

# CHILLI TECHNOLOGY PACKAGE

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Lim Lee Lee, Nur Najwa Hamsein and Lily Eng



**Research Division**  
**Department of Agriculture Sarawak**



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Front cover page: Chilli Tarat

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## PREFACE



Chilli (*Capsicum annuum* L.) is a popular fruit vegetable among Malaysians. The fruits are of many colours, shapes, sizes and pungency. The pungency is due to an alkaloid called capsaicin. Chilli is mainly used as flavouring in dishes and sometimes as garnishing.

The major constraints in chilli production are infestation by insects, bacterial and fungal diseases. A breeding programme on chilli was initiated in 1990s resulting in a new variety called chilli Tarat which was launched in 2012. Through research, the Department of Agriculture, Sarawak recommends chilli Tarat, Kulai and Hot Beauty for commercial production.

The Research Division has compiled and produced a technology package book on chilli production. It comprises the cultivation practices, pest and disease management, harvest and post-harvest practices, seed production, and the costs and returns analysis. This book serves as a useful guide to growers, home gardeners, extension workers, students and researchers.

Lastly, I wish to thank and congratulate all those involved in the production of this technology package book.

**“BERSATU BERUSAHA BERBAKTI”**  
**“An Honour to Serve”**

A handwritten signature in black ink, consisting of stylized, overlapping loops and curves, positioned above a dotted line.

.....  
**(LAU CHENG YUON)**

Deputy Director of Agriculture (Modernisation)  
Senior Assistant Director of Agriculture (Research)

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## 1. INTRODUCTION

Chilli or hot pepper is botanically known as *Capsicum annum* L. and it belongs to the Solanaceae family. In 2015, the estimated area and production of chilli in Sarawak was 204.7 ha and 1,560.4 mt/ha respectively (Anon., 2015). Chilli accounted for 6.1% of the total fruit vegetable production in the state in 2015.

Chilli may be a home garden vegetable as well as a commercial crop. The plant is erect, compact and usually cultivated as an annual. The flowers are usually white to purple, pendant shape, borne singly on the axils of the branches. There are many varieties of chillies being planted by the farmers. The fruits are very variable in size, shape, colour and pungency or hotness. Young fruits are either green, creamy, yellow, purple or white while mature ones are red. The pungency of chilli is due to an alkaloid called capsaicin (Siemonsma & Pileuk, 1994). The world's hottest chilli is *Capsicum chinense* having hotness of up to 300,000 Schoville Heat Units (DeWitt and Bosland, 1993).

Chilli is a good source of vitamin A, vitamin C, calcium and phosphorus (Sahadevan, 1987). Mature fruits are rich in carotenoids and xanthophylls (Siemonsma & Pileuk, 1994). It is a very popular fruit vegetable among Malaysians and is used in most cuisine, mainly as flavouring. The fruit can be consumed fresh, dried, pickled or processed into sauce. Besides the fruits, young shoots and leaves of chilli plants are cooked as vegetable too.

## 2. RECOMMENDED VARIETIES

ARC Semongok has been screening chilli varieties from local and imported sources. The Department of Agriculture, Sarawak recommends ARC-C-C1/L7 (Chilli Tarat), Hot Beauty and Kulai 907 for commercial planting (Chai, 1997, 2006). These varieties are high yielders with good quality fruits and good bacterial wilt

disease resistance. The characteristics of these varieties are as in Table 1.



### Recommended varieties of chillies

**Table 1:** Characteristics of chilli varieties

<b>Agronomic traits</b>	<b>Chilli Tarat</b>	<b>Hot Beauty</b>	<b>Kulai 907</b>
Days to harvest (from transplanting)	78	77	75
Harvest period (days)	65	66	65
Fresh fruit yield (mt/ha)	10.5–24.3	14.5–20.3	12.8–17.9
Days to 50% flowering	40	39	39
Fresh fruit yield (kg/plant)	1.0-1.3	0.9-1.3	1.0-1.1
Fruit weight (g)	13	9	13
Fruit size Length x width (cm)	10.0 x 2.1	11.0 x 1.5	11.6 x 1.7
Flesh thickness (mm)	2.3	2.1	2.4

<b>Agronomic traits</b>	<b>Chilli Tarat</b>	<b>Hot Beauty</b>	<b>Kulai 907</b>
Fruit shape	Wide shoulder, tapering	Narrow shoulder, tapering	Narrow shoulder, tapering
Fruit colour	Light green to bright red when ripe	Dark green to red when ripe	Light green to red when ripe
Pungency	Medium	Hot	Hot
Plant height (cm)	104	72	74
Plant type	Upright, tall	Upright, medium	Upright, medium
Bacterial wilt incidence	Highly resistant	Moderately resistant	Moderately resistant
Leaf disease incidence	Moderately resistant	Susceptible	Susceptible

### **3. SOIL AND CLIMATE REQUIREMENT**

#### **3.1 Climatic factors**

Chilli plants can tolerate a wide range of temperatures but for optimum growth, temperatures between 25-35°C are preferred. An optimum rainfall range is 150-250 mm/month with even distribution. Irrigation is important during the hot and dry weather.

#### **3.2 Soil factors**

Chilli plants can be grown on most soil types. Clay loam and loamy soils high in organic matter are most suitable for chilli cultivation. It cannot tolerate waterlogged soils or soils with high water table. An optimum soil pH of 5.5-6.8 is essential for chilli cultivation.

## 4. CULTURAL PRACTICES

### 4.1 Nursery

Chilli is planted from seeds. About 200-300g of seeds are required for one hectare of chilli cultivation. The seeds may be planted in well prepared nursery beds or seeding trays filled with Peat Gro or enriched soil. One or two sprays of foliar fertilisers and agrochemicals are necessary for healthy seedling growth. Seedlings are watered twice a day especially during the hot weather. Healthy seedlings are transplanted to the field when they are 4-5 weeks old.



Chilli seedlings ready for transplanting

## **4.2 Land preparation**

An ideal area for chilli planting is an open flat to gently undulating land provided the area is not waterlogged and free from floods. All existing vegetation has to be removed followed by ploughing and rotovation.

Chilli plants are grown on raised beds. Planting beds measuring 15-30 cm high, 1.0-1.2 m wide and 50 cm apart are prepared. The prepared beds are basal dressed with well decomposed chicken dung at 1-2 kg/m<sup>2</sup>, 100-200 g/m<sup>2</sup> dolomite and 30 g/m<sup>2</sup> of 15:15:15 or 12:12:17:2+TE at 1-2 weeks prior to transplanting. Beds may be covered with silvery plastic mulch to control weeds.

## **4.3 Planting**

Chilli plants are usually planted in the open field. It can also be grown in the nethouse if pollinators are introduced. Chilli plants may be grown in single or double rows. In single row planting, the seedlings are spaced at 60 cm within rows whereas in double row planting, the spacing is 60 cm within rows and 60 cm between rows. The planting density in single row planting is about 9,800-11,000 plants/ha whereas in double row planting, it is doubled. Dead and weak seedlings are replaced one week after transplanting.



Chilli planting in open field and mulching with silvery plastic sheets



Chilli planting in nethouse

## 4.4 Fertilising

Chilli plants are fertilised with 12:12:17:2+TE at 30 g/plant every two weeks (depending on soil fertility) until the crop ends.

## 4.5 Staking

Staking is necessary to support the bearing branches of the chilli plants and to minimise lodging. This may be done one month after field planting.



Staking of chilli plants

## **4.6 Pruning**

All basal side shoots may be removed to encourage vigorous plant growth and better aeration to plants; thereby reducing incidence of pests and diseases.

## **4.7 Weed control**

Weeds have to be controlled early. Covering the beds with silvery reflective plastic mulch helps to control weeds, retain soil moisture and reduce aphid infestation. Hand weeding is sometimes practised.

# **5. PEST MANAGEMENT**

The major pests of chillies are as below:

## **5.1 Fruit borer**

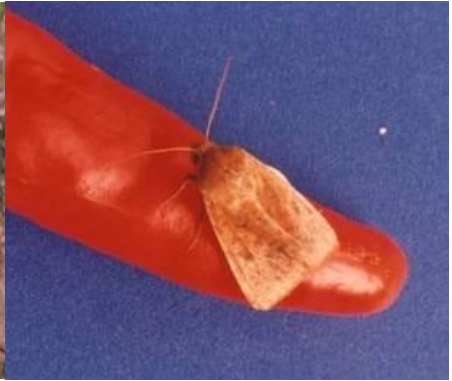
### **5.1.1 Fruit borer (*Helicoverpa armigera*)**

The larvae feed voraciously on buds, flowers, and fruits. This pest causes abscission of flowers and young fruits, and fruit rot or deformed fruit. Crop rotation can disrupt the pest life cycle. Planting chilli in netted structures can reduce borer infestation.

Insecticides that have been found to be effective against this pest are deltamethrin, permethrin and cyfluthrin.



Larva



Adult

### 5.1.2 Fruit borer (*Atherigona* sp.)

The female fly will lay eggs in the cracks of the fruit. The larvae feed on the fruit causing extensive damage and rotting of the fruit. Collecting and destroying affected fruits on the tree or on the ground can reduce the population of *Atherigona* sp. Insecticides such as deltamethrin and cypermethrin can be used during serious infestation.



Adult



Damage

## 5.2 Fruit fly (*Bactrocera* sp.)

Fruit flies lay their eggs in groups immediately under the skin of the fruit. Eggs hatch in two to three days. The larvae bore into fruit pulp causing them to rot and drop prematurely. Collecting and destroying affected fruits on the tree or on the ground can reduce the population of *Bactrocera* sp. Introducing fruit fly trap can also help to reduce fruit fly population. In severe cases, spraying with chlorpyrifos + cypermethrin, cypermethrin, chlorpyrifos or deltamethrin can be effective against fruit flies.



Larva



Adult



Damage

### 5.3 Thrips (*Thrips hawaiiensis*, *Haplothrips tenuipennis*, *Thrips palmi*)

The adults and larvae suck sap from the young buds, young leaves and stem resulting in mottling, distortion and stunting of the growing points. Mulching with reflective plastic mulch can prevent larvae from pupating in the soil. Insecticides that have been found to be effective against this pest are deltamethrin and fipronil.



Adult



Damage

### 5.4 Mites

The mites suck sap from between the leaf veins. These places show up as yellowish spots. In severe cases, the leaves curl downwards, the development of new leaves and buds is inhibited. Mites are most active during hot, dry weather. Frequent watering of the plants during dry weather can help to reduce mites' infestation. In severe cases, spraying with amitraz, dimethoate, lambda-cyhalothrin or malathion can be effective against mites.



Adult



Damage

### 5.5 White fly (*Bemisia tabaci*)

Both nymphs and adults feed on plants by sucking juices from the plant tissue. Infected plant may not fully develop. The honeydew produced encourages the growth of sooty moulds which inhibits photosynthesis. Removal of infested leaves can reduce pest infestation. The use of yellow sticky trap can also help in controlling light infestation of whiteflies. Insecticides such as imidacloprid and abamectin can be used during serious infestation.



Adult



## 5.6 Aphids (*Aphis gossypii*, *Myzus persicae*)

The adults and nymphs suck sap from growing points resulting in deformation of the leaves and reduced growth. Aphids secrete honeydew and this results in a fungus growth which affects photosynthesis. Natural enemies such as ladybird beetle and syrphid fly can help in controlling aphids. In severe cases, spraying with dimethoate or diazinon can be effective against aphids.



Adult



Infested leaf



Infested bud

## 5.7 Cut worm (*Spodoptera litura*)

*Spodoptera litura* is a highly polyphagous species. Young larvae feed on tender leaves, buds, flowers, and subsequently it bores into the fruit. To reduce pest population and infestation, collect and destroy the infected fruits, egg masses and grown up larvae. Light traps can be introduced to catch the adults and for monitoring pest population. Insecticides that have been found to be effective against this pest are deltamethrin, trichlorphon, indoxacarb and spinosad.



Larva



Stages of larva



Adult

## 6 DISEASE MANAGEMENT

The major diseases of chillies are as below:

### 6.1 Bacterial wilt

Bacterial wilt of chilli is caused by the bacterium, *Ralstonia solanacearum*, which causes the plant to wilt in the advance stage of infection. Wilting is more pronounced during the drier season. To diagnose the disease, uproot the plant and wash off the soil. Cut a foot-long section of the stem from the base of the plant upwards and place the bottom cut end into a narrow transparent vessel (eg. a tall glass or beaker or test tube) with clean water. If the plant is infected, a milky exudate of bacteria will ooze out of the end of the stem into the water.



Bacterial wilt of chilli caused by *Ralstonia solanacearum*

There is no cure for the bacterial wilt-infected chilli. Remove the infected plant completely to prevent the disease from spreading to healthy plants. Removal of plants infected with the bacteria, *Ralstonia solanacearum*, from the vegetable bed will prevent the pathogen from building up in the soil and infecting neighbouring plants. Practice crop rotation with non-solanaceous vegetables.

## 6.2 Sclerotium wilt

Wilting of the chilli plant is similar to bacterial wilt. If it is due to Sclerotium wilt, the white mycelia of the fungus causing the wilt, *Sclerotium rolfsii*, is often visible at the collar region (near the soil surface) of the stem of the infected plant. Sometimes, white or brown sclerotia can be seen. The infected collar turns brown and shrivels. The use of fungicidal sprays of carbendazim or thiophanate methyl can control the disease if the plant has not wilted too severely.



Sclerotium wilt of chilli caused by *Sclerotium rolfsii*

### 6.3 Anthracnose

The fungi, *Colletotrichum gloeosporioides* and *C. capsici*, cause anthracnose in chilli. This disease is more severe during the wet season. The disease develops as the fruit ripens. Circular greyish brown lesions with black zonal rings are present on the chill fruit. Good farm hygiene involving the removal of infected fruit and plant debris from the ground can reduce the disease occurrence. Improving soil drainage and increasing the planting distance to reduce humidity can also reduce the disease incidence. Where anthracnose is a severe problem, a prophylactic spray of chlorothalonil, mancozeb or trifloxystrobin can lower the disease severity.



Anthracnose of chilli caused by *Colletotrichum gloeosporioides* and *C. capsici*

#### 6.4 Fruit stalk wilt

The nematode, *Aphelenchoides besseyi*, is a foliage nematode that feeds on the upper parts of certain plants. In chilli, it attacks the fruit stalk. The infested chilli fruit stalk shrivels, turns brown and fruit drop occurs. The infestation can occur at the immature or green chilli stage. Other parts of the fruit look healthy. Removal of the affected fruit stalks and putting them into a small amount of tap water in a small transparent glass can reveal tiny nematodes when viewed with a magnifying glass. Due to the frequent harvests of the chilli fruit for consumption, nematicides cannot be applied because of their prolonged residue effects. Removal of infested fruit from the plant and those that drop to the ground, including the plant debris can reduce the population of *A. besseyi*. Soil amendment with organic matter can help to reduce the soil population of this nematode.



Fruit stalk wilt caused by the nematode  
*Aphelenchoides besseyi*

## 6.5 Chilli veinal mottle virus

The chilli veinal mottle virus, a potyvirus, can cause yield loss in chilli. Infected plants have less flowers and fruit setting is reduced. Dark green mottling symptoms appear next to the leaf veins, leaf sizes are reduced and leaves are distorted. Plants can become stunted. This disease is spread by aphids. Once infected, the plant cannot be cured. To prevent the disease, use reflective bed mulching to deter the aphids from landing on the chilli plants. The disease is not seed transmitted. However, it can spread through grafting and through contaminated pruning knives. Removal of the infected plants can prevent the spread of the disease to healthy plants by the aphids or contaminated farm tools.

## 7. HARVESTING

Chilli fruits are harvested at about 2-2<sup>1</sup>/<sub>2</sub> months from transplanting. Harvesting is done manually with the aid of a secateurs either in the morning or late evening. Baskets should be used for harvesting and chillies are stored immediately in a cool place before sending them out to the market. The fruits may be harvested either green or red depending on their utilisation. For

fresh market, the fruits are harvested mature but firm. Fruit harvesting is carried out every 3-4 days. The harvesting duration is about 3-6 months or more than a year if the plants are well maintained. Yield ranges from 10-24 mt/ha/season depending on variety, duration of harvest and level of management.



Fresh chilli Tarat

## **8. POST HARVEST HANDLING**

Besides fresh chillies, ripe fruits are also sold as dried chillies. These ripe fruits are sun dried for 7-10 days depending on weather condition. For retail market, fresh chillies are packed in either plastic bags with ventilation holes or in polystyrene trays wrapped with polyvinyl chloride film.

Fresh chillies can keep for 3-6 weeks at 5-8°C and 90-95% relative humidity while dried chillies can be stored for several months at ambient temperature.

## 9. SEED PRODUCTION

Chilli plants are either open-pollinated or hybrid varieties. Seeds from an open-pollinated variety such as chilli Tarat can be saved for future planting. Select and tag the best plants in terms of growth habit, yield, appearance of fruit and disease-free. Allow the fruits to mature fully and harvest selected fully ripe fruits. Slice fruits lengthwise without dissecting the seeds. Remove seeds from the placenta manually by knife or other tools; or alternately remove seeds by rubbing off in water. Dry the seeds thoroughly under the sun. Store seeds in polybags or paper envelope and keep it in the refrigerator to prolong vigour and germination of seeds.

## 10. FINANCIAL RETURNS

The estimated production cost and returns for one hectare of chilli production are shown in Tables 2, 3, 4 and 5.

**Table 2.** Estimated production cost for one hectare of chilli production per season

	Particulars	Quantity	Unit price (RM)	Cost (RM)
<b>A.</b>	<b>Input cost</b>			
1.	Seeds	0.2 kg	400.00	80.00
2.	Fertiliser			
	- Dolomite (50kg/bag)	20 bags	21.50	430.00
	- Chicken dung (40kg/bag)	250 bags	6.50	1,625.00
	- 12:12:17:2+TE (50kg/bag)	53 bags	117.50	6,227.00
3.	Nursery materials			
	- Peat gro (80 litre/bag)	10 bags	28.00	280.00
	- Seeding tray (51 holes/tray)	100 units	5.00	500.00
4.	Plastic mulch (5' x 250m)	25 rolls	85.00	2,125.00
5.	Agrochemicals			
	- Insecticide and fungicide	10 litres	60.00	600.00

	- Weedicide	8 litres	60.00 (4 litres)	120.00
6.	Stakes (1.5"-2" diameter, 7' long)	6,000.00	0.80	4,800.00
7.	Raffia string	12 rolls	7.00	84.00
	<b>Sub-total A</b>			<b>16,871.00</b>
<b>B.</b>	<b>Labour cost</b>			
	- Land clearing (secondary jungle)	Contract		1,000.00
	- Land preparation, bed making and plastic mulching (mechanically)	Contract		1,000.00
	- Nursery and maintenance	8 mdy*	30.00	240.00
	- Field planting	20 mdy*	30.00	600.00
	- Field maintenance**	3 workers x 5 months	600.00 /month	9,000.00
	<b>Sub-total B</b>			<b>11,840.00</b>
<b>C.</b>	<b>Fixed cost</b>			
1.	Diesel & lubricant for water pump engine	5 months	150.00	750.00
2.	Irrigation & water pump maintenance	5 months	50.00	250.00
3.	Depreciation value per season			
	- Sprinkle irrigation system			700.00
	- Water pump	1 unit		40.00
	- Water pump engine	1 unit		260.00
	- Knapsack sprayer	2 units		20.00
	- Hoe	4 units		7.20
	- Store & shed	1 unit		250.00
	<b>Sub-total C</b>			<b>2,277.20</b>
	<b>Grand total (A+B+C)</b>			<b>30,988.20</b>

\* Mandays

\*\*Inclusive of fertilising, plant replacement, weeding, irrigation system operation, pesticide spraying, staking, pruning, harvesting, processing and packaging.

Planting distance : 60 cm x 1.7 m

Plant density : 9,800 plants/ha  
 Bed size : 1.2 m (w) x 30 m (l) x 30 cm (h)  
 Harvest period : 2<sup>1</sup>/<sub>2</sub> -3 months  
 Days to harvest : 2-2<sup>1</sup>/<sub>2</sub> months from transplanting

**Table 3.** Estimated income, investment returns and production cost for one hectare of chilli production per season

<b>Particulars</b>	<b>Value</b>
a) Average yield (kg/ha)	18,000
b) Gross income @ RM3.50/kg (RM/ha)	63,000.00
c) Production cost (RM/ha)	30,988.20
d) Net income (RM/ha)	32,011.80
e) Return to every RM investment	2.03
f) Production cost/kg (RM)	1.73

**Table 4.** Estimated income against yield and price fluctuations

<b>Estimated income</b>	<b>Price (RM)/kg</b>	<b>Yield (kg)</b>		
		<b>15,000</b>	<b>20,000</b>	<b>24,000</b>
Gross	3.00	45,000.00	60,000.00	72,000.00
	4.00	60,000.00	80,000.00	96,000.00
	5.00	75,000.00	100,000.00	120,000.00
Net	3.00	14,011.80	29,011.80	41,011.80
	4.00	29,011.80	49,011.80	65,011.80
	5.00	44,011.80	69,011.80	89,011.80

**Table 5:** Depreciation value of fixed asset for chilli production per season\*

<b>Fixed asset</b>	<b>Unit price (RM)</b>	<b>Life span (years)</b>	<b>Depreciation value/season (RM)</b>
Sprinkle irrigation system	7,000.00	5	700.00
Water pump (1 unit)	400.00	5	40.00
Water pump engine (1 unit)	2,600.00	5	260.00
Knapsack sprayer (2 units)	200.00	5	20.00
Hoe (4 units)	72.00	5	7.20
Store & shed (1 unit)	5,000.00	10	250.00
<b>Total</b>	<b>15,272.00</b>		<b>1,277.20</b>

Source: MARDI, 2005

\* One season = 6 months

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