CULTIVATION AND SEED PRODUCTION OF EGGPLANT

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CULTIVATION OF EGGPLANT

INTRODUCTION

Eggplant, *Solanum nrelongena* L., *is* a common and popular vegetable crop grown in the subtropics and tropics. It is called *brinjal* in India, and in Europe *aubergine*. Eggplant is a perennial but grown commercially as an annual crop. The name *eggplant* derives from the shape of the fruit of some varieties, which are white and shaped very similarly to chicken eggs. Eggplant is essentially a warm weather crop which is grown extensively in India, Bangladesh, Pakistan, China, Japan, and the Philippines. It is also popular in Egypt, France, Italy, and the United States. According to the 1995 FAO Production Yearbook, the world eggplant production areas were 554,000 ha, and the total production was 9,026,000 metric tons. Asia has the largest eggplant production which comprises about 90% of the world production area, and 87% of the world production. (The data did not include India and Bangladesh). Gill and Tomar(1991) reported 299,770 ha of eggplant production area in India, and 29,150 ha in Bangladesh in 1992-93, bringing the Asian total close to 827,000. Eggplant can be grown in almost all parts of India all the year round except in higher altitudes. Its actual area under cultivation in India in not available due to its seasonal nature of cultivation.

COMPOSITION AND **USES**

Composition

Eggplant has been a common vegetable on our diet since the ancient time. Its composition per 100 g of edible portion is as below.

Calories	24.0	Sodium (mg)	3.0
Moisture content (%)	92.7	Copper (mg)	0.17
Carbohydrates (%)	4.0	Potassium (mg)	2.0
Protein (g)	1.4	Sulphur (mg)	44.0
Fat (g)	0.3	Chlorine (mg)	52.0_
Fiber (g)	1.3	Vitamin A (I.U.)	124.0
Oxalic acid (mg)	18.0	Vitamin B (mg)	
Calcium (mg)	18.0	Thiamine	0.04
Magnesium (mg)	16.0	Riboflavin	0.11
Phosphorus (mg)	47.0	B-carotene (ug)	0.74
Iron (mg)	0.9	Vitamin C (mg)	12.0

It was reported that on an average, the oblong-fruited eggplant cultivars are rich in total soluble sugars, whereas the long-fruited cultivars contain a higher content of free reducing sugars, anthocyanin, phenols, glycoalkaloids (such as solasodine), dry matter, and amide proteins. A high anthocyanin content and a low glycoalkaloid content are considered essential, regardless of how the fruit is to be used. For processing purposes, the fruit should have a high dry matter content and a low level of phenolics. Bitterness in eggplant is due to the presence of glycoalkaloids which are of wide occurrence in plants of Solanaceae family. The glycoalkaloid contents in the Indian commercial cultivars vary from 0.37 mg/100 g fresh weight to 4.83 mg. Generally, the high content of glycoalkaloids (20 mg/100 g fresh weight) produce a bitter taste and off flavor. The discoloration in eggplant fruit is attributed to high polyphenol oxidase

activity. The cultivars which are least susceptible to discoloration are considered suitable for processing purposes.

Uses

The unripe fruit of eggplant is primarily used as a cooking vegetable for the various dishes in different regions of the world. It has much potential as raw material in pickle making and dehydration industries. It may contain certain medicinal properties because medicinal uses of eggplant have been reported. For example, white eggplant is good for diabetic patients. It can cure toothache if fried eggplant fruit in til oil is taken. It has also been recommended as an excellent remedy for those suffering from liver complaints.

ORIGIN AND GENERAL BOTANY

Origin

Eggplant is probably a native of India and has been in cultivation for a long time. A wild type with many small fruits, sometimes called as *S. melongena* var. *insanum, is* found on the Bengal plains of India. Various forms, colors and shapes of eggplant are found throughout Southeast Asia, suggesting that this area is an important center of variation and possibly of origin. Vavilov (1928) felt that its center of origin was in the Indo-Burma region. It originated in India but has a secondary center of variation in China. In China, eggplant has been known for the last 1,500 years.

General Botany

Eggplant, *So/an= melongena* L. belongs to the Solanaceae family (Nightshade family), and has chromosomes 2n=24. There are three main botanical varieties under the species *melongena.* The round or egg-shaped cultivars are grouped tinder var. *esculentum,* common eggplant. The long, slender types are included under var. *serpentinum,* snake eggplant, and the small and straggling plants are put under var. *depressum,* dwarf eggplant.

Eggplant is a bushy plant and grows to a height of 60 to 120 centimeters. The plant is erect, compact, and well branched. It has a rather fibrous or lignified root system. The leaves are large, simple, lobed and alternate on the stems. The flowers are large, violet- or white-colored, and solitary, or in clusters of two or more. The stems, leaves, and calyx of some cultivars are spined. The fruit is a pendant, fleshy berry. The shape of fruit varies from ovoid, oblong, obovoid, or long cylindrical; the color of fruit varies from (shiny) purple, white, green, yellowish, or striped. The seeds are borne on the fleshy placentae filling the locular cavity completely.

ADAPTATION

Climatic Requirements

A relatively long growing season of about 120 days is required for successful production of this crop. Eggplant is a warm-weather plant, and the optimum temperatures for growth and fruit development are 21° to 29°C. It is intolerant of frost, and the growth of young plants will be retarded when night temperatures are below 16°C. On flowering plants, both cool temperatures and low light intensity can cause pollen viability and failure of fruit set. Eggplant, though more resistant than tomato in the sense that it can tolerate drought and excessive rainfall, shows relatively slow growth under a high temperature which results in stunting. When both temperature and relative humidity are high, eggplant becomes more vegetative.

Soil Requirements

Eggplant production can be successful on any good agricultural soil by using appropriate management methods. A deep, fertile and well-drained sandy loam or silt loam soils, with a pH of 5.5 to 6.8, and a high organic content are desirable for eggplant growth and development . Studies have indicated that lower or higher soil pH results in low yields because pH is closely related to the availability of soil nutrients. A sandy loam soil is ideal especially when an early yield is desired. For longer and later yields, heavier soils are preferable. Eggplant is susceptible to root rotting fungi, so saturated soil conditions and heavy clay soils should be avoided. Nematode problems are more likely to happen on very sandy soils. Choose the land after paddy rice in order to reduce bacterial wilt and nematode incidence.

CULTIVATION AND **CULTURAL REQUIREMENTS**

Seed Germination

The optimum temperature for eggplant seed germination is at 24 to 29°C. At this temperature, seedlings. should emerge in 6-8 days. The number of days required for emergence at various soil temperatures from seed sown at 1.2 cm deep are given below:

Soil temperature (°C)	20	25	30
Days to emergence	13	8	5

Germination conditions can be improved by covering the seeded flats or containers with a sheet of clear polyethylene, which must be removed as soon as emergence begins. For rapid and homogeneous germination, it is important to maintain a temperature range between 28°C day temperature and 20°C night temperature. Avoid using seeds older than 2 or 3 years according to the storage conditions, otherwise the germination rate may be substantially lower.

Raising of Seedling

Eggplant is usually transplanted rather than direct seeded in the field. The use of transplant makes the most efficient use of land and provides the best means of establishing a uniform and complete stand of plants. Sow seeds in seedling flats, beds, pots or modules. The seed beds should be fertile and well drained. The bed area can be incorporated with fertilizers at 40 g/m^2 ammonium sulfate, 50 g/m^2 superphosphate, 30 g/m^2 potassium chloride, and 2kg/m^2 of compost. Prepare seed beds of 15 cm high and 0.8 m wide, and sow the seed in rows of 6 cm apart and 0.5 cm deep. Apply a thin layer of compost on the bed before mulching with rice straw and cover them with a mesh screen net. Thin seedlings at the first true leaf stage. They will be ready for transplant in about 5- to 6-weeks depending on the sowing season.

Seedlings grown in cells or containers are ideal because they allow field planting without disturbing the root system. Bare-rooted seedlings could be successful if the field is irrigated and no drying of the young root system during the planting process. The most recent technique is the use of mechanical sowing. The seeds are mechanically dispersed into cells or plugs of a PE tray by the seeder. The plug seedlings are raised under greenhouse condition. Fertilize the plug seedlings weekly after two weeks, preferably with a water-soluble fertilizer solution. Plug seedlings will be ready to set in the field 4 to 5 weeks after sowing.

Land Preparation

Land preparation is done to create a favorable condition for seedling establishment and subsequent crop management. If properly done, it eliminates most of the weeds and soil-borne pathogenic microorganisms. It also improves the water holding capacity, drainage, and aeration

of the soil. Likewise, it facilitates field operations, such as furrow irrigation and mechanized weed control.

Choose land with fertile, good drainage, and accessible to irrigation water. Avoid the land that is previously planted with Solanaceous crops such as potato, tomato, pepper, etc. The land after paddy rice is ideal because of the reduction of nematodes and soil-borne pathogens.

If soil is dry, irrigate it 3-4 clays before land preparation. Temporary furrows can facilitate irrigation. Then the soil is rototilled or plowed . If it is plowed, the soil should be harrowed to achieve a fine filth prior to bed formation. Apply compost and basal fertilizers and incorporate them into soil by rototilling. Beds of 1.5 m wide and 20-25 cm high are formed and mulched with rice straw or PE sheets to control weed and conserve soil moisture.

Transplanting

A cloudy, cool weather condition and moist but not wet soil are ideal for transplanting. During sunny days, transplanting is best done in the late afternoon to allow the seedlings to recover at night. However, seedlings that are adequately hardened with slightly damaged roots could recover well when transplanted in a well-irrigated field, even on a hot day.

About 6-9 days before transplanting, seedlings are hardened by slightly withholding water and exposing them to strong sunlight by removing the netting. This will decrease the transplanting shock. The seedlings are thoroughly watered 12-14 hours before transplanting to the field. The ideal seedlings to be transplanted those with 3-4 true leaves, stocky and disease-free. Generally, seedlings are ready to set in the field 4-6 weeks after sowing. Eggplant seedlings are transplanted by hand into a hole deep enough to bury a plant. After transplanting, press the soil firmly around the root, and irrigate furrows immediately. Seedlings are planted on raised beds with a single row of plants in the middle of the bed (75-150 cm). In-row spacing varies from 50 to 70 cm, depending upon the vigour of the variety, the climate, and the soil productivity. In order to save the labors, eggplant is also mechanically transplanted by the transplanter.

Fertilization

Adequate application of manures and fertilizers is very important for successful crop production. Being a long duration crop, eggplant requires a good quantity of fertilizers. The following fertilization rates are generally recommended for growing eggplant in Taiwan. These rates may be used as a guide, and adjustment may be necessary according to information from a soil test.

Fertlizer	Total amt. kg/ha	Basala kg/ha.	1St side-dress b kg/ha	2°d side-dress c kg/ha
Compost	1,500	1,500		
N	168	84	42	42
P2O5	72	72		
K2O	180	180		

Application time.. apreplanting; b3weeks after transplanting, c5weeks after transplanting

An adequate amount of compost is essential to improve the efficiency of chemical fertilizers and to retain optimum soil physical/chemical conditions. If a longer harvesting period is preferred, an additional N application of 20 kg/ha is required at 7 weeks after transplanting or the amount of side-dressing can be equally divided and applied 3 times. Urea can be used to replace ammonium sulphate for side-dressing, however, only one-half of the amount of ammonium sulphate is needed at each application.

Macro-element fertilizer application has pronounced effects on the vegetative growth, development, yield and fruit quality of eggplant. Application of minor elements is not a high

requirement, and deficiencies are seldom a problem. However, the effects on the improvement of flowering and fruiting have been reported by adding micronutrients such as Cu, Mn, and Zn.

Irrigation

Irrigation is essential for eggplant cultivation in the region where only little or no rain is available during the growing season. The frequency and amount of water application are determined by the weather, soil conditions, the development stage, and depth of the root zone specific for the variety. The waterholding capacity of the soil is a major factor that determines the frequency of irrigation. A sandy soil must, therefore, be watered more frequently than a clay . soil. Eggplant is a medium-rooted crop with a root-zone depth of about 90 cm in well drained soil. Irrigate soil of at least 45 cm deep. The method of irrigation depends on soil texture, topography, and water supply. Generally, furrow (surface) irrigation is used in eggplant production. Mulching with black polyethylene will maintain a more uniform soil moisture between irrigations.

Weed Control

Eggplant is one of the initially slow growing crops which is incapable of competing with the aggressive weeds. Weed infestation also increases insect pests and diseases of eggplant. Therefore, the weeds should be controlled at the "critical period" when the maximum weeds are tolerable but without affecting the crop yield. Weeds are controlled either by physical/mechanical methods or chemical control. Physical methods, such as hand weeding, use of tools (hoe), cultivation and mulching, are quite common in small vegetable farms. Only shallow cultivation is necessary to remove weeds. Mulching with black polyethylene will effectively control weeds and greatly lessen labors. Natural organic mulches not only help conserve moisture, but also add organic matter to the soil.

Chemical weed control has developed rapidly and gained importance in vegetable production because of the selective properties of herbicides; that is, they destroy some plants but do not harm others. Chemical weed control is also popular in places where labor is very expensive or not readily available. Herbicides, Lasso (1.5 kg a.i./ha), Enide 50WP (dil. 1:300), Sancor 7OWP (dil. 1:4,000), Paraquat 24EC (dil. 1:250), etc. are recommended for use in eggplant production.

Disease and Insect Control

Diseases

The eggplant is subjected to the attack of many diseases which cause damages in all growth stages. Only the most common diseases are mentioned with their possible control measures.

Damping off *(Pythiuin* spp.; *Phytophthora spp.; Rhizoctonia* spp.)

The fungus attack usually starts on the germinating seed, sppreading to the hypocotyl, basal stern, and developing tap root. The affected seedlings are pale green, and a brownish lesion is found at the basal portion of the stem that girdles the stem. The affected tissue rots and the seedling collapses. The disease is soil-borne. The disease may be controlled by soil sterization and seed treatment with fungicides or hot water.

Phomopsis blight *(Phomopsis vexans)*

Phomopsis blight or fruit rot is probably the most serious and widespread eggplant disease. It occurs in the stems, leaves, and fruits. The fungus attacks the sterns of the young plants at the soil line, often girdlies the stem and causes the plant to break off, or at least to wilt and die. The fungus could also attack the stems of older plants at any point, causing sunken, oval, dark-brown cankers. Leaf infection first appears as round, brown spots; the centers of the spots later turn gray. Fruit spots are pale and sunken. The spots frequently orignate on the calyx and expand into the fruit pedicel and then into the fruit. Fruit decay is soft and spongy and may penetrate rapidly

throughout the fruit. To control this disease, use clean seeds, as the fungus may be carried on the seed; adopt a three- to four-year crop rotation; use resistant varieties such as Florida Market and Florida Beauty; and spray regularly with a protective fungicide such as maneb or zineb.

Leaf spot *(Alternaria* spp.; *Cercospora spp.)*

There are four different types of leaf spot in eggplant caused by *A. inelongenae, A. solani, C. solani-melongenae,* and C. *solani.* The *Alternaria* leaf spots produce the characteristic leaf spots with concentric rings. The spots are mostly irregular, 4-8 mm in diameter and may enlarge and cover a large area of the leaf blade. The leaves may drop off due to severe infection. The *Cercospora* leaf spots are characteristically chlorotic lesions, angular to irregular in shape, and later turn grayish brown with profuse sporulation at the center of the spot. Severely infected leaves drop off prematurely resulting in the reduction of yield. The leaf spot disease may be primarily controlled by maintaining proper field sanitation. If the general control measures suggested for *Phomopsis* blight are followed, the leaf spots should be much reduced.

Verticillium wilt *(Verticillium dahliae; Verticillium alboatrum)*

The most characteristic symptoms of *Verticillium* wilt. are found on the stems and roots. The infected plants become stunted in growth and generally, do not flower and set fruit. If the infection takes place after the flowering or fruit setting, the flowers and fruits are deformed, flaccid and finally drop off. The lengthwise cut of the infected stem shows dark-brown discoloration in the vascular tissue. The affected leaves turn yellow and then brown between veins followed by wilting and dropping off. After the plant is thoroughly invaded, the roots and the base of the stem may decay. The pathogen is soil-borne and the primary inoculum usually comes from the soil. Soil sterilization and crop rotation in which crops other than potatoes, tomatoes, and peppers are grown are recommended as a control measure. Grafting eggplants on suitable rootstocks also provides an effective method to minimize the disease infestation. Use of resistant varieties such as Black Beauty, Pusa Purple Long and Florida Market, however, control the disease permanently.

Bacterial wilt *(Ralstonia solanacearum)*

Bacterial wilt disease causes a severe problem in eggplant cultivation in the subtropics and tropics. Once it has become well established, it can be one of the most destructive pathogens known. The symptoms of bacterial wilt on susceptible plants are yellowing, curling and wilting of leaf; disintegration of stem and root; and dying of the plant. When newly infected stems or roots are cut crosswise and left for a short time or are pressed strongly, a dingy gray to yellowish ooze appears from the darkened circle. Crop rotations with immune species, eradication of weeds, good drainage, growing healthy seedlings, and grafting plants on the suitable resistant rootstocks are important control measures. A number of resistant germplasm has been identified at AVRDC.

Little leaf

Little leaf disease of eggplant is caused by mycoplasma. It is a serious eggplant disease throughout India. The infected plant is generally shorter 'but possesses a large number of branches, leaves and roots than a healthy one. The leaves are malformed into tiny chlorotic structures. Many lateral shoots develop in the axils leaf and with the shortened internodes give the plant a bushy appearance. The mycoplasma is transmitted by leaf hopper *Hishimonus phycitis* and also transmitted artificially by grafting. The suggested control measures are the complete eradication of all solanaceous weeds, the chemical control of leaf hopper, the roguing out of the diseased plants in the earlier stage of infestation, and the use of resistant cultivars such as Pusa Purple Cluster and Kartain.

Mosaic virus

There are several viruses which can infect eggplant tinder natural conditions and produce mosaic symptoms. They are cucumber mosaic virus (CMV), potato virus Y (PVY), potato virus X (PVX),tobacco ringspot virus (TRSV), etc. Plants infected with the virus are generally stunted in growth and show mosaic symptoms on leaves. The use of resistant or tolerant cultivars are the only control measure for these virus diseases.

Insect pests

Insect infestation is one of the most limiting factors for accelerating yield potential of eggplant. The crop is prone to damage by various insects, although there is wide variability in the degree of infestation. Some of the important ones are briefly described below.

Fruit and shoot borer *(Leucinodes orbonalis)*

Eggplant fruit and shoot borer is a very destructive pest in southeast and south Asia. It has been reported that the insect caused a loss up to 70% in yield. The larva attacks the terminal shoots and bores inside, resulting from withering and drying of the shoots. It also bores into the young fruit and feeds inside which makes the fruit unmarketable. Insecticides, Sumicidin 20EC, Lannate 9OWP, Decis 2.8EC, Sevin 50WP, etc. are effective in controlling this pest.

Thrips (mainly *Thrips pa/nil)*

Thrips have become serious pests of many vegetable crops. They attack eggplant mostly in dry season. Certain insecticides seem to cause resurgence in thrips population. Therefore, do not spray the crop until it has bben identified that thrips are the cause its damage. Insecticides Oxamyl 24EC, Carbosulfan 48EC, and Cyhalothrin 2.8EC are recommended for controlling thrips by spraying once a week until infestation stops.

Cotton leafhopper or Jassids (Amrasca biguttula biguttula, Hishimonus phycitis)

Cotton leafhoppers feed mainly on the underside of eggplant leaves. The infested leaves curl upwards along the margin. Their feeding results in small yellow patches on the foliage. They also transmit mycoplasma disease like little leaf. Fruit setting is adversely affected by the infestation. Spraying with Carbosulfan 48EC or Bifenthrin 2.8EC once a week is recommended for controlling the insect.

Two-spotted spider mite *(Tetranychus urticae)*

These small, polyphagous insects feed on the underside of eggplant leaves in large colonies. Resulting from white specks that appear on the leaves. These specks coalesce and -appear as white patches. Ultimately, the entire affected leaf are discolored and withered. The damage is more pronounced during the warm and dry season. Spraying with Bifenthrin 1OWP or Cyhalothrin 2.8EC are effective in controlling the insect.

Aphids *(Aphis gossypii)*

The aphid is small, soft, yellowish green or greenish brown found in colonies on the tender shoots and the undersurface of young leaves. They feed on leaves and stems by sucking the plant juice. Black sooty mould develops on the honeydew excreted by the aphid and covers on the leaves and adversely affects the photosynthesis. As a result, infested plants appear weak. These insects occur in the cool dry season. Spraying with Bifenthrin 10 WP or Carbosulfan 48EC once a week is suggested to control the aphids.

Epilachna beetle *(Epilachna vigintioctopunctata, E. indica)*

The beetle is brown to red, small, spherical and mottled with black spots. They feed voraciously on the leaves and tender parts of eggplant and often cause serious damage when they appear in numbers. As a result of their feeding, skeletonized , lacelike patches are developed on leaves and later the leaves dry away. They can be controlled with Carbaryl 50WP, or Malathion 50EC.

Nematodes

Root-knot nematodes *(Meloidogyne* spp.)

Eggplant is highly susceptible to the nematode. Attacked plants become stunted, reduced growth, and their leaves show yellowing or chlorotic symptoms. The infestation is also easily recognized by the characteristic root galls. Proper crop rotation with other crops resistant to root-knot nematodes such as marigold, will help in reduction of nematodes population. Terbufos (10%) or DCIP 80EC is recommended for controlling the root-knot nematodes.

HARVEST AND POSTHARVEST

The time required from flowering to market-fruit size is about 3-4 weeks, but fruit can be harvested and eaten at any earlier stage of the development. Fruit should be harvested while it still glossy with a desirable color. When the color dulls, the seeds become dark and the flesh becomes spongy and bitter. At market maturity, the fruit stem is tough and hard, so a sharp knife or hand-pruning clipper is needed to remove the fruit from the plants. The calyx and a short piece of the stem are left on the fruit, but care should be taken to prevent the stem from injuring other fruits in the package.

Eggplant yields are commonly in the range of 30 to 40 tons/ha of marketable fruit, although higher yields can be achieved. With the normal annual cropping practice, 6 to 12 marketable fruit may be expected per plant for the large-fruited type, weighing in the range of 300 to 400 gm each. The elongated oriental varieties may produce twice of that many fruit quantity, with individual fruit weighing in the range of 100 to 150 gm each.

Eggplant does not have a long storage life and should be marketed immediately after harvest. The fruit should be handled and packed carefully to avoid puncture or abrasion damage to the skin. Fruit are packed in a fiberboard carton or a special crate or other containers. Eggplant can be stored safely for 7 to 10 days at 7° to 10° C and 90-95% relative humidity. It is subject to chilling injury when stored at temperatures below 7° C for several days.

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SEED PRODUCTION OF EGGPLANT

INTRODUCTION

The eggplant originates from India and is now generally grown as a vegetable throughout the tropical, sub-tropical and warm temperate areas of the world. It is an important vegetable in India, China and Japan. In recent years it has increased in importance as a protected crop in Northern Europe. In japan, eggplant is one of the indispensable vegetables on daily table as pickles or boiled, grilled and fried dishes.

The cultivars *of Solanum melongena* L. display a wide range of fruit shapes and colours, ranging from oval or egg-shaped to long club-shaped; and from white, yellow, green, through degrees of purple pigmentation to almost black. Most of the commercially important cultivars have been selected from the old-long established types of the tropical India and China. In the past, farmers maintained and supplied seeds of eggplant with special type of varieties adapted in the region. However, there were increasingly F_1 hybrid varieties bred by seed companies recently, the seed production of eggplant has been shifted completely from farmer's hands to seed companies.

Environment

Environmental factors are important in the production of eggplant seed. The same climatic factors which influence the cultivation of eggplant as a market vegetable also act on seed production. Eggplant is a warm season crop. It requires a long, warm growing season for successful production. It is more susceptible to low temperature than tomato and pepper. A day temperature of 25-32°C and a night temperature of 21-27°C are ideal for plant growth and fruit development. Comparatively a hardy crop, it can tolerate drought and heavy rainfall. However, it is advisable to select a dry climate or at least a season with a low air humidity which discourages disease development such as fruit rot. Furthermore, good soil and adequate fertilization are essential. Eggplant can be grown on different kinds of soil but does best on well drained silt loams or clay loams with a pH of 5.5-6.5.

Flowering Habit

The eggplant does not have a specific daylength requirement for flower intiation. The flowers are borne solitarily or in cluster of two or more. In solitary flowering type, the flower drop is very low, whereas in clustered flowering one, the flower drop may be as high as 80%. The flower is normally perfect, having functional male (anthers) and female (pistil) parts. There are three types of flower depending upon the length of styles, viz., (1) long-styled with large size ovary, (2) medium-styled with medium size ovary, and (3) short-styled with rudimentary ovary. The ratio of the three flower types varies with the cultivars and the stage of plant development. It has been reported that the long-styled flowers are always appreciably more in number (52-90%) than the medium-styled (8.5-28%) and short-styled ones (1.5-25%). It was also reported that fruit set in eggplant cultivars with long-styled flowers varied from 70 to 86%, while those with short-styled flowers did not set fruit.

In most eggplant-growing areas, anthesis and pollen dehiscence in eggplant flowers occur between 6:00 and 11:00 in the morning. However, anthesis and dehiscence are mainly influenced by the daylight, temperature, and humidity, the exact timing for every area should be determined by observation and experience. Pollen viability is retained for 8-10 days at a temperature of 20-22° C and with a relative humidity of 50-55%.

Eggplant is a normally highly self-pollinated crop. The conelike formation of anthers favours self-pollination; but since stigma ultimately projects beyond the anthers, there is an ample opportunity for cross-pollination. The rates of natural cross-pollination may vary depending on genotype, location, and insect activity. It has been reported that the extent of natural outcrossing

was recorded from 2 to 48% in eggplant cultivars in India; from 30 to 40% in some Bulgarian varieties; and from 3 to 7% in China. At AVRDC field, from 0 to 8.2% of natural outcrossing rates (with a mean of 2.7%) were observed.

Crop Management

Cultural practices and crop management for seed production are almost same as for market fruit production except that fruits are harvested when they are ripe and the skins become yellow. Furthermore, seed crops require special attention in terms of isolation, roguing, harvesting and seed extraction. In general, higher levels of P and K fertilizers result in greater seed yield and better quality. The importance of nitrogen on accelerating flower formation in eggplant has been reported and practised in Japan. In Japan, special techniques are also adopted to train and support the plants. Eggplants are susceptible to many of the soil-borne pests and diseases associated with other members of *Solanaceae.* Rotation of seed crops with non-solanaceous crops must take into account.

Isolation

Appropriate isolation of the seed-producing field from other varieties of the same crop is generally required. Since there is a considerable amount of natural cross pollination in eggplant, an isolation is essential to seed production. An isolation distance of 200 m and 100 m for foundation and certified seed production, respectively, is recommended.

Roguing

Seed growers should be well acquainted with the characteristics of the cultivars so that they may effectively rogue out the off-types and undesirable plants at different stages of crop growth. Leaf and stern characters can easily be identified even at the seedling stage. Roguing can also be performed based on fruit size, shape and colour,and other plant characters. All the plants infected with virus diseases or other seed-borne diseases should be rogued out. Minimum of three roguings should be made one each before flowering, at flowering, and at fruiting stage. In case of F, hybrid seed production, both parent stocks need a final check for trueness to type before hybridization starts; any off-type or suspected deviants should be eliminated.

Production of Pr Hybrid Seed

In the last decade or so, the use of hybrid cultivars has increased dramatically. The major role played by the private seed sectors in developing and distributing improved eggplant cultivars has encouraged the trend towards increasing the use of hybrids. It is true that Fr hybrids exhibit favorable traits such as uniformity, high yield (heterosis), and, to some extent, better resistance to diseases, but their advantages over the standard cultivars have not been as great as in cross-pollinating species. The popularization of F_1 hybrids among self-pollinated species is due to that it gives better protection of variety right to the developer.

In general, Fr hybrid seed production is manually done in eggplant. Hand pollination is relatively easy due to its large-sized flowers. It is also more economical because each fruit contains a good quantity of seed as compared to other vegetables. High daytime temperature but a wide difference between day and night temperatures, especially during the fruit developing stage, and less rain during flowering and pollination periods, are considered suitable for hybrid seed production. Selection of a fertile, well-drained, and disease-free field is importance to successful hybrid seed production. It is also important that materials for seed production be given the optimum conditions for growth and reproduction to insure that good seed quality and high overall seed yield will be attained.

The process of hybrid seed production takes invariably many hours of skilled work. Several technical aspects that one must pay attention to in order to insure success are location-specific. Some of them might require modifications under local conditions and should be viewed as general guidelines in seed production.

Preparation for Hybridization

The male parent should be planted 7-10 days before the female parent so that an adequate source of pollen is available at pollination time. It is important that sufficient male plants producing good flowers at the right time should be assured. A ratio of 5 or 6 female to 1 male plants is adequate for commercial hybrid seed production. However, this ratio may be adjusted according to the flowering behavior of the parents.

The operation of emasculation and hand-pollination is usually done considering to coincide with better cycle of fruit setting. To obtain a period of concentrating flowering for efficient emasculation and pollination, fertilizer application and crop management are planned in such a way that plant growth is most vigorous during the mid-stage of flowering. Before starting emasculation, all the opened flowers and fruit set are removed completely along with any undesirable flower buds.

Emasculation

Flower buds about one to two days away from opening should be chosen for emasculation. At this stage, the petals are still white. Emasculating very young flower buds could lead to injury to the style and ovary. On the other hand, of large flower buds which petals have turned violet colour are emasculated, the chances that they have already been self pollinated are high. To emasculate, use sharp-pointed forceps to open the unopened bud from upper part, and then carefully remove all the anthers inside leaving only the petals, ovary, and the style. The emasculated flower buds are covered with bags or leaving without covering depending on the field isolation condition and insect activity.

Pollen Collection

Pollen flowers are collected from the male plants in the early morning hours before the anthers dehisce. After most of the anthers have dehisced in the container, the pollen is gathered in convenient small-sized vessels by vibrating the flowers. Alternative pollen collection method uses a specially made vibrator and adopts the same principle of shaking the dehiscent flowers to force the pollen to shed.

Pollination

The flowers emasculated one or two days earlier should have completely blossomedand are ready for cross-pollination. Using a small pair of scissors, cut two calyxes of the emasculated flower buds to mark the hybrid pollinations. Then, the stigma is dipped into pollen mass kept in a suitable pollen container. Pollination can also be done by dipping the tip of the little finger into a pool of pollen, then touch the stigma with the pollen-covered little finger. Marking the pollinated flowers could vary with preferences. Small rubber bands or strings or tin ties may be put on the peduncles of the cross-pollinated flowers.

Any unhybridized old flowers of the female plant should be removed to eliminate the chance of contamination from selfed seeds. The pollination period for a seed crop varies within a 25-35 day range. Number of hybrid fruits to be produced per plant depends on the average fruit size and seeds per fruit of the maternal parent. The average number of seed fruit per plant is 4-6 for the large-fruited, 6-10 for the medium-fruited, and 12-15 for the small-fruited parent.

Plant Protection

Crop protection measures should be taken in time. In the tropical climate eggplant is attacked by several insect pests such as *Epilachna* beetle, fruit and shoot borers, jassids, aphids, and mites. Repeated chemical sprays at an interval of 15 clays are recommended for controlling these insects.

The important diseases of eggplant are mentioned in the section of cultivation. Effective cont ol measures such as seed treatment, crop rotation, and soil fumigation should be taken before starting of the seed crop to prevent against seed- and soil-borne diseases. Chemical sprays are recommended for controlling *Cercospora* leaf spot, powdery mildew, and *Phoinopsis* fruit rot.

Harvesting

For seed production, fruits are allowed to ripen fully to ensure complete seed development and maturity. In general, the colour of fully matured fruits fades and turns normal colour to yellow. For open-pollinated cultivars, only the ripe yellow fruits are harvested. In case of hybrid seed production, the seed fruit fully matures about 50-55 days after pollination depending on the maternal parents. Only the marked pollinated-fruits are carefully harvested.

Seed Extraction and Drying

The harvested fruits are stored for three to four days until they become soft. This allows the seed to mature fully. One third of fruit from upper part where contains almost no seed is cut off. Then seeds are extracted by cutting, crushing or macerating with a mechanical extractor in large scale seed production. After extraction, seeds are washed and cleaned with extra water in a container. Some seed extractors are also capable of separating the seed from the pulp through a screen. Dry extraction of eggplant seed is used by very small-scale seed growers, however, it is time consuming and laborious.

Seed drying is done by spreading the wet seeds either in the sun or in an electric dehydrator. Stir the seed with hands at least 2-3 times a day, turning them over to dry uniformly. Seeds that stick together should be disaggregated. The seeds should be completely dry to about 8% moisture content.

Seed Yield

The seed yields of eggplant vary with different cultivars or parents and production conditions. Generally, the standard of seed yield is fallen between 600-800 kg/ha. The cost of hybrid seed production of eggplant is not as high as compared to other vegetables because each fruit contains larger number of seeds. The cost can be further reduced by the use of male sterile line in hybrid seed production. Therefore, exploitation of hybrid vigour in eggplant is economical.

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