

STUDY OF SUGARCANE GERMPLASM VARIETIES FOR FLOWERING ABILITY UNDER AGRO-CLIMATIC CONDITIONS OF THATTA

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ABSTRACT

Field experiments were conducted to observe flowering behavior of different sugarcane varieties under natural environment of Thatta and Ghorabari (coastal belt) sites in Sindh (Latitude 24.5°N). Different sugarcane varieties/genotypes were collected from all available sugarcane germplasm at different Sugarcane Research Institutes of Pakistan and were maintained by simple vegetative propagation (cuttings) method in non-replicated trials during 2008-09 and 2009-10. It was observed that latitude and mean minimum and maximum temperature during flowering inductive phase (September) were within acceptable limits to favour the flowering in sugarcane. However, flowering occurred in most of the cane varieties under natural environment in both sites of Thatta area but the time, intensity and percentage of flowered varieties differed widely between the years of the same environment. The results showed that in sugarcane germplasm planted as plant crop at Thatta during 2008-09, 30.44 percent varieties/genotypes flowered during 2009-10 with intensity ranging from 10.16 to 87.09 percent. In plant crop during the year 2009-10, 21.27 percent sugarcane varieties flowered during 2010-11 with intensity ranging from 6.12 to 66.66 percent and in ratoon crop of the year 2010-11, 12.43 percent varieties flowered with intensity ranging from 17.24 to 90.0 percent. During the same year in plant crop at Ghorabari site, 57.6 percent varieties/genotypes flowered with intensity ranging from 19.64 to 93.47 percent. The sugarcane crop took about thirteen to fifteen month's period for its complete flowering. The flowering in sugarcane varieties commenced from November and ended up to January. Most of the varieties flowered during the months of November and December. Only a few could flower during January. Moreover, Ghorabari site of district Thatta closer to sea shore was identified as best for profuse flowering in sugarcane.

Key words: Sugarcane, variety, flowering, time, percentage, intensity, Thatta.

INTRODUCTION

Sugarcane (*Saccharum officinarum*, L.) is an important cash and industrial crop of Pakistan. It is a source of raw material to sugar industry and generates employment for many people. The survival of sugar industry in Pakistan totally depends upon cane cultivation. It forms essential items for industries like sugar, chip board, paper, baggase, confectionary and use in chemicals, plastics, paints, synthetics, fiber, insecticides and detergents (Kazi *et al.*, 2010). Sugarcane crop, however, is currently facing severe crisis in the country. Both farming community and industry are striving for its sustainable existence and growth. The major challenges faced by the crop are lower average production per area and low sugar recovery (Arain *et al.*, 2011). The low cane yield and sugar recovery in Pakistan may be due to the fact that most of the sugarcane varieties under commercial cultivation are getting obsolete and losing their potential with the passage of time. As a result, the farming community has limited options for variance in their sugarcane crop with new improved sugarcane varieties. Therefore, it is direly

needed that new sugarcane varieties should be added time and again in the existing varietal pool and the pace of work on the development and release of new sugarcane varieties should be accelerated to the better headway.

New sugarcane varieties are usually produced through crossing of parental clones according to the objectives set within the sugarcane improvement programme. In many countries, due to low and poor flowering ability of the sugarcane, breeders very often resort to artificial induction as a means to initiate and promote flowering in non- and poor flowering clones of interest. The production of inflorescences, especially in the best varieties and elite clones has to be ensured for a successful sugarcane improvement programme. While, traditional breeding plots have been the major source of inflorescence for sugarcane breeding since the inception of the programme. Thus, before embarking on the adoption of artificial induction, which is the case in many sugarcane breeding countries, natural environment were screened for flowering ability of sugarcane.

The sugarcane variety development in Pakistan is being carried out through hybrid fuzz imported from abroad, direct introduction and acclimatization of exotic sugarcane varieties and little bit work on variety

development has been done through natural fuzz (self pollinated) collected locally. Cane fuzz (self pollinated) is produced locally in coastal areas of lower Sindh, where profuse flowering is observed in commercial cane fields. However, the efforts were also made to utilize the cane fuzz produced in Murree areas of Punjab as well as Dargahi areas of Khyber Pakhtoon Khuwa for variety development but the production of fuzz in these areas has always been uncertain and much below the desired quantum and quantity (Fasihi *et al.*, 1988). Hybrid fuzz imported from abroad has many limitations. Massive efforts are needed to utilize our local resources at coastal belt of Sindh for quality fuzz production through hybridization.

The fuzz is true seed of sugarcane obtained from flowering of different sugarcane varieties. Flowering in sugarcane is a complex physiological process consisting of multiple stages of development, each stage having specific environmental and physiological requirements (Julien, 1972). Thus, if the specific day length, temperature and moisture requirements are not satisfied, flowering is inhibited or the intensity is reduced, it is essentially the location (altitude) (Moore, 1987), temperature (Loch *et al.* 1999) moisture stress (Pereira *et al.* 1983) and the nutrition level (Marschner, 1997) that affect the timing and intensity of flowering.

Flowering is must for hybridization. Photoperiod is the principal desirable factor for controlling the flowering in sugarcane. In this crop, flowering shows a range of variation among the varieties (Miah and Paul, 2008). Among germplasm material at NSCRI Thatta some varieties exhibit early flowering, some are mid-flowering and some are late. So, it becomes difficult to cross unless the flowering dates are changed forcefully under controlled conditions in the glass house and photo-period chambers.

The coastal area of lower Sindh is endowed with some specific agro-climatic conditions, where many sugarcane varieties flower profusely, which can open up new avenues for hybrid fuzz production.

In this study, the cane flowering data in different sugarcane varieties/genotypes and their classification is compiled, which signify the prospectus of hybrid fuzz production for successful sugarcane variety development programme in Pakistan.

MATERIALS AND METHODS

Experiments were conducted to observe flowering behavior of sugarcane germplasm under natural environment in Thatta and Ghorabari sites of lower Sindh (Latitude 24.5°N). For this purpose, different sugarcane varieties/genotypes were collected from all available sugarcane germplasm at different Sugarcane Research Institutes of Pakistan. The varieties were added in sugarcane germplasm pool of NSCRI, Thatta and were

maintained by simple vegetative propagation method. During 2008-09 a total of 450 varieties/genotypes were planted as a plant crop at NSCRI, farm Thatta. During 2009-10 a total of 362 sugarcane varieties/genotypes were planted as a plant and ratoon crop at NSCRI, farm Thatta, during the same year a total of 250 sugarcane varieties/genotypes were planted at Ghorabari, district Thatta. Each year in all experiments, the varieties/genotypes were planted in five meters long single row at one meter row to row distance in a non-replicated trial. All the experiments received a calculated dose of 225-150-150 N-P-K kg ha⁻¹ as all P, K and 1/3 nitrogen at time of planting, remaining N in two splits, one during March and second during May. Recommended agronomic practices, insect pest and disease control measures were undertaken as and when required through out the growing season. The data of booting, flowering and flowering percentage were collected from October up to end of March. The number of flowering stalks and the total number of stalks (tillers) per five meters row of each variety/genotype was counted to work out flowering intensity. Flowering intensity for each flowering variety/genotype was expressed as percentage of flowered stalks out of the total number of stalks of each variety/genotype. Daily rainfall, mean minimum and maximum temperature and relative humidity were recorded during the induction and flowering development period. The mean temperature range during flowering induction period was 24.74-34.0°C. The flowering and non-flowering varieties/lines were identified and then for synchronization purpose, the groups of the flowered varieties were made in terms of matching booting dates at ten days interval period from first booting to complete flowering stage.

RESULTS

Experiment-1: In the experiment for the year 2008-09 total 450 sugarcane varieties/genotypes were planted on 21-10-2008 at NSCRI, farm Thatta. A total of 149 varieties/genotypes booted out of which 137 could flower during 2009-10.

The groups of the flowered varieties in terms of matching booting dates at ten days interval period revealed that there were two (2) varieties which booted during 21st to 30th October 2009 and were placed in group "A". While, sixty six (66) flowered varieties booted during 1st to 10th November and were placed in group "B", eighteen (18) varieties were placed in group "C" due to their booting during 11th November to 20th November. Moreover, twenty nine (29), seven (7), six (6), four (4) and five (5) flowered varieties during 21st to 31st November, 1st to 10th December, 11th to 20th December, 21st to 30th December and 1st January to 10th January, were placed in group "D", "E", "F", "G" and "H", respectively (Table-1).

As regards the flowering intensity, the data revealed that the varieties CoJ-84, Lam 76-620, Thatta-8, HoTh-610, Lam-TJ-76/803, L-89-113, CPM 76/611, B-46-364, HS-04, HS-12, Co-473, HoTh-316, S-84-I-724, Co-413, Co-348, HoTh-332, and Thatta-432 produced profuse flowering with maximum intensity ranging from 58.00-87.09%. While, the varieties CP-88-1165, S-82-US-937, S-86-US-375, S-2001-HoSG-315, CP-85-1389, CP-85-1165, HoTh-401, S-86-SP-571, Thatta-10, HoTh-127, CP-88-1573, CP-89-2143, S-2002-US-640, S-2003-US-694, HoTh-2109, S-97-SP-27, CP-85-1540, CP-84-1591, S-2003-US-127 and S-97-SP-102 exhibited scanty flowering with lowest intensity ranging from 10.16 to 15.87%.

Experiment-2: In the experiment for the year 2009-10 total 362 sugarcane varieties/genotypes were planted on 30-10-2009 and tested for their flowering ability at NSCRI, farm Thatta. A total of 85 varieties booted, out of which 77 varieties flowered.

The groups of the flowered varieties with regard to matching booting dates in Table-2 revealed that there were two (2) varieties which booted during 21st to 10th October and were placed in group "A". While, forty three (43) varieties booted during 1st to 10th November were placed in group "B", six varieties (6) were placed in group "C" due to their booting from 11th November to 20th November. Moreover, four (4), thirteen (13), three (3), two (2) and four (4) varieties booted during 21st to 31st November, 1st to 10th December, 11th to 20th December, 21st to 30th December and 1st January to 10th January, were placed in group "D", "E", "F", "G" and "H", respectively.

As regards the flowering intensity the data revealed that the varieties MCP-91-592, Lam-TJ-76/803, Lam-76-620, LHO-83/158, CP-29-120, B-43405, Thatta-8, Co-413 and Thatta-703 produced profuse flowering with maximum intensity ranging from 56.52 to 66.66%. While, the varieties NSG-555, S-2003-US-127, CP-89-

1059, S-2003-US-778, S-2003-US-160, CP-84-1591, S-95-HS-102, HoTh-326 and CP-88-2377 exhibited scanty flowering with minimum intensity ranging from 6.12 to 10.25%.

Experiment-3: In the experiment for the year 2009-10 total 362 sugarcane varieties/lines were studied for flowering behavior in ratoon crop at NSCRI, farm Thatta. A total of 58 varieties booted, out of which total 45 varieties flowered up to January 2011.

The groups of the flowered varieties with regard to matching booting dates revealed that there were two (2) varieties which booted during 10th to 30th October and were placed in group "A". While, twenty four (24) flowered varieties booted during 1st to 10th November were placed in group "B", Moreover, four (4), two (2), six (6), two (2), two (2) and three (3) flowered varieties were placed in group C, D, E, F, G and H due to their booting during 11th to 20th November, 21st to 30th November, 1st to 10th December, 11th to 20th December, 21st to 31st December and 1st January to 10th January, respectively (Table-3).

As regards the flowering intensity the data revealed that the varieties B-62163, I-M-61, MT-76-611, Lam-76-620 and Co-413 produced profuse flowering with maximum intensity ranging from 80.85 to 90.0%. While, the varieties, viz, HoCP-91-552, S-2002-US-133, CP-85-1491, HoTh-344 and S-86-US-375 exhibited lowest flowering with intensity ranging from 17.24 to 19.67%.

Experiment-4: During 2009-10, the experiment was conducted on 17-10-2009 at Ghorabari. The experiment was designed to observe the flowering behavior of different sugarcane varieties under extreme coastal climatic conditions of Ghorabari in district Thatta. It was observed that out of 250 sugarcane lines a total of 159 varieties booted, out of which total 144 varieties flowered.

Table1. List of National and International sugarcane germplasm, their flowering behavior in plant crop planted on 21-10-2008.

Sr. No	Group	Number of clones	Date of booting	Total number of cane/five meters row Mean \pm SD	Number of cane flowered Mean \pm SD	Intensity % Mean \pm SD
1	A	2	21to30-10-2009	51.0 \pm 16.97	17.5 \pm 3.53	35.1 \pm 4.75
2	B	66	01to10-11-2009	52.04 \pm 9.56	16.07 \pm 8.68	32.89 \pm 21.16
3	C	18	11to20-11-2009	49.72 \pm 11.29	16.61 \pm 7.63	35.35 \pm 19.11
4	D	29	21to30-11-2009	51.0 \pm 6.11	20.28 \pm 8.76	40.34 \pm 18.40
5	E	7	01to10-12-2009	53.58 \pm 8.48	11.34 \pm 6.39	21.57 \pm 11.59
6	F	6	11to20-12-2009	51.66 \pm 7.63	14.5 \pm 4.18	28.22 \pm 7.41
7	G	4	21to31-12-2009	56.25 \pm 5.31	9.25 \pm 2.98	16.43 \pm 5.36
8	H	5	01to10-01-2010	53.4 \pm 10.54	13.8 \pm 9.67	30.39 \pm 31.19

Table-2. List of National and International sugarcane germplasm, their flowering behavior in plant crop planted on 30-10-2009.

Sr. No	Group	Number of clones	Date of booting	Total number of cane/five meters row Mean \pm SD	Number of cane flowered Mean \pm SD	Intensity % Mean \pm SD
1	A	2	21to30-10-2009	47.0 \pm 8.48	13.5 \pm 7.77	30.71 \pm 22.09
2	B	43	01to10-11-2009	48.30 \pm 5.77	13.32 \pm 7.42	28.63 \pm 17.33
3	C	06	11to20-11-2009	50.83 \pm 6.46	18.05 \pm 7.73	56.90 \pm 16.22
4	D	04	21to30-11-2009	45.0 \pm 9.20	17.5 \pm 7.72	42.39 \pm 24.91
5	E	13	01to10-12-2009	49.69 \pm 5.32	11.30 \pm 4.90	23.04 \pm 10.05
6	F	03	11to20-12-2009	47.0 \pm 11.35	16.33 \pm 4.16	38.07 \pm 20.67
7	G	02	21to31-12-2009	45.5 \pm 6.36	12.5 \pm 6.36	28.73 \pm 18.0
8	H	04	01to10-01-2010	51.0 \pm 4.96	17.75 \pm 14.24	36.88 \pm 31.06

Table-3. List of National and International sugarcane germplasm, their flowering behavior in ratoon crop during 2009-10.

Sr. No	Group	Number of clones	Date of booting	Total number of cane/five meters row Mean \pm SD	Number of cane flowered Mean \pm SD	Intensity % Mean \pm SD
1	A	02	21to30-10-2009	49.5 \pm 2.12	18.0 \pm 1.41	36.33 \pm 1.30
2	B	24	01to10-11-2009	53.0 \pm 5.82	24.54 \pm 11.62	47.21 \pm 22.86
3	C	04	11to20-11-2009	49.25 \pm 7.27	25.0 \pm 13.90	54.54 \pm 35.89
4	D	02	21to30-11-2009	52.0 \pm 4.24	21.0 \pm 1.14	40.40 \pm 0.57
5	E	06	01to10-12-2009	54.33 \pm 3.72	23.83 \pm 11.47	43.86 \pm 22.03
6	F	02	11to20-12-2009	57.0 \pm 5.65	16.0 \pm 7.07	28.82 \pm 15.26
7	G	02	21to31-12-2009	55.0 \pm 4.24	13.0 \pm 4.24	24.0 \pm 9.56
8	H	03	01to10-01-2010	49.16 \pm 13.05	27.66 \pm 20.42	51.87 \pm 26.31

Table-4. List of National and International sugarcane germplasm, their flowering behavior planted on 17-10-2009 at Ghora Bari.

Sr. No	Group	Number of clones	Date of booting	Total number of cane/five meters row Mean \pm SD	Number of cane flowered Mean \pm SD	Intensity % Mean \pm SD
1	A	04	21to30-10-2009	49.25 \pm 6.23	30.0 \pm 4.96	61.25 \pm 9.74
2	B	72	01to10-11-2009	50.40 \pm 5.94	26.54 \pm 10.24	53.82 \pm 23.62
3	C	18	11to20-11-2009	47.27 \pm 5.27	24.55 \pm 9.88	53.19 \pm 23.69
4	D	07	21to30-11-2009	41.0 \pm 6.21	25.42 \pm 8.24	64.12 \pm 24.34
5	E	28	01to10-12-2009	47.28 \pm 7.58	20.78 \pm 8.07	45.32 \pm 19.02
6	F	06	11to20-12-2009	41.0 \pm 8.83	20.0 \pm 5.62	52.17 \pm 22.06
7	G	04	21to31-12-2009	46.5 \pm 5.0	22.75 \pm 9.21	50.39 \pm 23.66
8	H	05	01to10-01-2010	42.4 \pm 7.50	22.0 \pm 9.64	55.54 \pm 31.76

The groups of the flowered varieties with regard to matching booting dates indicated that there were four (4) varieties which booted during 21st to 30th October and were placed in group "A". While, seventy two (72) varieties booted during 1st to 10th November were placed in group "B", eighteen varieties (18) were placed in group "C" due to their booting from 11th November to 20th November. Moreover, seven (7), twenty eight (28), six (6), four (4) and five (5) varieties booted during 21st to 31st November, 1st to 10th December, 11th to 20th

December, 21st to 30th December and 1st January to 10th January, were placed in group "D", "E", "F", "G" and "H", respectively (Table-4).

As regards the flowering intensity the data revealed that the varieties Thatta-8, B-4176, Lam-Tj-76/803, HS-04, Co-310, LHO-83/158, B-43405, CoL-69, Lam-76/620, S-84-I-726, B-46364 and L-89-113 produced profuse flowering with intensity ranging from 88.09 to 93.47%. While, the varieties, viz. S-96-SP-302, S-2003-US-165, CP-85-1382, S-2003-US-160, S-97-SP-

102, CP-81-1236, CP-89-1945, CP-85-1540 and S-96-SP-571 exhibited relatively less flowering with intensity ranging from 19.64 to 24.0%.

Appendix-1. Summary of meteorological data recorded at Meteorological Station of National Sugar Crops Research Institute, Thatta during 2008.

Month	Temperature °C		Wet °F	Dry °F	Humidity %	Rainfall (mm)
	Minimum	Maximum				
January	9.39	22.61	48.58	62.00	30.87	-
February	11.41	26.72	52.66	65.03	38.07	3
March	19.19	34.32	66.52	79.68	46.58	-
April	22.43	36.10	73.20	82.60	54.70	-
May	26.23	35.39	78.96	88.44	65.61	-
June	27.73	26.23	81.26	90.00	66.07	-
July	26.63	33.06	79.18	86.12	72.94	102
August	25.77	30.90	77.73	83.60	76.27	31
September	25.18	33.32	77.32	83.71	74.21	-
October	22.24	34.35	71.58	81.76	60.76	-
November	16.48	31.00	63.46	74.77	54.32	-
December	13.22	24.92	55.65	61.08	47.52	10

Appendix-2. Summary of meteorological data recorded at Meteorological Station of National Sugar Crops Research Institute, Thatta during 2009.

Month	Temperature °C		Wet °F	Dry °F	Humidity %	Rainfall (mm)
	Minimum	Maximum				
January	13.07	24.23	54.76	64.69	50.19	-
February	15.09	29.97	58.71	71.23	44.90	5
March	19.82	21.34	67.44	78.62	54.88	-
April	21.90	39.05	73.04	84.57	57.38	-
May	26.31	38.36	79.85	88.31	69.04	-
June	26.37	36.17	81.21	88.17	73.76	-
July	26.78	34.55	80.63	86.31	77.78	107
August	26.57	32.63	78.84	84.63	75.44	12
September	25.47	32.82	76.64	83.84	69.00	-
October	20.20	36.12	67.16	80.00	49.00	-
November	14.70	32.87	58.00	75.17	30.31	-
December	12.61	28.04	57.09	67.42	38.14	8

Appendix-3. Summary of meteorological data recorded at Meteorological Station of National Sugar Crops Research Institute, Thatta during 2010.

Month	Temperature °C		Wet °F	Dry °F	Humidity %	Rainfall (mm)
	Minimum	Maximum				
January	10.90	27.75	55.01	65	50.00	-
February	12.09	30.04	55.09	68.08	42.08	-
March	20.44	36.58	70.06	80.72	64.00	-
April	23.75	38.86	77.09	86.54	62.86	-
May	26.85	38.95	80.74	90.95	62.66	-
June	27.08	37.69	80.95	90.00	65.30	30
July	26.94	35.72	80.84	87.36	75.00	102
August	26.05	34.02	80.00	85.85	76.71	52
September	23.57	35.87	73.14	85.42	54.00	Flood
October	22.52	36.14	71.04	83.42	53.23	15
November	16.94	25.11	49.80	70.58	34.61	08
December	10.22	27.04	57.45	65.27	61.90	-

DISCUSSION

The district Thatta, of lower Sindh, falls on latitude (24.5°N), where, the photoperiod might have remained fairly encouraging for the flowering induction in many sugarcane varieties. According to Malik (2011) cane flowering site in coastal area is situated at Thatta (located on 24.5° N latitude) is close to tropical limits, where, almost 22 photo inductive days are available for exposure of cane varieties to the required photoperiod (11.50 – 12.00 hrs) from 7 to 28 September. Clements and Awada, (1964) studied that optimum flowering stimulus is obtained in a decreasing day length of 12.0 hours to 11.5 hours and flowering is more profuse near to equator that away from it. Sugarcane flowers all the years round at 0-5° latitude, North or South. As the cane proceeds away from the Equator, the flowering time confined to certain photo period ranges (Moore, and Nuss, 1987). In Northern Hemisphere cane flowering at 10° N is observed in October, and the flowering time is delayed with the increase in latitude. At around 20° N flowering would commence by November and at 30° N in December (Mangelsdorf, 1956).

During 2008-09 and 2009-10 mean minimum and maximum temperature range of 25.18-33.32°C, 25.47-32.82°C and 23.57-35.87°C (Mean 24.74-34.0°C) was observed in Thatta during September 2008, 2009 and 2010, respectively (Appendix-1, 2 & 3), which is not far beyond the required range of 23-30°C (Fasihi *et al.*, 1988) for most of the cane varieties during flowering inductive phase (September). It is why most of the cane varieties/genotypes could show flowering under natural conditions. However, profuse flowering in most of the sugarcane varieties/genotypes was observed in fields closer to sea shore than the off shore region. The extreme coastal climatic conditions of the area near to sea shore might have favored the sugarcane to produce high flowering intensity. Malik (2011) observed that during flower-induction period the mean maximum and minimum temperatures at Thatta are 33°C and 25°C, respectively, which are close to inductive ranges and diurnal variation in temperature is not much wide. Coleman (1969) stated that besides photoperiod, flowering initiation is considered to be highly temperature dependant phase. Flowering may be adversely affected in subtropical and temperate areas where the daily nighttime lows are below a certain critical temperature. Experimental work in photoperiod house has shown that temperature must be controlled between 21° and 26.5° C for successful induction in many varieties; while, field observations have shown that temperatures below 18.3° C during the initiation phase of sugarcane can prevent flowering if these temperatures continue for six nights or more night (Thompson, 1984); while, daytime temperature above 32.2° C during the start of initiation inhibited flowering in sugarcane (Moore

and Nuss 1987). Similarly, Yousuf and Malukra, (1964) concluded that night temperature of 21.5-23.0° C with day temperature of 26.5-30.5° C provide proper conditions of flowering.

In all the experiments sugarcane varieties/genotypes were planted during October. Flowering in the same varieties/genotypes was exhibited when they attained age of about thirteen to fifteen months. Early and late flowering in different varieties might be due to the difference in maturity period of the varieties/genotypes. It was observed that mother plants in all varieties/genotypes produced florets earlier in relation to side tillers. According to Colvill and Marshall, (1984) the age of sugarcane may promote or inhibit floral initiation. They further stated that sugarcane displays 'ripeness-to-flower', in common with other plants, in that stalks which are too young cannot be induced to flower. Older tillers also develop more florets per primary branch than younger ones. Coleman (1969) and Moore (1987) stated that for induction to take place sugarcane stalks must be physiologically mature or have reached the ripeness to flower stage.

It was observed that the cane flowering in areas of lower Sindh commenced from November and ended up to January. However, all the varieties behaved differently with regard to flowering time, duration and intensity. The thin type sugarcane varieties flower earlier as compared to medium thin varieties, which produced relatively late flowering in the season.

It was also observed that all the varieties flowered profusely under extreme coastal climatic conditions of Ghroabari closer to sea shore as compared to off shore area of Thatta. Fasihi *et al.*, (1988) reported that profuse arrowing (80-100%) was observed in fields closer to sea shore than off shore region.

Conclusion: The results of the study revealed that the latitude, temperature range during flowering induction phase (September), and photoperiod in agro-climatic conditions of lower Sindh are almost in line with the required optimum of latitude, temperature and photoperiod, which stimulated the cane flowering in many sugarcane varieties/lines, particularly extreme coastal conditions, where climatic conditions were more favourable to profuse cane flowering.

Many new sugarcane varieties/genotypes viz, B-43405, B-46-364, Co-413, HS-4, L-89-113, Lam-76-620, Lam-TJ-76-803, LHO-83-158 and Thatta-8 were identified for their matching, flowering behavior, intensity and time, which were not ever studied in Pakistan. The identification of different sugarcane varieties/genotypes with synchronized flowering dates can provide ease to the sugarcane breeders for planting of crossing blocks under natural conditions in the field and controlled conditions in the glass house for quality fuzzi production which helps in new sugarcane variety

development in the country. Thus, the natural potential of cane flowering in lower Sindh can open up avenues for fortified sugarcane cross breeding programme for sugarcane variety development in Pakistan.

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