

Asian Journal of Agriculture and
rural Development



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Citation: Pradeep Kumar Singh (2012): “Cucurbits Cultivation under Diara-Land”, Asian Journal of Agriculture and Rural Development, Vol. 2, No. 2, pp. 243-247.



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Introduction

Diara land farming or riverbed cultivation is very old practice (possibly started during Mughal period with various cucurbits) of growing vegetables on the bank or basin of river after when flood level receded. Presently, in South Asian countries, cucurbitaceous vegetables are extensively being grown in riverbeds (called diara land). These diara lands are formed and subjected to alluvion and diluvion action of perennial Himalayan Rivers and due to inundation caused by swollen rivers during South- West monsoon. Fresh silt and clay deposits received every year, during the monsoons months, especially in Himalayan Rivers, makes these lands suitable for growing vegetables crops, literally on sand. Even though upper layers of land seem unsuitable for growing crops, the subterranean moisture seeped from adjacent river streams, makes it possible to grow early crops. This system is unconnected with any other crop rotation and cucurbits are specially adapted to this system of growing due to their long tap root system. It can be treated as a kind of vegetables forcing where in the cucurbits are grown under sub- normal conditions, literally on sand, during winter months from November- February, especially in North and North-Western India. About 65% of total cucurbit cropped area of the country falls under riverbeds.

Classification of Diara land according to cultivation

1. Main riverbed consisting sand- cultivation is done during December to June. Main crop is Bitter gourd and Bottle gourd.
2. Main Diara is located on beds of river. Main crop is Cucumber, Luffa, Muskmelon, Watermelon and Pointed gourd.
3. Upland diara where continuous deposition occurs less flooded and not much different from non-diara lands. Main crop is Pointed gourd.

Advantages of Diara land cultivation

There are several advantages of river bed cultivation, which includes: early yield, ease in irrigation, low cost, high net return per unit area and high yield, less mineral requirement due to high fertility, limited weed growth, easy in control of pest and disease by cultural, means, low cost labour facilities and additional crop.

Improved varieties for Diara land cultivation

Diara land cultivation continues to be carried out with the traditional varieties and manner. Many improved varieties of bottle gourd, bitter gourd, cucumber, luffa etc. have been developed by various research institutes but they yet to be evaluated and adopted in diara lands.

Pits or Trench making and filling

Pits or trenches or channels are prepared after the cessation of the southwest monsoon and recession of flood during October- November. The trenches are dug in North- West

direction to manage the availability of moisture and higher temperature. The channel should be 50-60 cm wide and 45-90 cm deep depending on height of water table. Generally, 60cm to 90cm is the height of water table in riverbeds. Sometimes circular pits of about 35-45cm in diameter are prepared having a depth of 90cm. The pits/ trenches are filled manured with FYM or any other organic decomposed waste or oil cakes. Especially in North- Western India, where winter temperatures in Dec- Jan. go down to 1-2^oC, the protection is provided by planting of grass stubbles (probably of Saccharam sp.) This protection is has three fold uses: (i) it checks the sand drifting on the dug-up trenches and covering the hills sown with seeds, (ii) it provides partial through insufficient protection against chilly winds and (iii) this grass is available for spreading over the sand when the vines, especially when "Loo" or hot summer winds sweep these areas in May.

Manures and Fertilizers

Earlier no practices of manures/ fertilizers were used for diara land cultivation but now day's farmers are slightly using. Since crop is taken only for one season, so organic manures and fertilizers are used. Well-decomposed FYM or compost, groundnut or castor cake is given in first application. River silt is generally used to enhance retentively of moisture in the feeding zone. These organic manures provide some kind of warmth to the germinating seeds or growing transplants. In some areas, single super phosphate urea or any standard fertilizer mixture is also given as a basal application but it is not known whether all

the nitrogen is fully available or some amount is leached away. Application of 30-60 g urea per pit at the time of thinning will be useful. After 30-40 days of sowing, top dressing of 40 g urea is usually done in two split doses.

Seed rate, seed treatment and seedling/ transplanting time

Seed rates varies according crops i.e. cucumber 2-3 kg, bitter gourd and bottle gourd 4-5 kg, sponge gourd and ridge gourd 3 kg for one hectare area. The seed sowing is generally done for early crop in first and second week of November and some time by first week of December. Late sowing is done in first week of January. The seeds are sown at a distance of 45-60 cm in the trench at a depth of 3 to 4 cm. Two seeds are generally sown at one place. If the temperature is very low, pre sprouted seeds are sown for smooth germination. For this, seeds should be pre soaked for 24 hours and latter on moist seed should be kept in gunny bag or covered with cotton cloth and kept for a week in warm place to get sprouted. Sometime growers wrap moisten seeds in gunny bags are castor leaves near the fiber burn for quick germination and in this way sprouting start after 5-6 days. As soon as sprouts are visible outside the seed coat they are planted. Generally, 3-4 pre- germinated seeds/hills in pits are sown. But in Andhra Pradesh one-week-old seedling are planted in pits or trench.

Irrigation

Most of the cucurbits are having deep root system, which enable the plant to survive in diara land. Irrigation is given through pitcher or left as usual. Sprinkler or trickle irrigation system may be quite beneficial because most of the nutrients applied by the farmers are leached away because of sandy soil, unless water level is managed.

Thatch Preparation

In northwest India, when winter temperature goes down to 1-2°C in Dec- Jan, young plants require protection in early

stage against low temperature and frost. The protection is provided by thatch screen made of locally available materials like Paddy straw, *Saccharum* grass or sugarcane leaves. In the month of February, grass is spread over the sand as a mulch and bedding. This helps to protect the young and tender plants/ fruits from heat of scorching sand during summer and also avoids drifting of vines during strong winds. Methods for using polyethylene cover as frost protection are yet to be developed. This will be economical and within the reach of ordinary growers.

Cropping Pattern

Cropping pattern usually practiced in riverbeds are Bottle gourd, Bitter gourd, Cucumber and Sponge gourd in North India, Ridge gourd in Rajasthan, M.P. and U.P. and Pointed gourd in Bihar.

Weed Management

In diara land areas major weeds are *Polygonum* sp., *Euphorbia hirta*, *Eclipta prostrata*, *Sida* sp., and *Fimbristylis dichotoma* etc. these weeds can be eradicated manually or by pulling, since soil is quite loosened due to excess sands. No weedicide should be used because it may mix with running water of river and may prove hazardous to human animal and fishes etc.

Harvesting of Fruits and Yield

In Cucurbits harvesting should be done when fruits are quite tender and edible. Kartoli, Kakrol and pointed gourd start flowering after 50, 60 and 80 days of transplanting, respectively. Generally, after 8-10 nodes, every nodes bear's fruits 30-35, 28.35, 15-18 days after flowering. Edible mature fruits should be harvested at 2-3 days interval, otherwise, quality deterioration start and fruits hardened due to seed maturity continuous harvesting can be done end of June to end of October. Potential yield of various vegetables is given in Table-1.

Table 1: Crop duration and yield of cucurbitaceous vegetables in diara lands

S.No.	Vegetables	Planting Time	Harvesting Time	Average Yield (q/ha)
1	Bottle gourd	Nov-Dec	March-July	200-350
2	Bitter gourd	Feb-March	May-July	100-150
3	Pointed gourd	Nov-Dec	March-July	350-400
4	Ridge gourd	Apr-May	June-July	100-200
5	Sponge gourd	Jan-Feb	April-May	100-200
6	Cucumber	Jan-Feb	March-June	225-250

Vegetables and Varieties

Some of the important river-bed cultivated crops and their cultivars are described.

Bottle gourd (*Lagenaria siceraria*)

A large number of varieties are available for cultivation, I.A.R.I. Pusa New Delhi has released two varieties.

1. **Summer prolific long:** Long fruiting variety with yellow green colour, suitable for spring and summer planting.

2. **Summer prolific round:** Fruits are round and are of green colour.

There are other promising varieties, developed Long green, Round Summer Season, Poches Long white, sutton long white etc.

Cucumber (*Cucumis sativus*)

Cucumber cultivars are usually classified on the basis of how they are used, fresh market (slicer) and picklings. In general fruits of slicers are larger than picklings. Cultivars and have a uniform cylindrical shape. 'Balam Khira' of Saharanpur (U.P.) is akin to pickling types of the West. Some of important cultivars are given here.

1. Japanese long green

A temperate cultivar, suited to lower hills, extra early with 45 days maturity fruits 30 to 40 cm long, flesh light green, crisp, released by I.A.R.I. Regional Station, Katrain . (Kulu Valley).

2. Straight eight

Early cultivar, suited to hills, white spined, fruit medium long, thick, straight with round end of medium green colour. Released by I.A.R.I. Regional Station, Katrain (Kulu Valley).

3. Pusa sanjog (Fl hybrid)

Early and high yielding hybrid, fruit 28 to 30 cm long cylindrical and dark green with yellow strips, crisp flesh, matures in 50 days. A hybrid between Japanese gynoecious line and green long naples, released by JARI, Regional Station, Katrain (Kulu Valley).

4. Poinsette

An American introduction multiplied by National Seed Corporation, fruit dark green, 20 to 25 cm long originally develop at Charleston (South Carolina) USA carrying resistance for downy mildew, powdery mildew, anthracnose and angular leaf spot.

Musk melon (*Cucumis melo*)

The species *Cucumis melo* is a large polymorphic type comprising a large number of botanical and horticultural varieties or groups. Apart from these botanical and groups of varieties, one is more important and recognized namely *Cucumis melo* var. *mormordica*, which is 'phoot' of North and Eastern India or also called snap melon, whose fruit is burst or cracks on maturity.

This classification of musk melon is no longer recognized, but nevertheless it shows the variability, available in the species. The most popular cultivars are described as follows.

1. Arka rajhans

It is a mid season variety, bearing large, oval fruits, weighing about lkg. The flesh is white and sweet and fruit has transportable qualities. Released by I.I.H.R Hessarghatta, for Southern Region.

2. Arka jeet

An early cultivar, very similar to 'Lucknow Safeda' of U.P. and a selection of Bati strain of U.P. The fruits are small and flat weighing 300 to 500 gms, orange to orange brown skin. White flesh with big seed cavity and very sweet. Released by I.I.H.R. Hessarghatta.

3. Pusa sharabati

An early cultivar matures in 85 days with round fruits, moderately sweet A hybrid between kutana and resistant no. 6 of the U.S.A. Released by I.A.R.I. New Delhi.

4. Pusa madhuras

It is a mid-season selection from Rajasthan collections with roundish flat fruit weighing 1 kg of pale colour. Released by I.A.R.I. New Delhi.

Water melon

The important varieties of muskmelon are mentioned here.

1. Sugar baby

An early American introduction. The fruits are slightly smaller in size weighing 3 to 5 kg round in shape, having bluish black rind, and deep pink flesh with small seeds. The fruits matures in 85 days. Released by I.A. R.I. New Delhi.

2. Improved shipper

An introduction from U.S.A. big sized melon, weighing 8 to 9 kg. The fruit is dark green with moderate sweetness. Released by Punjab Agricultural University Ludhiana.

3. Asahi yamato

It is a mid season Japanese introduction producing medium sized fruits averaging 6 to 8 kg. The rind colour is light green with deep pink flesh. The fruits matures after 95 days. Released by IAR!, New Delhi.

4. Durgapura meetha

A late cultivar maturing in 125 days, fruits round with green rind, rind thick with good keeping qualities, flesh sweet, weighing 6 to 8 kg Released by Agricultural Research Station.

There are several cultivars, locally grown which are named after the region in which they are grown, such as Farukhabadi, Moradabadi, Faizabadi of Uttar Pradesh. Most of them have fruits with dark green colour or pale green with black strips, moderately sweet with large seeds, weighing 8 to 10 kg, with thick rind. There is a local

cultivar of Jamuna river-bed called as Kalagolan, whose flesh is not sweet, but it keeps well for over 2 to 3 months at drastic temperature.

Other Vegetables

On the ridges other vegetables are also cultivated like Bitter gourd, Pointed gourd, Sponge gourd, Ridge gourd etc. Some general guidelines have been followed out according to the local and distance marketing in different crops is as follows in the table-2

Table 2: Important considerations for Cucurbits harvesting/marketing

SN	Crops	Harvesting	Test method	Stage of fruit	Remark
1	Cucumber	60-70 days after sowing	Anthesis duration	Tender green fruit	Optimum length 20-25 cm (depending upon variety/ consumers demand)
2	Bitter gourd	55-100 days after seed sowing (depending upon variety)	Anthesis duration	Tender green fruit	Optimum length 20-25 cm
3	Pointed gourd	80-90 days after transplanting	Anthesis duration	Green fruits having tender seeds	Optimum length 20-25 cm
4	Ivy gourd	Tender immature fruits	Anthesis duration	Green fruits having tender seeds	Optimum length 20-25 cm
5	Ash gourd	75-125 days after sowing	Anthesis duration	Full mature stage	White wax deposition on skin
6	Bottle gourd	60-100 days after sowing 12-15 days after fruit setting	Pressing the skin and little pubescence persisting on the skin Nail test	Light green colour	Seed should be soft, if examined in transverse section
7	Luffa species	55-60 days after sowing, 6-7 days after anthesis	Anthesis duration	Fruit should not turn fibrous and picking should be done earlier	Picking at 4-5 days interval

Diseases and Pests

The mixed cropping has some advantages in that it gives river-bed farmer continuous income from March to June, and cushions the losses or failure of any crop. But diseases like mildew and viruses can spread from one cucurbit to other, and their control becomes difficult. The river-bed system is comparatively free from major disease epidemics.

Diseases

A large number of fungal diseases affect the cucurbits. But in river-beds system, a few are important.

Powdery mildew

This is a fungal disease which attacks all cucurbits. It is caused by *Sphaerotheca fuliginea*. It is often very severe in rain free growing region, symptoms of white fluffy, circular patches are observed on the undersurface of leaves. In severe cases it may spread to petioles and stems, at later stages brown surface with shriveled leaves appear and lastly defoliation occurs. The perfect stage of the fungus is identified as *Erisiphe cichoracearum*.

Control

The spray of diathane M,45 (maneb) if given at an early stage and repeated 2 to 3 times can control the disease effectively. The disease is serious in Musk melon in Punjab and ridge gourd in W. Bengal.

Fusarium wilt

It is a common disease occurring in several cucurbits like water melon, musk melon, bottle gourd etc. The causal organism has been identified as *F. oxysporium* with sub species *nivarum* affecting water melon and sub species melons affecting musk melon. The disease is also related to the soil temperature. In young seedlings, cotyledons droop and wither. In older plants, leaves wilt suddenly.

Control

The disease can be checked by dressing of soil by captan or hexocaptan or thiride 0.2 to 0.3% solution.

Anthracnose

This disease is very serious in water melon, bottle, gourd, cucumber, snake gourd etc. caused by the fungus *Colletotrichum*. In case of cucumber and musk melon, reddish brown dry leaf spots are formed which often coalesce and cause shriveling and death of leaf. Lesions on petiole and stems are water soaked and yellowish. The leaf spots of water melon are black and foliage presents a scorched appearance.

Control

The disease can be controlled by repeated spraying at 5 to 7 days interval of with dithane M -45 (maneb) 0.2% or diathane Z-78 (zirab) 0.2% solutions.

Viral diseases

There are a large number of viruses which cause much damage to different cucurbits all over India. Identified

strains may be several, occurring singly or in mixtures especially in river-beds. The leaves show a mottling, mosaic, crinkling and twisting and stunted internodes and flowering in adversely affected. Exact transmission is yet to be verified, but, some have shown seed transmission. Some transmitted through insect vectors e.g. aphids, but mostly mechanical transmission is most common. Some of the important strains identified in I.A.R.I. are as follows.

1. Cucumber mosaic virus (Cucumis virus I)
2. Water melon mosaic virus (poly virus group)
3. Tobacco mosaic virus (Sap transmission without vector)
4. Non-classified consisting of Kakari mosaic virus and toris (Luffa) mosaic virus.

In a survey of river-bed growing different cucurbits, cucumber green mosaic virus, seed-borne musk melon mosaic virus, melon mild mosaic, and melon rings spot virus have been reported.

Complete control of virus disease is not possible, but spread can be checked if precaution is taken in case of mechanical transmission. For controlling viruses, insecticide use may be helpful while for seed borne, seeds from the virus affected plants should be avoided.

Pests

The pests like aphids and red pumpkin beetle are usually noted in early stages of crops. The fruit-fly incidence is more in pointed gourd and mite infestation increases in arid situations, when the day temperature rises above 40°C. For further details on diseases and pests of cucurbits.

Mineral deficiencies

Nonpathogenic diseases mostly caused by mineral deficiencies are also prevalent in some situations. This is a special problem in river-beds. Absence of rich sub-soil, silt or alluvium beneath the sandy layer and leaching of nutrients due to sandy substrate sometimes cause deficiencies of macro and micro nutrients.

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