

TOMATO CULTIVATION IN THE DRY ZONE OF CEYLON—IV

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YIELDS

One of the most important factors determining the success of tomato cultivation is yield, which as previously shown is largely dependent on the cultural methods adopted by the grower. The weather conditions prevailing during the growth of the crop and the incidence of pests and diseases, which in the case of the tomato crop is particularly associated with unseasonable weather, also influence the yield to a considerable extent.

There is a wide variation in the recorded yields of tomatoes from different countries. Under field conditions yields vary from about 3 to 20 tons per acre in general, although according to Work (1926) as much as 35 tons per acre have been obtained in the U.S.A.

Mc Cue and Pelton (1913) state that in U.S.A. tomatoes when grown for canning purposes are not profitable under about 6 tons per acre, but Jones and Rosa (1928) record 4 tons as being the U.S.A. average. Pearson and Porter (1932); however, report 7 to 12 tons as being the usual yield. The yields of canning tomatoes need to be high, since the profits are otherwise small owing to the lower prices paid for the crop in comparison with market tomatoes.

Market tomatoes do not generally give as high a yield of salable fruit as in the case of tomatoes for canning and manufacture. Yields usually vary from about 3 to 6 tons per acre, but with intensive cultivation, pruning, training and closer spacing gross yields of 15 to 25 tons per acre have not been uncommon. At the Central Farm, Coimbatore, Raghavan (1933) states that the yields vary from 7 to 17 tons per acre, the lowest yield being 4.8 tons.

In Ceylon, the yields of tomatoes are generally between 2 to 3 tons per acre. This is low but the spacing has been comparatively wide, usually about 3 ft. apart. The yield per

plant is about 2 lb., although this could be increased with the application of manures and fertilisers and judicious irrigation during dry weather. In the Canaries, Holmes (1931) states that the yield per plant varies from 2 to 6 lb. depending on the type of land used and the intensiveness of cultivation. The spacing there is fairly close, about 9,000 to 13,500 plants being grown per acre. At 3×1 ft. there are 14,520 plants per acre and hence if each plant in Ceylon gives a minimum yield of 2 lb. at this spacing the total yield per acre can be very greatly increased. Factors which tend to reduce yields are unfavourable weather conditions and pests and diseases as stated above. The effect of the former can be lessened to a limited extent by cultural devices and the latter by preventive and control methods against the particular pests and diseases attacking the crop, but these may not be entirely effective and during certain unfavourable seasons the yields may be low. But, generally, the yields of tomatoes in Ceylon can be largely increased particularly by closer planting, but also by the intensive methods of culture previously described.

COST OF PRODUCTION

The cost of growing tomatoes under field conditions largely depends on the method of cultivation and labour rates. It has been previously stated that for high yields intensive methods must be practised, but consideration should be paid to the cost of labour and materials in any locality before deciding on the particular method to be adopted. In view of the variation in labour rates paid in different localities figures of cost alone are not a sufficient guide unless the work required for each operation is recorded in units of days per head, *e.g.* men days. These units vary within certain limits with the efficiency of the labour and the implements used for each operation and so any cost figures that are published on this basis are only an approximation. The cost of materials required also varies considerably with the locality, *e.g.* in the case of stakes and scantlings which may in certain areas be prohibitive in cost for trellising tomatoes.

Nevertheless, as a general guide the cost of production of tomatoes per acre in the dry zone is given here, based on average labour rates in the area. The method employed in growing the crop is staking and pruning to a single stem, the planting distance being 9,680 plants per acre.

ESTIMATED COST OF PRODUCTION PER ACRE OF TOMATOES

	Men days @ -/60Cts.	Women days @ -/35Cts.	Bullocks @ Re. 1/- perpair	Rs. Cts.
1. Seed and Nurseries	6	5	—	15·00
2. Ploughing	2	—	2	3·20
3. Harrowing	$\frac{1}{2}$	—	$\frac{1}{2}$	0·80
4. Manure and application 12 tons at Rs. 3·00	4	—	—	38·40
5. Harrowing after Manuring	$\frac{1}{2}$	—	$\frac{1}{2}$	0·80
6. Ridging (plough and hoes)	14	6	2	12·50
7. Fertilisers	—	—	—	25·00
8. Planting out	2	35	—	13·45
9. Intercultivation, earthing up and application of fertilisers	25	50	3	35·50
10. Pruning, Staking and Tying	40	60	—	45·00
11. Irrigation	—	—	—	60·00
12. Picking and Transporting	10	25	—	14·75
13. Grading and Marketing (in- cluding freight)	—	30	—	135·60
	<u>104</u>	<u>211</u>	<u>8</u>	<u>400·00</u>

Yield per acre (minimum)	6 tons
Yield of graded fruits (85% of total)	5·1 tons
Quantity of marketable fruits (allowing 15% for damage, etc. in transit)	4·3 tons
	<u> = 8,632 lb.</u>

Estimated Value—1st Grade 6% — 518 lb. @ 15 Cts.	77·70
2nd Grade 48% — 4,143 lb. @ 10 Cts.	414·30
3rd Grade 31% — 2,676 lb. @ 05 Cts.	133·80
	<u>625·80</u>

The prices offered to the grower will vary considerably according to the season in which the crop is produced, but for good quality fruits prices of the 1st and 2nd grade may vary between 10 to 30 cents per lb.

In U.S.A., Carncross and Nissley (1932) carried out a survey of tomato farms in New Jersey and report an average cost of \$107·15 per acre with variations from \$83·93 to \$156·01 per acre; while Norton (1922) records an average of \$164·59 for New York farms, of which \$59·20 are used in marketing costs. Raghavan (1933) gives the cost of cultivation at the Central Farm, Coimbatore, as not exceeding Rs. 160·00 per

acre, including the cost of irrigation, but the labour rates there are low even in comparison with Ceylon.

When the yields are high due to better methods of cultivation the cost per ton of the crop is decreased even though the total expenditure is higher. Norton found the cost of production varied from \$43.56 per ton where the yield was below 5 tons per acre to \$10.15 where it was over 15 tons. The tomato grower should, therefore, aim at intensive production of his crop in order that his net returns should be large.

SEED GROWING

Although it is now, generally, advisable for tomato growers to purchase their seed from reliable seedsmen it may be necessary for a grower to raise his own seed on occasions. It is also possible for a careful grower under suitable conditions for the production of seed, to develop an improved acclimatised strain by selection.

In selection for new strains, the grower should mark particular plants which show any outstandingly desirable characters for propagation, but where seed of an already established strain or variety is to be raised, plants which are not true should be removed. In the former instance, individual plants should be selected for such characters as early maturing, bearing capacity, size, shape and quality of fruit. It is of course essential that the plants should be vigorous and healthy.

For seed purposes only fully ripe fruits should be picked, as immature or green fruits give rise to seed which produces plants which are poorer in yield and quality. The fruits should also be large and regular in shape and it is advisable to pick the fruits for seed purposes when the plants are in the best period of their fruiting.

As tomatoes are liable to a certain amount of crossing, even though this may not be very great, it is best that each variety be grown as widely separated from another as possible. In the case of selection for a new strain the seed from a single selected plant should be sown separately and multiplied up the following season. The selection of individual plants should, however, be continued for sometime until the plants show no signs of degeneration of the new characters of the selected strain.

In the preparation of seed, the ripe fruits should be pulped by pounding or by passing them through a grinder. The resulting gelatinous mass should be allowed to stand for a period of 1 to 3 days for fermentation. Water should then be added and after stirring, the skin and pulp with any poorly developed seed which floats on top can be separated from the plump seeds

which sink to the bottom. Water should again be added and the process repeated several times until the seeds are thoroughly cleaned. They should then be removed mixed with fine wood ashes and dried in the sun as quickly as possible. When quite dry the excess ash should be removed by winnowing and the seeds stored in airtight vessels.

DISEASES

Some of the more serious diseases of tomatoes are caused by fungi or bacteria which are carried over in the seed or live in the soil of seed beds. It is for this reason that precautions should be taken to sterilise the soil in seed beds where tomatoes or other solanaceous seedlings like tobacco have been grown often. The seed may be effectively sterilised by soaking it in a solution of 2 oz. of copper sulphate dissolved in 1 gallon of water. It should be tied up loosely in a cheese cloth bag and soaked for 1 to 2 hours in the copper sulphate solution after which it may be dried or sown immediately.

(A) "DAMPING-OFF" (PYTHIUM, RHIZOCTONIA, ETC.)

This disease, which is attributed to the attacks of various fungi, occurs in the nurseries. The young seedlings are chiefly attacked, the first symptom being a slight wilting of the cotyledons at their tips and then the stems become water-sodden just above the surface of the soil. Later a white or grey mycelium becomes evident. Damping-off is favoured by humid conditions and inadequate ventilation. The disease is prevented earlier by sterilisation of the soil and seed. Watering should be reduced and ventilation increased. A layer of sand about $\frac{1}{4}$ " deep should be sprinkled over the surface, as it prevents the surface soil remaining damp. This disease is, however, not very serious in the dry zone.

(B) WILT DISEASES

The class of diseases grouped together as wilt are, in general, the most serious of those attacking tomatoes in the field. The three main wilt diseases of tomatoes in the tropics are given below.

(1) *Fusarium wilt*.—This disease is caused by the fungus *Fusarium lycopersici* (Sacc.) and is one of the commonest of the wilt diseases. Infected plants turn yellow and wilt and later die. One of the chief characteristics of the disease is the presence of a brown discoloration of the woody tissues of the stem just below the greyish green outer skin. As soon as a diseased plant is observed it should be immediately removed and destroyed. A crop rotation should be practised, and, as far as possible, solanaceous plants should be avoided for 2 to 3

years. There are varieties of tomatoes that have been bred for resistance to wilt, such as Marglobe and Norton in the U.S.A. But it is possible that owing to the existence of a number of strains of the fungus differing in virulence, a variety known to be resistant in one country may not prove resistant in another.

As a precaution against wilt, the seed and nursery should be sterilised.

(2) *Bacterial wilt*.—This is a bacterial disease caused by *Bacterium solanacearum* (E.F. Smith). Prior to wilting the plants frequently assume a stunted appearance. Wilting takes place rather rapidly and completely without a preliminary yellowing and the plants soon die. If the stems are cut across the tissues are seen to be brown and a creamy bacterial discharge exudes from the cut vessels.

The same measures advocated against Fusarium wilt, with the exception of wilt resistant varieties which are not known for this disease, may be adopted.

(3) *Sclerotium wilt*.—The fungus *Sclerotium rolfsii* (Sacc.) has been found responsible for this disease which is somewhat common in the dry zone. The leaves of affected plants wilt with no preliminary discoloration. The fungus generally attacks the plant near the ground level where the stem is usually killed. Just above ground level a white feathery mycelium may be seen growing around the stem and numerous sclerotia of about the size of a mustard seed may be seen among the mycelium on the stem as well as the roots.

Infected plants should be removed and burnt. Attention should be paid to cultural methods. The soil should be kept well-drained and in a good state of tilth.

(C) PHYSIOLOGICAL DISEASES

(1) *Leaf Curl*.—This is a little understood disease in which the leaves of attacked plants show a pronounced curling and wrinkling. Fruiting becomes restricted and the plants remain stunted.

(2) *Blossom end rot*.—This disease is common wherever tomatoes are grown. It is a non-infectious disease which is connected with environmental conditions—moisture and temperature. Small brown spots which later enlarge in size form at the blossom end of the fruit rendering it usually flattened at this end.

It is considered that when the soil moisture is suddenly diminished or there is an abrupt rise in temperature more moisture is lost from the plant than can be taken through the roots and moisture from the fruits is withdrawn at the end

furthest away from the stem. The disease seldom appears where the amount of soil moisture is adequate or gradually diminishes towards the end of the growing season.

When conditions become suddenly arid or hot irrigation of the plants, if possible, should be carried out.

(3) *Sun Scald*.—The presence of patches on the surface of the fruit in which the skin appears blistered characterises this condition.

(4) *Cracking*.—Fruits in certain seasons show marked cracking of the skin. The cracks develop both radially and concentrically from the stem end. The radial cracks penetrate slightly below the skin into the flesh while those that are concentric are only confined to the skin.

(D) VIRUS DISEASES

There are several types of virus diseases of tomatoes that have been described by plant pathologists. They are caused by infective agents which are too small even to be seen by the best microscope. These diseases are transmitted by aphides and other sucking insects.

The commonest virus disease is Mosaic which produces a green and yellow or light green mottling of the foliage. The plants may be distorted by crinkling, dwarfing, etc. The flowers become distorted and "setting" of the fruits is prevented. When the disease once appears in the field, it is difficult to control because just a few aphides are sufficient to carry the infection. It is important that all weeds which are susceptible to mosaic should be early removed from the vicinity of the field. Mosaic infected plants should not be pruned or handled. When, however, only a few plants are infected they should be removed at once and destroyed taking care to disinfect one's hands before handling uninfected plants immediately after removing the mosaic plants.

(E) EELWORM

The eelworm *Heterodera marioni* is responsible for a serious infection of the roots and is known as root-knot. The roots of affected plants develop gall-like swellings and the plants become stunted, turn yellow and finally die. Within the tissues of the gall-like swellings, the eelworm will be found in all stages of development.

Rotation of crops for 2 to 3 years should be carried out to starve the nematode out from infected soil and only eelworm-resistant crops should be grown during this period.

For further information on any of the above diseases application should be made to the Mycologist, Peradeniya.

PESTS

The following brief notes are given on some of the commoner pests found attacking tomatoes in Ceylon.

(A) FLEA-BEETLES

Damage by flea-beetles results in a pitted appearance of the leaves of young plants in the nurseries. This causes considerable weakening of the young plants.

(B) GRASSHOPPERS

Various species of grasshoppers have been responsible in the dry zone for attacking young plants in the nurseries. Lighted fires at night in the neighbourhood of the nurseries are sometimes effective in trapping the insects.

(C) CUTWORMS

These caterpillars, which are usually active at night, cut the young plants at ground level. A poisoned bait may be employed, such as Paris Green $\frac{1}{4}$ lb., bran or rice dust 5 lb., jaggery 1 lb., and water 7 pints. These ingredients are mixed to form a stiff marsh, and small lumps are put out near the plants overnight.

(D) HORNWORMS (PROTOPARCE SP.)

These are large green caterpillars with white stripes extending diagonally across the body and a curved horn on the rear. They rapidly strip off the foliage leaving the plants quite bare. The plants may be sprayed with lead arsenate at the rate of 1 oz. per 2 gallons of water, but hand picking should also be resorted to whenever possible. The lead arsenate spray is also useful against all leaf-eating insects, such as flea-beetles, etc.

(E) FRUIT-BORERS (HELIOTHIS OBSOLETA AND PRODENIA LITURA)

These are the most serious pests of tomatoes and are very prevalent when the crop matures in wet weather. The young caterpillars at first feed on the leaves and then burrow into the fruit generally at the calyx and rendering such fruit completely unsaleable. Spraying with lead arsenate is partially effective, but it should not be done after the fruits are half-grown. All damaged fruits should be picked and fed to poultry. The soil between the rows of plants should also be hoed to destroy the pupae.

Further information on insect pests of tomato can be obtained on application to the Entomologist, Peradeniya.

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