RESEARCH ARTICLE

CYTO-GEOGRAPHICAL DIVERSITY IN GERMPLASM COLLECTIONS OF *ERIANTHUS ARUNDINACEUS* (REITZ.) JESWIET (A WILD RELATIVE OF SUGARCANE)

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Abstract

The genus *Erianthus* Michaux. is a member of '*Saccharum* complex'. *Erianthus arundinaceus* (Reitz.) Jeswiet is a tall, perennial grass, possess vegetative canes and broad leaves as sugarcane. *E. arundinaceus* attained greater emphasis in sugarcane breeding as it is a source for high fibre, biomass, multiple pest resistance, tolerance to drought and water logging and multiratoonability. It is highly utilized in prebreeding programmes to broaden the genetic base in the commercial varieties and also to develop multipurpose varieties to meet the emerging needs in various countries. ICAR- Sugarcane Breeding Institute holds the largest assemblage of about 220 accessions of *E. arundinaceus*, collected from India and other countries *viz*., Thailand, Indonesia, New Guinea, Pakistan, and Burma from various expeditions since 1915 to till date. In order to have chromosome map of all available collections of *E. arundinaceus* and to analyze their cytological diversity, ploidy of 204 clones has been determined through root tip squash method. The chromosomes count revealed the existence of three cytotypes with 2n=30, 2n=40 and 2n=60 (x=10). The cytotype 2n=30 (triploid) was found to occur with less frequency of 5.8 % among the clones of India, Pakistan and Burma. The cytotype 2n=40 distributed with a frequency of 34.3 % in India and Fiji. Majority of the clones exhibited 2n=60 (hexaploid) with the frequency distribution of 59.8 % in India, Indonesian Archipelago and Fiji. In India, among the 80 clones examined, the cytotype 2n=40 was predominant in distribution with a frequency of 86.2 %. The cytotype 2n=30 occurred in five clones from Orissa, Rajasthan and Punjab with the frequency of 5.8 %. Two clones of Andaman and Nicobar and SES 133, SES 342, IND 02-1208 and IND 84-105 possess 2n=60 with a frequency of 7.5 %. The evolution of these different ploidies might have occurred through functioning of restitution in gametes. Further studies on meiotic behavior, pollen mitosis of different cytotypes and segregation in the selfs are suggested.

Key words: *E. arundinaceus*, chromosome, ploidy, cytotype

Introduction

The genus *Erianthus* Michaux. is a member of '*Saccharum* complex'. It has originated in the Indo-Burma-Chinese region and it was involved in the origin of *Saccharum*, either directly or through the species of *Sclerostachya* and or *Narenga* (Mukherjee 1957). *Erianthus arundinaceus* (Reitz.) Jeswiet is a tall, perennial grass, possess vegetative canes and broad leaves as sugarcane. It is widely distributed in India, China, Burma, Thailand, Philippines, Indonesia, New Guinea (Amalraj and Balasundaram 2006; Nair and Praneetha 2006; Jackson and Henry 2011). *E. arundinaceus* attained greater emphasis in sugarcane breeding as it is a source of high fibre, biomass, multiple pest resistance, tolerance to drought and water logging and multiratoonability (Amalraj et al. 2013; Tisurta et al. 2011; Wu et al. 2014). It is highly utilized in prebreeding programmes to broaden the genetic base in the commercial varieties and also to develop multipurpose varieties to meet the emerging needs in various countries (Piperidis et al. 2000; 2010; Cai et al. 2005). ICAR- Sugarcane Breeding Institute holds the largest assemblage of about 220 accessions of *E. arundinaceus*, collected from

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all over India and other countries *viz*., Thailand, Indonesia, New Guinea, Pakistan, and Burma from various expeditions since 1915 to till date. The major schemes include SES (Spontaneum Expedition Scheme), IBPGR collections (International Bureau of Plant Genetic Resources), NATP (National Agricultural Technology Project) and Institute Collections (Sreenivasan et al. 2001). These collections are clonally maintained and continuously utilized in the sugarcane improvement programme. The cytological characterization of sugarcane germplasm has been initiated by Janakiammal (1936) in the clones of *S. spontaneum* and it became the continuous activity with new collections (Panje and Babu 1960; Praneetha 2007; Sobakumari 2007). However, limited clones of *E. arundinaceus* have been characterised for ploidy level (Mohan and Sreenivasan 1983). In order to have chromosome atlas of all available collections of *E. arundinaceus* and to analyze their cytological diversity, ploidy of 204 clones has been determined.

Materials and Methods

A total of 204 clones were taken for the study, of which 53 clones were redetermined. The clones belong to India, Burma, Pakistan, New Guinea, Indonesian archipelago and Fiji from the major collections of India (80 clones of IND series and SES) and Indonesian forms (108 clones) of Ik, IS, IM, IJ series (Sreenivasan et al. 2001) (Table 1). Root tip squash method was followed for mitotic preparation. Healthy root tips from single budded settlings raised in pots were utilized for the study. They were treated in a saturated solution of alpha -bromo naphthalene for two hours. After repeated washes, the root tips were fixed in 3 : 1 ethanol-acetic acid mixture at least for overnight and hydrolyzed in 1N Hydrochloric acid at 60°C for 13 minutes, treated with pectinase for 30 minutes and stained in leuco-basic fuchsin under dark for 30 minutes. Repeated washes with distilled water were given after each treatment. Deeply stained root tips were excised and squashed in 1% acetocarmine. Well spread mitotic chromosomes

Table 1. List of clones used for ploidy determination

Indian Collections
SES 3, SES 7, SES 17, SES 27, SES 75, SES 79, SES 89, SES 133, SES 136, SES 149, SES 153, SES 159, SES 181, SES 206, SES 288, SES 293, SES 342, SES 347
IND 84-105, IND 84-478, IND 85-547, IND 98-8, IND 99-871, IND 99-873, IND 99-875, IND 99-877, IND 99-880, IND 99-884, IND 99-886, IND 99-888, IND 99-889, IND 99-890, IND 99-892, IND 99-895, IND 99-901, IND 99-906, IND 99-907, IND 99-956, IND 99-957, IND 99-958, IND 99-965, IND 99-990, IND 99-991, IND 99-995, IND 00-1013, IND 01-1091, IND 01-1099, IND 01-1101, IND 01-1105, IND 01-1107, IND 01-1110, IND 01-1131, IND 01-1134, IND 01-1136, IND 02-1201, IND 02-1208, IND 03-1223, IND 03-1225, IND 03-1228, IND 03-1253, IND 03-1255, IND 03-1260, IND 03-1262, IND 04- 1335, IND 04-1388, IND 10-1575, IND 10-1591, IND 10-1594
Dr. Rakki 1, Dr. Rakki 2, Dr. Rakki 3, E. a Coimbatore, E. a Dr. N.B, E. a Pugalur, E. a Andamon and Nicobar, E. a B Munja, E. a Cuttack, E. a Lakshadweep , E. a Thornless

Indonesian collections
IJ 76-327, IJ 76-332, IJ 76-333, IJ 76-334, IJ 76-340, IJ 76-341, IJ 76-342, IJ 76-345, IJ 76-346, IJ 76-347, IJ 76-357, IJ 76-358, IJ 76-359, IJ 76-364, IJ 76-365, IJ 76-367, IJ 76-370, IJ 76-374, IJ 76-379, IJ 76-381, IJ 76-383, IJ 76-384, IJ 76-388, IJ 76-389, IJ 76-390, IJ 76-394, IJ 76-397, IJ 76-398, IJ 76-400, IJ 76-402, IJ 76-403, IJ 76-404, IJ 76-407, IJ 76-408, IJ 76-410, IJ 76-411, IJ 76-476, IJ 76-502, IJ 76-503, IJ 76-508, IJ 76-511, IJ 76-513 IK 76-5, IK 76-11, IK 76-22, IK 76-24, IK 76-25, IK 76-27, IK 76-44, IK 76-45, IK 76-48, IK 76-55, IK 76-62, IK 76-63, IK 76-75, IK 76-76, IK 76-78, IK 76-80, IK 76-81, IK 76-88, IK 76-90, IK 76-91, IK 76-92, IK 76-93, IK 76-99, IK 76-101, IK 76-103, IK 76-105, IK 76-109, IK 76-111 IM 76-223, IM 76-227, IM 76-247, IM 76-252, IM 76-253, IM 76-257 and E. a Glangong IS 76-120, IS 76-126, IS 76-133, IS 76-134, IS 76-139, IS 76-140, IS 76-142, IS 76-145, IS 76-149, IS 76-150, IS 76-153, IS 76-156, IS 76-158, IS 76-160, IS 76-162, IS 76-163, IS 76-169, IS 76-172, IS 76-174, IS 76-176, IS 76-178, IS 76-188, IS 76-189, IS 76-191, IS 76-193, IS 76-202, IS 76-205, IS 76-215, IS 76-218, IS 76-219, IS 76-220

Other Countries
E.a Layalpur, E.a Sarkender (Pakistan), EC 362-813, EC 362-814, Eri 2384, Eri 2798, Fiji 10, Fiji 54 (Fiji), 28 NG 7 (New Guinea), Mythan A, Mythan B, Mythan C (Burma), Timor wild, Tongarang, US 57- 3-1, IMP 1576

were counted and subsequently photographed through Carton CM 402T microsystem. The chromosome number of the clones were analyzed with passport data available in the catalogues of sugarcane genetic resources.

Results

The somatic chromosome count in 204 clones of *E. arundinaceus* revealed the existence of three cytotypes with 2n=30, 2n=40 and 2n=60. The cytotype 2n=30 (triploid) was found to occur with less frequency of 5.8 % in the clones of India, Pakistan and Burma. These clones include SES153, SES 288, SES 347, EA Munja, EA thornless (India), Mythan A, Mythan B, Mythan C (Burma), EA Layalpur and EA Sarkander (Pakistan) (Plate 1). Limited collections of Pakistan and Burma had shown the lower cytotype 2n=30 with the frequency of 0.98 % and 1.47% respectively. The cytotype 2n=40 distributed with frequency of

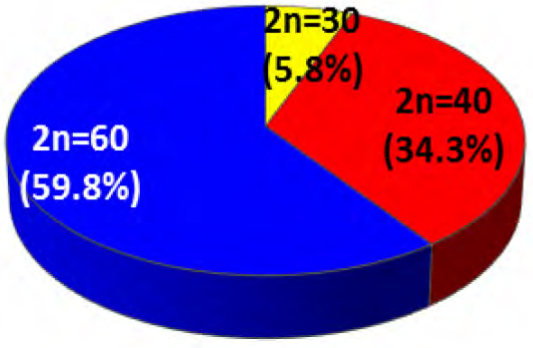

Fig. 1. Frequency distribution of cytotypes of *E. arundinaceus* in different counties

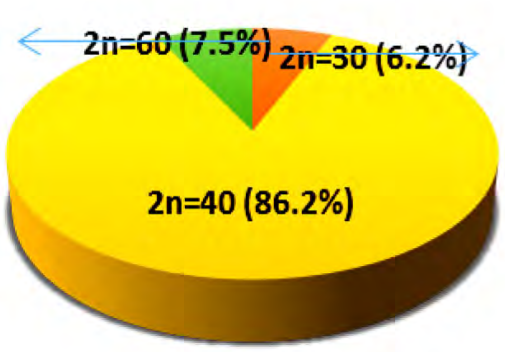

Fig. 2. Frequency distribution of cytotypes of *E. arundinaceus* in India

34.3 % in India and Fiji. Majority of the clones exhibited 2n=60 (hexaploid) with the frequency distribution of 59.8 %. It was distributed in India, Indonesian Archepelago and Fiji (Table 2 and Fig.1). The Indonesian collections exhibited the cytotype 2n=60 solitarily. The clone of Fiji 10 and Fiji 54 exhibited 2n=60 and 2n=40 respectively. The clone NG 77-7 of New Guinea had shown 2n=60.

Among the 80 clones of Indian origin examined, the cytotype 2n=40 was predominant in distribution with a frequency of 86.2 %. The cytotype 2n=30 occurred in five clones from Orissa, Rajasthan and Punjab with the frequency of 5.8 %. Two clones of Andaman and Nicobar and SES 133, SES 342, IND 02-1208 and IND 84-105 possessed 2n=60 with a frequency of 7.5 % (Table 3 and Fig. 2). Among the three major collections of Tamil Nadu, Kerala and Orissa in India, the clones of Tamil Nadu exhibited only 2n=40.

Discussion

Cytological characterization of '*Saccharum* complex' revealed the chromosome number from 2n=20 to 2n=194 (Moore 2014). *Erianthus* has mostly euploid series with lower chromosome numbers in multiples of 10 (x=10). Species of *Erianthus* have the lowest chromosome number among the related genera, *Saccharum, Sclerostachya* and *Narenga* (Sreenivasan et al. 2001). A relatively wide range of somatic chromosome number

Table 2. Distribution of cytotypes of *E. arundinaceus* in the germplasm collection

S. No.	Country	Cytotype			Total no. of clones
		2n=30	2n=40	2n=60	
1	India	5 (2.45%)	69 (33.81%)	6 (2.90%)	80
2	Indonesia	–	–	108 (52.94%)	108
3	Pakistan	2 (0.98%)	–	–	2
4	Burma	3 (1.47%)	–	–	3
5	Fiji	_	1 (0.49%)	1 (0.49%)	2
6	Others	2 (0.98%)	–	7 (3.43%)	9
	Total	12 (5.88%)*	70 (34.30%)*	122 (59.78%)*	204

* Denotes frequency of cytotypes

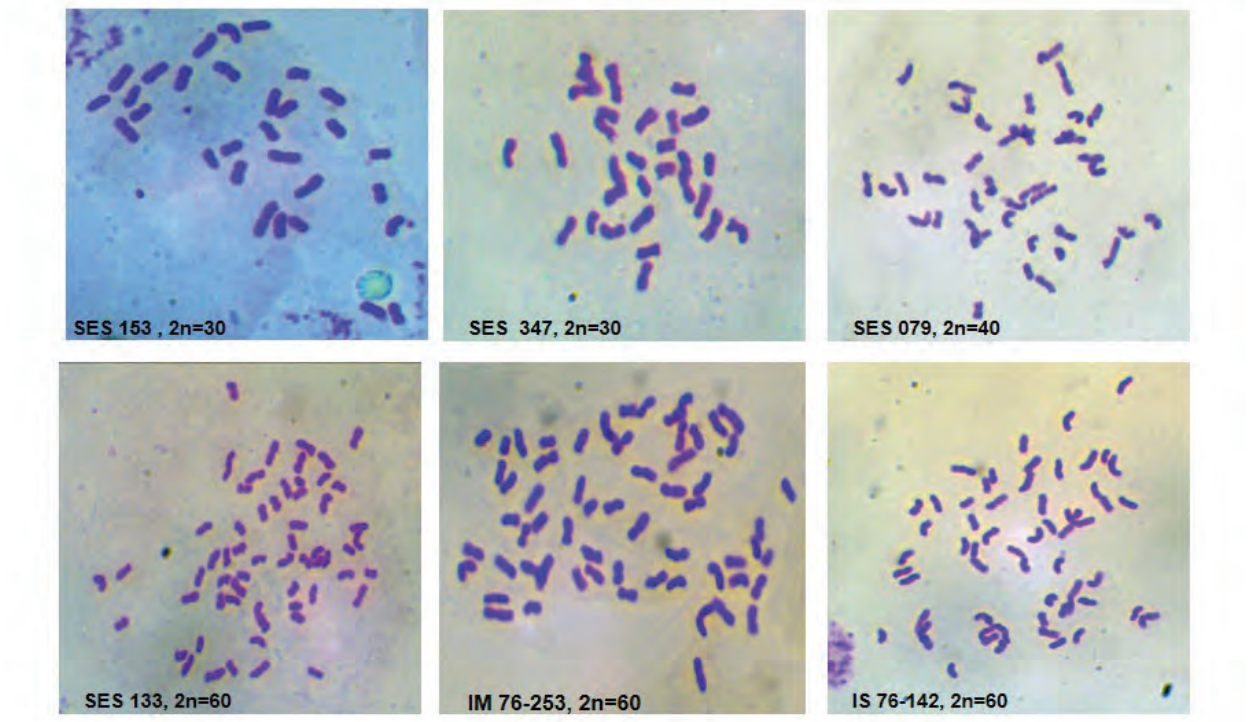

Plate. 1. Somatic chromosome number of clones of *E. arundinaceus*

Table 3. Distribution of cytotypes of *E. arundinaceus* from India

S. No.	State	Cytotype			Total no. of clones
		2n=30	2n=40	2n=60	
1	Tamil Nadu	–	21 (26.25%)	–	21
2	Kerala	–	18 (22.50%)	1(1.25%)	19
3	Orissa	1 (1.25%)	12 (15.00%)	–	13
4	Karnataka	–	4 (5.00%)	–	4
5	Andhra Pradesh	–	1 (1.25%)	1(1.25%)	2
6	West Bengal	–	4 (5.00%)	–	4
7	Uttar Pradesh	1 (1.25%)	–	–	1
8	Punjab	1 (1.25%)	–	–	1
9	Rajasthan	–	–	1(1.25%)	1
10	Haryana	–	1 (1.25%)	–	1
11	Arunachal Pradesh	–	1 (1.25%)	–	1
12	Madhya Pradesh	–	1 (1.25%)	–	1
13	Andaman and Nicobar	–	3 (3.75%)	2 (2.50%)	5
14	Lakshwadeep	–	1 (1.25%)	–	1
15	Others	2 (2.50%)	2 (2.50%)	1 (1.25%)	5
	Total	5 (6.25%)*	69 (86.25%)*	6 (7.50%)*	80

* Denotes frequency of cytotypes

(2n=20, 30, 40, 50 and 60) has been reported in the genus *Erianthus.* In *E. arundinaceus,* the chromosome number ranges from 2n = 20 - 60 with 4 cytotypes, 2n = 20, 30, 40 and 60. The cytotype 2n = 20 is a rare cytotype reported only in China, while the cytotypes 2n = 30, 40 and 2n=60 found to be distributed in India, while the 2n = 60 was predominant in Indonesian collections (Mohan and Sreenivasan 1983; Wu and Raven 1994; Yang et al. 1997; Cai et al. 2004). The present study revealed the existence of three cytotypes, 2n =30, 40 and 60. Though the majority of island forms are hexaploids with 2n=60, presence of few clones with 2n=40 indicated the origin of 2n=60 from the clones with 2n=40. In Thailand also two cytotypes 2n=40 and 2n=60 were observed by Tagane et al. (2011). Presence of 2n=40 in the mainland and island indicates their geographical proximity (Nair and Praneetha 2006).

The Indian collections were more diverse with presence of three cytotypes. However, the lower cytotype 2n=30 was observed only in older collections of 1915-1951 in the areas of Orissa, Utter Pradesh, Punjab and Pakistan with a frequency of 6.2%. Expedition strategies are to be planned for collection of this cytotype based on monograph/flora of different states. As the lowest cytotype 2n=20 was as observed as rare occurrence, the evolution of different ploidies might have occurred through functioning of restitution in gametes (male or female or both). Androgenetic lines have been observed in intergeneric crosses involving *E. arundinaceus* (Anon 1991; 2011). Further studies on meiotic behavior, pollen mitosis of different cytotypes and segregation in the selfs need to be investigated for confirmation.

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