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Karyotype Analysis of Four Varieties of White Petioles Leaf Beet

Bo Sun[1)], Yuxiao Tian[1)], Xue Xia[1)], Fen Zhang[1)], and Haoru Tang[1, a)]

[1]*College of Horticulture, Sichuan Agricultural University, Chengdu 611130, China.*

[a)]Corresponding author email: htang@sicau.edu.cn

Abstract. Leaf beet was one of the important leaf vegetables which had important ornamental value, and was popular with consumers. There were many kinds of leaf beet existed in the world. However, leaf beet with white petioles is the most common type generally planted by farmers. In this study, we try to obtain cytological parameters on four varieties of white petioles leaf beet. The results showed that the relative length of W1 was ranged from 9.12% to 12.38% and max arm ratio was determined 1.62. The karyotype asymmetry index was 57.12%, and the karyotype formula was 2n=2x=18=18m (2SAT). The relative length of W2 was ranged from 10.07% to 12.36% and max arm ratio was determined 1.87. The karyotype asymmetry index was 60.27%, and the karyotype formula was 2n=2x=18=12m+6sm (2SAT). The relative length of W3 was ranged from 9.13% to 13.25% and max arm ratio was determined 1.84. The karyotype asymmetry index was 60.22%, and the karyotype formula was 2n=2x=18=12m+6sm (2SAT). The relative length of W4 was ranged from 10.00% to 12.33% and max arm ratio was determined 1.85. The karyotype asymmetry index was 58.37%, and the karyotype formula was 2n=2x=18=16m+2sm (2SAT).The karyotype characteristics of four varieties of leaf beet were all type 1A. The findings revealed the karyotypic characteristics of leaf beet from the cytogenetic aspects.

Key words: Leaf beet, White petioles, Varieties, Chromosome, Karyotype.

INTRODUCTION

Leaf beet (Beta vulgaris var. cicla) belongs to Chenopodiaceae, and it is the variety of beet. Leaf beet is origin from Mediterranean coast, so it prefer warm and humid climate[1]. And it is the common leaf vegetable consumed in summer, for containing abundant nutrients. Besides, leaf beet had good high yield, disease resistance and adaptability. It is widely planted in China because of its good comprehensive characters. Varieties of leaf beet exist in the world, and they present significant difference in appearance. However, white petioles leaf beet which had many varieties was the type of most planted. Karyotype analysis is a basic method to study chromosomes, it is a basic work in cytogenetics research. It has been reported that sugar beet has diploid, triploid and tetraploid[2]. However, the chromosomes of different types of plants, even different cultivars vary widely. In this experiment, the karyotype analysis was carried out on four varieties of white petioles leaf beet to reveal theirs chromosome composition and diversity, and to provide the basis for determining the genetic composition of leaf beet.

MATERIALS AND METHODS

Plant Materials

There are four varieties of white petioles leaf beet were used as experimental material, including the representative Beta vulgaris cv. Fuda numbering W1, and three landrace from Yibin, Meishan and Wulong, respectively numbering W2, W3 and W4.

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Chromosome Preparation

The seeds were soaked for 2 h, then cultured in dark in petri dishes with moist filter paper at 25 °C incubator to the root length of 1-1.5 cm and cut root tips of about 1 cm. Pretreated in 0.002 mol·L-1 8-hydroxyquinoline at 4 °C for 9 h, and fixed in Carnoy's solution (acetic acid: absolute ethanol, 1:3, v/v) at 4 °C for 24 h, subsequently, the root tips were macerated in 1 mol·L-1 hydrochloric acid at 60 °C for 12 min, stained with Carbol Fuchsin, and observed under microscope[3].

Karyotype Analysis

Chromosome counts were performed on 30 well-spread metaphase chromosomes from five different root tips. Karyotype analysis referred to the standard of Li et al.[4]. Following parameters were calculated: chromosome relative length, arm ratio, type of chromosomes, index of chromosomes relative length and centromere index. karyotypic formula referred to the standard of Levan et al.[5], and the asymmetry coefficient of karyotypes was calculated by the method of Arano[6], the karyotypes were calculated according to Stebbins' standard[7].

RESULTS

Chromosome Number of Four Varieties of White Petioles Leaf Beet

Metaphase chromosomes and karyotype of four varieties of white petioles leaf beet are shown in Fig. 1, detailed karyotype parameters of chromosome are listed in Table 1. The chromosome number of the four varieties of white petioles leaf beet were 2n=18.

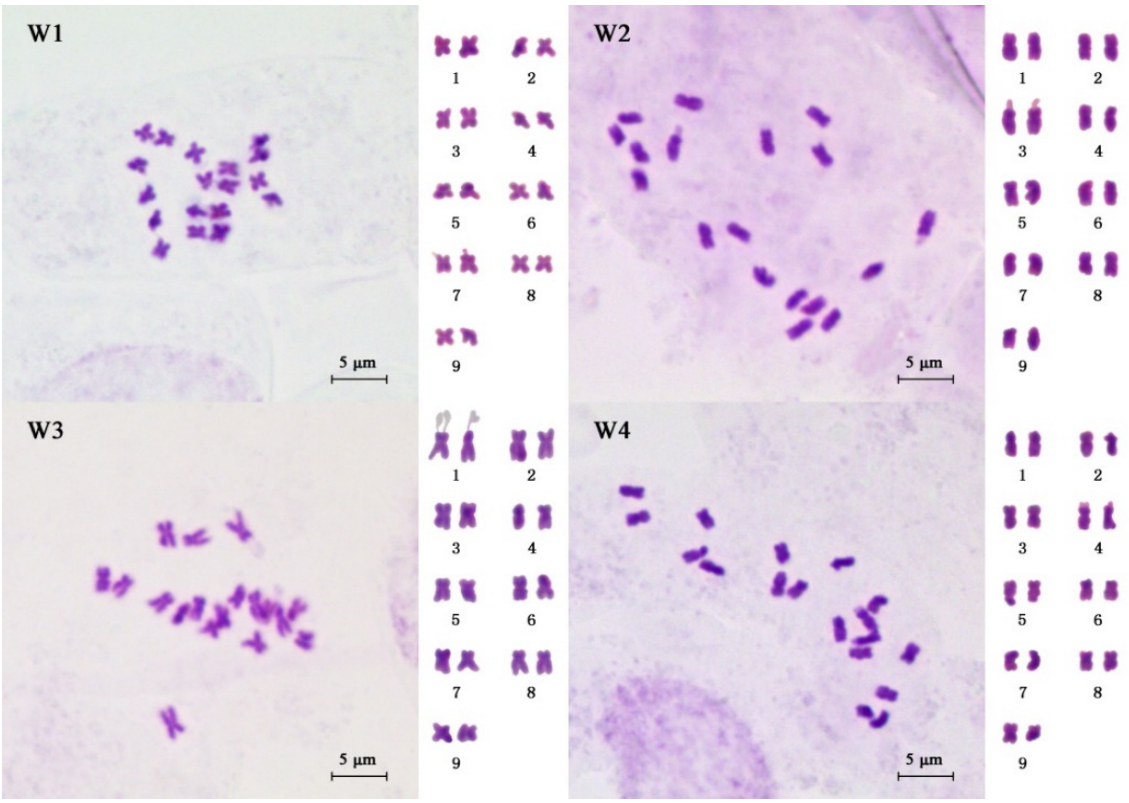

FIG 1. Metaphase chromosomes and karyotype of four varieties of white petioles leaf beet root tips
Note: The number 1-9 represent chromosome No.

TABLE 1. Karyotype parameters of chromosome of four varieties of white petioles leaf beet

No.	Chromosome No.	Relative length / %			Index of relative length	Type of relative length	Arm ratio	Centromere index / %	Centromere type
		Short arm	Long arm	Total length					
	1	5.53	6.85	12.38	1.11	M2	1.24	44.69	m
	2	4.77	7.27	12.04	1.08	M2	1.53	39.59	m
	3	5.80	6.06	11.86	1.07	M2	1.05	48.90	m
	4	5.40	6.44	11.84	1.07	M2	1.19	45.63	m
W1	5	4.27	6.90	11.17	1.00	M1	1.62	38.20	m
	6	5.37	5.76	11.13	1.00	M1	1.07	48.24	m
	7*	3.97	6.43	10.39	0.94	M1	1.62	38.18	m
	8	3.93	6.15	10.08	0.91	M1	1.56	39.00	m
	9	3.84	5.27	9.12	0.82	M1	1.37	42.16	m
	1	5.14	7.22	12.36	1.11	M2	1.41	41.58	m
	2	5.66	6.31	11.97	1.08	M2	1.11	47.28	m
	3*	4.13	7.28	11.41	1.03	M2	1.76	36.19	sm
	4	4.63	6.68	11.31	1.02	M2	1.44	40.94	m
W2	5	4.12	7.00	11.12	1.00	M1	1.70	37.06	m
	6	4.22	6.87	11.09	1.00	M1	1.63	38.04	m
	7	3.69	6.67	10.36	0.93	M1	1.80	35.65	sm
	8	4.63	5.68	10.31	0.93	M1	1.23	44.93	m
	9	3.51	6.56	10.07	0.91	M1	1.87	34.86	sm
	1*	4.79	8.45	13.25	1.19	M2	1.76	36.19	sm
	2	4.68	8.02	12.70	1.14	M2	1.71	36.85	sm
	3	4.88	6.42	11.30	1.02	M2	1.32	43.18	m
	4	4.37	6.53	10.90	0.98	M1	1.49	40.11	m
W3	5	4.27	6.46	10.73	0.97	M1	1.51	39.79	m
	6	4.91	5.81	10.72	0.96	M1	1.18	45.79	m
	7	4.02	6.67	10.69	0.96	M1	1.66	37.61	m
	8	3.72	6.85	10.58	0.95	M1	1.84	35.21	sm
	9	4.13	5.00	9.13	0.82	M1	1.21	45.25	m
	1	5.24	7.09	12.33	1.11	M2	1.35	42.49	m
	2	4.97	7.18	12.16	1.09	M2	1.44	40.90	m
	3	5.01	6.51	11.53	1.04	M2	1.30	43.47	m
	4*	4.03	7.46	11.49	1.03	M2	1.85	35.06	sm
W4	5	4.17	6.99	11.16	1.00	M1	1.68	37.36	m
	6	4.66	6.01	10.67	0.96	M1	1.29	43.70	m
	7	4.88	5.73	10.60	0.95	M1	1.17	46.00	m
	8	4.31	5.76	10.07	0.91	M1	1.34	42.77	m
	9	4.36	5.63	10.00	0.90	M1	1.29	43.65	m

Note: * means the chromosomes with satellites, and the length of satellites is not included in the chromosome length.

Karyotype Analysis

The chromosome relative length of W1 ranged from 9.12% to 12.38%, W2 ranged from 10.07% to 12.36%, W3 ranged from 9.13% to 13.25% and W4 ranged from 10% to 12.33%, and chromosome length ratio of W1, W2, W3 and W4 were 1.36, 1.23, 1.45 and 1.23, respectively. The relative length constitution of W1, W2 and W4 was 8M2+10M1, and W3 was 6M2+12M1. The centromeric index of W1 ranged from 38.18% to 48.90%, and arm ratio ranked from 1.05 to 1.62. The centromeric index of W2 ranged from 34.86% to 47.28%, and arm ratio ranked from 1.11 to 1.87. The centromeric index of W3 ranged from 35.21% to 45.79%, and arm ratio ranked from 1.18 to 1.84. The centromeric index of W4 ranged from 35.06% to 46.00%, and arm ratio ranked from 1.17 to 1.85.There were three pairs (the fourth chromosome) of submetacentric chromosomes (sm) and other six pairs of metacentric chromosomes (m) in W2 and W3, and one pair of submetacentric chromosomes (sm) and eight pairs of metacentric chromosomes (m) in W4, while W1 only consisted by metacentric chromosomes (m). Moreover, the four varieties of white petioles leaf beet all had one pairs of satellites, and the two satellites were observed at the seventh, third, first and fourth pair of chromosomes, respectively, in W1, W2, W3 and W4. Besides, the satellites of W2, W3 and W4

were all located in submetacentric chromosomes. The karyotype formula of W1 was 2n=2x=18=18m(2SAT), W2 and W3 was 2n=2x=18=12m+6sm(2SAT), and W4 was 2n=2x=18=16m+2sm(2SAT). Karyotype asymmetry index of W1 was 57.12%, W2 was 60.27%, W3 was 60.22%, and W4 was 58.37%. The karyotype characteristics of four varieties of white petioles leaf beet fell into type 1A according to Stebbins's classification criteria. The chromosome idiogram of W1, W2, W3 and W4 are shown in Fig. 2.

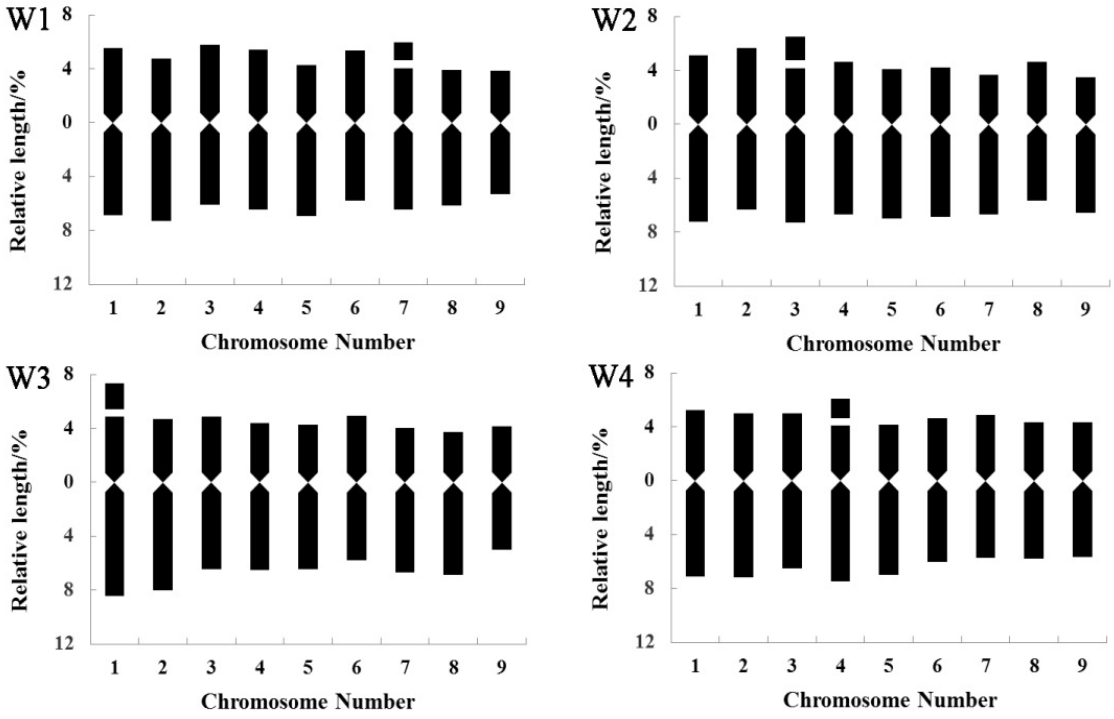

FIG 2. Chromosome ideogram of four varieties of white petioles leaf beet

SUMMARY

All of the four varieties of white petioles leaf beet were diplomat with 18 chromosomes, and they have one pair of satellites. The relative length type of four varieties of white petioles leaf beet was all consisted by M1 and M2, and the chromosomes type of them was mainly composed by metacentric chromosomes (m). Besides, the karyotype characteristics of four varieties of white petioles leaf beet all fell into type 1A. However, diversities were also existence among them. For example, the satellites were observed at different chromosomes. Furthermore, the karyotype asymmetry index of W1, W2, W3 and W4 was 57.12%, 60.27%, 60.22% and 58.37%, respectively. The basic evolutionary trend of plant karyotypes is from symmetry to asymmetry. Thus, primitive plants have symmetrical karyotypes. And the more asymmetric the plant karyotype is, the higher its degree of evolution [8]. In our study W2 and W3 were similar on evolutionary degree and they were senior than other two varieties according to the karyotype asymmetry index and average arm ratio. Our research provides a reference for the genetic evolution of white petioles leaf beet.

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