Cytological Studies in Genus *Zizyphus*

N. S. Nehra, P. K. Sareen and S. D. Chitkara

Haryana Agricultural University,
Hissar, Haryana, India

Received January 26, 1981

Ber (*Zizyphus mauritiana* Lamk.) is an important fruit crop of arid sub-tropics. It has lot of potential because of its drought hardiness and high salinity tolerance. It outranks most of other important fruits in its nutritional value (Jawanda and Bal 1978). In spite of its economic importance very little work has been done on the cytological aspect of this fruit. However, preliminary reports on chromosome number are available. Morinaga *et al.* (1929) have reported chromosome number as $2n=24$ in *Z. jujuba* and *Z. sativa*. The chromosome number of *Z. mauritiana* Lamk., *Z. oenoplia* Mill. and *Z. rotundifolia* Lamk. have also been reported to be $2n=48$, 48 and 72 respectively by Srinivasan (1952). He also observed $2n=48$, 72 and 96 in *Z. jujuba* Mill. Dodds (1958) has also listed the same chromosome number in this species. Khoshoo and Singh (1963) also found $2n=48$, 60 and 96 in *Z. jujuba* and $2n=48$ and 72 in *Z. rotundifolia* Lamk. Recently the chromosome number of four cultivars of *Z. mauritiana* Lamk. was reported to be $2n=48$ by Daulta and Sareen (1980). Thus the information on chromosome number of genus *Zizyphus* is meagre and whatever available is obsolete. Moreover, there has been no report in the recent past on the chromosome number of wild forms and other species. It was, therefore, considered desirable to investigate the chromosome number of important cultivated varieties and few wild forms of ber. The study reports critical cytological analysis of the genus.

Materials and methods

The two cultivated varieties viz. Illaichi and Umran and two wild forms viz. Gola ber and Boradi belonging to *Z. mauritiana* Lamk. and another wild form Jhar ber (*Z. rotundifolia* Lamk.), which are available at Hissar, Haryana, India were selected for meiotic studies. Meiotic studies were made from pollen mother cells (PMC). The flower buds were collected at 7 A. M. and fixed in Cornoy's fluid (one part glacial acetic acid+3 parts chloroform+6 parts ethanol). After 24 hours of fixation the flower buds were washed and stored in 70 per cent alcohol. The anthers were separated from flower buds and smears prepared in 1 per cent acetocarmine.

Observations

The meiotic studies revealed that chromosomes were very small in size. The chromosome number of the two cultivated varieties and three wild forms alongwith their chromosomal associations are listed in Table 1.

Table 1. Chromosome number alongwith chromosomal association at diakinesis or metaphase I

S. no.	Name of species/form	Chromosome number (2n)	Chromosomal association at diakinesis			
			I	II	III	IV
1.	<i>Z. mauritiana</i> Lamk. cv. Illaichi	96	—	48	—	—
2.	cv. Umran	48	—	24	—	—
3.	Gola ber (wild)	96	1	36	1	5
4.	Boradi (wild)	96	1	44	1	1
5.	<i>Z. rotundifolia</i> Lamk.	48 and	—	22	—	1
	Jhar ber (wild)	72	—	36	—	—

Figs. 1–4. Photomicrographs showing meiosis in *Z. mauritiana* Lamk. 1, diakinesis in Umran (24_{II}). 2, diakinesis in Illaichi (48_{II}). 3, diakinesis in Gola ber ($5_{IV} + 1_{III} + 36_{II} + 1_I$). 4, diakinesis in Boradi ($1_{IV} + 1_{III} + 44_{II} + 1_I$). (→)=Univalent, (·→)=Trivalent, (×→)=Quadrivalent.

The chromosome number in cultivar Umran was found to be $2n=48$ (Fig. 1). In another cultivar viz. Illaichi of the same species a chromosome number $2n=96$ was observed (Fig. 2). The chromosome number in two wild forms viz. Gola

Figs. 5-8. Meiosis in *Z. rotundifolia* (Jhar ber). 5, diakinesis (24_{II}). 6, metaphase ($22_{II}+1_{IV}$). 7, metaphase (36_{II}). 8, anaphase ($36+36$). ($\times \rightarrow$)=Quadrivalent.

ber and Boradi was also observed to be $2n=96$ (Figs. 3 and 4). Another wild form Jhar ber (*Zizyphus rotundifolia*) showed a range of chromosome number which in some stocks (Figs. 5 and 6) was counted to be $2n=48$ while in the others belonging to same wild form (Figs. 7 and 8) $2n=72$ were also recorded. Thus there exists a high degree of polyploidy in genus *Zizyphus*.

The chromosomal association in Gola ber as observed at diakinesis was $5_{IV}+I_{III}+36_{II}+I_I$. Out of 36_{II} two were associated with nucleolus. In another wild form Boradi, the association at diakinesis was $I_{IV}+I_{III}+44_{II}+I_I$. Out of 44_{II} two showed association with nucleolus. In Jhar ber the chromosomal association at

metaphase I or diakinesis varied from 24_{II} to $22_{II} + I_{IV}$. Nucleolus was associated with two of these chromosomes. In the same wild form 36_{II} were also counted at metaphase I. The distribution of chromosomes at anaphase I was regular and thus 36 chromosomes moved to each pole. In Umran 24_{II} were noticed at diakinesis of which two showed association to nucleolus whereas in Illaichi out of 48_{II} a maximum of four were attached to nucleolus at nucleolar organizer region.

Discussion

In the present study it was observed that the chromosomes in genus *Zizyphus* were very small. This may be one of the reasons that many workers did not attempt to make detailed cytological study in this genus as was the case in grapes (Sudharsan Raj and Seethaiah 1973). In this study attempt was made to find out chromosome number of wild and cultivated ber stocks grown in Haryana. The chromosome number of cultivar Umran was found to be $2n=48$. The same chromosome number has also been reported in *Z. mauritiana* Lamk. by Srinivasan (1952) and Daulta and Sareen (1980). The chromosome number of another cultivar Illaichi and two wild forms viz. Gola ber and Boradi belonging to same species was found to be $2n=96$. However, the same chromosome number was reported in *Z. jujuba* by Srinivasan (1952), Dodds (1958) and Khoshoo and Singh (1963) which was possibly the Indian cultivated ber now known as *Z. mauritiana* Lamk. (Chatterjee and Randhawa 1952). The chromosome number of Jhar ber (*Z. rotundifolia* Lamk.) was either $2n=48$ or 72. These observations are in conformity with those of Srinivasan (1952) and Khoshoo and Singh (1963). All the present cultivars of ber are possibly the natural selections. The chromosome number of Illaichi as $2n=96$ which was also recorded in wild forms, indicates that it may be a selection from some wild material.

On the basis of our findings and the observations of Morinaga *et al.* (1929), Bowden (1945) and Khoshoo and Singh (1963) on chromosome number in *Z. jujuba* and *Z. sativa* as $n=12$, it appears that genus *Zizyphus* is monobasic ($x=12$). However, the intriguing reports on chromosome number of *Z. jujuba* as $2n=40$ and *Z. oenoplia* as $2n=20$ by Srinivasachar (1940) and that of *Z. sativa* as $2n=26$ by Chiarugi (1930) creates confusion. These observations indicate that genus *Zizyphus* is tribasic ($x=10, 12, 13$) which needs to be verified by further investigations on these species.

In all the wild and cultivated forms of ber, the presence of nucleolar organizer region in some chromosomes was a common feature, their number varying from one to four. The present investigations also indicated the common occurrence of quadrivalents, univalents and trivalents at diakinesis and metaphase I in wild forms, which lead to meiotic irregularities resulting in chromosomal imbalance.

The chromosome number of genus *Zizyphus* varied from $2n=48, 72$ to 96. In such polyploids the increase or decrease in chromosome number may be due to the fertilization of unreduced gametes. Generally the lower number is considered to be primitive from which higher ones might have evolved, but occasional reduction from higher to lower is also not ruled out. The polyploidy may result in reduction

of fertility and seed setting. This may be one of the reasons for the production of non-viable seeds in cultivar Illaichi. In autopolyploids the meiosis is often disturbed because of the formation of quadrivalents, trivalents and univalents in addition to bivalents. This may lead to irregularities in chromosomal segregation and consequent formation of unbalanced gametes (Stebbins 1971). In Illaichi the seeds are not viable but multivalent formation was also not observed. The reason for this may be that due to repeated cultivation over long time the multivalent associations might have disappeared due to the process of diploidization. Thus, the reason for formation of unviable seeds may simply be excessive gene dose or female sterility which needs further investigations.

Summary

The genus *Zizyphus* showed a high degree of polyploidy. Chromosome number of cultivar Umran (*Z. mauritiana* Lamk.) was found to be $2n=48$ whereas in the other cultivar Illaichi of same species it was $2n=96$. The chromosome number of two wild forms viz. Gola ber and Boradi was also recorded as $2n=96$. Another wild form Jhar ber (*Z. rotundifolia* Lamk.) showed variation in chromosome number. The chromosome number was either $2n=48$ or 72 . The association of chromosomes to nucleolus during meiosis and formation of multivalents was also noticed. The evolution of polyploid forms and its impact have also been discussed.

References

- Bowden, W. M. 1945. A list of chromosome number in higher plants. *Amer. J. Bot.* **32**: 191.
- Chiarugi, A. 1930. Parthenocarpia in *Zizyphus sativa* Gaertn. *Bot. Ital.* **37**: 287–312.
- Chatterjee, D. and Randhawa, G. S. 1952. Standardised names of cultivated plants in India 1. Fruits. *Indian J. Hort.* **9**: 26.
- Daulta, B. S. and Sareen, P. K. 1980. Studies on chromosome number and *in vitro* pollen viability and germination in ber (*Z. mauritiana* Lamk.). *H. A. U. J. Res.* **10**: 60–64.
- Dodds, K. S. 1958. Incompatibility system in fruit breeding. *Indian J. Hort.* **15**: 248–255.
- Jawanda, J. S. and Bal, J. S. 1978. The ber highly paying and rich in food values. *Indian Hort.* **23**: 19–21.
- Khoshoo, T. N. and Singh, N. 1963. Cytology of jujubes. *Curr. Sci.* **32**: 235–236.
- and — 1963. Cytology of North West Indian trees I. *Z. jujuba* and *Z. rotundifolia*. *Silv. Genetica* **12**: 158–174.
- Morinaga, T., Fukushima, E., Kano, T. and Yamasaki, Y. 1929. Chromosome number of cultivated plants II. *Bot. Mag. (Tokyo)* **43**: 589–594.
- Srinivasachar, D. 1940. Embryological studies of some members of Rhamnaceae. *Proc. Indian Acad. Sci.* **11B**: 107.
- Srinivasan, V. K. 1952. Chromosome number in the genus *Zizyphus*. *Curr. Sci.* **21**: 224.
- Stebbins, G. L. 1971. *Chromosomal Evolution in Higher Plants*. Edward Arnold Ltd. London.
- Sudharsan Raj, A. and Seethaiah, L. 1973. Cytological study in grape (*Vitis vinifera* L.). *Cytologia* **38**: 549–557.
-