Table 1 *Coriolis coupling coefficients*

Molecule	Coupling $A' \times A''$				Coupling $A' \times A'$		Coupling $A'' \times A''$
	$-\zeta^x_{15}$	ζ^x_{16}	$-\zeta^z_{15}$	ζ^z_{16}	ζ^y_{12}	$-\zeta^y_{23}$	
	ζ^x_{25}	$-\zeta^x_{26}$	$-\zeta^z_{25}$	$-\zeta^z_{26}$	$-\zeta^y_{13}$	ζ^y_{24}	ζ^y_{56}
	$-\zeta^x_{35}$	$-\zeta^x_{36}$	ζ^z_{35}	$-\zeta^z_{36}$	ζ^y_{14}	$-\zeta^y_{34}$	
	ζ^x_{45}	$-\zeta^x_{46}$	ζ^z_{45}	ζ^z_{46}			
$SeOF_2$	0.1123	0.4831	0.1433	0.6731	0.1671	0.2543	0.3720
	0.7896	0.3832	0.5830	0.5315	0.1619	0.4995	
	0.0896	0.1297	0.0543	0.9786	0.7881	0.4826	
	0.5334	0.6412	0.3422	0.1213			
$SeOCl_2$	0.1614	0.6179	0.1694	0.7012	0.0903	0.0094	0.2151
	0.5514	−0.5329	0.4615	0.9757	0.2655	0.1796	
	0.4728	0.1966	0.3702	0.8079	0.9054	0.5179	
	0.5462	0.7965	0.2502	0.2214			
$SeOBr_2$	0.2037	0.6415	0.2141	0.7199	0.2385	0.5428	0.0720
	0.7467	0.1985	0.5236	0.6994	0.2351	0.3289	
	0.2517	−0.0472	0.1905	0.6302	0.9240	0.3182	
	0.5138	0.4930	0.2334	0.2093			

Table 2 *Centrifugal distortion constants (k Hz)*

Molecule	D_J D_k	$-D_{JK}$ $-R_5$	$-R_6$ $-\delta_J$
$SeOF_2$	5.0026	10.3375	0.7538
	11.2476	3.0227	2.8243
$SeOCl_2$	2.0054	−0.2635	0.4138
	33.2035	2.8909	0.4343
$SeOBr_2$	10.3526	31.0463	2.5484
	51.8746	10.0080	6.3686

the cases studied here. ζ^x_{25} and ζ^z_{25} show strong coupling between species concerned. It is interesting to note that ζ^x_{45}, ζ^x_{46}, ζ^z_{45} and ζ^z_{46} assume almost equal values in selenyl halides. The centrifugal distortion constants are given in table 2. The values appear to be resonable. R_5, R_6 and δ_J assume negative values for all the case while D_{JK} is either negative or very small as observed from the table. Since there are no experimental values available, a comparison is not possible both for coriolis and centrifugal distortion constants.

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1. Milne, J., *Spectrochim. Acta*, 1982, **A38**, 569.
2. Decius, J. C., *J. Chem. Phys.*, 1963, **38**, 241.
3. Cyvin, S. J., *Molecular vibrations and mean square amplitudes*, Elsevier, Amsterdam, 1968.
4. Mohan, S. and Ravikumar, K. G., *Indian J. Phys.*, 1983, **B57**, 303.
5. Meal, J. K. and Polo, S. R., *J. Chem. Phys.*, 1956, **24**, 1119, 1126.
6. Cyvin, S. J., Cyvin, B. N. and Hagen, G., *Z. Naturforsch*, 1968, **23a**, 1649.
7. Kivelson, D. and Wilson, E. B. Jr, *J. Chem. Phys.*, 1952, **20**, 1575.
8. Kivelson, D. and Wilson, E. B. Jr, *J. Chem. Phys.*, 1953, **21**, 1229.
9. Mohan, S. and Durai, S., *Proc. Indian Natl. Sci. Acad.*, 1987 (in press).

EDAX MINERAL ASSAY OF CROSS-BRED BULL'S SEMEN

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MACRO-micro mineral elements are associated with metabolic pathways of spermatozoa and influence semen quality and freezability. The present study was conducted to know the mineral contents in

freeze-dried whole semen, seminal plasma and spermatozoa using the method of energy dispensive analysis of X-rays (EDAX, dry wt. %) in good and poor freezer cross-bred bulls.

Eight experimental cross-bred (4 K × J and 4 K × HF) bulls aged between 5 and 6 years, under weekly once semen collection schedule were utilized for the study. The bulls were maintained under identical nutritional and managerial conditions. The bulls were grouped into good freezer (post-thaw motility above 50%) and poor freezer bulls (post-thaw motility below 50%). Four (2 K × J and 2 K × HF) were good freezer bulls and the other four were poor freezer bulls. Single representative semen ejaculate from each bull was divided into two equal parts. One part was centrifuged at 4500 rpm for 20 min and the seminal plasma and sperm pack were separated out. Then the whole semen, seminal plasma and sperm pack were freeze-dried in liophilizer (Model RS/FD/Rajdhani Freeze Dryer, New Delhi) at the Reproductive Biology Research Unit of our college. The liophilized powder was stored at −15°C till assay. These (8 × 3 = 24) samples were subjected to macro-micro mineral assay using the method of EDAX (PV 9100/60) with electron microscope (Phillips EM 400, The Netherlands) at the Sardar Patel University, Vallabh Vidynagar. The EDAX system used detected all the elements present in a small area of the specimen, on qualitative and quantitative basis expressed as atomic weight % or dry weight %.

The mineral elements (dry wt. %) in whole semen, seminal plasma and spermatozoa observed were calcium 4.06, 10.23 and 6.33; phosphorus 12.04, 13.57 and 30.47; Ca : P ratio 0.316, 0.754 and 0.208; sodium 6.46, 15.41 and 9.25; potassium 15.04, 11.12 and 9.43; Na : K ratio 0.428, 1.386 and 0.981; sulphur 26.73, 26.12 and 30.44, and chloride 22.24, 21.04 and 12.18, respectively. The details are presented in table 1. Significantly higher concentrations were observed for calcium and sodium in seminal plasma, phosphorus and sulphur in spermatozoa and potassium in whole semen, but the chloride content was significantly low in spermatozoal fraction. Good freezer bulls showed lower calcium, Ca : P ratio, potassium, sulphur and chloride, and higher contents of phosphorus, sodium and Na : K ratio in whole semen, seminal plasma and spermatozoa than in poor freezer bulls. However, sodium and Na : K ratio observed in spermatozoa of good freezer bulls was lower than in poor freezer bulls. Several workers[1–3] have made similar observations regarding the levels of minerals in whole semen, seminal plasma and spermatozoa.

Among the trace elements, copper and zinc could be detected only in the whole semen by EDAX method. The values (dry wt. %) for copper and zinc in good and poor freezer bulls were 7.47 and 7.27

Table 1 *EDAX mineral assay of cross-bred bull semen (dry wt. %)*

Mineral elements	Whole semen			Seminal plasma			Spermatozoa		
	Good freeza-bility (4)	poor freeza-bility (4)	Avarage (8)	Good freeza-bility (4)	Poor freeza-bility (4)	Average (8)	Good freeza-bility (4)	Poor freeza-bility (4)	Average (8)
Calcium	3.88 ±1.08	4.29 ±1.35	4.06 ±0.72	8.98 ±0.73	11.89 ±2.15	10.31* ±1.08	4.61 ±1.03	8.62 ±1.81	6.33 ±1.19
Phosphours	14.06 ±4.35	11.20 ±2.18	12.04 ±2.48	15.78 ±2.44	10 61 ±1.60	13.57 ±1.78	34.98* ±1.28	24.44 ±6.45	30.47* ±3.31
Ca P ratio	0.28	0.38	0.32	0.60	1.12	0.75	0.13	0.35	0.21
Sodium	7.73 ±2.06	4.77 ±0.86	6.46 ±1.20	16.22 ±1.12	14.34 ±2.12	15.41* ±1.01	7.72 ±0.85	11.30 ±1.83	9.25 ±1.11
Potassium	12.78 ±3.20	18.04 ±6.65	15.04* ±3.00	10.81 ±0.87	11.52 ±1.80	11.12* ±0.81	9.25 ±0.50	9.66 ±0.19	9.43 ±0.28
Na.K ratio	0.61	0.26	0.43	1.50	1.25	1.37	1.83	1.17	0 98
Sulphur	22.52 ±2.95	28.59 ±3.73	26.73 ±1.96	25.02 ±1.78	27.57 ±5.56	26.12 ±2.36	29.97 ±1.94	31.06 ±2.26	30.55 ±1.36
Chloride	22.16 ±1.94	22.35 ±0.91	22.24 ±1.01	18.77 ±1.70	24.07 ±2.66	21.04* ±1.73	10.91 ±1.24	14.91 ±4.31	12 18* ±2.01

*Significant at 5% level (between fractions of semen and freezability groups); Figures in parentheses indicate the numbers of samples studied.

and 3.05 and 4.12, respectively. The average values were 7.32 ± 1.09 and 3.53 ± 0.46, respectively. There is a want of literature giving information of mineral assay on dry wt % basis for comparison with the present findings. The poor freezability of 4 bulls could be explained on the basis of variations in the levels of mineral elements.

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1. Cragle, R. G., Salisbury, G. W. and Muntz, J. H., *J. Dairy Sci.*, 1958, **41**, 1273.
2. Salisbury, G. W., VanDemark, N. L. and Lodge, J. R., *Physiology of reproduction and artificial insemination of cattle*, W. H. Freeman & Co., San Francisco, 2nd Edn., 1978.
3. Sidhu, K. S. and Guraya, S. S., *Buffalo semen, morphology, biochemistry, physiology and methodology*, USG Publishers & Distributors, Sarabha Nagar, Ludhiana (India), 1st Edn., 1985.

MONOSOMICS IN *BRASSICA CARINATA* A. BR

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A MONOSOMIC is a $2n-1$ aneuploid with one chromosome missing from a normal $2n$ somatic complement. Monosomics occur spontaneously at very low frequencies. At relatively higher frequencies they occur in the progeny of triploids, interspecific hybrids, asynaptic mutants and translocation heterozygotes. Cytogenetically, they are important because of their usefulness in assigning genes to specific chromosomes and establishing independence of linkage groups. For this reason, monosomic series have been developed for several crop plants[1,2]. However, in amphidiploid *Brassica* species monosomics were reported only recently in *B. napus*[3,4]. There are no previous reports of the occurrence of monosomics in *Brassica carinata*.

B. carinata is an amphidiploid species ($2n = 34$, BBCC) derived from natural hybridization between the two diploid species *B. nigra* ($2n = 16$, BB) and *B. oleracea* ($2n = 18$, CC)[5]. In a study on artificial synthesis of *B. carinata* from its diploid progenitors, a hybrid was obtained from crosses between *B. oleracea* var. *italica* and *B. nigra*[6]. This paper reports the occurrence of monosomic and double monosomic plants in the progeny of this hybrid.

B. oleracea var. *italica* was crossed with *B. nigra* and only one hybrid could be raised to maturity. This hybrid was designated BN and was cytologically confirmed to be a triploid ($2n = 26$). Twenty plants (BN-1 to BN-20) were obtained from the seeds set on BN. Based on meiotic analysis of these plants, two plants, BN-7 and BN-12, were identified as double monosomic and monosomic respectively (figures 1–4).

In the double monosomic plant BN-7 ($2n = 32$), the pollen mother cells showing 15 bivalents and 2 univalents were most frequent at metaphase I (figure 1). At anaphase I, chromosome distribution to the two poles varied considerably in different cells. Distributions of 16:16 and 17:15 (figure 2) were frequent.

In the monosomic plant, BN-12 ($2n = 33$), a majority of pollen mother cells showed a chromosome configuration of 16 bivalents and 1 univalent at metaphase I (figure 3). The univalent lay away from the metaphase plate. At late anaphase I all the cells examined contained 16 chromosomes at one pole and 17 at the other (figure 4).

Meiotic abnormalities in pollen mother cells of the two monosomic plants BN-7 and BN-12 resulted in reduced pollen fertility. The monosomic plant BN-12 had pollen fertility of 17% compared to 95% in natural *B. carinata*. Even with the loss of two chromosomes, the double monsomic plant BN-7 had a relatively higher pollen fertility of 53%. Thus, pollen grains having chromosome numbers other than the haploid need not always be abortive in amphidiploid species such as *B. carinata*. Similar observations were reported in the amphidiploid species *B. napus* ($2n = 38$, AACC) where a plant with 6 chromosomes missing had a pollen fertility of 66%[3,4,7].

Both the plants, BN-7 and BN-12, were morphologically indistinguishable from their sib plants and natural *B. carinata*. The loss of one chromosome in BN-12 and of two non-homologous chromosomes in BN-7 was thus not only tolerated but apparantly failed to alter the gross morphology of these plants. This indicates the possibility of establishing a monosomic series in *B. carinata*.

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