented RBD design with a plot size of four rows of six meter length with inter row spacing 0.9m along with the standards CoC 671 and Co 86032 for cane yield, juice quality, field stand and red rot resistance. The results revealed that, the clone PZVT 13-175 (2010-202) recorded the highest cane yield of 143.52 t/ha which was significantly superior to the both standards. Consequently the clone was given Co number as Co 15002. The performance of Co 15002 in comparison to other early maturing Co selections is presented in Table 1.

Co 15002 was proposed for Initial Varietal Trial (IVT) testing during the Group Meeting of All India Co-ordinated Research Project on Sugarcane (AICRP-S) held at Rajendra Agricultural University, Pusa in the year 2015 and it was approved for multilocation testing in Peninsular Zone. Co 15002 was tested under IVT along with 25 other test entries and four standards viz., Co 86032,

Table 1. Performance of Co selections (Early) at Coimbatore

Co Number	Parentage	Cane yield (t/ha)	CCS (t/ha)	At 10 months			NMC ('000/ha)	Red rot (nodal)
				Brix	Sucrose (%)	CCS (%)		
Co 15001	CoM 0265 x Co 86011	133.80*	18.52*	21.05	19.56	13.84	86.11	R
Co 15002	1148-S4-242-4 PC	143.52*	19.65*	21.66	19.58	13.69	110.18	R
Co 15003	CoM 0265 X Co 89003	106.48*	14.85*	21.30	19.73	13.94	74.07	R
Co 15004	{Co 740 x Co 2000-03} x {Co 86002 x Co 88039 }	102.80*	14.09	21.84	19.65	13.71	87.59	R
Co 15005	{Co 8371 x ISH 69} x {Co 86032 x Co 99006 }	127.80*	19.10*	22.53	21.06	14.94	111.2	R
Co 15006	CoM 0265 x Co 89003	100.00*	13.73	22.00	19.72	13.73	103.79	R
Co 15007	ISH 100 x Co 0209	95.40	15.27*	23.52	22.39	16.01	85.27	R
CoC 671		79.68	11.23	21.58	19.97	14.11	62.59	
Co 86032		103.33	12.93	19.88	17.93	12.52	85.74	
CD		17.35	3.05	1.31	1.15	1.06	14.44	
CV		11.39	11.54	3.20	2.95	3.11	8.00	

Source: SBI Annual Report 2014-15

CoC 671, CoSnk 05103 and Co 85004 at 15 locations adopting RBD in two replication with net plot size of 5 m x 6 rows during the year 2018-19.

For CCS yield, Co 15002 exhibited superior performance at Navsari (16.20 t/ha) and Perumalapalle (16.25 t/ha) than the best standards Co 86032 (14.51, 11.81 t/ha) and CoC 671 (14.22, 9.43 t/ha at respective locations). At Basmathnagar, Co 15002 (14.36 t/ha) was superior to Co 86032 (10.96 t/ha) and CoC 671 (16.5 t/ha) and at Sameerwadi, it (15.21 t/ha) was superior to Co 86032 (13.34 t/ha) (Table 2).

Average cane yield obtained in the IVT trial conducted in 15 test locations of peninsular zone indicated that Co 15002 (96.27 t/ha) was on par with the recently released variety CoSnk 05103 (97.23 t/ha) and CoC 671 (99.30 t/ha) (AICRP-S Project Coordinator Report 2018-19). Co 15002 showed

significant superiority over CoSnk 05103 for cane yield at Basmathnagar (115.36 t/ha), Navsari (119.80 t/ha), Perumalapalle (130.17 t/ha) and Pugalur (106.13 t/ha). It registered significantly higher cane yield than the best standard Co 86032 at Navsari (119.80 t/ha over 95.25 t/ha) and Perumalapalle (130.17 t/ha over 86.83 t/ha) (Table 3). Stalk length and stalk diameter are the major contributing factors for high cane yield (Naidu et al., 2007) and similar trend was observed in Co 15002.

Co 15002 recorded significantly higher CCS % than the check CoSnk 05103 at seven locations viz., Coimbatore, Mandya, Perumalapalle, Pravaranagar, Pugalur, Rudrur and Sameerwadi. Co 15002 (13.37 %) was superior to both CoC 671 (13.31 %) and Co 86032 (12.91%) at Pugalur and to Co 86032 at six locations viz., Coimbatore, Mandya, Pugalur, Pravaranagar, Rudrur and Sameerwadi (Table 4).

Table 2. Performance of Co 15002 for CCS yield (t/ha) at harvest

Entry	Basmathnagar	Coimbatore	Navsari	Perumalapalle	Pugalur	Sameerwadi
Co 15002	14.36	17.63	16.20	16.25	14.18	15.21
Co 86032	10.96	19.57	14.51	11.81	14.05	13.34
CoC 671	9.88	16.57	14.22	9.43	14.37	17.05
CoSnk 05103	13.66	15.88	15.36	8.42	9.49	15.90
CD	-	3.19	2.36	2.49	2.94	-
CV	-	10.98	7.04	9.90	11.81	20.51

Source: Principal Investigator (Crop Improvement) Report (AICRP-S)-2018-19

Table 3. Performance of Co 15002 for Cane yield (t/ha) at harvest

Entry	Basmathnagar	Navsari	Perumalapalle	Pugalur	Sameerwadi
Co 15002	115.36	119.80	130.17	106.13	110.17
Co 86032	84.01	95.25	86.83	108.79	101.87
CoC 671	72.01	92.33	74.16	108.10	114.35
CoSnk 05103	108.58	101.60	73.87	81.87	121.03
CD	-	14.80	20.79	24.50	-
CV	-	6.15	9.805	12.31	20.87

Source: Principal Investigator (Crop Improvement) Report (AICRP-S)-2018-19

Table 4. Performance of Co 15002 for CCS % at 300 days

Entry	Sameerwadi	Pugalur	Perumalapalle	Pravaranagar	Rudrur	Coimbatore	Mandya
Co 15002	13.80	13.37	12.56	14.85	12.87	15.27	14.25
Co 86032	13.06	12.91	13.59	14.27	12.59	13.88	13.91
CoC 671	14.95	13.31	12.76	15.13	14.28	16.76	14.92
CoSnk 05103	13.28	11.58	11.41	12.94	11.00	12.10	13.73
CD	-	0.59	0.56	1.21	0.16	1.34	0.92
CV	7.79	2.30	6.62	4.25	0.60	4.76	3.20

Source: Principal Investigator (Crop Improvement) Report (AICRP-S)-2018-19

Yanam et al. (1997) observed that juice quality mainly depends on the genetic nature of the variety. Juice quality at 300 days of crop maturity, Co 15002 was tested along with other test entries in 18 locations. Co 15002 (21.61%) was found significantly superior to Co 86032 (19.72 %) at Coimbatore centre. Besides, it was superior to Co 86032 at six locations viz., Mandya, Padegaon, Pravaranagar, Rudrur, Sameerwadi and Sankeshwar (Table 5). Co 15002 registered significantly higher sucrose content (19.43 %) across the 15 locations of the zone in comparison with the recently released sugarcane variety CoSnk 05103 (18.96 %) and on par with the ruling variety Co 86032 (19.63 %) at 10th month of age (AICRP (S) Project Coordinator Report 2018-19).

Evaluation of Co 15002 for resistance to biotic stresses

Evaluation for red rot resistance

Co 1148 was a promising mid-late variety which went out of cultivation in sub-tropics because of its susceptibility to red rot (Verma 2001). Red rot and smut are the major diseases that affect sugarcane production in India and hence no variety can be released without red rot resistance. Further, most of resistance behavior to prevailing biotic/abiotic stresses is expected from the variety which is also considered as environment friendly in the context of climate change. Co 15002 was screened for red rot, smut and yellow leaf diseases under natural and artificially inoculated conditions at Coimbatore, Pune, Kolhapur and Navsari.

Table 5. Performance of Co 15002 for sucrose % at 300 days

Entry	Sankeshwar	Coimbatore	Mandya	Padegaon	Pravaranagar	Rudrur	Sameerwadi
Co 15002	19.40	21.61	20.05	21.54	20.66	19.17	19.75
Co 86032	19.27	19.72	19.69	21.06	20.12	19.13	18.78
CoC 671	21.88	23.49	21.02	23.09	22.19	19.21	21.22
CoSnk 05103	20.43	17.20	19.23	21.20	18.84	20.26	19.03
CD	2.22	1.73	1.11	1.55	1.67	0.20	-
CV	5.55	4.34	2.75	3.65	4.13	0.49	7.04

Source: Principal Investigator (Crop Improvement) Report, (AICRP-S)-2018-19

In case of plug method, two canes in each of the 20 clumps were selected and inoculated at middle of the third exposed internode and two drops of freshly prepared spore suspension concentration of one million/ ml was placed with syringe in each cane and sealed with plasticine. The canes were split open longitudinally sixty days after inoculation along the point of inoculation. The clones were rated as R, MS, MS, S and HS based on disease reaction using international scale of 0-9 (Srinivasan and Bhat 1961).

In nodal method of testing, freshly prepared inoculum suspension was applied between sheaths of 3rd and 4th leaves from top and immediately placing cotton swap dipped in around the cane covering nodal region. This was held in place by wrapping parafilm over the swab. Observation on spindle infection was taken at the end of 60 days after inoculation. The intensity of the acervuli at node was recorded. The nodes were scraped to see whether lesions are developing into stalks. Whenever lesions are progressive, the entries are rated as susceptible. If the lesions are dark and restrict-

ed to rind tissues, the clones are rated as resistant. Among the three AICRP (S) locations which test the red rot resistance of sugarcane clones, the trials at Thiruvalla were vitiated due to flooding. The results of the centres are presented in Table 6.

Evaluation of Co 15002 for smut resistance

Three budded setts of test clones were presoaked in smut (*Sporisorium scitamineum*) teliospore suspension with ensured spore viability and a concentration of 10⁶spores /ml for a period of 30 minutes along with the respective checks / standards for R and S categories and planted in 6 m rows. Around 45 days after planting, field observations were made at the time of whip emergence at fortnight intervals and numbers of smut infected clumps were recorded. Evaluation was based on the percentage of clumps infected. The following grading was followed for calculating the disease reaction. 0 % - Resistant (R); 0.1-10 % - moderately resistant (MR); 10.1 to 20 % - Moderately susceptible (MS); 20.1 to 30 % - Susceptible (S); above 30 % - Highly susceptible (HS) (Table 7).

Table 6. Reaction of Co 15002 to red rot pathogen at AICRP (S) locations

Genotype	Coimbatore (PZVT)		Coimbatore (IVT)		Navsari	
	Plug	Nodal	Plug method	Nodal Method	Plug method	Nodal Method
Co 15002	R	R	R	R	MR	R
Susceptible checks						
CoC 671	HS	S	HS	S	HS	HS
Co 94012	HS	S	HS	S	-	-

Table 7. Reaction of Co 15002 to smut pathogen at various locations / years

Genotype	Coimbatore		Navsari	Kolhapur
	2014-15	2020-21		
Co 15002	R	R	R	MR
Susceptible check				
Co 97009	HS	HS	HS	

Evaluation of Co 15002 for Yellow Leaf Disease resistance

Yellow leaf disease symptoms of midrib yellowing are expressed during 6-8 month crop stage. If disease severity increases, the yellowing spread to laminar region and at later stage, there will be drying of affected mid-rib and adjoining laminar tissue from leaf tip downwards along the midrib. Severity grades were computed on 8th, 10th and 12th month and disease grading is done from 0-5 scale. Each time 25 canes are scored according to the photograph of yellow leaf symptoms display-

ing severity grade as followed in the AICRP (S) technical programme. Reaction of Co 15002 to yellow leaf diseases at the two mandatory centers of AICRP (S) is presented in Table 8.

Table 8. Reaction of Co 15002 to yellow leaf disease

Genotype	Navsari	Coimbatore
Co 15002	R	R
Susceptible checks		
Co 86032	S	
Co 85004	MS	-



(a) Field stand, (b) Internode shape, (c) Canopy top, (d) Bud shape, (e) Dew-lap colour, (f) Auricle shape and colour
Figure 1. Salient features of Co 15002

Table 9. Morphological description of Co 15002

Sl.No	Descriptor	Co 15002
1	Parentage	1148-S4-242-4 PC
2	Stool growth habit	Semi erect
3	Stem colour (Exposed to sun)	Pinkish yellow (greyed yellow)
4	Stem colour (unexposed)	Light orange yellow (yellow)
5	Ivory marks	Absent
6	Corky patches	Present
7	Internode shape	Cylindrical to slightly conoidal
8	Internode alignment	Slight zig zag
9	Internode diameter	2.8 cm
10	Internode pithiness	Absent
11	Growth cracks	Absent
12	Internode waxiness	Light
13	Node swelling	Slight
14	Root zone colour (exposed)	Light green
15	Root zone colour (unexposed)	Light yellow
16	No. of root eyes rows	2 to 3
17	Arrangement of root primordia	Irregular
18	Bud size	Large
19	Shape of bud (Artswager)	Oval
20	Bud cushion	Absent
21	Gerpore position	Apical
22	Bud groove	Absent
23	Growth ring colour	Yellow
24	Leaf length	1.4 cm
25	Leaf width	4.8 cm
26	Lamina colour	Green
27	Leaf carriage	Erect, tip droopy
28	Leaf sheath colour	Green with red blotches
29	Leaf sheath waxiness	Light
30	Leaf sheath spines	Light
31	Leaf sheath clasping	Not loose
32	Colour of dewlap	Light yellow
33	Shape of ligular process	Short lanceolate
34	Shape of ligule	Crescent
35	Ligule hairiness	Absent
36	Flowering	Yes
	Salient features:	Medium thick tall pinkish yellow, light wax coated canes, projecting bud and long narrow curved leaves

Morphological description of Co 15002

The clone is characterized by erect, medium thick tall canes with long internodes without bud groove, yellow wax band, big ovoid projecting buds, erect and tip droopy closed green canopy, light green leaf sheath with red blotches and short lanceolate ligular process. (Table 9). The genotype has 20 % flowering intensity during the first fortnight of November and has low pollen fertility of 30% unlike the original parent which has the pollen fertility of more than 60% and hence can be used as a female parent.

Co 15002 is a poly cross derivative of 1148-S4-242-4 developed by selfing of Co 1148 for five generations followed by hybridization and selection which combines quality, cane yield, red rot and smut resistance at ICAR-Sugarcane Breeding Institute, Coimbatore. It was also found to be free of yellow leaf disease. This genetic stock, improved over the proven parent Co 1148 with respect to red rot resistance and yield component traits especially cane thickness and sucrose content is probably the first of its kind developed through repeated selfing followed by hybridization and selection in sugarcane and owes promise in developing varieties with stable yield and wide adaptability with disease resistance.

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