

BELL PEPPER

Julianna S. Mariano and Erlinda F. Jimenez

Introduction

Bell pepper (*Capsicum annuum* L.), also known as 'sweet pepper', 'kampana' or 'lara' is grown for its fruits, which usually comes in various colors such as red, green, yellow, brown, and orange. It is also known as capsicum, pepper, chili, chile, chilli, aji, or paprika. Within the species are hot pepper, paprika, chili, and cayenne. The other pepper species include the most pungent *Capsicum chinense* Jacquin- habañero, *Capsicum frutescens*- tabasco (tabasco sauce), malagueta (Brazil), *Capsicum baccatum*- aji (South America). Bell pepper is a good source of vitamins A and C, and potassium. In 2006, bell pepper contributed around P401,000 to the local economy.

Organic bell pepper is being produced in limited quantities. In the year 2006, 11,614 metric tons were produced, which is 6 % higher than the production of 2005 which was 10,951 metric tons. The major producers of bell pepper are in the Cordillera Administrative Region, 45%; Northern Mindanao, 17%; and the Ilocos region, 13%.

Peppers are members of the Solanaceae (night shade family). *Capsicum annum* is a native of the tropics and is related to many crop plants such as potatoes, tomatoes and eggplant. Peppers may be "hot" or "sweet". The fruit size varies from 1 to 30 cm in length, from thin to thick fleshed, conical to blocky or flattened, both yellow and green, at an immature stage, and with, red, yellow and brown mature fruits. This plant is a perennial in warm climates but grows as an annual in northern climates.

It is thought that all species of capsicum are of American origin. The centers of origin appear to be Mexico and Central America. When America was discovered peppers became adopted immediately and their use became worldwide.

Peppers are a tender, warm-season crop. They resist most pests and offer something for everyone: spicy, sweet or hot, and a variety of colors, shapes and sizes. Peppers are a long season, heat loving crop. This crop requires 3 to 4 months of frost free weather for good yields. They are very sensitive to frost and cold weather so they are not generally transplanted until mid June. The minimum soil temperature for seed germination is 15°C with a maximum of 35°C and an optimum range of 18 to 35°C. Best growth and quality occurs at an optimum range of 21 to 24°C with a minimum of 18°C and a maximum of 26°C. Fruit set for many cultivars fail when temperatures drop below 13 to 18°C. At temperatures above 32°C blossom drop becomes excessive. Large fruited cultivars tend to drop many of the flowers that form after several fruit have started to develop on the plant. Flowering will resume if these fruit are harvested and soil and weather conditions are favorable.

Only with the development of cultivars such as "Ace Hybrid" and "Super Set", has pepper growing in the field become a possibility. Peppers are mainly limited to the areas of the Atlantic which can successfully grow grain corn.

High production is possible in unheated tunnel houses. Early cultivars may have some fruit by the 1st week in July and production can carry on until late October. Red peppers do not mature on cultivars such as "Super Set" until late August. In the field crops are highly variable in yield from year to year. 10,000 kg per hectare is thought to be a good field yield. In tunnel houses yields of 4.5 kg per square meter have been obtained (45,000 kg per hectare).

A green pepper is a highly nutritious vegetable. This bell shaped vegetable with a green, glossy exterior adds a dash of color to any dish. It is also referred to as a bell pepper. It has a tangy taste that enhances food flavor. The inside has a small, white foam-like core with tiny seeds attached to it. This pepper isn't "hot" due to the absence of capsaicin which gives pepper the characteristic "hot" taste. Orange, yellow and red variants also exist. The pepper is packed with nutrients. It is a good source of vitamins, minerals and phytochemicals.

Various vitamins and phytochemicals found in green peppers have antioxidant properties. The peppers contain vitamin A in the form of carotenoids as well as vitamins B6, B9 and C, all of which are powerful antioxidants. These vitamins play a vital role in neutralizing free radicals in the body which have the capacity to cause serious damage to cells during their roaming activities. Free radicals also contribute to the build-up of cholesterol in blood vessels which increases the likelihood of stroke and heart disease. Besides their antioxidant properties, phytonutrients in green peppers play an anti-inflammatory role. This gives relief from pain and inflammatory conditions. It makes bell peppers a useful dietary item if you have rheumatoid arthritis or osteoarthritis. Phytonutrients also help to relax the airways and reduce wheezing in asthma cases.

CULTURE AND MANAGEMENT

- A. **Climatic Requirements.** Sweet pepper requires cool weather for best fruit quality. In low elevations, October to December planting is best. In mid and high elevations, it can be grown throughout the year.
- B. **Soil Requirements.** Sweet pepper grows well in any type of soil with a pH of 5.5 to 6.5. Production is best in sandy loam soil. Its temperature requirement ranges from 25 to 32 degrees Celsius
- C. **Commercial Varieties**
 - 1. 'California Wonder' - It matures at 120 days. The shape of the pepper is 4 lobed, weighing 60 grams. It grows best during the dry season. It is for fresh market production.
 - 2. 'Cony Island' (Condor) - It matures at 120 days. The shape of the pepper is conical, with an average length of 10 cm, with a green to red color, weighing 22 - 25 grams. It can be grown year round. It has long harvest duration and is highly recommended for commercialization.
 - 3. 'Gold Flame Hybrid' - It matures at 100 days. The shape of the pepper is blocky bell, with a length of 15 - 16 cm, with green to yellow color, weighing 200 - 250 grams. It has a very good shelf life and vigor. It is resistant to tobacco mosaic virus.
 - 4. 'Smooth Cayenne' - It matures at 90 - 120 days. The shape of the pepper is cone with a green color becoming red when ripe. It can be grown year round. It has thick glossy flesh tolerant to some diseases. It is sustainable for upland and lowland production.
 - 5. 'Sweet Plastic' - It matures at 60 days. The shape of the pepper is cone, weighing 24 grams. It can in all seasons. It is high yielding.

6. 'Tosca' (Condor) - It matures at 120 days. It is bell shaped, with an average length of 8 cm, with a green to red color, weighing 100 - 130 grams. It can be grown year round. It is good for outdoor growing and it has good vigor and shipping quality. It is resistant to bacterial wilt.
7. F1 sweet blocky type 'Redondo' (Nunhems) - It matures at 75 days. The shape of the pepper is blocky, with an average length of 10 cm, with a deep green to shiny red color, weighing 150 - 200 grams. It can be grown year round under greenhouse condition. It is heat tolerant and has a parthenocarpic set. It is resistant to TMV races, 1, 2, and 3.
8. OP 'Sweet California Wonder' (Bonanza) - It matures at 75 days. The shape of the pepper is blocky, with an average length of 10 cm, with a dark green to red color, weighing 150 - 200 grams. It can be grown year round. It has a high yield potential.
9. F1 'Sweet nun 3020 PP' (Nunhems) - It matures at 75 days. The shape of the pepper is blocky, with an average length of 12 cm, with a green yellow color, weighing 300 - 350 grams. It can be grown year round under greenhouse condition. It is resistant to tobamovirus and has a high yield potential.
10. 'Bless' Hybrid - It has a deep green color. It can be grown year round. It has high yield in any season and is very prolific. It has a smooth, shiny and firm with tough skin allowing for a good shipping quality.
11. 'Enterprise' Hybrid - - It matures at 70 days. The shape of the pepper is blocky, with a green to red color, weighing 200 - 350 grams. It is resistant to bacterial spot races 1, 2, 3 and Tobamovirus Pathotype PO.
12. 'Haifa Wonder' - The shape of the pepper is blocky and with a green color. It has a thick flesh; the plant is compact and early producing.
13. 'Improved Smooth Cayenne' Hybrid - - It matures at 90 - 100 days. The shape of the pepper is conical and with a green to red color. It can be grown year. It is a prolific variety, with a thick flesh and protected with a plastic like cover making it adapted to rainy season as well as dry season. It is tolerant to bacterial wilt, anthracnose and mosaic virus.
14. 'King Solomon' - The shape of the pepper is slightly elongated and with a dark green color. It is firm and thick walled with a strong growing plant.
15. 'Majesty' Hybrid - It is light green in color. The plant is very strong and can withstand high levels of disease pressure particularly bacterial wilt.
16. 'Trinity' Hybrid - The shape of the pepper is blocky, with a glossy deep green color, weighing 65 - 75 grams. It can be grown year round. The plants are strong against disease.
17. 'Vega' - The shape of the pepper is blocky, with an average length of 8.2 cm, with a green color, weighing 190 grams. The plants are early, slightly dwarf, short internodes, vigorous and have a good wind tolerance. It is very good for shipping.
18. 'Kalahari 914' Hybrid - It matures at 65 days. The shape of the pepper is blocky and weighing 130 grams. It is a high yielding variety that can yield as much 49 tons per hectare.
19. 'Kampana' 133 Hybrid - It is a big fruited, high yielding sweet pepper variety that adapts well in mid to high elevation areas.

D. Seedling Production. One hectare would require 100 to 200g of seeds. Sow the seeds in germination boxes with sterilized media composed of one part compost, 1 part burned

rice hull, and one part coir dust, at the depth of 0.5 cm. Use the same media for seedling trays. As a precaution against damping off, broadcast a small amount of fungicide over the media. Water the sown seeds thoroughly for the first 3 days. Regulate watering as soon as the seeds have germinated. Harden the seedlings a week before transplanting then gradually withhold water until they show temporary wilting. Seedlings 3-4 week-old are ready for transplanting.

- E. **Land Preparation.** Prepare the area thoroughly. Plow and harrow the field 2-3 times until the soil is well pulverized. For small areas, make plots 0.75 to 1 meter wide for two-row/plot planting. In bigger areas, set furrows at 0.6 m to 0.75 m apart for single row planting. This can be adopted during dry seasons. Use raised bed method (20-30 cm high, 1 meter wide) during the wet season.

F. **Crop Establishment**

- a. **Transplanting.** Apply basally 10 g of complete fertilizer (16-16-16) in each hole. Application of 250 g of compost per hole is also recommended. This will maintain the good texture and condition of the soil aside from supplementing its fertility. Transplant during cool weather or in the afternoon when the sun is not too hot to avoid seedling shock. Transplant at a spacing of 0.3 to 0.5 meter between hills.
- b. **Mulching.** Use mulch to control weeds and promote better growth. Rice hull, rice straw or plastic may be used. In case of the latter, make beds 1 meter wide and incorporate the required manure and fertilizer. Spread the mulch, covering the sides with soil. Make holes 0.5 m x 0.5 m apart.

- F. **Fertilization.** Sidedress 2 parts ammonium sulfate and 1 part muriate of potash at the rate of 10 g/hill, 10 days after transplanting, then again at 30 days; 1 part urea and 1 part muriate of potash at the rate of 10 g/hill. Repeat application of 1 part urea and 1 part muriate of potash, 50 days after transplanting at the same rate. Cultivate between the plant rows when the weeds are just starting to emerge. Three to four alternate off-baring and hilling-up are recommended to attain maximum yield control.

- G. **Irrigation.** Irrigate the field once every 7-10 days. Sufficient irrigation water is critical during the early vegetative stage and during flowering time until the peak of the fruit setting stage.

H. **Pest Management**

- a. **Thrips (*Thripstabaci*).** Thrips attack the upper and lower side of the leaves by sucking the sap. Areas near the mid-vein are brown and dried up. The major damage occurs on the undersides of new or old leaves. Managing the disease through chemical controls- check plants frequently and treat when damage is first observed and destroy refuse and control weeds
- b. **Aphids (*Aphids gossypil*).** Young and adults feed on underside of leaves by sucking the sap. Leaves becomes distorted, stunted and often curled under. The upper leaf surface is sticky and has a black moldy growth. Botanical pesticides/compounds may be tried such as neem extract and water. There are

many natural enemies that will feed on aphids, thus helping to reduce the populations of this pest in the field. Natural enemies that produce larvae which will feed on aphids include syrphid flies, lacewings and the predaceous midge. Adults and larvae of minute pirate bugs, big eyed bugs, lady beetles, soldier beetles and parasitic wasps like *Diaeretiellarapaewill* also consume aphids. Cultural controls include using high pressure sprinkler irrigation to knock the insects off of plants, as well as using living mulch such as clover interplanted with the crop. If using chemical controls, check plants frequently and treat when damage is first observed.

- c. **Broad Mite (*Polyhagotarsonemuslatus*)**. Direct feeding of leaves of pepper causes the leaves to become distorted and curled downwards. Young leaves are cupped downward and narrower than normal. Botanical pesticides/compounds may be tried such as neem extract and water, or madre de cacao, oil and water.
- d. **Tomato fruit worm**. A small darkened partially healed hole at the base of the fruit is evident. The inside of the fruit has a cavity that contains frass and decay. Often, the caterpillar can be seen inside the fruit. Chemicals can be used. There are many natural enemies that will help control these pests in fields. Ground beetles, spiders, damsel bugs, minute pirate bugs, assassin bugs, big eyed bugs, and lacewing larvae will all attack the caterpillars. Cultural controls include pheromone emitters to disrupt mating. Evening overhead sprinkler irrigation. Placement of floating row covers over young crops to exclude egg-laying females.
- e. **Bacterial Wilt**. The first symptom of the disease is wilting of some of the younger leaves or slight yellowing of the lower leaves. If such plants are pulled out, the roots and lower part of the stem which appears normal on the outside will show burning of the water conducting tissue under the back of the stem and water soaked appearances of the roots.

Management

- Avoid using compost and manure contaminated with bacterial organism.
 - 2. Use only healthy seedlings for transplanting.
 - Remove and burn any diseased plant as soon as it appears in order to reduce the sources of infection.
- f. **Anthractose of Pepper**. Anthractose may occur in the field and develop as a post-harvest decay of pepper fruits. Typical symptoms appear on mature fruits such as small water-soaked sunken lesions that expand rapidly. Lesions may be covered with raised, dark, fungal tissues which may appear in concentric rings.

Management

- Be sure to clean seeds.
 - Practice crop rotation.
 - Fungicides like Mancozeb or Benomyl may be used.
- g. **Cercospora Leaf Spot**. Early symptoms appear as small, circular, water-soaked spots on leaves which later enlarge up to 1 cm or more in diameter. Typical lesions are brown and circular with small to large light gray centers and dark brown margins. Several spots may coalesce causing the entire leaf to turn yellow and drop without yellowing.

Management

- Collect and burn all leaves and stems.

- Use clean, certified seed or a hot water seed treatment if certified seed is not available.
 - Practice long rotations.
 - Avoid overhead irrigation. Make sure to incorporate plant debris.
 - Good air circulation is needed in the field.
- h. **Powdery mildew** (*Leveillulataurica*). Yellowish blotches or spots appear on the upper leaf surface. The leaf surface is covered with a white to grey powdery fungal growth. The disease progresses from the older to younger leaves and shedding of the foliage is pronounced. Leaf defoliation leads to reduction in size and number of fruits. It also results in fruits being sun-burned. The disease is favored by warm, humid and dry weather. The fungus causing powdery mildew also attacks eggplants and tomatoes. Overhead irrigation reduces disease severity.

Management

- Plant resistant cultivars, if available.
 - Apply sulphur based fungicides at the onset of disease symptoms.
 - Remove and destroy crop debris after harvest.
- i. **Bacterial spot** (*Xanthomonas campestris* sp. *vesicatoria*). Leaves, fruit and stems can be attacked by the disease. Leaf spots begin as circular, water-soaked that become necrotic with brown centers surrounded by yellowish borders. The spots are sunken on the upper leaf surface and slightly raised on the lower surface. On stems spots are elongated. Affected leaves turn yellow and drop. Affected fruits have raised brown spots that are wart-like in appearance. The disease has a wide distribution wherever peppers are grown. It spreads rapidly during warm, rainy conditions. High relative humidity with free moisture on leaves for long periods favors infection. Ideal temperatures for infection are above 20° C. The bacterium is seed-borne and survives in crop debris.

Management

- Use of resistant varieties, if available.
 - Use certified disease-free seed.
 - Crop rotation.
 - Copper sprays can reduce the rate of disease development.
- j. **Cercospora leaf spot or Frog-eye** (*Cercospora capsici*). Spots on leaves are brown and circular with small to large light grey centres and dark brown margins. Spots on stems, petioles and peduncles are typically elliptical and also have light grey centres with dark borders. Infected leaves are shed. Extensive defoliation occurs under severe disease pressure. Fruits are not attacked. The fungus survives on seeds and in crop debris. The disease is favoured by prolonged periods of wetness.

Management

- Plant resistant cultivars, if available.
 - Use certified disease-free seeds.
 - Practise good field sanitation.
- j. **Root-knot nematodes** (*Meloidogyne* spp.). Symptoms of infestation by root-knot nematodes are similar in all crops: wilting of plants and if infested plants are pulled from the soil the roots can be seen to be distorted, swollen and bearing knots (galls). The galls on pepper are much smaller than those on cucurbits or tomatoes. The infested roots eventually rot and affected plants die.

Management

- Use of resistant varieties.
- Crop rotation.
- Mixed cropping with African marigold (*Tagetes* spp.)
- Maintaining high levels of organic matter in the soil (manure or compost). Presently, some bioproducts are available for control of the root-knot nematodes (e.g. neem extracts).
- Harvest the fruits when they have deep green color turning dull or red. This is the index of maturity which normally occurs around 80 to 90 days after planting
- Sort fruits according to market standard and separate damaged fruits. Fresh fruits can be stored up to 5 weeks at 4 degrees Celsius and 95% humidity.

Utilization

- Consumed fresh as a salad or cooked together with other vegetables
- Can be eaten raw, stir-fried, baked, grilled, or stewed
- Makes an important addition to 'chop suey', and meat dishes such as 'menudo', 'afritada', and 'kaldereta'
- Red type is also processed into 'pimientos', which makes into a delicious sandwich spread when combined with mayonnaise and cheese

COST AND RETURN ANALYSIS FOR SWEET PEPPER PER HECTARE

1. ESTIMATE YIELD PRODUCTION/week =	1,763kg
2. ESTIMATE YIELD PRODUCTION/cropping =	28,215kg/ha
3. GROSS PRODUCTION (@ Php.45.00/kg) =	Php.1,269,675.00
4. TOTAL COST PRODUCTION =	Php.233,024.50
5. NET PRODUCTION =	Php.1,036,650.50
6. RETURN OF INVESTMENT =	444.87%
7. BREAK EVEN PRICE (per kg) =	36.74

Sweet Pepper Production Cost/ha

A. MATERIAL COST	QTY	UNIT	Unit Price	Total Cost
Hybrid seeds	4	cans	1020/cans	4,080.00
Seedling tray	260	Pcs	85/pcs	22,000.00
Plastic mulch	15	rolls	2,200/roll	33,000.00
Organic fertilizer	50	bags	250/bag	12,500.00
Chicken manure	50	bags	50/bag	2,500.00
Inorganic fertilizer;				
Calcium nitrate	5	Bags	1500/bag	7,500.00
16-16-16	5	Bags	1,300/bag	6,500.00
00-00-60	5	Bags	2,000/bag	10,000.00

Foliar fertilizer	4	Li	500/li.	2,000.00
Adjuvant	1	Li	800/li.	800.00
Insecticide;				
Lannate	4	Kg	450/kg	1,800.00
Prevthon	4	Bottle	700/bottle	2,800.00
Bulduck	4	Li	600/li.	2,400.00
Fungicide	3	Kg	750/kg	2,250.00
Humus plus	20	Sachet	250/sachet	5,000.00

Sub-total of material cost	115,130.00
-----------------------------------	-------------------

Sweet Pepper Production Cost/ha.				
B. LABOR COST	QTY	UNIT	Unit Price	Total Price
Land preparation;				
Flowing	1	Passing	2,500/passing	2,500.00
Harrowing	1	Passing	1,500/passing	1,500.00
Plot preparation	40 Man	200/day	8,000.00	
Organic fertilizer application	40	Man	200/day	8,000.00
Plastic application	20	Man	200/day	4,000.00
Seed sowing	4	Man	200/day	8,000.00
Trans planting	10	Man	200/day	2,000.00
Inorganic fertilizer application	20	Man	200/day	4,000.00
Insecticide application	10	Man	200/day	2,000.00
Fungicide application	10	Man	200/day	2,000.00
Irrigation	40	Man	200/day	8,000.00
Weeding	20	Man	200/day	4,000.00
Harvesting/ hauling/ packaging	80	Man	200/day	16,000.00
Sub-total of labor cost				70,000.00

C. IRRIGATION COST = 15cavans per cropping at Php10 per kilogram
= **Php7,500.00**

D. RENT FOR LAND = 20cavans per cropping at Php10 per kilogram
= **Php.10,000.00**

SUB-TOTAL PRODUCTION COST = Php.202,630.00

INTEREST RATE OF CAPITAL = 15% per cropping of the cost production.
= .15 X 202,630.00

= Php.30,394.50

TOTAL COST PRODUCTION= Php.233,024.50

References

- Cultural Management Practices. East-West Seed Company 1990. On farm Research o. 94-427 Manual: Cropping Systems Research. Department of Agriculture, Bureau of Agricultural Research.
- Parker; B.L., Talekar, N.S. and Skinner, M. 1995 Field Guide: Insect Pests of Selected Vegetables In Tropical and Sub-tropical Asia. Asian Vegetable Research and Development Center, Shanhua, Tainan, Taiwan, R.O.C. Publication no. 94-427
- Package of Technology of Different Vegetable Crops: Technology Generation and Dissemination for the Growth and Development of Vegetable Industry. 2005. DA-RFU 4A& Bureau of Agricultural Research, Diliman Quezon City.
- <http://www.pinoybisnes.com/agri-business/sweet-pepper-production-guide/#ixzz27dbzIR8d>
- <http://www.fitday.com/fitness-articles/nutrition/healthy-eating/the-nutrition-of-a-green-pepper.html>
- <http://www.gov.pe.ca/agriculture/index.php3?number=70465&lang=E>
- <http://www.pinoy-entrepreneur.com/2010/03/08/sweet-pepper-or-bell-pepper-production/>
- http://www.park-promotions.co.uk/acatalog/Online_Catalogue_Vegetables_14.html
- <http://localfoods.about.com/od/peppers/tp/peppertypes.htm>

SOME COMMERCIAL VARIETIES OF BELL PEPPER



CALIFORNIA WONDER PEPPER *Photo © Molly Watson*



YELLOW WONDER
Photo © Molly Watson

Diseases



Powdery Mildew
© A. A. Seif & B. Nyambo, icipe



Anthracnose
© Courtesy EcoPort (<http://www.ecoport.org>):
J. Kranz



Bacterial spot © Courtesy EcoPort
(<http://www.ecoport.org>): Volcani Center Archives,
Bet Dagan, Israel, www.insectimages.org



Bacterial wilt
© A.M. Varela, icipe



Cercospora leaf spot on soybean
© Courtesy EcoPort (<http://www.ecoport.org>):
Clemson University, USDA



Root-knot nematodes