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ORIGINAL RESEARCH ARTICLE

Karyomorphological and stomatal studies in two varieties of *Avena sativa* L.

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Abstract: The varieties of *Avena sativa* L. var. RO-19 and *Avena sativa* L. Kent were collected from Birsa Agriculture University, Ranchi, Jharkhand for the studies on karyotype and stomatal characters. The varieties under investigation were reported to show hexaploid set of 42 chromosomes (2n = 2*x* = 42) and were asymmetrical in nature. Graminaceous type of stomata were found in these varieties of *Avena sativa* L. with variation in size and distribution. The stomatal index was found to be maximum in *Avena sativa* L. var. RO-19 at apex portion of dorsal surface stomatal length and width was found to be maximum in *Avena sativa* L. var. Kent at apex portion of ventral surface.

Key Words: *Avena sativa* L; Hexaploid, Karyotype; Graminaceous; Stomatal index.

Introduction

Avena sativa L. commonly known as oats "jai" or "javi" and belongs to family Poaceae. Plants have been used as medicines for curing various ailments since time immemorial.

It is an economically and medicinally important plant. The dietry fiber complex with its antioxidant and other phyto-chemicals is effective against cardiovascular disease and some cancer[1].

Information on the karyotype studies in *Avena sativa* L. are very scanty. The karyotype analysis and stomatal studies form an important tool in taxonomic identifications. Keeping these views, the present investigation was undertaken to unravel the stomatal index and karyomporphological data.

Stomatal study of two varieties of *Avena sativa* L. and the detailed karyotype analysis to assess their evolutionary status. The stomatal character and detailed karyotype analysis of the two varieties of *Avena sativa* L. collected from Ranchi district of the State Jharkhnad in India was not performed earlier. Stomata are important features for taxonomic studies therefore, it was found necessary to do the cytology and stomatal studies of the two varieties of *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent.

Materials and Methods

The varieties of *Avena sativa* L. were collected from the Plant Breeding and Genetic Department of Birsa Agriculture University, Ranchi, Jharkhand, India. Fresh and healthy seeds of *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent were soaked in water and left for 1 - 2 days. The root apices of about 1 - 4 mm in length were excised from the seeds between 2:00 pm under sunlight and were pretreated with 1,4 para di-chloro-benzene for 6 hours at 15°C. The pretreated root apices were transferred to fixative 1:3 aceto alcohol (Cranoy's fluid) for 24 hours. After 24 hours, the root apices were transferred to 70% alcohol for preservation.

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The photomicrograph was taken using Nikon SLR Camera. The data were statistically analysed of the following variety. Karyotype classification was made according[2]. The total form percent i.e. is the average degree of symmetry over the whole karyotype was calculated according to[3].

Stomatal studies were done by usual method of peeling of epidermis from fresh leaves. Peeling of the epidermis was done at apex, middle and base portion on dorsal and ventral surface of leaf[4]. The epidermis peels were stained with aqueous safranin and mounted in glycerin. The stomatal index was calculated by counting the number of stomata and the epidermal cells. Length and width of stomata were measured with the help of ocular and micrometer.

$$\text{Stomatal index} = \frac{\text{Number of stomata}}{\text{Number of stomata + Number of epidermal cell}} \times 100$$

Results

The leaves of both *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent were long and pointed. Graminaceous types of stomata were found in both the varieties. Stomatal index was found to be maximum at the apex of dorsal surface (32.034 ± 1.49µm) and was minimum (17.22 ± 0.74µm) at the base of ventral surface of *Avena sativa* L. var. RO-19. Stomatal length of *Avena sativa* L. var. Kent was maximum (58.56 ± 0.484µm) at apex of ventral surface and minimum (21.80 ± 0.55µm) at base of dorsal surface of Avena sativa L. var. RO-19. The width was maximum (14.016 ± 0.275µm) at apex of dorsal surface of *Avena sativa* L. var. Kent and was minimum (6.00 ± 0.00µm) at base of dorsal surface of *Avena sativa* L. var. RO-19 (Table 1).

The varieties of *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent were hexaploid cultivar with 2n = 2x = 42 chromosome. Chromosome of *Avena sativa* L. var. RO-19 were small measuring 0.96 to 6.528µm in length and in *Avena sativa* L. var. Kent were 0.96 to 6.72µm in length. Nearly sub medium chromosome were found in somatic complement of *Avena sativa* L. var. RO-19 while in *Avena*

sativa L. var. Kent nearly sub medium and sub medium was found in somatic complement. The karyotype formula of *Avena sativa* L. var. RO-19 x=7=5nsm (-) + 2nsm (+) and the karyotype formula of *Avena sativa* L. var. Kent was x=7=6nsm (-) + 1sm. The total haploid chromatin length was 50.34µm in *Avena sativa* L. var. RO-19 and 45.12µm in *Avena sativa* L. var. Kent (Table 2). The Total form percentage, Gradient index, Symmetry index, Disparity index and Centromeric index are depicted in table 3. The Gradient index of *Avena sativa* L. var. RO-19 was 14.28% and *Avena sativa* L. var. Kent was recorded as 14.70% (Table 3). The Gradient index of both the varieties was less than 30.

Table 1 :Stomatal index, Length and Width (µ) of stomata in dorsal and ventral surface of the two varieties of *Avena sativa* L. var. RO-19 and Kent

Surface of Leaf	Type	Apex Portion of Leaf			Middle Portion of Leaf			Base Portion of Leaf		
		S.I.	Length (µ)	Width (µ)	S.I.	Length (µ)	Width (µ)	S.I.	Length (µ)	Width (µ)
Dorsal	RO-19	32.03 ± 1.49	29.30 ± 0.42	7.10 ± 0.17	26.17 ± 0.73	26.30 ± 0.63	8.00 ± 0.00	21.87 ± 1.58	21.80 ± 0.55	6.00 ± 0.00
	Kent	23.68 ± 1.38	49.34 ± 0.85	14.02 ± 0.27	21.10 ± 1.58	51.65 ± 1.27	12.67 ± 0.39	19.88 ± 1.82	53.57 ± 0.87	13.44 ± 0.27
Ventral	RO-19	19.66 ± 1.52	25.00 ± 0.37	7.10 ± 0.09	18.11 ± 1.34	25.60 ± 0.69	6.90 ± 0.22	17.22 ± 0.74	25.80 ± 0.48	6.80 ± 0.12
	Kent	21.89 ± 1.46	58.56 ± 0.48	12.86 ± 0.27	20.64 ± 1.39	51.36 ± 2.62	12.86 ± 0.27	19.63 ± 1.89	51.61 ± 2.59	12.67 ± 0.00

S.I=Stomatal index

Table 2: Karyomorphological Data related Avena sativa L. var. RO-19 and Kent

Species and varieties	Chrom. No.	Arm Length		Chromosome Length in (µ)	Arm ration L/S	R.L. in (µ)	F%	TCI	Ci	Classification
		Long	Short							
Avena sativa L. var. RO-19	I	6.528 ± 0.326	2.304 ± 0.591	8.832 ± 0.427	2.800	100	26.09	19.57	36.57	nsm (-)
	II	5.952 ± 0.174	2.496 ± 0.523	8.448 ± 0.427	2.385	95.65	28.26	18.72	39.62	nsm (-)
	III	5.568 ± 0.174	1.728 ± 0.326	7.296 ± 0.445	3.200	82.54	19.56	16.17	27.43	nsm (+)
	IV	4.800 ± 0.276	1.344 ± 0.214	6.144 ± 0.349	3.571	69.56	15.22	13.62	21.33	nsm (+)
	V	4.032 ± 0.174	1.728 ± 0.326	5.760 ± 0.275	2.330	65.22	19.56	12.76	27.43	nsm (-)
	VI	3.456 ± 0.214	1.344 ± 0.214	4.800 ± 0.390	2.571	54.35	15.22	10.64	21.33	nsm (-)
	VII	1.920 ± 0.000	0.960 ± 0.000	2.880 ± 0.000	2.000	32.61	10.87	6.39	15.24	nsm (-)
Avena sativa L. var. Kent	I	6.720 ± 0.467	3.840 ± 0.233	10.56 ± 0.467	1.750	100	36.36	20.98	53.41	nsm (-)
	II	5.760 ± 0.000	3.072 ± 0.326	8.496 ± 0.599	1.880	80.45	29.09	16.88	42.69	nsm (-)
	III	5.570 ± 0.170	2.304 ± 0.445	7.872 ± 0.326	2.417	74.54	21.82	15.64	32.04	nsm (-)
	VI	4.800 ± 0.275	2.496 ± 0.349	7.296 ± 0.213	1.923	69.09	23.58	14.49	34.71	nsm (-)
	V	4.608 ± 0.174	1.728 ± 0.508	6.336 ± 0.524	2.670	60.00	16.36	12.59	24.03	nsm (-)
	VI	4.032 ± 0.174	1.920 ± 0.000	5.952 ± 0.174	2.100	56.36	18.18	11.82	26.70	nsm (-)
	VII	2.880 ± 0.000	0.960 ± 0.000	3.840 ± 0.000	3.000	36.36	9.09	7.63	13.35	sm

R.L. = Relative Length nsm = nearly sub medium
F% = For Percentage sm = sub medium
TCI = Total Chromatin Index
Ci = Centro Meric Index
Di=Disparity index

Table 3: Data related to karyotype of *Avena sativa* L. variety

Species and varieties	TCL in (µ)	TF%	GI%	SI%	DI%
Avena sativa L. var. RO-19	50.34	32.41	14.28	47.45	75
Avena sativa L. var. Kent	45.12	26.98	14.70	37.78	74.36

TCL = Total Chromatin Length GI% = Gradient Index
TF% = Total Form Percentage SI% = SymmetryIndex
Di=Disparity index

Figure 5: Column graph showing comparative stomatal index, length and width (□) of stomata in dorsal surface of *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent

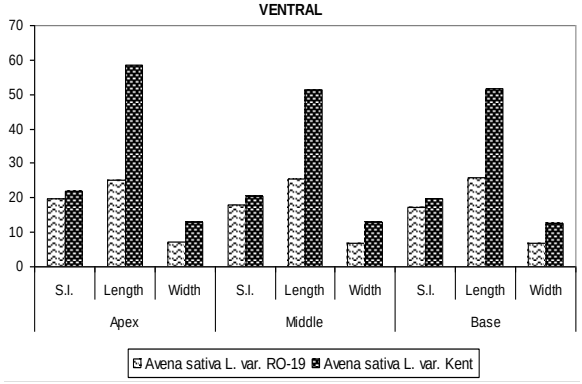


Figure 6: Column graph showing comparative stomatal index, length and width (□) of stomata in ventral surface of *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent

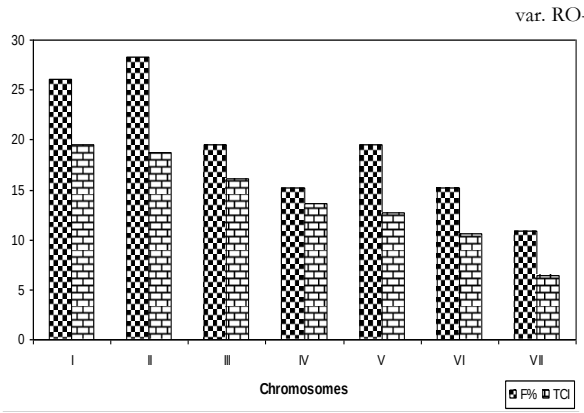


Figure 7: Column graph showing comparative Form Percentage (F%) and Total Chromatin Index (TCI) in *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent

var. Kent

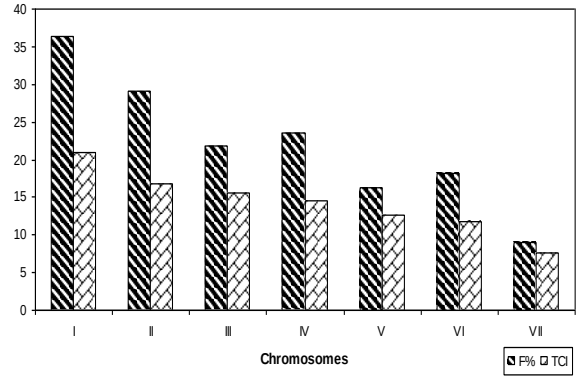
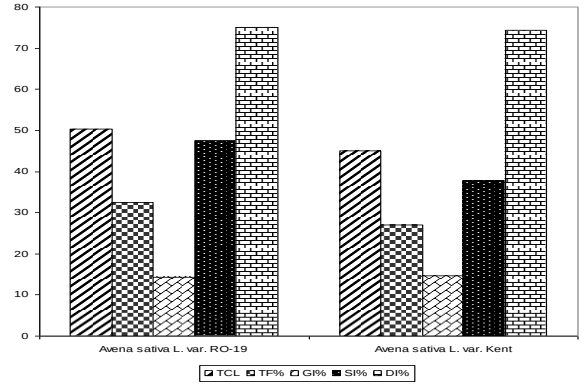


Figure 8: Column graph showing comparative Total Chromatin Length (in μ), TF%, GI%, SI% and DI% in different varieties of *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent



Discussion

Various studies have emphasized the significance of foliar epidermal anatomy in the systematic of many plant groups[5,6] thus suggesting that leaf surface pattern, anatomical features and structures are genetically controlled.

The stomata were Gramineceaous type with subsidiary cells. Each stoma was surrounded by two kidney shaped guard cells, of which the middle portion were narrow. There was slight difference in all the parameter i.e. stomatal index, stomatal length and stomatal width of leaf on both dorsal and ventral surfaces.

The leaf epidermis is the second most important character after cytology for solving taxonomic problem[7]. Stomatal function is important beyond the level of plant physiology and functions, and its significance reaches from evolutionary history to atmospheric and environmental science. This investigation concludes that stomatal variation in these varieties of *Avena sativa* L. is of taxonomic significance.

The varieties of *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent under investigation was hexaploid, showing 2n = 2x = 42 chromosome. Normal mitotic division were observed in all the examined cells. Neither the secondary constriction nor the satellites were observed.

The two varieties of *Avena sativa* L. var. RO-19 and *Avena sativa* L. Kent have low symmetrical index values, thus indicating the tendencies towards asymmetry. Gradient index in both the varieties are below 30. Therefore, they are considered highly asymmetrical as GI value was less than 30. Asymmetrical karyotypes are considered advanced[8].

Conclusion

On the basis of above findings, it may be concluded that in both the varieties of *Avena sativa* L. var. RO-19 and var. Kent, the stomata were of graminaceous type and the chromosome were asymmetrical in nature, which reflects their tendency towards advancement.

Research highlights

The investigation reveals that in the two varieties of *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent the stomata were of graminaceous type.

The chromosomes were asymmetrical showing their tendency towards advancement.

Limitation

The two varieties of *Avena sativa* L. var. RO-19 and *Avena sativa* L. var. Kent were collected from Birsa Agriculture University, Ranchi (Jharkhand, India), their stucture of stomata and cytological studies were performed in the Laboratory of University Department of Botany, Ranchi University, Ranchi.

Recommendation

The structure of stomata and the karyotype analysis gives an authentic data for the preparation of chromosome atlas and its taxonomic position.

Funding and Policy aspects

Preparation of chromosomes atlas and taxonomic position of cereals and medicinal plants of Ranchi, Jharkhand, India.

Justification of Research

Taxonomic position and chromosome atlas.

Acknowledgement

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