A STUDY OF THE GENUS CAPSICUM, WITH SPECIAL REFERENCE TO THE DRY CHILLI—VI*

W. R. C. PAUL, M.A. (Cantab.), Ph.D., M.Sc. (Lond.), D.I.C., F.LS.,
AGRICULTURAL OFFICER, CENTRAL DIVISION

(*d*) *Flowering and picking.*—The Tuticorin chilli crop, generally, comes into flower about 6 weeks after planting out and continues for an optimum period of about 3 months. Picking of green but well-developed fruit commences about $2\frac{1}{2}$ months after planting out or about $3\frac{1}{2}$ months after germination of the seed, while picking of red ripe fruit can be done about 2 to 3 weeks later. In picking, the fruit stalks are snapped off the axils in which they are developed with a sharp but downward twist given to them with the hand.

In order to ascertain whether picking of fully developed but green fruit gives a higher yield than red ripe fruit, 5-weeks-old Tuticorin chilli seedlings were planted out in 18 rows each containing 50 hills, of four plants each, at the Experiment Station, Vavuniya. In half the number of rows the fruit was picked green and the other half red ripe. Five pickings were taken in each case, the first picking of " green " chillies being done on January 25, 1938, and the first picking of fresh ripe chillies on February 15, 1938, while the last picking of " green " chillies was done on March 20, 1938, and/or of ripe chillies on March 25, 1938. The results are given in Table I.

TABLE I.

Showing the mean yield of fresh chillies in lb. between fruit picked green and ripe.

	Mean yield of fresh chillies in lb.
Picking green	30·97±4·16
Picking ripe	12.28±1·45
Difference=	18·69±4·31
When n=9 and P= ·01	t=3·250

The results are significant and indicate that picking of chillies in the fully developed but green condition gives a much higher yield than picking of red ripe fruits. Apparently when the fruits are picked green, there is a stimulus created in the plant

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for the production of more flowers and, therefore, of fruit, but when they are allowed to ripen on the plant itself, a decline in productivity sets in. The number of pickings in each case in this experiment was the same and although the first picking of red chillies was done about three weeks later than that of the "green" chillies, the crop terminated in each case about the same time. In localities accessible to urban markets, the peasant in Ceylon prefers to pick his crop, even of the Dry chilli type, green rather than red, because of the higher yield in fresh weight of the former, but in areas where chilli growing is extensive, the green chilli market is naturally restricted and the crop is picked red and dried. There is, however, a belief that, even though the crop is to be produced as dried chillies, the first picking should be for green fruits, and the subsequent pickings for red ripe fruits, as this will avoid the initial check to production, which is caused by picking red fruits from the commencement.

In order to test this hypothesis an experiment was carried out by Joachim, Harbord and Thuraisingham (1939) who found that harvesting chillies "green" with the first picking and "red" at subseduent pickings resulted in a fresh weight increase of 7·5 cwt. per acre over picking "red" throughout. The intervals between pickings in Ceylon range between 5 and 10 days, but in Western India, Bhatarkar (1912) states that, under dry conditions, pickings of ripe chillies are carried out at intervals of 21 days. In U. S. A., paprikas presumably in the green stage are picked, according to Young and True (1913), every 7 days. The number of "green" and "red" pickings of the Dry or Green chilli varies from about five to eight, during a period of 3 to 4 months. It is generally uneconomical to take more than seven pickings per crop, as not only is the yield poor but the size of the fruits becomes so small as to be unsalable.

(*e*) *Curing.*—This is a process by which the fresh red ripe fruits of forms with thin pericarps and elongate fruits (var. *acuminatum*) are converted into dried pods so that they may be utilized within a period of 1½ years after they have been cured. In the East and in certain parts of U. S. A. it is a simple sun-drying process although, generally, in U. S. A. kiln curing is practised. Young and True (1913) found that artificially cured paprika pods from South Carolina showed 15 per cent. glucose and 1·2 per cent. sucrose while in sun-dried pods the glucose fell to 2·5 per cent, and the sucrose rose to 5·9 per cent. Jones and Rosa (1928) report that sun-drying gives a better colour than kiln curing. In sun-drying, bright sunshine throughout the day is essential. Fruits which are ripe or show a tinge of the ripe colour on them should be picked and then

kept heaped in the shade so that all the fruits may turn fully ripe and develop a red colour. If partially ripe fruits are placed immediately in the sun, they develop white patches. After being stored indoors for at least two full days, the fruits should be spread out on a drying floor in layers of about two to three fruits thick and exposed to the heat of the sun. In New Mexico, according to Garcia (1908), the ripe fruits after harvesting are heaped in medium-sized piles from 4 to 6 days. At the end of this period, they are spread out on the ground in a layer of about two fruits thick and left to dry in the sun. The other and less common way of sun-drying is to tie four or six fruits together and to string them in long festoons which are hung out to dry. The latter method is more often employed for large fruits of the variety *longum*.

A sandy or concrete floor is best used for drying, as it becomes rapidly heated and acts as a type of hot pan to the fruits. In Ceylon, it is usual to collect all the fruits indoors at night owing to the uncertainty of rain, but in South India, where much larger areas are brought under cultivation and the danger of untimely rain is small, the fruits are kept out all the time on the flat roofs of houses which act as drying floors.

For the first day the fruits should be kept out in the sun for about 3 hours but from the second day onwards, they should be exposed to a full day's sunshine. On the morning of the third day while the pods still retain some degree of flaccidity they should be well trampled or rolled over in order that they may become flattened, a condition in which dried chillies are marketed in gunny bags in India and Ceylon as a larger number can be packed per bag. With a strong sun in India, drying for 3 to 5 days is sufficient, but under ordinary conditions prevailing in the dry zone areas of Ceylon, about 7 to 10 days' exposure to the sun is necessary for complete drying. In New Mexico, Garcia (1908) states that the time taken for drying when the fruits are spread out on the ground in the autumn is about 6 to 8 weeks.

No difference in the number of days taken for curing nor in the colour of the pods was found between drying chillies on an earth floor and on zinc sheets. The out-turn by weight of fresh to dry chillies by sun-drying varies from 28 to 50 per cent. the average being about 33 per cent. Joachim and Paul (1938) recorded the average out-turn as 30 per cent. by weight of dry chillies on fresh chillies at Anuradhapura and 33 per cent. at Vavuniya Experiment Station, while Joachim, Harbord and Thuraisingham (1939) obtained 30 per cent. at Jaffna Experiment Station. In California and Southern Carolina, kiln drying is almost universally practised for drying chillies on a large scale. Jones and Rosa (1928) state that these houses are

heated with gas burners to a temperature of 55°C. while ventilation is provided by flues through the roof. The peppers are placed in thin layers in wire-bottomed trays stacked one above the other. They require to be frequently stirred and are given 2 to 3 days in which to dry. The whole fruit is used including the stems, seed and placenta.

(*c*) *Yields.*—Yields vary according to the variety and form of *Capsicum* grown in addition to the cultural methods adopted. After drying is complete, the pods should be sorted into two grades, and in the second grade, all pods which do not possess a uniform colour or are attacked by *Vermicularia, Gloeosporium* or *Colletotrichum* are classed. A certain quantity, however, owing to their diminutive size and colour will be unsalable.

Mann and Paranjpye (1919) report a yield of 2,480 lb. of dried chillies per acre from a crop which was given a top dressing of artificials with farmyard manure, while Jones and Rosa (1928) state that the yield of dried chillies in the United States varies from 1,250 to 3,000 lb. per acre. With paprika, an average annual yield of 1,092 lb. of dried pods per acre during the years 1905–1908 was reported by Young and True (1913).

For Bell peppers, Lloyd (1926) found that in the case of the variety Sweet mountain, an average of 3 lb. of green peppers per plant was obtained, while Erwin (1932) gives the following figures of fresh fruits per plant in ounces, based on yields from 10 plants: Anaheim (Dry chilli) 48, World Beater 45, Chinese Giant 67. Woodruff and Bailey (1929) reported the records of 21 farmers in Georgia, who grew Pimento peppers on 108 acres under contract, the average yield per acre being slightly less than 2 tons (fresh weight) but under favourable conditions even more than double this was obtained by some growers.

In Ceylon, yields of Tuticorin chillies vary from 20 to 30 cwt. of fresh chillies per acre and with irrigation up to about 40 cwt. At the Anuradhapura Experiment Station (Anon 1939), an average yield of 24 cwt. of fresh chillies per acre was obtained from a block of 3 acres during the 1938–39 north-east monsoon season. With a first picking for "green chillies", 5 cwt. were produced, and the balance of 18 cwt. gave on drying 6 cwt. of which 5 cwt. were first grade and 1 cwt. second grade.

The first picking of green chillies under average soil and climatic conditions amounts to about 20 per cent. of the total fresh weight of the crop and with a yield of 30 cwt. of fresh chillies per acre, the first picking will realize about 6 cwt. The balance 24 cwt. of fresh red chillies on drying (33 per cent.) will give about 8 cwt. and of this the first quality will be about 6 cwt. (75 per cent.) and of the balance 2 cwt., 50 per cent. will be second grade and the rest unsalable.

2. ECONOMICS OF PRODUCTION

Bhatarkar (1913) at Surat in Western India and Gopalaratnam (1933) at Guntur in Southern India, each give the cost of cultivation under local systems as being about Rs. 60 per acre. The details are given in Table II.

TABLE II.

Showing the costs of cultivating chillies from data obtained by Bhatarkar and by Gopalaratnam.

Operations.	Bhatarkar. Rs. a.	Gopalaratnam. Rs. a.
Nursery	3 13 ..	4 6
Preparatory cultivation	3 8 ..	9 6
Manures and manuring	30 9 ..	32 3
Transplanting	2 0 ..	3 0
Intercultivation	4 8 ..	1 4
Harvesting	8 7 ..	7 8
Drying and marketing	1 14 ..	1 5
Interest for 8 months on Rs. 40	1 9 ..	
Assessment	7 0 ..	
Digging out the stems	0 7 ..	
	63 11	60 0

At the Anuradhapura Experiment Station, the cost of production of Tuticorin chillies was about Rs. 106·60 per acre from a block of 3 acres (Anon 1939). Full details of the costs of each item are given. In Table III. is given an estimate, prepared by the writer, of the cost of cultivating one acre of Tuticorin chillies under unirrigated conditions in the dry zone.

TABLE III.

Cost of production of Tuticorin Dry Chillies per acre.

	Units of Labour. Men at 60c.	Women at 30c.	Boys at 45c.	Bullock Pairs at Re. 1.	Rs. c.	Total Rs. c
1. *Nursery*—						
Preparation of beds	3 ..	— ..	— ..	— ..	1 80	
Sowing, covering seed and upkeep	— ..	4 ..	— ..	— ..	1 20	
Cost of manure, seed and straw..	— ..	— ..	— ..	— ..	2 0	
						5 0
2. *Preparatory tillage*—						
Ploughing ..	2 ..	— ..	— ..	2 ..	3 20	
Harrowing disc (twice) ..	1 ..	— ..	— ..	1 ..	1 60	
Harrowing tooth ..	½ ..	— ..	— ..	½ ..	0 80	
						5 60

	Men at 60c.	Women at 30c.	Boys at 45c.	Bullock Pairs at Re. 1.	Rs. c.	Total Rs. c.
3. *Manuring*—						
Value of 8 cart-loads=6 tons compost at Re. 1 per ton ..	—	—	—	—	6 0	
Transporting and spreading ..	2	4	—	2	4 40	
Cost of fertilizer N. of soda 1 cwt.	—	—	—	—	11 0	
Applying fertilizer	2	—	—	—	1 20	
						22 60
4. *Planting*—						
Lining with marker	1	—	—	1	1 60	
Transplanting ..	—	10	2	—	3 90	
Filling vacancies ..	—	2	1	—	0 75	
						6 25
5. *Intercultivation*—						
Tooth cultivator (3 times) ..	3	—	—	3	4 80	
Mamoty weeding and earthing up	—	20	—	—	6 0	
						10 80
6. *Harvesting*—						
30 cwt. fresh chillies at ½ cwt. per woman ..	—	60	—	—	18 0	
Transporting to store ..	2	—	—	—	1 20	
						19 20
7. *Drying, Sorting and bagging* ..	2	10	—	—	4 20	
						4 20
8. *Cost of uprooting chilli stumps* ..	4	—	—	—	2 40	
						2 40
9. *Spraying* ..	—	—	—	—	2 50	
						2 50
10. *Depreciation on implements* ..	—	—	—	—	2 0	
						2 0
11. *Cost of transport*—						
On 7 cwt. dried chillies and 6 cwt. "green" at 50c. per cwt. ..	—	—	—	—	6 50	
						6 50
12. *Incidentals* ..	—	—	—	—	—	2 95
						90 0

This statement does not take into consideration the interest on the capital expenditure in opening the land and the rental value of the land.

Dried chillies are sold by weight, while green chillies and Bell peppers are sold by number in Ceylon. In the wholesale market for dried chillies, the unit is the candy (525 lb.) and prices vary from about Rs. 40 to Rs. 125 per candy, while in retail markets they vary from about 10 cents to about 30 cents per lb. Green chillies sell at 4 cents to about 10 cents per 100 ($\frac{1}{2}$ lb. approximately) in the case of the forms with stout, medium-sized fruits and from 10 cents to 40 cents per 100 for the larger fruit varieties such as Elephant's Trunk. In Jaffna, green chillies are sold by the measure (2 lb. approximately) at 10 to 20 cents a measure, but during November and December when there is a scarcity of green chillies in the Jaffna market, prices rise to as much as 60 cents a measure.

It has been suggested that by a system of tariff regulation, there should be a fixed minimum price for dried chillies payable to the grower in Ceylon. By the introduction of the Agricultural Products (Regulation) Ordinance in 1940, Government has guaranteed the minimum prices at Rs. 22 per cwt. for first grade chillies and Rs. 15 for second grade chillies and imposed a restriction of imports on a sliding scale of quotas. At these prices, the net return on one acre should be Rs. 69 reckoned as follows :—

			Cwt.			Rs.	c.
Yield per acre fresh chillies	..	..	30				
First picking " green " chillies (20 per cwt. of total crop)	..	..	6 at Rs.	2	=	12	0
Balance fresh " red " chillies		..	24				
			Cwt.				
On drying (33 per cent.)	..	=	8				
1st grade (75 per cent.)	..	=	6 at Rs.	22	=	132	0
Balance dried chillies	..	..	2				
2nd grade (50 per cent.)	..	=	1 at Rs.	15	=	15	0
Balance unsalable	..	..			Total ..	159	0
					Cost of production ..	90	0
					Net return ..	69	0

In areas where Dry chillies are grown extensively, it may not be possible to obtain a suitable market for " green " chillies, which are the green fruits of the Dry chilli type and are inferior in quality to the stout fruits of the typical Green chilli variety. Green chillies are a perishable commodity and if there is a large output in any particular area, these chillies may have to be sent to distant markets for immediate sale or sometimes may not be salable at all. As such, it is estimated that the first

picking of "green" chillies may only realize on the average about Rs. 2 per cwt. although in areas not too distant from the large towns they may realize about Rs. 6 to Rs. 8 per cwt. Even at Rs. 2 per cwt. for the first crop of "green" chillies, the profit per acre on growing chillies as a rotation crop in the dry zone areas of Ceylon is considerable and it can be regarded as one of the most remunerative crops that can be cultivated in these areas.

(*f*) *Storage and packing.*—Dried chillies are usually stored in gunny bags in the tropics. They lose their colour in course of time, generally after about three months, bright, deep-red pods becoming a darker maroon-red, while light-red pods turn paler, the latter changing colour more quickly in storage. Darkness has apparently no effect on the keeping colour of the pods.

An experiment was carried out on five samples of 1 lb. each of Tuticorin chillies, stored in darkness and in indoor light for one year, but no differences in the samples which had all turned a maroon-red colour could be detected. In addition to the change in colour, there is a gradual increase in the number of broken pods and pods separated from their stalks.

Fresh peppers are subject to shrivelling and storage diseases. In Ceylon, *Vermicularia* and anthracnose often cause a dry decay at ordinary temperatures. Lauritzen and Wright (1920) report that in cold storage, *Botrytis cinerea* Pers. and anthracnose were the chief causes of deterioration. They found that at a temperature of 32°F. and a humidity of 90 per cent. the minimum of decay, shrivelling and ripening took place up to about 3 weeks. This temperature is sufficiently above the freezing point of peppers (-/·06°F) to prevent injury against freezing. Platenius, Jamison and Thompson (1934) found that the limit at which peppers remained in good condition was 10 days at 70°F, 16 days at 50°, 4 weeks at 40° and 40 days at 32°F. As compared with other vegetables the rate of shrinkage is very low, less than 40 per cent. for 40 days.

Bell peppers are graded for size and packed in crates, hampers, splint baskets and ventilated barrels in U. S. A. In Jamaica, the Florida pepper crate is used, having a net weight of 40–45 lb. (Moxsy 1936). Wardlaw (1936) states that-according to Smith, wrapping of the fruits has not been found necessary, but they should not be squeezed.

3. ECONOMIC USES

(*a*) *As a condiment.*

1. *Curry powder.*—Reference has already been made to the importance of dried chillies as a condiment in the foods of the peoples of the East. In the usual peasant home in Ceylon,

curry is the chief form in which vegetables, and to a less extent meat, are consumed with rice, millets or yams. Curry powder is the essential ingredient of every curry, and it is prepared by grinding dried chillies to a powder, after slight roasting, and mixing with ground turmeric (*Curcuma domestica* Val.) and coriander (*Coriandrum sativum* L.). Other condiments such as cumin (*Cuminum Cyminum* L.) and fennel (*Foeniculum vulgare* Mill) after being ground may also be mixed with these in small quantities.

2. *Cayenne pepper.*—This is the term generally used for the powder prepared by finely grinding the pods of the Bird chilli and other small chillies such as Japanese. The powder is sifted and then mixed with salt in quantities up to 25 per cent. of its weight, or the pods may be subjected to a special treatment after grinding. It is sometimes made by mixing wheat flour with the powder and adding yeast to form a cake, which is then baked hard and reduced to a fine powder which is sifted. The pungency is reduced by the removal of all or part of the placenta tissue and seeds. Cayenne pepper is not utilized in the same way as curry powder, but is used for seasoning Western dishes.

3. *Nepaul pepper.*—This is a product made from the pods of the Nepaul chilli, a small-fruited form of the var. *acuminatum* grown only in Nepaul (P11, Fig. 2, No. 1*). It has a special flavour not produced elsewhere. The pepper which is held to be of exceptionally high quality has a light golden-brown colour, possessing an odour faintly resembling that of sweet violets.

4. *Paprika.*—This is a specially prepared powder of certain forms of the variety *longum* cultivated in Hungary and Spain, although it more correctly refers to the former. There are five grades of Hungarian paprika and the following description of these is taken from Redgrove (1938).

A. *Sweet.*—The two grades of Delicate Noble Sweet and Noble Sweet are prepared from selected ripe pods from which the placenta, stalks and calyces are removed. The pericarp with the stalks cut are washed several times to remove any pungent matter and after removal of the ribs (placentae) by special knives, the fruits are dried and ground. In the Delicate Noble Sweet grade, the pericarp and seeds are mixed in the proportion of 100 parts pericarp to 45 parts of seeds, and in the Noble Sweet grade 100 parts pericarp to 75 parts of seeds. The maximum ash content is fixed at 6½ per cent. with ½ per cent. for acid insoluble ash. The product is described as sweet, pleasant in taste and non-pungent.

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* See Part I. of this paper in *The Tropical Agriculturist*, January, 1940.

B. *Hot.*—The two grades—Near Sweet Goulash and Rose—are made from selected pods from which the placenta, calyces and stalks are removed, though small particles of these are permitted.

The last grade known as Hot is made from defective fruits ground with the stalks, seeds and calyces, to which may be added parts of the fruits remaining over from the finer grades. A maximum ash content of 10 per cent. is allowed and 1·5 per cent. for acid insoluble ash.

5. *Pepper sauce.*—There are various brands of pepper sauce, consisting chiefly of the unground fruit of the pungent varieties preserved in brine or strong vinegar. The liquid is extracted by pressure and all the flavour, colour, strength and aroma of the fruits retained. Tabasco sauce is made from Tabasco chillies grown in some of the southern United States.

6. *Mandram.*—This is a West Indian stomachic which is prepared by mashing a few pods of Bird pepper, mixing them with sliced cucumber and shallots and adding a little lime juice and Madeira wine.

7. *Chilli con carne.*—This consists of the small pungent peppers finely ground and mixed with meat. It is a popular dish in the southern United States, and Mexico.

8. *Canned pimento.*—Ripe pimentos after being carefully selected are used, the skins being removed by immersing in hot cooking oil or by exposing them to dry heat. They are then dipped quickly in cold water and the skins slipped off. The stems and cores are removed and after the addition of salt are canned.

9. *Vitapric.*—Redgrove (1938) states that this is a Hungarian conserve of a marmalade-like character made from paprika. It is preserved in benzoic acid and is marketed in small tins for culinary use. It contains ·40 per cent. Vitamin C, while paprika puree contains 0·18 per cent. and lemon juice 0·02 per cent. It is bright red, somewhat pungent with a pleasant aromatic odour and flavour and is used for flavouring dishes of a savoury type.

(*b*) *Pharmaceutical value.*

In the B. P. the name of *Capsicum* is applied to the dried pods of *C. minimum* Roxb. which is now known as *C. frutescens* and is referred to in this paper as var. *minimum*. In the U. S. P. X., the drug is described as the " dried ripe fruit of *C. frutescens* L. grown in Africa " for it is only from that country that the pods are most pungent.

The B. P. C. (1934) contains 11 preparations of *Capsicum*.

Capsicum is given internally in tincture form as a powerful stimulant and carminative especially in flatulent dyspepsia. Externally, it is an irritant producing warmth, redness and vesication, and in strong tinctures, liniments and ointments, is used for rheumatism, lumbago, neuralgia and generally where counter-irritation is required. Extracts of chillies are used, according to Redgrove (1933), in the mineral water industry for addition to ginger beer and other beverages.

PART III.

A brief account is given in this part of this paper of the diseases and pests which have been recorded in Ceylon on *Capsicum*.

(*a*) *Diseases of parasitic origin.*

(1) *Damping off.* (*Pythium* sp.).—Seedlings have been found attacked about a week to a fortnight after germination, when there has been excessive moisture in the soil and insufficient light for their development. The presence of shade increases the humidity in the nursery beds and the damping off organism becomes actively parasitic. Chilli seedlings require no shade at all once the cotyledons have emerged.

Spraying the seedlings with Potassium permanganate solution at the rate of 1 oz. per gallon of water (0·6 per cent. solution) for every 4 sq. feet of the nursery, or with Bouisol (a proprietary colloidal copper compound) at 1 oz. per gallon of water, proved very effective in controlling damping off.

(2) *Collar rot.* (*Sclerotium rolfsii* Sacc.).—This is one of the commonest diseases of *Capsicum* in Ceylon. The fungus attacks the plant at its collar producing a brown decay, and then a wilt, resulting in its death. Along the region of the collar, white fans of mycelium can be seen and on these white, and later brown, mustard-like sclerotia visible to the naked eye develop in abundance. The fungus can live as a saprophyte in decaying vegetable matter for several years, and when conditions—the nature of which is not understood—become favourable for its parasitic development, plants are attacked all over the field.

The disease occurs in all soil and climatic conditions in Ceylon and no resistant varieties are known.

(3) *Bacterial wilt.* (*Bacillus solanacearum* E. F. Sm.).—This disease is generally confined to the wet zone areas of the Island, especially in areas where the soil is markedly alkaline. Attacked plants wilt and die. Applications of sulphur in order to reduce the pH value of the soil did not prove successful. The only

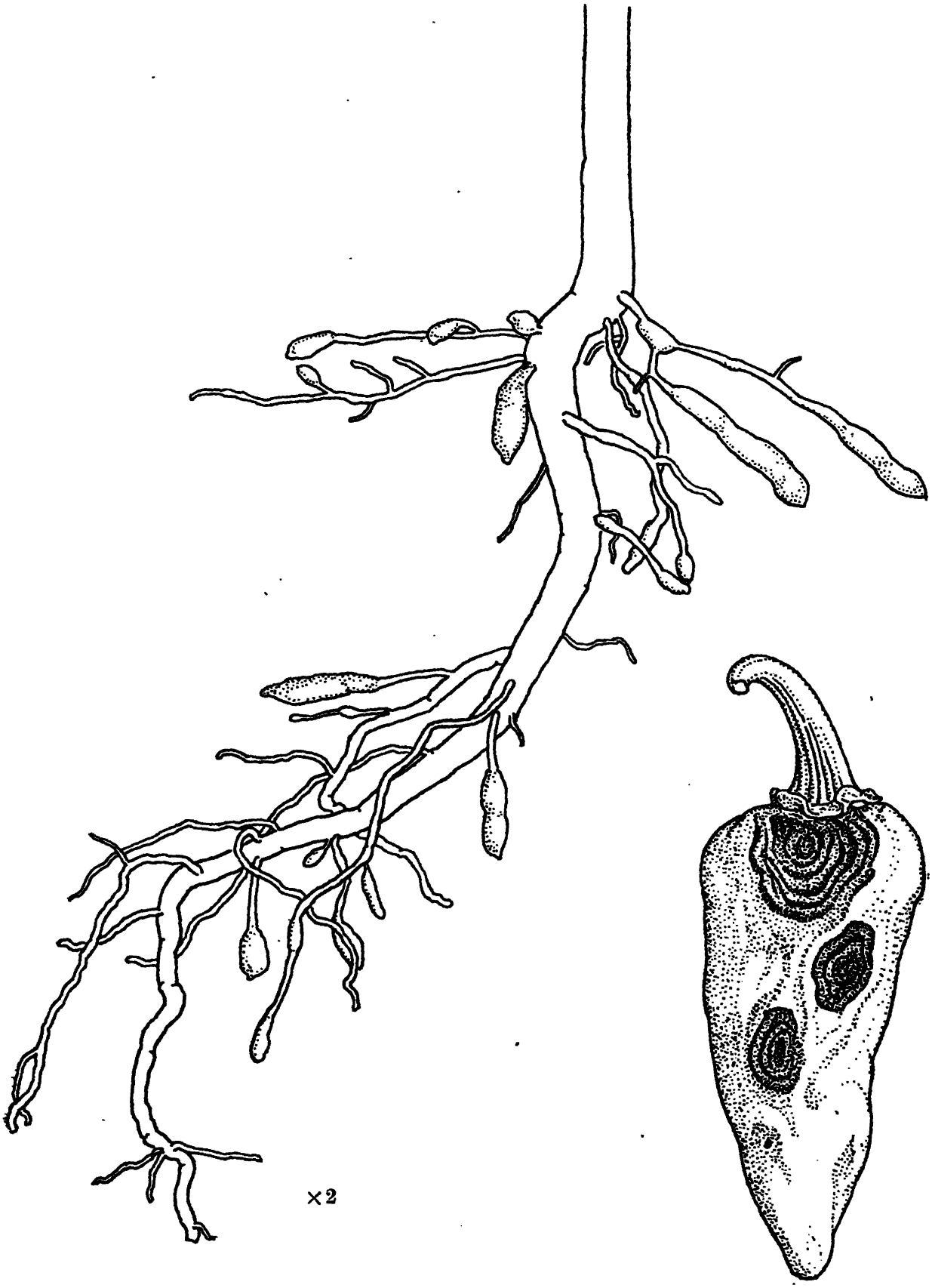

Fig. 2.
Eelworm galls on the roots of the Bird Chilli.

PLATE 1.

Fig. 1
Fruit rot.

Block by Survey Dept.

satisfactory method of control is to breed disease-resistant varieties, but as the chilli is not an important crop in the wet zone, the problem has not been investigated.

(4) *Leaf spot.* (*Cercospora capsici* H. and W.).—Nursery seedlings can be severely attacked by this disease which causes circular, water-soaked spots, which later become grey-brown and dry, on the leaves. When serious, a partial defoliation takes place. On older plants in the field, a decay of the fruit at the calyx end occasionally occurs. Infection comes from spores which can over-winter in the soil for a number of years.

Seed sterilization is of value and in the alternative the seed should be well sifted and cleaned free of fragments of the fruit wall which can harbour the spores. Weekly spraying with Bouisol (a proprietary colloidal copper compound) at the rate of 1 oz. per gallon was found effective in controlling the disease.

(5) *Powdery mildew.* (*Oidiopsis taurica* Lev. Salon.).—This is not a common disease, but under conditions of prolonged wet weather, it appears on the leaves and stems of affected plants causing a white powdery appearance.

The disease is easily controlled by an application of Sulfinette (a proprietary sulphur fungicide) used at the rate of $1\frac{1}{2}$ oz. per gallon of water, on two occasions at intervals of 4 to 7 days.

(6) *Fruit diseases.*—*Gloeosporium piperatum* E. and E.
Colletotrichum nigrum E. and H.
Vermicularia capsici Syd.

The fruit diseases, due to one or more of the above fungi, occur commonly in Ceylon, particularly in wet weather but also during periods of prolonged dry weather when dew prevails. *Gloeosporium* attacks the ripe or ripening fruits, *Colletotrichum* when the fruits are about half grown, often causing a premature reddening, while *Vermicularia* attacks, in addition to the ripe fruits, the young shoots eventually resulting in a die-back. *Vermicularia* does more damage than the others, in that the attack spreads to the branches via the pedicels.

On the fruits, a characteristic spotting is caused by these fungi. Each spot appears black, on which later concentric lines develop (Pl. I, Fig. 2). *Gloeosporium* and *Colletotrichum* form the same type of spotting, but *Colletotrichum* and *Vermicularia* can be distinguished from *Gloeosporium* by the presence of setae in the pustules. *Vermicularia* usually has more abundant and conspicuous setae than *Colletotrichum*. Bertus (1927) has shown that in Ceylon only one strain of *Colletotrichum* on *Capsicum* has given rise in culture to the perfect stage—*Glomerella piperata*; but in India and U. S. A. *Gloeosporium* has in

culture developed the perfect stage which in India has also been found on the plant itself. The fungus over-winters in the seed from infected fruits and seed disinfection is, therefore, an important preventive measure. These fruit diseases are, however, not sufficiently serious in Ceylon to undertake extensive spraying operations in the field, but in years when a high percentage of pods is attacked and a die-back of the young stems occurs, spraying with Bouisol at 1 oz. per gallon may be undertaken.

(7) *Eelworm disease.* (*Heterodera marioni* (Cornu) Goodey).—This disease is not common in Ceylon, but when chilli plants are severely affected, they become stunted, turn yellow and finally die. The galls on the roots are sometimes present on plants which show no other symptoms than a stunted growth. All varieties are susceptible, including the Bird chilli (Pl. I, Fig. 1) and plants at all stages of growth are attacked.

No satisfactory method of control is known at present.

(*b*) *Physiological diseases.*

(1) *Sunscorch.*—This condition is common on Bell peppers in Ceylon and results in the destruction of the cells of the fruit wall from exposure to direct sunlight. It differs from blossom-end rot in that it appears at any place on the surface of the pod. The exposed surfaces develop a light colour, which is indefinite in extent. This area soon becomes slightly sunken or wrinkled and creamy-white in colour. The tissue then dries out and during dry weather becomes thin, papery, brittle, shiny and smooth. Eventually soft rotting bacteria invade the dead cells and cause a soft decay.

No direct control measures are known, but adequate ventilation and moisture in the soil are factors which tend to reduce the incidence of this condition.

(2) *Blossom-end rot.*—The conditions of blossom-end rot in *Capsicum* are similar to those in the Tomato. As in the case of sunscald only the Bell peppers are attacked in Ceylon. The early symptoms are similar to sunscald except that they appear at the stylar end of half-grown fruits. The spots are light coloured and sunken at first, but they enlarge rapidly.

The disease is due to inadequate or varying soil moisture and serious losses occur in dry weather. No control measures are known except that irrigation during dry periods tends to reduce the trouble.

(*C*) *Pests.*

(1) *Crickets and cockchafer attacks.*—The young seedlings are sometimes attacked by crickets, cockchafer grubs and grasshoppers. The tops are nipped off generally about halfway along the stems.

(2) *Disphinctus humaralis.*—This is a bug allied to *Helopeltis*, the tea mosquito, and punctures the leaves causing water-soaked areas which dry up leaving brown, papery tissues. Each spot is small and irregular in outline, but several may coalesce forming larger patches. Each spot or patch is surrounded by a darker brown margin, but the tissue within may dry up and fall out leaving a hole. The attack is more common in the nursery. Spraying with a contact insecticide such as Kerala soap 1 lb. to 6 or 8 gallons of water or a tobacco wash is recommended.

(3) *Leaf curl.*—There are two chief types of leaf curl on chillies in Ceylon, and these can be regarded as the most serious of all the pathological conditions of this crop in the Island. The characteristic symptoms in the wet zone areas are the abnormal curling of the leaf blade with or without distortion of the intervenous areas, and the abortion of the apical meristems. Fruits which are attacked in the course of development become truncated or curled at the stylar end.* Park and Fernando (1938) carried out certain experiments which indicate that the damage is due to direct insect injury, in view of the fact that infected plants which were sprayed with a contact insecticide and placed under an insect-proof cage produced a new flush free from leaf curl, while the controls remained attacked. Again, other plants showing leaf curl symptoms and subsequently subject to periodic spraying also produced a clean flush. These authors considered that the presence of thrips, mites and aphides on affected leaves indicated that one or more of these insects may be responsible for the damage. A lime sulphur spray used every three days on three successive occasions was found to be very effective in controlling this type of leaf curl, although during periods of abnormal dry weather, control is more difficult.

Another type of leaf curl is present in the dry zone areas, particularly the Jaffna Peninsula, where the margins of the lamina curl in adaxially and there is marked buckling of the intervenous areas which appear deeply concave on the under side of the leaf. Considerable reduction in the size of the leaves occurs, as in the previous type of leaf curl, but there is no necrosis of apical meristems. The internodes, however, fail to reach their maximum length and the leaves and flowers appear clustered, while the fruits, which are few, remain small and malformed. Paul and Fernando (1939) examined the possible effect of deficiency in soil nitrogen and organic matter on the incidence of leaf curl and found no evidence of a relationship. The distribution of affected plants, however, in this experiment suggested the possiblity of insect damage either directly or as the vector of a virus disease.

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* See Fig. 5 in Part III. of this paper in *The Tropical Agriculturist*, March, 1940.

(4) *Aphides.*—Occasional large numbers of aphides may be found present on the leaves, pedicels and flowers, and the withering of certain flowers is due to aphide attack. This is readily controlled by 2 or 3 sprayings with soft soap and water at the rate of 2 oz. soap to 1 gallon of water, but often the attack is due to some unfavourable environmental condition which lowers the plant's vitality and renders it a suitable host to aphides.

SUMMARY

1. This paper deals with the general botany and agronomy of *Capsicum* and its cultivated forms, whose taxonomy has been studied. It is suggested that the two species maintained by Irish *viz.*, *C. frutescens* L. for the semi-wild Bird chilli and *C. annuum* L. for the field and garden varieties are two ecologically distinct species which show interspecific sterility. As such, the view held by Bailey and other American horticulturists to-day, that these two species should be reduced to a single form, *viz. C. frutescens* L. on the ground that they are all perennial in the tropics, cannot be accepted.

2. Apart from this sterility, there is every gradation in taxonomic characters including the perennial habit from the Bird chilli to the highly-developed forms of *C. annuum* L. All the varieties of *C. annuum* L. cross freely with each other and innumerable forms have arisen. An amended classification of the cultural varieties of *Capsicum* based on the character of the calyx and the main fruit shapes has been suggested.

3. A description of the commercial types of Capsicums is given and reference made to the characters on which quality in each type depends.

4. A stimulus to germination in the disinfection of the seed with copper sulphate and lime has been traced to the presence of the calcium ion. Sun-dried seed stored for 6 months has been shown to be significantly more viable than fresh dried seed, and the latter more than fresh undried seed.

5. The morphological characters of the *Capsicum* plant and its floral biology are described. No difference in the size or shape of the pollen grains between the Bird chilli, the Dry chilli, and the Bell pepper can be seen. Details of anthesis are given and anther dehiscence is shown to be dependent on light and low humidity.

6. Glossiness of the pods which is an important quality in the Dry chilli is held to be a physical character due to the shape of the epidermal cell cavities. In glossy pods, a higher percentage of rectangular-shaped cell cavities occur resulting in greater reflection of light from the outer walls than in the case of dull pods which exhibit a larger number of pyramidal-shaped cell cavities causing more scattering of the reflected rays of light.

Block by Survey Dept.

FIG 1.—PLANT ENCLOSED IN A SELFING BAG.

Block by Survey Dept.

FIG 2.—A TUTICORIN CHILLI PLANT IN FRUIT.

Block by Survey Dept.

FIG 1.—INTERCULTIVATION OF CHILLIES WITH THE MAMMOTY.

Block by Survey Dept.

FIG 2.—INTERCULTIVATION OF CHILLIES WITH A TOOTH CULTIVATOR.

7. Dried chillies differ in the percentage of breakage of the pedicels from their pods in storage, but it was not possible to demonstrate significant differences in the force required to sever the pedicels from their pods owing to the high standard errors in the samples investigated.

8. Reference is made to the factors which affect flowering, setting of fruit, and ripening. The percentage of fruit set in Ceylon varies from about 4 to 40 under different conditions of soil moisture, humidity, and temperature. Low soil moisture, low humidity, and high temperature retard flowering and setting of the fruit. Nitrogenous fertilizers produce significant increases in yield and tend to hasten fruiting. Light or darkness has little effect in inducing ripening.

9. Details are furnished of the cultural methods, including curing, of dried chillies in Ceylon. The cost of production is approximately Rs. 90 per acre. Picking chillies in the green but fully developed stage gives a significantly higher yield than when they are picked red ripe. There appears to be a check to production if chillies are picked ripe from the commencement, and it is suggested that the first one or two pickings from a crop grown primarily for dried chillies should be picked and sold as " green " chillies.

10. A brief account of the diseases and pests of chillies in Ceylon is given. Reference is made to the two chief types of leaf curl which may be regarded as the most serious of all pathological conditions affecting chillies in Ceylon.

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