

Fig. 1. Female flower of *Momordica dioica* tetraploid

LARGE-SCALE CULTIVATION OF SMALL BITTER-GOURD PROBLEMS AND POSSIBILITIES

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SMALL BITTER-GOURD (*Momordica dioica*, *kakrol* in Hindi, *sarpadamini*, in Sanskrit) is a tropical vegetable plant of Cucurbitaceae family, indigenous to India. It is a herbaceous perennial climber. Its fruits are ovoid in shape and have soft spines. Its aerial parts die during winter and sprout from underground tubers with the onset of rains.

Kakrol is found throughout India from the Himalayas (1,500 m) to Sri Lanka. It is found on hedges in warm humid places. It grows wild in the hills of Rajmahal, Hazaribagh and Rajgir in Bihar, hilly regions of the Pune district in Maharashtra as well as in the western Rajasthan desert. The somatic chromosome num-



Fig. 2. Vine of *Momordica dioica* tetraploid

ber of this cultivar is 28 (diploid). Another cultivar (Fig. 2) found naturally in Khasi and Jaintia hills of Assam and Darjeeling has chromosome number 56 (tetraploid). Its fruit is larger than that of the diploid cultivar. This cultivar is commercially suitable for large-scale cultivation. The plant growth is vigorous and it sprouts in spring from underground tubers, thereby giving an early crop. In the diploid cultivar the flower opens during night, whereas in the tetraploid it opens in the morning. Leaf size, petiole length, peduncle length, and the size of sepals and corolla are more in the tetraploid cultivar than in the diploid (Fig. 4). A cross between diploid and tetraploid produces a triploid, which has characters intermediate between the

portion of the vine is used as cuttings, hormone treatment can be dispensed with. For small-scale multiplication in kitchen garden, such cuttings may be used.

Keep the planted cuttings in a lighted place, but away from direct sunlight. Irrigate lightly after planting. To prevent wilting of leaves, spray water on them from a sprayer or atomizer regularly. It is better to take up this work in the rainy season when relative humidity is very high. The months of July and August (when it is drizzling) are most suitable.

Cuttings take about 15 days to root. When a new leaf comes out, rooted cuttings should gradually be brought to direct sunlight and then planted in the main field.

These latter two methods have several advantages over the methods of tuber planting and seed sowing in vogue. They have made large-scale commercial cultivation of *kakrol* a profitable possibility. The planting material free from virus infection and in suitable sex ratio can be made available. For planting in 1 ha about 1,000 rooted cuttings are required.

Field Preparation and Planting

Raise the rooted cutting as mentioned above. For transplanting the cuttings, select and prepare the main field in advance. Select field free from waterlogging. Plough the field deep (200 cm) in both the directions and bring soil to a fine tilth. Prepare basins of about 30 to 45 cm diameter and 30 cm depth, giving spacing of 180 cm between rows and 120 cm between plants. Apply 2 kg compost, 80 g fertilizer containing equal parts (15:15:15) of N, P and K, and 3 g Furadan per basin. Irrigate the basin a day before transplanting. Transplant the rooted cuttings on a cloudy day or in the evening at the rate of two plants per basin. After planting, irrigate basins by hand, and then irrigate plants daily till a new leaf emerges.

The crop requires warm growing season. If irrigation facilities exist,

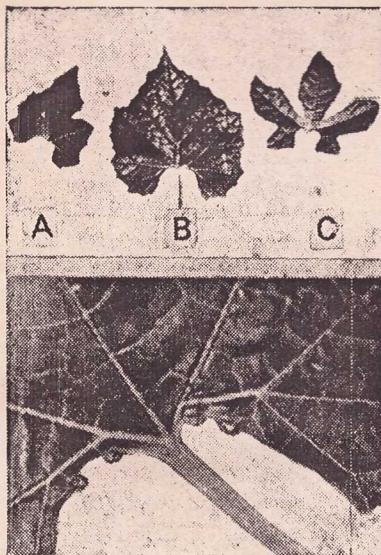


Fig. 4. Top: Leaves of *Momordica* species. (A) *M. dioica* diploid; (B) *M. dioica* tetraploid; and (C) *M. cochinchinensis*. Bottom: Leaf of *M. cochinchinensis* showing umbilicate glands on the base of leaf lamina

an early crop may be taken from the underground tubers of the previous year, since sprouting takes place early if the land is irrigated in February. It thrives well under sunny condition. The crop can be grown in a variety of soils but sandy-loam soil rich in organic matter is ideal. In commercial cultivation, planting of 8-10 per cent male plants is sufficient for pollination. The male plants should be uniformly distributed in

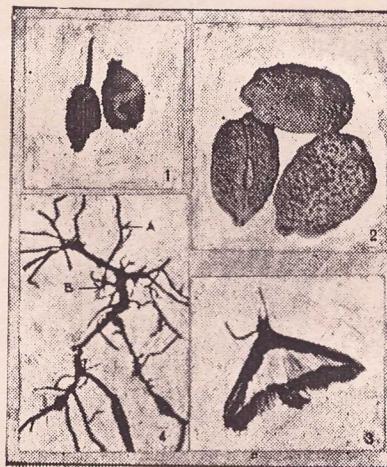


Fig. 5. (1) Fruits affected by pumpkin caterpillar; (2) seeds of *Momordica cochinchinensis*; (3) adult moth of *Margarinia indica*; (4) roots of *M. dioica* tetraploid affected by root-knot nematode; A, dried shoot; B, nematode galls

the field for achieving maximum pollination.

Top-dress the crop with 30 g fertilizer, containing equal parts (15:15:15) of N, P and K, and 10 g urea per basin at the stage of 4-5 leaves and again with 15 g urea per basin 30 days after the first top-dressing.

Momordica dioica tetraploid is a large heavy climber, growing 5-10 m in one season. For better growth and yield, the vine should be trained on strong bowers 1.5 to 2.0 m high and of suitable size. Vines of *Momordica dioica* diploid are comparatively less heavy but require staking.

Flowering

Flowering in *Momordica dioica* tetraploid occurs on nodes 9-23 on the primary stem, on 1-13 on the secondary branches and on node 1 onwards on the tertiary branches. Therefore primary stem should be cut after node 23 and secondary branches after node 13.

If the *M. dioica* tetraploid crop is raised from tuber in February-March, flowering starts from April and continues till September. This gives an early-season crop. However, if the crop is raised by cuttings in July, flowering starts from September and continues till October. The diploid cultivar sprouts from underground tubers at the onset of monsoon and starts bearing fruit from August till October. This is the main-season crop. The diploid form is most suitable for rainfed condition.

The male flower bud of tetraploid cultivar takes 22-24 days from visible initiation to full flowering, whereas the female bud takes 19-22 days (Fig. 1). Anthesis commences in the female at 5.50 AM and in the male at 6.20 AM. The anther dehiscence commences at 10.45 PM and completes at 12 PM with peak at 11 PM. The stigma remains receptive for 12 hr before anthesis to 12 hr after anthesis. The flowers of the diploid plant open at 7.30 PM and close at 5.30 AM, with slight variations from season to season.

diploid and tetraploid cultivars.

Another species, *Momordica cochinchinensis*, is probably native of Vietnam and is found in Taiwan, Hong Kong, China and India. It is cultivated in Kyoto Herbal Garden, Japan. It has very large fruits (9.5 cm × 12.5 cm, weight 500 g). Seeds are numerous, 2.2 cm × 1.6 cm × 0.5 cm in size, ovoid, much compressed, and sculptured on both sides (Fig. 5:2). The leaves of *M. cochinchinensis* are deeply lobed and have umbilicate glands in lamina base (Fig. 4), whereas those of *M. dioica* do not have such glands.

Analysis of edible portion of the fruits of *M. cochinchinensis* gave the following values: moisture 84.09 per cent, protein 2.61 per cent, fat 0.66 per cent, carbohydrate 5.69 per cent, crude fibre 5.93 per cent, minerals 1.02 per cent, calcium 21 mg/100 g, phosphorus 148 mg/100 g, iron 2.59 mg/100 g, and vitamin C 247 mg/100 g. Similarly, analysis of edible portion of the fruits of *M. dioica* showed: moisture 84.1 per cent, protein 3.1 per cent, other contents 0.97 per cent, carbohydrate 7.7 per cent, fibre 2.97 per cent, ash 1.1 per cent, iron 4.6 mg, calcium 33 mg, phosphorus 42 mg, carotene (as vitamin A) 2,700 iu, thiamine 45.2 µg, riboflavin 176 µg and niacin 0.5 mg/100 g. The fruit is rich in ascorbic acid (275.1 mg/100 g). It also contains iodine (0.7 µg/100 g), and has low protein fat and carbohydrate but is rich in vitamins. These vegetables are ideal for patients of diabetes and gout. Unlike *M. charantia* (bitter-gourd), these are not bitter in taste.

Cultivation in India

Both these vegetables are not cultivated on large scale in India. *M. dioica* (diploid) is collected from hill forests. Tetraploid cultivar is cultivated in Assam and Nadia district in West Bengal. Fruits of diploid cultivar are available only in the vegetable markets of Bihar. A few tribals have domesticated this cultivar in their backyards. The vegetable is very costly (Rs 4-8/kg) and is always in demand. It is available in

July-October. But the crop is not grown on large scale because of want of sufficient planting material and lack of appropriate cultivation technique.

Propagation Technique

By Seed

Kakrol is propagated less commonly by seeds. The method of propagation by sowing seeds has several disadvantages. As the fruits are mostly consumed while still green, its seeds are not available on commercial scale. Fresh seeds do not germinate, but remain dormant for about 9 months. In the first year of its life the seeded vine of *M. cochinchinensis* may not bear fruit. Moreover, the seeds give mostly vines that bear male flowers (48.7 per cent female and 51.3 per cent male).

By Tuberous Roots

The plant is propagated mainly by tuberous roots. The underground roots are not easily available, because the owner does not want to part with them. Also these roots are not easily detectable in the off-season. This limits its large-scale cultivation. But in *M. dioica* (tetra-

ploid) the production of plants from underground tuberous roots is good and these roots may be removed and planted separately.

By Hormone

By the use of this new method, *M. dioica* (diploid and tetraploid) and *M. cochinchinensis* may be propagated vegetatively by treating stem cuttings having one leaf and one auxiliary bud with naphthalene acetic acid (NAA) 500 ppm. The NAA hormone promotes rooting. It is available in liquid form (Planofix) and also in powder form (Seradix).

The plant hormone solution may be prepared by the following 2 methods:

Concentrated solution dip method. To prepare 500 ppm NAA solution (concentrated), take Planofix. It contains 49 per cent NAA (49,000 ppm). Take 0.1 ml Planofix with a syringe and mix it with 10 ml of 50 per cent ethyl or methyl alcohol; it will give 490 ppm concentrated solution of NAA. The solution remains in good condition for use for a long period. Dip the cuttings in this solution for about 5 sec so that the lower 1 cm of the cut end may come in contact with the solution. Then dip the cuttings in some fungicide and finally in the rooting medium.

Dilute solution method. If ethyl or methyl alcohol is not available, prepare 200 ppm solution of NAA in water by mixing 0.1 ml Planofix in 20 ml water. Dip the cuttings in this solution for about 24 hr in shade. The solution cannot be stored.

In the form of powder, Seradix B (No. 2) is most convenient. Dip the base of freshly trimmed cuttings in this white powder. Tap the cuttings against the rim of the container to remove surplus powder and then plant in a suitable rooting medium. To prepare rooting medium, mix sandy-loam soil with equal amount of compost.

Without using any Hormone

Auxin is synthesized by the growing points. Hence if the topmost

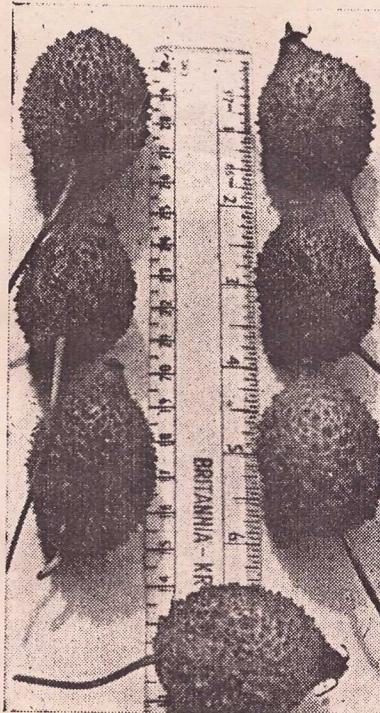


Fig. 3. Fruits of *Momordica dioica* tetraploid female × *M. dioica* male

Pollination and Fruit Set

Fruit set in all the cultivars is unsatisfactory. The average fruit set in the tetraploid is 14.72 per cent, the highest being 22.89 per cent in mid-August. The fruit setting in the diploid is still worse. It flowers at night when natural pollinating agents are fewer.

For effective pollination, take pollen from male flowers using a small camel-hair brush and place it on the stigma of female flowers (Fig. 4). In this way the yield can be raised four times. The cost of manual labour is offset by the increase in the yield. An economic alternative will be to keep an apiary. Bees are more efficient than man in pollinating cucurbits.

Fruits reach harvesting maturity within 15-20 days after fruit set. The edible fruits are harvested when tender and slightly green. If harvesting is delayed, fruit colour becomes yellow and then red. An average vine yields 42-60 fruits. Yield per hectare is 75-100 q.

It is possible to prolong the growing and fruiting period by staggered planting. Thus it is possible to obtain flowering in November from the plants grown by cuttings when vines grown from tubers have died.

Preservation

Slice the fruits. Then blanch 100 g of these for 4 min at 82°C in a pot containing 300 ml lactic acid

solution at pH 3.5. At this level the retention of ascorbic acid is maximum (94.7 per cent). The slices should be dried in the sun and kept in closed tin container for further use.

Insect Pests and Diseases and their Control

The crop is attacked by epilachna beetle (*Epilachna vigintioctopunctata*), fruitfly (*Dacus maculatus*), pumpkin caterpillar (*Margaronia indica* (Fig. 5:1,3) red pumpkin beetles (*Raphidopalpa foveicollis*, *R. intermedia*, *R. cincta*), aphids (*Aphis gossypii*, *Myzus persicae*) and cut-worms (*Agrotis ypsilon*, *A. flammatrix*). Roots are found infested with root-knot nematode (*Meloidogyne incognita*) (Fig. 5:4). Among the diseases, powdery mildew (*Erysiphe cichoracearum*) and fruit-rot (*Pythium aphanidermatum*) were observed. The crop is also affected by watermelon mosaic virus.

To protect the crop grow it in full sun in a well-drained field, which has been deeply ploughed previously. Apply 3 g carbofuran per basin to protect the crop for about 30 days. After that spray the crop weekly with carbaryl 50 WP (2 g per litre water) or malathion 50 EC (2 cc per litre water) mixed with Dithane M-45 (2.5 g per litre water). Spray Bavistin (1 g per litre water) at an interval of 14 days to control foliage diseases. The fruitfly is the most serious pest of the tetraploid cultivar in Bihar. Bagging fruits in polythene bags is the most effective control

method. Use the planting free of nematodes and virus.

Physiological Disorders

Excessive Fruiting

Excessive flowering is observed in some female plants of the diploid cultivar, but all such flowers do not develop into fruits. The reason is that the amount of photosynth and auxin shared by each flower becomes inadequate. Excessive growth of the plant should be controlled by applying less nitrogenous fertilizer, by pruning stem tips and removing some fruits at the time of pollination.

Lack of Pollination

In diploid *M. dioica*, most of the female flowers are not pollinated; such flowers do not develop. They turn yellow and finally red but do not fall down. Hand-pollination increases the yield.

Lack of Auxin

When a fruit is developing, another developing flowering bud is found turning yellow. It does not grow to become a flower. This is owing to lack of auxin. Application of auxin 2,4,5-T 50 ppm is beneficial in producing parthenocarpic fruit.

The planting material may be obtained from the Krishna Chandra Mishra Institute of Agricultural Research, Division of Wild Vegetables, Horticultural Experiment Station, P.O. Bandanwar 814 147, Santhal Parganas, Bihar.

GROWTH...

PRODUCTION

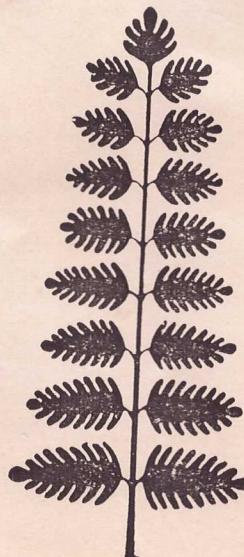
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