

Seed Production Techniques for Vegetables

The Revitalizing Rainfed Agriculture Network (RRAN) is a growing network of civil society organizations, research institutions, policy makers, donors and individuals engaged in evolving a differentiated agricultural policy with enhanced public investments and support system for rainfed areas in India. The Comprehensive Pilots (CPs) are part of the RRA Network's action research programme that seeks to establish evidence and experience on the ground, in support of the various propositions that the Network has developed. In order to offer support for CPs a set of organizations have been identified as Nodes on specific identified themes such as – seeds, soils, water, millets, fisheries, livestock, credit, markets and institutions.

The Centre for Indian Knowledge Systems (CIKS) has been identified and functioning as the nodal anchor for the theme of seeds. A series of booklets is being published on various technical and institutional aspects of seed systems to build the capacity of the CPs as well as various field groups who are involved in the efforts to build community managed seed systems.

This publication describes the procedures involved in the production of quality seeds of 15 vegetables. The techniques involved in the certified and foundation stages of seed production from seed selection to storage including the quality standards and appropriate storage methods are explained in detail in this publication.



Centre for Indian Knowledge Systems, Chennai
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Revitalising Rainfed Agriculture Network
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PREFACE

The Revitalizing Rainfed Agriculture Network (RRAN) is a growing network of civil society organizations, research institutions, policy makers, donors and individuals engaged in evolving a differentiated agricultural policy with enhanced public investments and support system for rainfed areas in India. Based on the vast experience on the ground and analysis of issues, RRA Network is evolving specific propositions on various aspects of rainfed agriculture such as seeds, soils, water, crop systems, millets, livestock, fisheries, credit, markets and institutions. The Comprehensive Pilots (CPs) are part of the RRA Network's action research programme that seeks to establish evidence and experience on the ground, in support of the various propositions that the Network has developed. In order to offer support for CPs a set of organizations have been identified as Nodes on specific identified themes such as – seeds, soils, water, millets, fisheries, livestock, credit, markets and institutions.

The Centre for Indian Knowledge Systems (CIKS) has been identified and functioning as the nodal anchor for the theme of seeds. The CPs started functioning in the year 2012 and in June 2012 the seed node convened a meeting of representatives of CPs for an inception workshop in Chennai. During this workshop the CPs shared their proposals and plans of work as well as their thinking about the work that they plan to undertake in the area of seeds. Presentations were made during the workshop on how to undertake a situation analysis with respect to seeds, the elements of designing a robust seed system for rainfed areas and also about undertaking a planning exercise through which each CP can proceed towards the establishment of a robust community managed seed system in its area of work. A part of the workshop was to identify the specific needs expressed by each of the CPs in terms of the support and help they would need in the area of seeds. A beginning was made in terms of the capacity building exercise through a series of presentations.

Beginning from the early part of the year 2012 Dr. G. Venkat Raman of the Seed node had started making a series of visits to various CPs. During the visits he provided help and assistance to the CPs for performing situation analysis, evolving a plan for a robust seed system for the area undertaking capacity building exercises and also trying to create linkages between the groups and scientists and institutions who could provide technical support. During this process he also identified various needs in the form of topics on which training and capacity building was required.

Subsequently, on two different occasions when the seed node team met the CPs – in Bagli in Madhya Pradesh in November 2012 and in Tiptur in Karnataka in December 2012 there were opportunities to review the progress of each CP as well as provide technical inputs and training. Earlier this year, towards the end of July 2013 a workshop was held by the seed node in the CIKS Technology Resource Centre in the Kancheepuram district of Tamil Nadu. In this workshop a series of technical trainings were provided on various aspects of seeds. The training was not only in the

form of lectures and presentations but also included field work, experiments, visits to government and private seed farms and seed production centres as well as meetings with the officials of the Directorate of Agriculture and Seed Certification departments. During these meetings drafts of some of the technical training modules that were prepared were circulated and comments and suggestions were sought from the CPs. Based on these efforts and also building upon discussions that took place during the visits to CPs a set of topics had been identified to produce training modules. We expect this process to be dynamic and interactive so that changes can be made based on the suggestions received from the various user groups. A series of reports and books that have been circulated and discussed as drafts and presentations are now being brought out as publications.

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About this Book

This publication describes the procedures involved in the production of quality seeds of 15 vegetables. The techniques involved in the certified and foundation stages of seed production from seed selection to storage including the quality standards and appropriate storage methods are explained in detail in this publication.

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INTRODUCTION

In India 1.2% of the total cultivated area comes under vegetable cultivation. Most of the vegetables if grown properly have the capacity to give an yield which could be 5 – 10 times higher than any cereal crop. Vegetables provide proteins, carbohydrates, mineral salts, vitamins and bulk which along with some cereals and other foods form the essentials of a balanced diet. The daily consumption of vegetables and fruits in advanced countries is 362 gms whereas in India it is only 80 gms. Regular consumption of vegetables is a must for the nutritional security of the household.

The present production of vegetables in our country is very low. For successful vegetable production better seeds, improved cultural practices and better plant protection methods are essential. Amongst this good quality seeds is the most important component. In the following sections of the book we deal with good quality seed production techniques for common vegetables. While the standards provided are for certified seed production one can follow these techniques even for regular seed production to get good quality seeds.



LADY'S FINGER (*Abelmoschus esculentus*)

Lady's finger or okra or bhendi (*Abelmoschus esculentus*) is the sixth important vegetable crop of India belonging to the family Malvaceae. The seed production can be done throughout the year but, the maturation and the harvesting period should not coincide with heavy rains. Seed production during early kharif and summer seasons are very suitable.

Method of seed production

Lady's finger is a self pollinated crop with 0 – 5% of cross pollination through insects. The crop should be raised in isolation from the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements of certification. The isolation distance maintained between the varieties is 500 metres for foundation and 250 metres for certified seed production.



Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should not be cultivated with lady's finger in the previous season. The soil should be fertile, free from soil borne diseases and with good drainage facility.

Seed selection and sowing

Certified seeds should be obtained from an authorised source. Seeds should be healthy, free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 3 – 4 kg/acre (8 – 10 kg/ha) for kharif crop and 4 – 6 kg/acre (10 – 15 kg/ha) for summer crop.

Selected seeds should be treated appropriately. In case of summer crop, the seeds should be soaked in water for 12 hours before sowing. The seeds can also be treated with sweet flag rhizome extract or cow's urine solution (diluted with water in 1:5 ratio) for 30 minutes before sowing. This gives resistance against a number of bacterial and fungal diseases.

Seeds can also be treated with cow dung solution like *Bija amrut/ Jeeva amrut/ Amrut pani / Panchgavya* for 4 - 6 hours after soaking in water for 8 hours. The seeds can then be dried in shade and sown.

Treated seeds should be sown in ridges @ two seeds per hill by following a spacing of 60 x 30 – 45 cm for kharif crop and 45 x 30 cm for summer crop.

Intercultural operation

Thinning out closely germinated plants should be done at the stage of one true leaf or 12 days after sowing.

Nutrient management

Farm Yard Manure (FYM) is applied @ 10 tonnes/acre (25 tonnes/ha) during first ploughing and incorporated into the soil. Neem cake is applied @ 100 kg/acre (250 kg/ha) and groundnut cake is applied @ 32 – 40 kg/acre (80 - 100 kg/ha). Each of the biofertilizers like *Azospirillum* and *phosphobacteria* are used @ 800 gms/acre (2 kg/ha).

Weed management

Hoeing and weeding should be done at regular intervals based on the requirement. First weeding is done 20 days after sowing. Regular weeding can be done at an interval of 25 days. A total of 3 - 4 weedings can be done at regular intervals from 20 days after sowing till the crop canopy covers the soil surface. Earthing up is done 30 days after sowing.

Irrigation

First irrigation is done immediately after sowing. Depending on the soil moisture content irrigation should be done once a week or 10 days. Irrigation during flowering and pod setting are very crucial.

Pest and disease management

Lady's finger is commonly affected by pests and diseases like shoot and fruit borers, yellow vein mosaic and vein clearing. Management measures for these pests and diseases are provided in Appendix – 1.

Roguing

Roguing should be done from early vegetative phase upto three fruit stage. In lady's finger, the plants affected with yellow mosaic are periodically identified, removed and destroyed. All the off-types and diseased plants should be rogued off before flowering based on the plant height, leaf and stem types, pigmentation, shape, size and colour of the flower and shape of the fruits. Maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from flowering to harvesting stage by the Seed Certification Officer. The first inspection is done before flowering, second during peak flowering and fruiting stage followed by the third one during mature fruit stage or prior to harvest.

Field standards

	Foundation seed	Certified seed
Isolation distance	500 m	250 m
Off-types	0.10%	0.20%

Harvesting

Harvesting is done once the pods are physiologically mature. The physiological maturity of pods is identified by a change in colour from green to brown and by the drying of the pods. Pods should be harvested at the right time, since dried pods tend to dehisce (split open) with very little force.

Threshing and processing

Harvested pods should be dried under the sun. Later, seeds should be removed from the peels of the pods by beating with stick. The separated seeds are then winnowed to remove the debris.

Drying and storage

The seeds should be dried well before storage upto 10% of the moisture content. Under dry climatic conditions seeds can be stored for one year.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 99% with a minimum of 65% of germination capacity and 10% of moisture content. The presence of inert matter should not exceed 1.0% and the seeds of other crop varieties should not be more than 10/kg of foundation seeds and 20/kg of certified seeds.

TOMATO (*Lycopersicum esculentum*)

Tomato (*Lycopersicum esculentum*) belonging to the family Solanaceae is one of the most nutritious and remunerative vegetable crop. It is the world's important vegetable next to potato. The crop is cultivated throughout the year. In northern plains, the crop is cultivated during autumn, spring and summer. In south India, the crop is grown in June – July, October – November and January – February. The optimum season for seed production in southern India is October – December. Nursery raised in late October and transplanted in the first week of December will produce a good seed crop.

Method of seed production

Tomato is a predominantly self-pollinated crop with some amount of natural cross-pollination. The crop should be raised in isolation from the fields of other varieties. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 50 metres for foundation and 25 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should not be cultivated with tomato in the previous season and free from volunteer plants. The soil should be fertile, free

from soil borne diseases and with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy, free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 200 gm/acre (500 gm/ha).

Selected seeds should be treated appropriately to prevent the crop from seed borne diseases.

- Seeds should be soaked in a fermented mixture of buttermilk (3 days old) and water in a 1:4 ratio for six hours and shade dried before sowing. The practice is applicable only for the seeds which are 6 to 12 months old.
- The seeds should be treated with *Trichoderma viride* and *Pseudomonas fluorescens* (@ 5 g/100g of seeds). This will help in the control of early blight and other pathogens.

Nursery preparation and sowing

Seeds are sown in the nursery and then the seedlings are transplanted in the main field. Nursery beds of 2 – 2.5 metre long and 1 – 1.25 metres wide @ 10 numbers per acre (25 numbers per hectare) should be laid to raise the required seedlings. The beds should be raised 15 – 20 cm from the ground level.

The bed should be covered with a layer of farmyard manure and sand in equal proportion. Addition of farmyard manure should be @ 4 kg/m². Neem cake and groundnut cake (@ 2 kg/cent) can also be added to enrich the nursery soil. Dusting of wood ash on the seedlings in the nursery acts as an insect repellent and protects the young plants from the pest and disease attacks. It also serves as a good source of mineral nutrients.

Treated seeds should be sown in the nursery beds in rows with 3 – 4 cm spacing. Soon after sowing





irrigate the beds using a rose can and cover the beds using paddy straw or coconut fronds.

Transplanting

The seedlings are transplanted to the main field 4 –5 weeks after sowing, preferably in the evening. At the time of transplanting the plant should be about 7.5 – 10 cm in height and with a sturdy stem. The roots of the seedlings should be soaked in asafoetida solution (100 gms in 5 litres of water) for 15 – 30 minutes before transplanting. This prevents the soil borne bacterial diseases. After uprooting, the roots of seedlings can also be dipped in cow dung and cow's urine slurry / *Cow Pat Pit* / *Amrit Pani* / *Panchagavya* overnight before transplanting in the field. This helps in better root growth and early establishment. The treated seedlings should be transplanted following 75 x 60 (or) 45 x 30 cm spacing. A well prepared seed bed with 4 – 5 ploughing is necessary for transplanting tomato. The seedlings are transplanted on the sides of the ridges.

Nutrient management

Farmyard manure is applied @ 10 tonnes/acre (25 tonnes/ha) during first ploughing and incorporated into the soil. Green manure with crops like sunhemp (*Crotalaria juncea*), cowpea (*Vigna catjang*), Daincha (*Sesbania aculeata*) and cluster bean (*Cyamopsis tetragonoloba*) can also be used to substitute the farmyard manure. Neem cake should be applied @ 60–100kg/acre (150-250kg/ha) as a basal dose to prevent nematode attack. Top dressing should be given with groundnut cake @ 30 – 40 kg/acre (80-100 kg/ ha) after 40 days of sowing. This will help in increasing the yield as well as the size of the fruits.

Weed management

Weeding during the initial stages of plant growth is very necessary. Manual weeding is most preferred. Weeding at 45 days after transplanting is very critical. The plants require frequent shallow hoeing especially during the first four weeks after transplanting. This facilitates soil aeration for proper root development. Hoeing can be done to loosen the soil after every irrigation. Earthing up should be done twice.

Irrigation

First irrigation is done immediately after sowing. Subsequent irrigation should be done once a week or 10 days depending on the soil moisture. Irrigation during flowering and fruit setting stages are very crucial.

Pest and disease management

Pests and diseases like white fly, fruit borers, damping off and *Fusarial* wilt affects the crop. The management techniques for these pests and diseases can be found in Appendix – 1.

Roguing

Roguing should be done from early vegetative phase upto three fruit stage. The plants that are morphologically different from other plants should be rogued off during vegetative stage. During fruiting stage based on the colour and shape of the fruit the off-types are rogued off. Maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from flowering to harvesting stage by the



Seed Certification Officer. The first inspection is done before flowering, second during flowering and fruiting stage and the third during mature fruit stage or prior to harvest.

Field standards

	Foundation seed	Certified seed
Isolation distance	50 m	25 m
Off-types	0.10%	0.20%
Seed borne diseases affected seeds	0.10%	0.50%

Harvesting

Harvesting is done once the fruits are physiologically mature and turns from green colour to orange or red. The fruits of the lower three hands of each plant is the best for seed extraction. The fruits that should be harvested are those that are ripe just beyond the eating stage.

Seed extraction and processing

- The seeds with the pulp of the mature fruits should be squeezed into a jar and left in a warm spot for two to three days and allowed

to ferment. Then the whole mass should be poured through a sieve, and the seeds should be rubbed and washed.

- Alternatively, lemon juice can be used for seed extraction in place of corrosive hydrochloric acid (which is commonly used). The seeds should be treated with the juice @ 20 lemons / kg of wet seeds for 2 - 3 hours.
- Seeds can also be extracted from the ripe fruits by squeezing the fruits on well-spread rice bran (@ 1 kg rice bran for 1 kg seed). After thorough mixing and drying for 24 - 48 hours, the bran is separated from the mixture by hand winnower.

Drying and storage

The extracted seeds are dried in the shade for a day or two before storage to attain a moisture level of 8%. The dried seeds should be packed in a cloth or moisture proof containers and stored in a dry and cool place. Under optimum conditions the properly dried seeds can retain the viability for 2 - 3 years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 70% of germination capacity and 8% of moisture content. The presence of inert matter should not exceed 2.0%.



CAPSICUM AND CHILLI

(*Capsicum annuum* and *Capsicum frutescens*)

Capsicum and Chilli (*Capsicum annuum* and *Capsicum frutescens*) commonly known as sweet pepper and hot pepper are commercially important crops of the family Solanaceae. The seed production can be done throughout the year but spring season is the best to obtain maximum quantity of seeds.

Method of seed production

Capsicum and chilli are often self-pollinated crops, but cross-pollination occurs to the extent of 7 - 36% mainly through insects. Seeds should be allowed to set by self-pollination. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 500 metres for foundation and 250 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants and objectionable weeds. There should be at least two years interval between the related crops cultivated in the selected land. The soil should be fertile, free from soil borne diseases and with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 400 gms/acre (1 kg/ha).

Selected seeds should be treated appropriately to prevent the crop from seed borne diseases.

- Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will

inhibit the seed borne diseases like fruit rot and die back. (or)

- Seeds should be bundled using a thin cotton cloth and soaked in the bio gas slurry for 12 hours prior to the sowing. This will kill all the disease causing microbes and also enhance the seed vigour.
- Treat the seeds with *Trichoderma viride* @ 4 gms / kg of seeds (or)
- Treat the seeds with biofertilizers @ 1 kg/acre of seeds. Mix the biofertilizers with rice gruel and then mix it with seeds. Dry the seeds under shade for 30 minutes before sowing.

Nursery preparation and sowing

Seeds are sown in the nursery and the seedlings are then transplanted to the main field. Nursery beds of 2 – 2.5 metre long and 1 – 1.25 metre wide @ 10 numbers per acre (25 numbers per hectare) should be laid to raise the required seedlings. The beds should be raised 15 – 20 cm from the ground level.

The bed should be covered with a layer of farmyard manure and sand in equal proportion. Addition of farmyard manure should be @ 4 kg/m². Neem cake and groundnut cake (@ 2 kg/cent) can also be added to enrich the nursery soil. Dusting of wood ash on the seedlings in the nursery acts as an insect repellent and protects the young plants from pest and disease



attacks. It also serves as a good source of mineral nutrients.

Treated seeds should be broadcasted or sown in the nursery beds in rows at 2 cm depth with 3 – 4 cm spacing. Soon after sowing irrigate the beds using a rose can and cover the beds using paddy straw or coconut fronds.

Transplanting

The seedlings are transplanted to the main field 4 – 5 weeks after sowing. At the time of transplanting the seedling should be about 15 – 20 cm tall. The apical buds of the seedlings should be nipped off 10 days before transplanting to enhance the growth of the seedling. The roots of the seedlings should be soaked in asafetida solution (100 gms in 5 litres of water) for 15 – 30 minutes before transplanting. This prevents soil borne bacterial diseases. After uprooting, the roots of the seedlings can also be dipped in cow dung and cow's urine slurry / *Cow Pat Pit* / *Amrit Pani* / *Panchagavya* overnight before transplanting in the field. This helps in better root growth and early establishment.

The treated seedlings should be transplanted to the main field. The spacing followed is 60 x 45 cm for hot pepper and 45 x 30 cm for sweet pepper. The main field should be ploughed thoroughly for 4 - 5 times to get proper tilth before transplanting. The seedlings are transplanted on the sides of the ridges.

Nutrient management

Farmyard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake should be applied @ 60 – 100 kg/acre (150 - 250 kg/ha) as a basal dose to prevent nematode attack. Top dressing should be given with groundnut cake @ 30 – 40 kg/acre (80 - 100 kg/ha) after 40 days of sowing. This will help in increasing the yield as well as the size of the fruits.

Weed management

Weeding is most important during the early stages of the crop. Manual weeding is most preferred. The crop should be hoed once in 15 days from

30th day after transplanting for two times to get proper aeration in the soil. Weeding should be done on 20th and 45th day after transplanting.

Irrigation

First irrigation is done immediately after sowing. Subsequent irrigation should be done once a week or 10 days depending on the soil moisture. Irrigation during flowering and fruit setting stages are very crucial.

Pest and disease management

Capsicum and Chilli are commonly affected by pests and diseases like damping off, fruit rot, aphids, whitefly, hoppers, mites etc., during different growth stages of the crop. The management measures for these pests and diseases are provided in Appendix – 1.

Roguing

Roguing should be done from early vegetative phase upto fruiting stage. The off-types are identified based on the morphological characteristics like plant type, shape and colour of the leaves and flowers etc. The plants that are different from other plants and diseased plants should be rogued off periodically. Maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from flowering to harvesting stage by the Seed Certification Officer. The first inspection is done before flowering, second during flowering stage and the third during fruiting stage or prior to harvesting.



Field standards

	Foundation seed	Certified seed
Isolation distance	500 m	250 m
Off-types	0.10%	0.20%
Seed borne diseases affected seeds	0.10%	0.50%

Harvesting

Harvesting is done once the fruits are physiologically mature and turns from green colour to red. The matured fruits are harvested by hand picking.

Seed extraction and processing

The seeds are extracted from freshly harvested pods or from the dried pods after proper drying. The dried pods are taken in a gunny bag and beaten with a pliable bamboo stick to separate the seeds. The seeds are then cleaned by winnowing. The seeds from the fresh pods should be scraped out and dried in the shade for a few days. Seeds from fresh pods can also be extracted by following methods,

- For large quantities of seeds, the ripe pods along with water should be blended in a blender at slow speed. Pulp will rise to the top and seeds will settle in the bottom. Seeds should be collected after decanting the water.

- The seeds from the matured fruits should be squeezed into a jar and left in a warm spot for two to three days and allowed to ferment. Then the whole mass should be poured through a sieve, and the seeds should be rubbed and washed.
- Alternatively, lemon juice can be used for seed extraction in place of corrosive hydrochloric acid (which is commonly used). The seeds should be treated with the juice @ 20 lemons / kg of wet seeds for 2 - 3 hours.
- Seeds can also be extracted from the ripe fruits by squeezing the fruits on well-spread rice bran (@ 1 kg rice bran for 1 kg seed). After thorough mixing and drying for 24 - 48 hours, the bran is separated from the mixture by a hand winnower.

Drying and storage

The extracted seeds should be dried in the shade for a few days before storage to attain a moisture level of 8%. The dried seeds should be packed in cloth bags or moisture proof containers and stored in a dry and cool place. When the seeds are kept under the cold, dark and dry storage conditions, they will remain viable for upto five years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 60% of germination capacity and 8% of moisture content. The presence of inert matter should not exceed 2.0%. The presence of other crop seeds and weed seeds should not be more than 5/kg for foundation seeds and 10/kg for certified seeds.



BRINJAL / EGGPLANT (*Solanum melongena*)

Brinjal (*Solanum melongena*) commonly called as eggplant is one of the important vegetables of the family Solanaceae. The seed production can be done throughout the year but the maturity of the fruits should not coincide with rains.

Method of seed production

Brinjal is a self-pollinated crop, but cross-pollination occurs to the extent of 5% mainly through insects. Seeds should be allowed to set by self-pollination. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 300 metres for foundation and 150 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants and objectionable weeds. The land should be fertile, rich in organic matter with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and

free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 160 gms/acre (400 gms/ha).

Selected seeds should be treated appropriately to prevent the crop from seed borne diseases.

- Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases like fruit rot and die back. (or)
- Seeds should be bundled using a thin cotton cloth and soaked in the bio gas slurry for 12 hours prior to the sowing. This will kill all the disease causing microbes and also enhance the seed vigour.
- Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

Nursery preparation and sowing

Seeds are sown in the nursery and the seedlings are then transplanted to the main field. Nursery beds of 2 – 2.5 metre long and 1 – 1.25 metre wide @ 10 numbers per acre (25 numbers per hectare) should be laid to raise the required seedlings. The beds should be raised 15 – 20 cm from the ground level.

The bed should be covered with a layer of farmyard manure and sand in equal proportion. Addition of farmyard manure should be @ 4 kg/m². Neem cake and groundnut cake (@ 2 kg/cent) can also be added to enrich the nursery soil. Dusting of wood ash on the seedlings in the nursery acts as an insect repellent and protects the young plants from the pest and disease attacks. It also serves as a good source of mineral nutrients.

Treated seeds should be broadcasted or sown in the nursery beds in rows at 2 cm depth with 3 – 4 cm spacing. Soon after sowing irrigate the beds using a rose can and cover the beds using paddy straw or coconut fronds.



Transplanting

The seedlings are transplanted to the main field 4 – 5 weeks after sowing. At the time of transplanting the seedling should be about 12 – 15 cm tall. The roots of the seedlings should be soaked in asafoetida solution (100 gms in 5 litres of water) for 15 – 30 minutes before transplanting to prevent the soil borne bacterial diseases. After uprooting, the roots of the seedlings can also be dipped in cow dung and cow's urine slurry / *Cow Pat Pit* / *Amrit Pani* / *Panchagavya* overnight before transplanting in the field. This helps in better root growth and early establishment.

The treated seedlings should be transplanted to the main field. The spacing followed is 60 x 60 cm for non-spreading types and 90 x 60 for spreading type. The main field should be ploughed thoroughly for 4-5 times to get proper tilth (Tilth is the physical condition of the soil that is soft, friable and properly aerated) before transplanting. The seedlings are transplanted on the sides of the ridges.

Nutrient management

Farmyard Manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake should be applied @ 60 – 100 kg/acre (150 - 250 kg/ha) as a basal dose to prevent nematode attack. Top dressing should be given with groundnut cake @ 30 – 40 kg/acre (80 - 100 kg/ha) after 40 days of sowing. This will help in increasing the yield as well as the size of the fruits.

Weed management

Weeding is most important during the early stages of the crop. About 3 – 4 hoeing and weeding are



required for effective control of weeds. Manual weeding is most preferred. The crop should be hoed once in 15 days from 30th day after transplanting for two times to get proper aeration in the soil. Weeding should be done on 20th and 45th day after transplanting.

Irrigation

First irrigation is done immediately after sowing. Subsequent irrigation should be done once a week or 10 days depending on the soil moisture. Irrigation during the flowering and fruit setting stages are very crucial.

Pest and disease management

Brinjal is commonly affected by the pests and diseases like fruit and shoot borer, whitefly, damping off and wilt at different growth stages. The management techniques for these pests and diseases are provided in Appendix – 1.

Roguing

Roguing should be done from early vegetative stage to flowering and fruiting stage. The off-types are identified based on the morphological characteristics like plant type, shape and colour of the leaves and flowers, presence of thorns etc. The plants that are different from the other plants and diseased plants should be rogued off periodically. The maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from vegetative to fruiting stage by the Seed Certification Officer. The first inspection is done

at vegetative stage to check the isolation distance, presence of volunteer plants and diseased plants based on the physical appearance and other requirements. The second and third inspections should be done during flowering and fruiting stage and the off-types are identified based on the flower colour, fruit shape etc., and removed. The third inspection at maturity stage will also estimate the yield.

Field standards

	Foundation seed	Certified seed
Isolation distance	300 m	150 m
Off-types	0.10%	0.20%
Seed borne diseases affected seeds	0.10%	0.20%

Harvesting

Harvesting is done once the fruits are physiologically mature. In brinjal, fruits are allowed to mature beyond the edible stage for seed purpose. The physiological maturity of the fruits is identified by change in colour. The mature fruits of different varieties will vary in colour from yellow to dull purple. The matured fruits are harvested by hand picking and hung in sheds until their colour dulls.

Seed extraction and processing

The selected matured fruits are cut into pieces and crushed to extract the seeds. Then the pulp around the seeds are separated by washing and sieving. In other way, fruits should be cut into cubes and put in to a blender on slow speed with water. The masses and the pulp float on the surface can be removed and the seeds which settle at the bottom should be collected, washed and dried. In general, the extraction process should be done in the morning hours to make sure that the seeds are at least half dried by evening in order to avoid the danger of germination.

Drying and storage

The extracted seeds should be thoroughly washed and dried on a sieve in the shade for a day or so before storage to attain a moisture level of 8%. For longer storage period the seeds should be dried to a moisture level of 6%. The dried seeds should be packed in paper bags and hung for a couple of weeks before storage. If seeds are packed in moisture proof polythene bags (700 gauge polythene bags) and stored in cool dry place it can be stored for a long time.

Seed standards

The percentage of minimum physical purity of the foundation and certified seeds should be 98% with a minimum of 70% of germination capacity and 8% of moisture content. The presence of inert matter should not exceed 2.0%.



BITTER GOURD (*Momordica charantia*)

Bitter gourd (*Momordica charantia*) is a widely grown vegetable variety in India. It is one of the important members of the family Cucurbitaceae. The seed production can be done throughout the year in tropical climate and during spring, summer and rainy season in subtropical climates. In Tamil Nadu September – October is suitable for seed production. In hills seed production can be done during summer season.

Method of seed production

Bitter gourd is a self-pollinated crop with minimum cross-pollination. Seeds should be allowed to set by open-pollination in isolation. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 1000 metres for foundation and 500 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants, wild species and objectionable weeds. The land should be fertile with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy, free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 2 kg/acre (4.5 kg/ha).

The selected seeds should be soaked in warm water for 30 minutes before sowing. This helps in the softening of the hard seed coat of the bitter gourd seeds. To speed up the germination the seeds are kept in wet gunny bags or cloth bags for



3 – 4 days to soften the seed coat. Soaking in butter milk is also reported to promote germination. Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

Treated seeds should be sown in the main field which is ploughed 3 – 4 times and formed with channels of 60 cm width and 2 metres of spacing. Along the channel the pits of 30 cm³ and 1 metre deep are dug at 2.5 x 2 metre spacing. Normally in summer season crop, seeds are sown in raised mounds with a spacing of 0.6 – 1.2 metre.

Seeds are sown in the pits at 2 cm depth in a vertical orientation. Sow 5 seeds per pit and thin it 15 days after sowing. Allow only three seedlings per pit to grow and remove the rest. Irrigate the field before seed sowing.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. In each pit, farm yard manure or compost @ 1 kg mixed with 100 gms of neem cake is applied as a basal manure. One month after sowing apply 500 gms of vermicompost per plant as top dressing.

Intercultural practice

The flower drop in the crop can be controlled by spraying asafoetida solution (125 gms of asafoetida in 1 litre of water) over the plants.

Weed management

Weeding is most important during all the growth stages of the crop. The field should be maintained clean by frequent hand weeding. Periodical removal of objectionable weeds should be done.

Irrigation

First irrigation is done before sowing. Subsequent irrigation should be done once a week. Irrigation during flowering and fruit setting stages are very crucial.

Pest and disease management

Bitter melon is affected by pests and diseases like stem borer, fruit fly and leaf spot at different growth stages. Detailed management measures for these pests and disease are provided in Appendix – 1.

Roguing

Roguing should be done from early vegetative stage to flowering and fruiting stage. All the off-types and diseased plants should be rogued off periodically. The off-types are identified based on the morphological characteristics like plant type, leaf shape, flower colour, fruit shape etc. Removal of the off-types during fruit setting stage is helpful in preventing further genetic contamination. The maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from vegetative to fruit maturity stage by the Seed Certification Officer. The first



inspection is conducted during vegetative stage before flowering followed by the second one at flowering and fruiting stage. The final inspection should be scheduled during fruit maturity stage to determine the true characteristics of the fruits.

Field standards

	Foundation seed	Certified seed
Isolation distance	1000 m	500 m
Off-types	0.10%	0.20%

Harvesting

Harvesting is done once the fruits are physiologically mature. The physiological maturity of the fruits is identified by colour change from green to yellow - orange. The matured fruits are harvested by hand picking and dried until they split open and expose the shiny blood – red seeds.

Seed extraction and processing

The seeds from the split opened fruits are scooped out and soaked in the water for a day to get rid of the red pulp. After this, seeds are washed repeatedly and dried. The dried seeds are graded using 16 – 64” round perforated metal sieve.

Drying and storage

The extracted seeds should be washed and dried thoroughly before storage because of the hard seed coat in bitter melon seeds. Before storage the moisture content of the seeds should be 7%. Under cool and dry condition the well dried seeds can be stored up to five years with good germination capacity.

Seed standards

The percentage of minimum physical purity of the foundation and certified seeds should be 98% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 2.0%.

RIDGE GOURD / RIBBED GOURD (*Luffa acutangula*)

Ridged gourd (*Luffa acutangula*) belonging to the family Cucurbitaceae is a well known vegetable variety in India. The seed production can be done in both summer and rainy season.

Method of seed production

Bitter gourd is a cross-pollinated crop and cross-pollination occurs through bees. Seeds should be allowed to set by open-pollination in isolation. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 1000 metres for foundation and 500 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants, wild species and objectionable weeds.

The land should be fertile with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 600 gms/acre (1.5 kg/ha).

The selected seeds should be soaked in warm water for 30 minutes before sowing. This helps in the softening of the seeds. Soaking in butter milk is also reported to promote germination. Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

After 3 – 4 ploughing the main field is formed with channels of 60 cm width with a spacing of 2 metres. Along the channel, pits of 30cm³ diameter and 1 metre depth should be dug with a spacing of 2.5 x 2 metre. Treated seeds should



be sown in the pits at 2 cm depth in vertical orientation. Sow 5 seeds per pit and thinning should be done 15 days after sowing. Only three seedlings per pit are allowed to grow and the rest are removed. Normally for summer season crop, seeds are sown in raised mounds with a spacing of 0.6 – 1.2 metre. The field should be irrigated before seed sowing.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. In each pit, farm yard manure or compost @ 1 kg mixed with 100 gms of neem cake is applied as basal manure. One month after sowing apply 500 gms of vermicompost per plant as top dressing.

Intercultural practice

The flower drop in the crop can be controlled by spraying asafoetida solution (125 gms of asafoetida in 1 litre of water) over the plants.

Weed management

Weeding is most important during all the growth stages of the crop. The field should be maintained clean by frequent hand weeding. Periodical removal of objectionable weeds should be done.

Irrigation

First irrigation is done before sowing. Subsequent irrigation should be done once a week. Irrigation during flowering and fruit setting stages are very crucial.

Pest and disease management

Ridged gourd is commonly affected by pests like stem borer, fruit borer and army worm. Management measures for these pests are provided in Appendix – 1.

Roguing

Roguing should be done from early vegetative stage to flowering and fruiting stage. All the off-types and diseased plants should be rogued off periodically. The off-types are identified based on the morphological characteristics like plant type, leaf shape, flower colour, fruit shape etc. Removal of the off-types during fruit setting stage is helpful in preventing further genetic contamination. The maximum percentage of

off-types permitted at final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from the vegetative to fruit maturity stage by the Seed Certification Officer. The first inspection is conducted during vegetative stage before flowering followed by the second one at flowering and fruiting stage. The final inspection should be scheduled during the fruit maturity stage and prior to harvest.

Field standards

	Foundation seed	Certified seed
Isolation distance	1000 m	500 m
Off-types	0.10%	0.20%

Harvesting

Harvesting is done once the fruits are physiologically mature. The physiologically mature fruits will dry on the vine with cracked skin. The matured fruits should be harvested by hand picking and dried further.

Seed extraction and processing

The harvested fruits are dried under the sun for 2 -3 days. In well dried fruit shell, the seeds will rattle inside. Seed extraction in ribbed gourd is very simple and easy. The harvested, dried fruits should be cut open at one end and shaken. The seeds held by dry fibre will come out. These seeds can be collected and conserved. No further cleaning is required.

Drying and storage

The extracted seeds should be dried to attain a moisture level of 7% before storage. The dried seeds are graded using 16 – 64” round perforated metal sieve. Under dry, cool and dark storage conditions the well dried seeds can be stored up to five years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 2.0%.

CUCUMBER (*Cucumis sativus*)

Cucumber (*Cucumis sativus*) belonging to the family Cucurbitaceae is an important and well known summer vegetable variety in India. The seed production can be done in kharif (June - July) and summer (January - February) in North India and during October – November in South India.

Method of seed production

Cucumber is a cross-pollinated crop with an extent of 0 – 5% of self-pollination. Seeds should be allowed to set by open-pollination in isolation. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 1000 metres for foundation and 500 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants, wild species and objectionable weeds. The land should be fertile with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 1 kg/acre (2.5 kg/ha). Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

Treated seeds should be sown in the main field ploughed for 3 – 4 times and formed with ridges at 1.5 – 2.5 metres of spacing. The spacing between the plants should be about 60 – 90 cm. Seeds can also be sown in raised mounds @ 5 seeds



per mound. Seeds are sown at 2 cm depth and the field should be irrigated before seed sowing. Seedlings of more than three are thinned out 15 days after sowing. If seeds are sown along the furrows, the plants in each pit are reduced to one or two.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. In each sowing pit, farm yard manure or compost @ 1 kg mixed with 100 gms of neem cake is applied as basal manure. One month after sowing apply 500 gms of vermicompost per plant as top dressing.

Intercultural practice

The flower drop in the crop can be controlled by spraying asafoetida solution (125 gms of asafoetida in 1 litre of water) over the plants.

Weed management

Weeding is most important during all growth stages of the crop. The field should be maintained clean by frequent hand weeding. Periodical removal of objectionable weeds should be done.

Irrigation

First irrigation is done before sowing. Subsequent irrigation should be done once a week or depending upon the rains. Irrigation during flowering and fruit setting stages are very crucial.

Pest and disease management

Cucumber is commonly affected by pests like fruit fly, aphids and diseases like powdery mildew and downy mildew at different growth stages. The management measures for these pests and diseases are provided in Appendix – 1.

Roguing

Roguing should be done from early vegetative stage to flowering and fruiting stage. All the off-types and diseased plants should be rogued off periodically. The off-types are identified based on the morphological characteristics like plant type, leaf shape, flower colour, fruit shape etc. Removal of the off-types during fruit setting stage is helpful in preventing further genetic contamination. The maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from vegetative to fruit maturity stage by the Seed Certification Officer. The first inspection is conducted during vegetative stage before flowering followed by the second one at flowering and fruiting stage. The final inspection should be scheduled during fruit maturity stage and prior to harvest.

Field standards

	Foundation seed	Certified seed
Isolation distance	1000 m	500 m
Off-types	0.10%	0.20%

Harvesting

Harvesting is done once the fruits are physiologically mature. The physiological maturation of the fruits can be identified by change in the colour of fruits from greenish to pale yellow or golden. The matured fruits are harvested by hand picking and stored for a while before the extraction of the seeds.

Seed extraction and processing

The seeds from the harvested fruits are scooped out and collected in a vessel and left for few days to ferment. During this period the jelly around the seeds will be dissolved and the seed borne diseases will be removed. Then the seeds are sieved and washed thoroughly in running water and dried.

Drying and storage

The extracted seeds should be dried for a week or 10 days to attain a moisture level of 7% before storage. Seeds can be stored under closed storage conditions upto ten years. In dry climate under open storage conditions, seeds can be stored for four years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 2.0%.

BOTTLE GOURD (*Lagenaria siceraria*)

Bottle gourd (*Lagenaria siceraria*) is a well known member of the family Cucurbitaceae. It is a well known vegetable variety in India. The seed production can be done in summer season (February – March), rainy season (May - June) and in spring season (November) in North India and in Southern India during rainy season (June - July) and summer season (December - January).

Method of seed production

Bottle gourd is a cross-pollinated crop and cross-pollination occurs through honey bees, moths and other night insects. To conserve the purity of the seeds isolation distance should be maintained. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 1000 metres for foundation and 500 metres for certified seed production.



Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants, wild species and objectionable weeds. The land should be fertile with proper drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 1 kg/acre (3 kg/ha).

The selected seeds should be soaked in warm water for 30 minutes before sowing. This helps in the softening of the hard seed coat. Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

Treated seeds should be sown in the main field ploughed for 3 – 4 times, pulverized and leveled. Channels of 40 – 50 cm wide are formed after leveling the field at a distance of 2 – 2.5 metre. The length of the channels can be decided based on the available irrigation facility and land slope.

Seeds should be sown directly in furrows or in pits or trenches @ 5 seeds / pit and thinning should be done 15 days after sowing. Only two seedlings per pit are allowed to grow.

The field should be irrigated before seed sowing. Seeds sown in hills at a spacing of 300 x 45 cm @ 1 seed / hill reported to give higher yield.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. In each pit, farm yard manure or compost @ 1 kg mixed



with 100 gms of neem cake is applied as basal manure. One month after sowing, apply 500 gms of vermicompost per plant as top dressing.

Intercultural practice

The flower drop in the crop can be controlled by spraying asafoetida solution (125 gms of asafoetida in 1 litre of water) over the plants.

Weed management

Weeding is most important during all growth stages of the crop. Weeding and hoeing should be done along and in between the channels. The field should be maintained clean by frequent hand weeding. Periodical removal of objectionable weeds should be done.

Irrigation

First irrigation is done soon after seed sowing to improve the germination. Subsequent irrigation should be done once a week. Irrigation during flowering and fruit setting are very crucial.

Pest and disease management

Pests like stem borer, fruit fly and *Epilachna* beetle affects the crop. The management techniques for these pests are provided in Appendix – 1.

Roguing

Roguing should be done from early vegetative stage to flowering and fruiting stage. All the off-types, wild species and diseased plants should be rogued off periodically. The off-types are identified based on the morphological characteristics like plant type, leaf shape, flower colour, fruit shape, colour, stripe and neck. Removal of the off-types during fruit setting stage is helpful in preventing further genetic contamination. The maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from vegetative to fruit maturity stage by the Seed Certification Officer. The first inspection is conducted during vegetative stage before flowering followed by the second one at flowering and fruiting stage. The final inspection should be done during fruit maturity stage and prior to harvest.

Field standards

	Foundation seed	Certified seed
Isolation distance	1000 m	500 m
Off-types	0.10%	0.20%

Harvesting

Harvesting is done once the fruits are physiologically mature. The physiologically mature fruits will sound hollow when tapped and their fruit stalks will turn from green colour to brown colour. The matured gourds should be harvested by hand picking and dried further.

Seed extraction and processing

The harvested fruits are dried under the sun until the seeds inside the gourd start rattling. Seed extraction in bottle gourd is very simple and easy. The harvested, dried gourd should be cut open at the top and seeds are shaken out. The dry flesh around the seeds should be removed by hand rubbing.

Drying and storage

The extracted seeds should be dried to attain a moisture level of 7% before storage. The dried seeds are graded using 16/64" round perforated metal sieve. Under proper storage conditions the seeds can be stored for upto five years. Conserving the seeds intact with the gourd will increase the germination and vigour of the seeds.

Seed standards

The minimum percentage of physical purity of foundation and certified seeds should be 98% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 2.0%.

SQUASH (*Cucurbita pepo*)

Squash (*Cucurbita pepo*) commonly called as summer squash is a well known vegetable belonging to the family Cucurbitaceae. The seed production can be done in January – March as summer crop in plains and in hills during April – May.

Method of seed production

Squash is a naturally cross-pollinated crop and self-pollination occurs to the extent of 0 – 5%. Seeds should be allowed to set by open-pollination in isolation. The isolation distance maintained between the fields of the other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 1000 metres for foundation and 500 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants, wild species and objectionable weeds. The land should be fertile with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy, free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 2 – 3 kg/acre (5 - 8 kg/ha).

The selected seeds should be soaked in warm water for 30 minutes before sowing. This helps in the softening of the seeds. Soaking in buttermilk also reported to promote germination. Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

Treated seeds should be sown in the main field ploughed for 3 – 4 times and formed into furrows. Seeds can also be sown in pits as practiced in South India. A spacing of 1.24 x 0.45 metres and 1 x 1 metre should be followed for sowing in furrows and pits respectively. For pit sowing, pits of 30 cm³ diameter and 1 metre deep are dug.

Seeds are sown in the pits at 2 cm depth in vertical orientation. Sow 5 seeds per pit and thinning should be done 15 days after sowing. Only three seedlings per pit are allowed to grow and rest are removed. The field should be irrigated before seed sowing.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. In each pit, farmyard manure or compost @ 1 kg mixed with 100 gms of neem cake is applied as basal manure. One month after sowing apply 500 gms of vermicompost per plant as top dressing.

Intercultural practice

The flower drop in the crop can be controlled by spraying asafoetida solution (125 gms of asafoetida in 1 litre of water) over the plants.

Weed management

Weeding is most important during all growth stages of the crop. The first weeding can be done 15 – 20 days after seed sowing or transplanting. Frequent weeding should be done to keep the field clean. This results in good yield. Periodical removal of objectionable weeds should be done.

Irrigation

First irrigation is done 4 – 5 days after seed sowing or immediately after transplanting. Subsequent irrigation should be done at an interval of 4 – 5 days. Irrigation during flowering and fruit setting stages are very crucial.

Pest and disease management

Squash is commonly affected by the diseases like powdery mildew, downy mildew and *Fusarial* wilt at different growth stages. The management measures for these diseases are provided in Appendix – 1.

Roguing

Roguing should be done from early vegetative stage to flowering and fruiting stage. All the off-types and diseased plants should be rogued off periodically. The off-types are identified based on the morphological characteristics like growth pattern of runners or bush types. These off-types should be rogued off immediately to conserve the genetic purity of the seeds. The maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from vegetative to fruit maturity stage by the Seed Certification Officer. The first inspection is conducted during vegetative stage before flowering followed by the second one at flowering and fruiting stage. The final inspection should be scheduled during fruit maturity stage and prior to harvest.

Field standards

	Foundation seed	Certified seed
Isolation distance	1000 m	500 m
Off-types	0.10%	0.20%
Seed borne diseases affected seeds	0.10%	0.50%

Harvesting

Harvesting is done once the fruits are physiologically mature. The physiologically mature fruits can be identified by colour change from green to yellow, orange and golden yellow to straw yellow. In matured fruits the rind becomes harder. The matured fruits are harvested by hand picking and stored further for the maturation of seeds.

Seed extraction and processing

The seeds are scooped from the matured fruit and washed thoroughly to remove the pulp around them. After washing the seeds are dried under the shade to attain safe moisture content. Separate the good quality seeds from others based on the relative size, shape, weight, texture, colour etc.

Drying and storage

The extracted seeds should be dried immediately to attain a moisture level of 7% before storage. Under suitable storage conditions the seeds can be stored for 3 – 10 years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 2.0%.

PUMPKIN (*Cucurbita maxima*)

Pumpkin (*Cucurbita maxima*) is a well known and widely cultivated vegetable variety of the family Cucurbitaceae. The seed production can be done in summer season (February - March) and in rainy season (April - May). In Tamil Nadu, sowing during July – August is best for seed production.

Method of seed production

Pumpkin is a cross-pollinated crop and self-pollination occurs to the extent of 5%. Seeds should be allowed to set by cross-pollination in isolation. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 1000 metres for foundation and 500 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants, wild species and objectionable weeds. The land should be fertile with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the

broken, coloured seeds and use uniformly graded seeds. Seed rate is 400 gms/acre (1 kg/ha).

Soak the seeds in double the quantity of water for 4 hours and bundle them in a wet cotton cloth for five days to ensure the uniform emergence of the seeds in the field. Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

The treated seeds are sown directly in the field in raised beds or furrows or in pits @ 2 seeds per hill at 4 – 5 cm distance. For sowing in raised beds and furrows the row to row spacing of 2 – 2.5 metres and plant to plant spacing of 100 – 150 cm should be followed. For pit sowing, pits of 60 x 60 x 60 cm should be dug. After the preparation of the main field, 45 cm wide and 25 – 30 cm deep channels are formed with a spacing of 3 – 4.5 metre. Sowing in 'channel and hill' method is very effective. Seeds are sown in the pits at 2 cm depth in vertical orientation. The field should be irrigated before seed sowing.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. In each pit, farm yard manure or compost @ 1 kg mixed with 100 gms of neem cake is applied as a basal manure. One month after sowing, apply 500 gms of vermicompost per plant as top dressing.

Intercultural practice

The flower drop in the crop can be controlled by spraying asafoetida solution (125 gms of asafoetida in 1 litre of water) over the plants.

Weed management

Weeding is most important during all growth stages of the crop. The first weeding can be done 15 – 20 days after seed sowing. Frequent weeding





should be done to keep the field clean. Periodical removal of objectionable weeds should be done.

Irrigation

Regular irrigation is a must for optimum yield. First irrigation is done at the time of sowing followed by the life irrigation at 3 days after seed sowing. Subsequent irrigation should be done at an interval of 5 – 7 days. Irrigation during flowering and fruit setting stages are very crucial. But, excessive irrigation during fruit maturity should be avoided for better storage life.

Pest and disease management

Fruit fly, powdery mildew and downy mildew are the common pest and diseases affecting pumpkin crop at different growth stages. The management techniques for these pest and diseases are provided in Appendix – 1.

Roguing

Roguing should be done from early vegetative stage to flowering and fruiting stage. All the off-types and diseased plants should be rogued off periodically. The off-types are identified based on the morphological characteristics like growth pattern, flowering, fruit shape etc. These off-types should be rogued off immediately to conserve the genetic purity of the seeds. The maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from vegetative to fruit maturity stage by the Seed Certification Officer. The first

inspection is conducted during vegetative stage before flowering followed by the second one at flowering and fruiting stage. The final inspection should be scheduled during fruit maturity stage and prior to harvest.

Field standards

	Foundation seed	Certified seed
Isolation distance	1000 m	500 m
Off-types	0.10%	0.20%

Harvesting

Harvesting is done once the fruits are physiologically mature. The physiological maturity can be identified by colour change from green to yellow and drying of the fruit stalks. The matured fruits should be harvested by hand picking and stored for few weeks for further maturation of seeds.

Seed extraction and processing

The seeds are scooped from the matured fruit and washed thoroughly to remove the pulp around them. After washing the seeds are dried under the shade to attain safe moisture content. The dried seeds are graded using 16/64” round perforated metal sieve.

Drying and storage

The extracted seeds should be put in paper envelopes and hung out for further drying for a week to attain a moisture level of 7% before storage. Under suitable storage conditions of dry environment with even temperatures the seeds can be stored to an extent of 3 – 10 years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 2.0%.

RADISH (*Raphanus sativus*)

Radish (*Raphanus sativus*) belonging to the family Brassicaceae is one of the common root crops widely cultivated all over India. The seed production can be done during September – October in autumn and during March in spring season. Seed production can also be taken up during summer season.

Method of seed production

Radish is a highly cross-pollinated crop and self-pollination occurs to the extent of 0 - 5%. Cross-pollination mainly occurs through bees and other flies. Seeds should be allowed to set by cross-pollination in isolation. Seed production is done by seed to seed or root to seed method. In seed to seed method, the matured roots are left to produce flowers and seeds in the place where seeds are sown initially. It is used for certified seed production alone. In root to seed method, roots at edible maturity should be uprooted and the roots of true to varietal characteristics should be selected and transplanted to the well prepared field after proper trimming of roots and shoots. Breeder seeds and foundation seeds are produced by this method.

The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 1600 metres for foundation and 1000 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should not be cultivated with same crop for the past two seasons. If cultivated it should be inspected by the certification agency and found not to contain any soil borne diseases. The land should be fertile with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 400 gms/acre (10 kg/ha).

The selected seeds should be soaked in warm water for 30 minutes before sowing. This helps in the softening of the seeds. Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

The treated seeds are sown directly in the field ploughed for 3 – 4 times and formed into ridges. Well prepared soil of soft and smooth texture will enhance the germination and growth of the plant. Seeds are sown in ridges about 60 – 70 seeds per metre of row at 1.5 – 2.5 cm depth. After thinning the intra row spacing should be 5 – 10 cm. In replanting method, the mother roots are pulled out carefully without damage to the roots and selected based on the typical characteristics. Before replanting the shoot and the root parts are trimmed to $\frac{2}{3}$ and $\frac{1}{2}$ to $\frac{3}{4}$, respectively. The roots (also known as stecklings – roots used for replanting for seed production) are planted at a required spacing of 45 x 45 cm.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should be applied 20 – 25 days after sowing as first top dressing. Second top dressing should be done 40 – 45

days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms of asafetida per acre (35 kg neem cake + 600 kg vermicompost mixed with 500 gms of asafetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed.

Weed management

Weeding at regular intervals is very important for the seed crop. The first weeding can be done 15 – 20 days after seed sowing / replanting. Periodical removal of objectionable weeds should be done.

Irrigation

Regular irrigation is a must for optimum yield. First irrigation is done at the time of sowing / replanting. Subsequent irrigation should be done at an interval of 10 - 15 days. Irrigation should be stopped when lower few pods start drying. Irrigation should be done 3- 4 days before uprooting.

Pest and disease management

Radish commonly affected by pest and diseases like aphids, radish mosaic virus and Alternaria blight. The management measures for the same are provided in Appendix – 1.

Roguing

Roguing should be done in all growth stages like vegetative stage, flowering stage, stock formation stage and pod formation stage. All the off-types, diseased plants, plants with thin roots, plants coming to early flowering etc., should be rogued off. The maximum percentage of off-types and roots not confirming to the varietal characteristics permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production. The maximum percentage of plants with seed borne diseases permitted at final inspection is 0.10% for foundation seed production and 0.50% for certified seed production.

Field inspection

In radish a minimum of three field inspections should be done during the mother root production stage and seed production stage. In mother root

production stage, two inspections should be done. The first inspection at 20 – 30 days after sowing to check isolation, off-types and other factors and the second inspection at uprooting of roots to determine the true characteristics of the roots. In seed production stage an inspection is scheduled during the flowering stage to check isolation, off-types, designated diseases and other relevant factors.

Field standards

	Foundation seed	Certified seed
Isolation distance	1000 m	500 m
Off-types	0.10%	0.20%
Plants affected by seed borne diseases	0.10%	0.50%

Harvesting

Harvesting is done once the pods are physiologically mature. The physiologically mature pods are in pearl brown colour. The matured pods should be harvested by hand picking and hung in an open space for further drying.

Seed extraction and processing

The dried pods are crushed to separate the seeds, since the pods do not shatter. The separated seeds should be cleaned using gauged screens.

Drying and storage

The extracted seeds should be dried under the shade for a week or two to attain a moisture level of 6% before storage. Seeds can be stored in cloth bags or 700 gauge polythene bags. Under suitable storage conditions the seeds can be stored for about four years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 70% of germination capacity and 6% of moisture content. The presence of inert matter should not exceed 2.0%.

BEAN (*Phaseolus vulgaris*)

Bean (*Phaseolus vulgaris*) belonging to the family Leguminosae is a commercially important vegetable variety. It is one of the widely cultivated vegetable varieties. The seed production of this crop can be taken up in July – September and January – February in plains and in hills during September – November (in south India) and end of October in North India.

Method of seed production

Bean is a self-pollinated crop. Cross-pollination occurs very rarely since self-pollination takes place before the opening of the flowers. To maintain the varietal purity an isolation distance of 25 metres for certified and 50 metres for foundation seed production is necessary from the fields of other varieties and of the same variety not conforming to the varietal purity requirements of certification.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should not be cultivated with other variety of the same crop in the previous season and should be free of volunteer plants. The land should be fertile with neutral pH. The soil should be light with proper drainage facility.

Seed selection and sowing

Certified seeds of good quality should be obtained from an authentic source. Seeds should be healthy with good germination percentage. Remove the off coloured and out sized seeds. The seed rate varies depending on the variety. It is 26 kg/acre (65 kg/ha) for bushy variety and 10 – 14 kg/acre (25 - 35 kg/ha) for pole varieties.

Treat the seeds with powder form of *Trichoderma viride* @ 4 gms/kg or *Pseudomonas* @ 10 gms/kg of seeds. Seed treatment with *Trichoderma* or *Pseudomonas* protects the crops from disease causing microorganisms. Seeds can be soaked

in diluted panchagavyam for 20 minutes and dried before treating with *Trichoderma* or *Pseudomonas*. After treating the seeds with these bio-control agents treat them with biofertilizer *Rhizobium* @ 600 gms/acre of seeds 24 hours before sowing to facilitate natural nitrogen fixation by plants. Mix *Rhizobium* in rice gruel and then mix it with seeds. Seeds should be dried under the shade for 15 minutes and then sown.

Treated seeds are sown in double row of 30 cm apart with 1.5 metre distance between each pair of rows in a land prepared to fine tilth. Seeds should be sown in line method at a depth of 4 – 5 cm. A spacing of 60 x 10 - 30 cm should be followed for getting high yield and quality seeds.

Nutrient management

Farm yard manure @ 10 – 20 tonnes/acre (25 - 50 tonnes/ha) should be applied at the time of land preparation incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should be applied 20 – 25 days after sowing as first top dressing. Second top dressing should be done 40 – 45 days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms of



asafoetida per acre (35 kg neem cake + 600 kg vermicompost mixed with 500 gms of asafoetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed. For rainfed cultivation replace the neem cake with pungam cake and apply all the above mentioned inputs only when the soil is wet.

Weed management

The first hand weeding is done in 20 days after sowing followed by the second weeding in 40 days after sowing. Weeding is not required after 60 days of sowing. If needed, then manual weeding should be done.

Irrigation

Irrigation is very important factor for good yield of seeds with high quality. The first irrigation is done immediately after sowing and the second irrigation is done 2 – 3 days after sowing. After this, the field is irrigated once in 8 – 10 days. Irrigation during flowering and pod filling stages are very critical.

Important operations

The shoot apex of the plants should be nipped off in 65 days after sowing in pole variety to increase the seed yield.

Pest and disease management

The pests and diseases like aphids, pod borer, yellow mosaic virus, stem blight, root rot and powdery mildew affects the bean crop at different growth stages. The management techniques for these pests and diseases are provided in Appendix – 1.

Roguing

Roguing should be done from vegetative stage to harvesting stage. The off-types and volunteer plants are removed based on the morphological characteristics like plant type, leaf, flower and pod colour etc. Off-types and diseased plants affected by leaf spot, stem blight, yellow mosaic virus should be removed from the seed field to maintain healthy crops. Plants of early and late flowering types should also be removed.

Field inspection

A minimum of two inspections should be done from flowering to fruiting stage by the Seed Certification Officer. The first inspection is done before flowering followed by the second during flowering and fruiting stage to determine isolation, off-types, volunteer plants and diseased plants etc.

Harvesting

The crop reaches the physiological maturity in 80 days after flowering. Harvesting takes place soon after the maturation of the seeds. Physiological maturation of the pods can be identified by change of colour from green to yellow. Matured pods should be harvested in two to three pickings. Harvest should not coincide with rains, because it will result in off coloured and dimpled seeds. Delay in harvesting will result in shattering of pods.

Threshing and processing

Harvested pods are dried under the sun light to attain a moisture content of 15 – 18%. Then the dried pods are beaten with pliable bamboo stick to separate the seeds. The seeds should then be cleaned by winnowing. Seeds are graded using 19/64” round perforated metal sieve. Seeds of different colour and sizes should be removed.

Drying and storage

Processed and graded seeds are further dried for 2 – 3 days under the mild sun light between 9 – 11 am and 2 – 4 pm to attain a moisture content of 8 – 10% for safe storage. Coating seeds with edible oil will prevent weevil infestation during storage. Seeds can also be treated with activated clay @ 1 kg/100 kg of seeds to control bruchid infestation. Under appropriate storage conditions, bean seeds can be stored for three years.

Seed standards

The percentage of maximum physical purity of foundation and certified seeds should be 98% with minimum germination capacity of 75%. The maximum moisture content should be 9%. The presence of inert material should not exceed 2%.

AMARANTH (*Amaranthus sp.*)

Amaranth (*Amaranthus sp.*) is a widely used leafy vegetable belonging to the family Amaranthaceae. In India it is being cultivated throughout the year. This short duration crop is well suited for crop rotation. The seed production of this crop can be taken up in February – March as a summer crop and as rainy season crop in June – July.

Method of seed production

Amaranth is a cross-pollinated crop. Cross-pollination occurs mainly by wind. Seeds are allowed to set by open pollination under isolation. To maintain the varietal purity an isolation distance of 200 metres for certified and 400 metres for foundation seed production is necessary from the fields of other varieties and of the same variety not conforming to the varietal purity requirements of certification and wild *Amaranth*.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from other species of *Amaranth* including wild *Amaranth*. The land should be fertile with proper drainage facility.

Seed selection and sowing

Certified seeds of good quality should be obtained from an authentic source. Seeds should be healthy with good germination percentage. Remove the off coloured and out sized seeds. Seed rate is 800 gms/acre (2 kg/ha) for direct sowing and 400 gms/acre (1 kg/ha) for long transplanted crop.

The selected seeds should be soaked in hot water (70°C) for one minute or in 50°C water for 12 hours or at 4°C for seven days to break the dormancy of the seeds. Treat the seeds with the powder form of *Trichoderma viride* @ 4 gms/kg of seeds or *Pseudomonas* @ 10 gms/

kg of seeds. Seed treatment with *Trichoderma* or *Pseudomonas* protects the crop from disease causing microorganisms.

Treated seeds should be broadcasted @ 2 gms/sq. metre in seed beds prepared with one ploughing and 2–3 harrowing followed by levelling. Usually seed beds of 2 x 1.5 metre size are formed. Seeds are mixed with 20 kg of fine sand and broadcasted uniformly on the beds. After sowing the seeds are covered with a thin layer of sand or soil. The seedlings should be transplanted after three weeks in the main field. Mostly the crop is sown directly. A spacing of 30 x 30 cm is maintained for seed crop. In transplanted method, seedlings are planted in rows of 60 – 80 cm apart with a spacing of 40 – 50 cm between the plants.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should be applied 20 – 25 days after sowing as first top dressing. Second top dressing should be done 40 – 45 days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms of asafoetida per acre (35 kg neem cake + 600 kg vermicompost mixed with 500 gms of asafoetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed. For rainfed cultivation replace the neem cake with pungam cake and apply all the above mentioned inputs only when the soil is wet.

Weed management

Hoeing and weeding should be done as and when it is needed. The field should be maintained without weeds and other contaminants.

Irrigation

The first irrigation is done immediately after sowing and the second irrigation is done 3 days after sowing. After this, the field is irrigated once a week. Irrigation during flowering and seed filling stages are very critical.

Important operations

After four weeks of transplanting till flowering nick off the apical buds to promote the secondary shoots.

Pest and disease management

Amaranth is commonly affected by pests and disease like weevil, aphids, yellow mosaic virus and white rust. The management measures for these pests and diseases are provided in Appendix – 1.

Roguing

Roguing should be done at a regular interval. A minimum of three Roguing should be done. The off-types are clearly identified by morphological characteristics like leaf type, colour and pigmentation and rogued off. The maximum percentage of off-types not confirming to the varietal characteristics permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production. The maximum percentage of objectionable weeds permitted at the final inspection is 0.010% for foundation seed production and 0.020% for certified seed production.

Field inspection

A minimum of two inspections should be done from vegetative stage to flowering stage by the Seed Certification Officer. The first inspection



is done before flowering followed by the second during flowering stage to determine isolation, off-types, volunteer plants and diseased plants and to estimate the yield.

Field standards

	Foundation seed	Certified seed
Isolation distance	400 m	200 m
Off-types	0.10%	0.20%
Objectionable weed seeds	0.01%	0.02%

Harvesting

The seeds reach the physiological maturity in 25 days after flowering. Harvesting takes place soon after the maturation of seeds. The physiological maturation of the glumes and seeds are identified by colour change from green to brown and green to shiny black, respectively. Seed heads (glumes) nearing maturation should be harvested now and then, since seeds tend to drop from the fully matured glumes.

Threshing and processing

Harvested seed heads are dried under the sun light to attain a moisture level of 15%. After this, using a pliable bamboo stick the glumes are beaten to shed the seeds. The separated seeds are then cleaned to remove the debris. Winnowing is avoided since the seeds are very small and less in weight. To separate the debris from the seeds, the seeds should be heaped in a bowl and tossed. The debris will collect at the top and can be blown away. Then the seeds are graded using BSS 22 x 22 wire mesh sieve.

Drying and storage

Processed and graded seeds are further dried for safe storage. Seeds should be dried to attain a safe moisture content of 8%. Seeds can be stored for upto five years under open storage conditions.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 95% with minimum germination capacity of 70%. The maximum moisture content should be 8%. The presence of inert material should not exceed 5%.

CARROT (*Daucus carota*)

Carrot (*Daucus carota*) is one of the most important and widely used root vegetable belonging to the family Umbelliferae. The seed production can be done during September – October in plains and in hills the sowing takes place in June and roots are replanted during the first week of October.

Method of seed production

Carrot is a cross-pollinated crop and self-pollination occurs to the extent of 0 - 5%. Cross-pollination is mainly through insects. Seeds should be allowed to set by cross-pollination in isolation. Seed production is done by seed to seed and root to seed method. In seed to seed method, the matured roots are left to produce flowers and seeds in the place where seeds are sown initially. In root to seed method, roots at edible maturity should be uprooted and the roots of true to varietal characteristics should be selected and transplanted to the well prepared field after proper trimming of roots and shoots. This root to seed method is preferred for seed production in carrot since the root rot infection is high in seed to seed method of seed production.

The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to varietal purity requirements for certification is 1000 metres for foundation and 800 metres for certified seed production. During mother root production an isolation of 5 metres should be followed.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants. The soil should be fertile and soft with good drainage facility. Since carrot is a cross-pollinated crop the land should be with pronounced isolation distance.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 1.5 kg/acre (4 kg/ha).

The selected seeds should be soaked in water for 72 hours and water should be changed every 24 hours. This method will remove all the germination inhibitors and improve germination. Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

The treated seeds are sown directly in the field ploughed for 3 – 4 times and formed into ridges or beds of convenient size. Well prepared soil of soft and smooth texture will enhance the germination and growth of the plant. Seeds are mixed with fine sand to facilitate uniform distribution and sown in ridges at 1.5 – 2.5 cm depth. After thinning the intra row spacing should be 5 – 10 cm. In replanting method, the mother roots are pulled out carefully without damage to the roots and selected based on the typical characteristics. Before replanting the shoot and the root parts are trimmed to $\frac{2}{3}$ and $\frac{1}{2}$ to $\frac{3}{4}$, respectively. The roots (also known as stecklings – roots used for replanting for seed production) are planted at a required spacing of 60 x 30 cm.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should

be applied 20 – 25 days after sowing as first top dressing. Second top dressing should be done 40 – 45 days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms of asafetida per acre (35 kg neem cake + 600 kg vermicompost mixed with 500 gms of asafetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed.

Weed management

Weeding at regular intervals is very important for the seed crop. The first weeding can be done 15 – 20 days after seed sowing / replanting. Periodical removal of objectionable weeds should be done.

Irrigation

Regular irrigation is a must to maintain a moisture content of 60 – 80%. First irrigation is done at the time of sowing / replanting. Subsequent irrigation should be done at an interval of 10 - 15 days. In replanted method, first irrigation is done soon after the replanting followed by second irrigation 4 - 5 days after planting. Frequency of the irrigation depends on the moisture content of the soil. Irrigation should be stopped when lower few pods start drying. Irrigation should be done 3 - 4 days before uprooting.

Pest and disease management

Diseases like Alternaria blight and powdery mildew are commonly affecting the crop. The management measures for these diseases are provided in Appendix – 1.

Roguing

Roguing should be done in all growth stages like vegetative stage, flowering stage, stock formation stage and pod formation stage. All the off-types, diseased plants, plants with thin roots, plants coming to early flowering etc., should be rogued off. The maximum percentage of off-types and roots not confirming to varietal characteristics permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

In carrot a minimum of six field inspections should be done during the mother root production

stage and seed production stage. In mother root production stage, two inspections should be done. The first inspection at 20 – 30 days after sowing to check isolation, off-types and other factors and second inspection at the time of uprooting the roots to determine the true characteristics of the roots. In seed production stage four inspections are scheduled during the pre flowering stage followed by two inspections at flowering stage and fourth one during maturity stage to check isolation, off-types, designated diseases, varietal characteristics and other relevant factors.

Field standards

	Foundation seed	Certified seed
Isolation distance	1000 m	800 m
Off-types	0.10%	0.20%
Roots not confirming to varietal characteristics	0.10%	0.20% (by numbers)

Harvesting

Harvesting is done once the seed heads are physiologically mature. The physiologically mature seed heads will turn from green to brown colour. The matured seed heads should be harvested at once and dried further.

Seed extraction and processing

The dried pods are crushed to separate the seeds, since the pods do not shatter. The separated seeds should be cleaned using BSS 12 wire mesh sieve.

Drying and storage

The extracted seeds should be dried under the shade for a week or two to attain a moisture level of 8% before storage. Seeds can be stored in cloth bags or 700 gauge polythene bags. Under suitable storage conditions the seeds can be stored for about four years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 95% with a minimum of 60% of germination capacity and 8% of moisture content. The presence of inert matter should not exceed 5.0%.

CORIANDER (*Coriandrum sativum*)

Coriander (*Coriandrum sativum*) is one of the most important condiments belonging to the family Umbelliferae. The seed production can be done in rabi season. Best sowing time for seed production is mid October – mid November.

Method of seed production

Coriander is a cross-pollinated crop and self-pollination occurs to the extent of 0 - 5%. Cross-pollination is mainly through insects. Seeds should be allowed to set by cross-pollination in isolation. The minimum isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 200 metres for foundation and 100 metres for certified seed production.

Seed production stages

Breeder seed → Foundation seed → Certified seed

Land selection

The land selected should be free from volunteer plants. The soil should be fertile and soft with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy, free from disease and pest infection. Remove the



broken, coloured seeds and use uniformly graded seeds. Seed rate is 8 kg/acre (20 kg/ha).

The selected seeds should be split into two halves by rubbing before sowing. The selected seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds. The treated seeds are sown directly in the field ploughed for 3 – 4 times and formed into ridges at 1.5 – 2.5 cm depth. Well prepared soil of soft and smooth texture will enhance the germination and growth of the plant. Seeds are sown in rows at a spacing of 30 cm apart.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should be applied 20 – 25 days after sowing as first top dressing. Second top dressing should be done 40 – 45 days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms of asafoetida per acre (35 kg neem cake + 600 kg vermicompost mixed with 500 gms of asafoetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed. For rainfed cultivation replace the neem cake with pungam cake and apply all the above mentioned inputs only when the soil is wet.

Weed management

Weeding at regular intervals is very important for the seed crop in the earlier stages. In rainfed crop the first weeding is done 25 – 30 days

after sowing and in irrigated crop it is done in 40 – 45 days after sowing. Periodical removal of objectionable weeds should be done.

Irrigation

First irrigation should be done before sowing. Subsequent irrigation should be done at an interval of 10 - 15 days. Frequency of the irrigation depends on the moisture content of the soil. Irrigation during flowering and seed setting is a must.

Pest and disease management

Coriander crop is commonly affected by the pests and diseases like blight, powdery mildew, wilt and aphids at different growth stages. The management measures for the same are provided in Appendix – 1.

Roguing

Roguing should be done in all growth stages from vegetative stage to harvesting stage. All the off-types, diseased plants, plants with thin roots, plants comes to early flowering etc., should be rogued off. The maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.50% for certified seed production.

Field inspection

In coriander a minimum of three field inspections should be done. The first inspection is done before flowering within 45 days of planting followed by the second one during 50% flowering to check the isolation, volunteer plants, off-types and other relevant factors. The third inspection is scheduled at the time of maturity and prior to

harvest to check the varietal characteristics of the plant and other factors.

Field standards

	Foundation seed	Certified seed
Isolation distance	200 m	100 m
Off-types	0.10%	0.50%

Harvesting

Harvesting is done once the seeds are physiologically mature. The matured seeds will turn to yellowish green and hard. The physiologically mature seeds should be harvested successively since the minimum pressure or disturbance will make the matured seeds to fall.

Seed extraction and processing

The harvested plants are dried under the sun. After drying the plants are threshed by hand and seeds are removed. The removed seeds are cleaned further by winnowing.

Drying and storage

The extracted and cleaned seeds should be dried under the sun to attain a moisture level of 10% before storage. Under suitable storage conditions the seeds can be stored for about three years.

Seed standards

The percentage of minimum physical purity of the foundation and certified seeds should be 97% with a minimum of 65% of germination capacity and 10% of moisture content. The presence of inert matter should not exceed 3.0%. Presence of seeds of other crops are permitted at the maximum of 10/kg for foundation and 20/kg for certified seeds.



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APPENDIX – I PEST AND DISEASE MANAGEMENT IN VEGETABLE CROPS

Sl. No.	Crop	Common Pests and Diseases	Management measures
1.	Lady's finger	Shoot and fruit borer (<i>Earias vittella</i> , <i>E. insulana</i>) - (Infestation starts at the early vegetative stage and persists up to fruiting stage)	Summer ploughing, spray ginger, garlic, chilli or <i>Sida acuta kashayam</i> .
		Yellow vein mosaic / Vein clearing	Spray 5% neem seed kernel extract or ginger, garlic and chilli extract, destroy affected plants, weeds and other wild hosts and avoid summer cropping.
	Lady's finger, Capsicum, Chilli, Ridged gourd	Fruit borers (<i>Helicoverpa armigera</i> , <i>Spodoptera litura</i>) - (affect during the flowering stage)	Summer ploughing, use bird perches @ 6 – 8/acre (15 – 20/ ha), use pheromone traps @ 3 – 4/acre (8/ha), spray 5% neem seed kernel extract, ginger, garlic and chilli extract or <i>Andrographis kashayam</i> or five leaf extract to kill early stages of larvae or use <i>Trichogramma</i> @ 20250 eggs/acre (50,000 eggs/ha) six times at weekly intervals.
2.	Tomato	White fly – (<i>Bemisia tabaci</i>) (affects from vegetative to maturation stage)	Cover the nursery bed with 40 mesh nylon net to prevent entry of flies, install yellow sticky traps @ 20/acre (50/ha) and spray 5% neem kernel extract when the pest incidence is above Economic Threshold Level (ETL).
	Tomato	Fruit borers (<i>Helicoverpa armigera</i> , <i>Spodoptera litura</i>) - (affects during flowering stage)	Hand pick and destroy the larva, use bird perches @ 6 – 8/acre (15 – 20/ha), spray 5% neem seed kernel extract or <i>Andrographis kashayam</i> or five leaf extract, soil application of the seed extracts of <i>Strychnos nux-vomica</i> @ 1.5 gms/plant at an interval of 20 days for twice, use NPV @ 250 LE/ha, <i>Bacillus thuringiensis</i> (1 g/litre of water), <i>Trichogramma chilonis</i> (50,000 eggs / ha, six times at weekly intervals) and <i>Bracon</i> hibitor (larval parasite).
		Damping off (<i>Pythium aphanidermatum</i>)	Use healthy seeds, sterilization of the field soil by surface burning of a thick stack of farm trash, use raised beds with better drainage facilities and apply 400 gms of neem cake / sq.metre of nursery bed 15 days before sowing and water at 3 – 5 days interval.

		<i>Fusarium wilt (Fusarium oxysporum f. lycopersici)</i>	Dip the root part of the seedlings in a solution (10 gms each of turmeric and asafoetida dissolved in 1 litre of water) before transplanting, keep the fruits away from the soil by proper pruning, pull out the affected plants and destroy and spray fifteen days old panchagavyam, diluted with 10 parts of water.
3.	Capsicum and Chilli	<p>Damping off (<i>Pythium aphanidermatum</i> and <i>Pythium debaryanum</i>)</p> <p>Fruit rot (<i>Phytophthora capsici</i>) and Anthracnose (<i>Colletotrichum capsici</i>)</p> <p>Thrips, aphids, whitefly, hoppers and yellow spider mites, moths – (affect during vegetative stage)</p>	<p>Use good quality and healthy seeds, sow the seeds in rows with 5 -10 cm spacing and raise the seedlings on the raised nursery beds.</p> <p>Use disease free, healthy seeds for raising seedlings, collect and destroy affected, rotten fruits.</p> <p>Use yellow sticky traps @ 20/acre (50/ha), collect and destroy adult moths using light traps @ 2/acre (5/ha), spray 10% neem seed kernel extract.</p> <p>Use pheromone traps @ 3 – 4/acre (8/ha), collect and destroy the infected shoots, whole plants, fruits etc., use <i>Trichoderma chilonis</i> @ 20,000/acre (50,000/ha) or spray <i>Bacillus thuringiensis</i> @ 200 gms/acre (500 gms/ha), incorporate neem cake @ 90 kg/acre (225 kg/ha) during last plough.</p> <p>Use disease free good quality seeds, treat seeds in hot water (30 minutes @ 52°C) before sowing, sow in rows with 5 -10 cm spacing, raise seedlings in raised beds.</p>
4.	Brinjal	<p>Brinjal fruit and shoot borer (<i>Leucinodes orbonalis</i>) – (Infestation starts at the early vegetative stage and lasts up to fruiting stage)</p> <p>Damping off (<i>Pythium sp. and Phytophthora sp.</i>)</p>	<p>Use disease free, healthy seeds and collect and destroy affected plants.</p>
5.	Bitter gourd Ridged gourd Bottle gourd	<p>Wilt (<i>Verticillium daliae</i>)</p> <p>Stem borer – (affects in the later vegetative stage)</p>	<p>Use disease free, healthy seeds and collect and destroy affected plants.</p> <p>Use pheromone traps @ 3 – 4/acre (8/ha), collect and destroy the infected shoots, whole plants, fruits etc., use <i>Trichoderma chilonis</i> @ 20,000/acre (50,000/ha) or spray <i>Bacillus thuringiensis</i> @ 200 gms/acre (500 gms/ha).</p>

	Bitter gourd Cucumber	Fruit fly - (affects during the fruiting stage)	Managed by collection and destroying of affected fruits.
	Bitter gourd	Leaf spot	Destroy the diseased plant debris and seed treatment using asafoetida solution (125 gms in 1 litre of water for 10 kg of seeds).
6.	Ridged gourd	Army worm – (Infestation starts at the early vegetative stage and lasts up to fruiting stage)	Use light traps @ 2/acre (5/ha) and spray five leaf extract or ginger, garlic and chilli extract @ 1 litre/tank.
7.	Cucumber, Bean, Amaranth, Coriander	Aphids (<i>Aphis craccivora</i>) – (affects during the vegetative stage)	Spray neem seed extract or neem cake extract @ 1 litre/tank, maintain crop spacing.
	Cucumber, Squash, Pumpkin, Bean, Carrot, Coriander	Powdery mildew	Spray butter milk extract (two parts of water in one part of curd) @ 1 litre / tank or Eucalyptus leaf extract @ 10%.
	Cucumber, Squash, Pumpkin, Bean	Downy mildew	Remove infected seedlings at the time of thinning and plants from time to time.
8.	Bottle gourd, Pumpkin	Fruit fly (<i>Dacus cucurbitae</i>)- (Affects during the fruiting stage)	Treat seeds with <i>Trichoderma viride</i> @ 4 gms/kg of seeds and remove and destroy the affected and decayed fruits.
	Bottle gourd	<i>Epilachna</i> beetle – (affects during the vegetative stage)	Remove and destroy egg masses, grubs and adults on leaves.

9.	Squash	<i>Fusarium</i> wilt	Treat seeds using <i>Trichoderma viride</i> @ 4 gms/kg of seeds and apply neem cake as basal manure.
10.	Radish, Carrot, Coriander	<i>Alternaria</i> blight	Treat seeds with hot water, use disease free healthy seeds.
	Radish	Radish Mosaic Virus (RMV) and Aphids	RMV is transmitted through aphids. By controlling aphids the disease can be checked. Spray Neem seed extract or Neem cake extract @ 1 litre/tank and maintain proper spacing between the crops.
11.	Bean	Pod borer (<i>Helicoverpa</i>)- (Infestation starts at the early vegetative stage and lasts up to fruiting stage)	Use light traps, use bird perches @ 4 – 5/acre (10 – 12/ha), release <i>Chrysoperla</i> @ 2000 eggs/acre (5000 eggs/ha) 15 days after sowing and <i>Trichogramma</i> @ 2000 eggs/acre (50,000 eggs/ha) (2-3 cards) 30 days after sowing and spray five leaf extract or ginger, garlic and chilli extract @ 1 litre/tank.
		Stem blight / Root rot	Treat seeds with talc formulation of <i>Trichoderma viride</i> @ 4 gms/kg of seed or <i>Pseudomonas fluorescences</i> @ 10 gms/kg seed and apply neem cake @ 60 kg/acre (150 kg/ha) as basal manure.
	Bean, Amaranth	Yellow mosaic virus	Remove and destroy infected plants periodically.
12.	Amaranth	Weevil (<i>Hypolixus truncatulus</i>) – (affects during the later vegetative stage)	Remove and destroy the alternative hosts such as wild <i>Amaranthus</i> and maintain proper spacing.
		White rust	Seed treatment using <i>Trichoderma viride</i> @ 10 gms/kg and spray Vermiwash mixed with water @ 1:13.5 ratio for protection from fungal infections.

APPENDIX - II PREPARATION PROCEDURES OF BOTANICALS AND ANIMAL PRODUCTS

1. Sweet flag rhizome extract

Pound 10 g of sweet flag rhizome to a coarse powder and add 50 ml of water. Leave the solution undisturbed for one hour and filter the Sweet flag rhizome extract. For seed treatment, boil one litre of water and add 50 ml each of cow's urine and sweet flag rhizome extract the next day. Soak the seeds in water for six hours and then in the above solution for about 30 minutes. Filter the seeds, shade dry and sow. This gives protection against a number of bacterial and fungal diseases.

2. Cow dung extract

Mix one kilogram of cow dung with 10 litres of water and filter using a gunny cloth. Dilute the solution with 5 litres of water and filter again. This can be used for spraying.

3. Panchagavyam

Panchagavyam is a growth regulator produced with the combination of five products obtained from the cow along with a few other bioproducts. Collect fresh cow dung (5 kg), mix it with ghee (1 litre) and keep it in a plastic barrel separately for 3 days. On the same day, mix the other ingredients namely cow's urine (3 litres), cow's milk (2 litres), curd (2 litres), yellow banana (400 g, without skin), coconut water (3 litres), Jaggery (one kilogram dissolved in 3 litres water) in a plastic barrel separately. Filter the jaggery solution before adding it to the other ingredients. On the 3rd day, mix the contents of both the barrels and leave it aside for 7 days. Stir the contents with a wooden stick twice a day. After 7 days, filter the product with a khada cloth / Terracot (TC) cloth and store it in closed containers. (Pierce small holes in the cap of the containers to prevent bursting). This is diluted @ 300ml / 10 litres water and sprayed.

4. Amirthakaraisal

Take fresh cow dung (10 kg), cow's urine (10 litres), country jaggery (1 kg) and water (100 litres) in a cement tank and mix well. This

can be used the next day. Add this extract to the irrigation channel or spray directly. This improves the soil fertility and gives good yield.

5. Bija Amrut

Ingredients : Cow dung – 5 kg, cow's urine – 5 lit, cow's milk – 1 lit, lime – 250 gms and water – 100 lit.

Mix all the ingredients and keep it overnight, sprinkle this formulation on seeds to be sown, dry in shade before sowing.

6. Jiwa Amrut

Ingredients: Cow dung – 10 kg, cow's urine – 10 lit, jiggery (old) – 2kg, flour of gram, pigeon pea, moong dal or cowpea or urad dal – 2 kg, live soil – 1 kg and water – 200 lit

Take 100 litres of water in barrel and add 10 kg cow dung + 10 lit cow's urine. Mix well with the help of wooden stick, add 2 kg old jaggery and 2 kg flour. Mix this solution well with wooden stick. Keep this solution for fermentation for 2 to 7 days. Shake the solution regularly three times a day.

7. Amrit Pani

Mix 10 kg of cow dung with 500 gm honey and mix thoroughly to form a creamy paste. Add 250 gm of ghee and mix at high speed. Dilute with 200 litres of water. Sprinkle this suspension in one acre over soil or with irrigation water. After 30 days, apply second dose in between the row of plants or through irrigation water.

8. Ginger, Garlic, Chilli Extract

This extract is made from three plants. For preparing the extract required for one acre, 1 kg of garlic, ½ kg of ginger and ½ kg of green chillies are required. Take all the three separately and make them into a fine paste. Dissolve all the three pastes in 7 litres of water and mix them well. On filtering this, 6 litres of extract can be

obtained. The concentration of the extract can be increased or decreased from 500-1000 ml/tank (10 litre capacity) depending on the intensity of the pest attack. This extract should be used immediately after preparation. This extract can be stored for a maximum of 3 days.

9. Five Leaf Extract

This extract is prepared using leaves of five different plants. Leaves with five different characteristics are used for this purpose.

- Plants with milky latex - *Calotropis*, *Nerium*, *Cactus* and *Jatropha*.
- Plants which are bitter - *Neem*, *Andrographis*, *Tinospora* and *Leucas*.
- Plants that are generally avoided by cattle - *Adathoda*, *Ipomea fistulosa*
- Aromatic plants – *Vitex*, *Ocimum*, *Papaya*
- Plants that are not affected by pests and diseases – *Morinda*, *Ipomea fistulosa*

One plant in each category should be taken in equal quantities (1 kg in each) and pound well. Take them in a mud pot and add twice the quantity of water. To this, add 1 litre of cow's urine and 100 g of Asafoetida. Tie the mouth of the pot tightly with a cloth. This extract should be mixed well daily in the evening.

This extract should be used after a period of one week. If this extract is to be used for prophylactic as a precautionary measure, 500 ml of the extract should be added for a tank of 10 litre capacity. This should be diluted with 9½ litres of water and used. If the pest infestation is severe 1000 ml of extract should be used per tank and diluted with 9 litres of water. This extract can be stored and used for a period of 25-30 days.

Note : Cow's urine is used for disease control and Asafoetida prevents flower dropping and enhances the yield.

10. Neem Kernel Extract

About 3–5 kg of neem kernel is required for an acre. If the seeds are fresh, 3 kg of kernel is sufficient. If the seeds are old, 5 kg is required. Remove the outer seed coat and use only the kernel. Pound the kernel gently and place it in

an earthen pot. To this, add 6-10 litres of water. Tie the mouth of the pot securely with a khada cloth. Leave it as such and filter after 3 days. On filtering, 5-9 litres of extract can be obtained. When the pest incidence is more, 1000 ml of this extract should be used for one tank (a tank of 10 litre capacity). If the pest population is less, it is enough to use just 500 ml of the extract for one tank. 500-1000 ml of extract should be diluted with 9½ or 9 litres of water before spraying. Khadi soap solution @ 10ml/litre (100 ml/tank) should be added to help the extract stick well to the leaf surface. For one acre of the crop, 6-7 tanks of the diluted extract should be used.

Note : The seeds used for preparing this extract should be at least 3 months old. When they are less than 3 months or more than 8 months old, the azadirachtin content in the seeds will be less and hence the pest control property in these seeds will also be poor. The extract prepared should be milky white in colour. If they are prepared from aged seeds, the extract will be brownish in colour.

Preparation of Khadi Soap Solution

Khadi soap solution should be added with all botanicals before spraying. This is a neem based soap without any detergent. Khadi soap solution helps the extract to stick well to the plant surface. It should be soaked overnight in water and used. The soap solution should be sticky and thick in nature. Before spraying the botanicals, for every one litre of the extract, 10 ml of khadi soap solution should be added.

11. Neem Cake Extract

5 kg of Neem cake is required for an acre of land. Powder the neem cake well and place it in a khada cloth and tie it. Soak it in a vessel containing 10 litres of water for 3 days. After 3 days squeeze the pouch well into the water. About 7–8 litres of extract can be obtained. About 500–1000 ml of this extract is used for one tank (a tank of 10 litre capacity). 500-1000 ml of the extract should be diluted with 9½ or 9 litres of water before spraying. Khadi soap solution @ 10 ml / litre (100 ml/ tank) should be added to help the extract stick well to the leaf surface. For one acre 6-7 tanks of the extract should be used.

12. Neem Oil Extract

About 1200–1800 ml of neem oil is required for one acre. 200–300 ml of oil is required for one tank (a tank of 10 litre capacity). Take the required neem oil and the soap solution and mix it well. Khadi soap solution @ 10ml/litre (100 ml/tank) should be added. Once the soap solution is mixed well with the extract, it should be diluted and used for spraying.

Note : This spray should be used immediately after preparation. Otherwise oil droplets will start floating on the surface. Power sprayers should be used for spraying this extract. The oil which has been prepared within a year's time should only be used.

13. Preparation of Kashayam

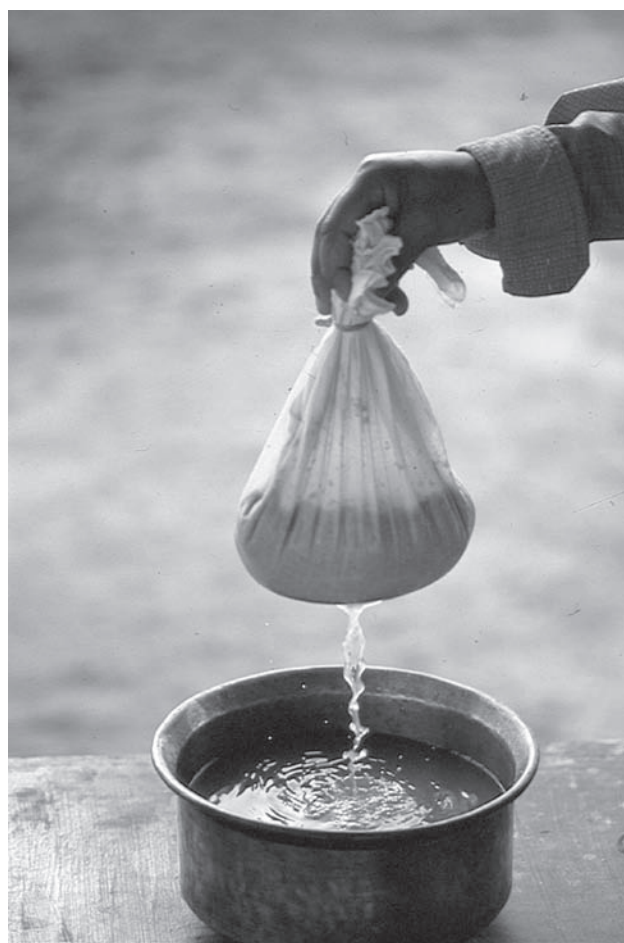
The plants selected for kashayam preparation should be collected without the roots. The plants should be cut into small pieces and used. For one acre of crop, 2 kg of the cut plants should be mixed with 8 litres of water. This has to be taken in a wide mouthed vessel and boiled until the extract reduces to 2 litres. This has to be cooled and filtered. 300 ml of this extract should be diluted with 100 ml of soap solution and 9.4 litres of water to obtain one tank capacity of the extract.

Plants used in kashayam preparation	Pests and diseases controlled
1. <i>Andrographis paniculata</i>	All kinds of larvae
2. <i>Sida spinosa</i>	Aphids and Sap feeders
3. <i>Adathoda zeylanica</i>	Fungal diseases
4. <i>Panchathiktha kashayam</i> *	All kinds of pests

* *Panchathiktha kashayam* is prepared by using equal quantities of five types of bitter leaves.

Note:

1. The extracts that are kept closed should be stirred well daily.
2. Power sprayers should be used for controlling winged pests such as green plant hoppers, ear head bugs and white flies.
3. For one tank of the extract 100 ml of khadi soap solution should be added.
4. The extracts should always be sprayed in the morning (between 7.00 a.m.–10.00 a.m.).
5. Use 500 – 1000ml of extract per tank depending upon the intensity of the pests.
6. Use 6 – 7 tanks of extract per acre (15 – 17 tanks per hectare).



APPENDIX – III

COMMON AND SCIENTIFIC NAMES OF PLANTS

Sl. No.	English Name	Scientific Name
1.	Adhatoda	<i>Justicia adhatoda</i>
2.	Amaranth	<i>Amaranthus sp.</i>
3.	Andrographis	<i>Andrographis paniculata</i>
4.	Bean	<i>Phaseolus vulgaris</i>
5.	Bitter gourd	<i>Momordica charantia</i>
6.	Bottle gourd	<i>Lagenaria siceraria</i>
7.	Brinjal/Egg plant	<i>Solanum melongena</i>
8.	Capsicum	<i>Capsicum annuum</i>
9.	Carrot	<i>Daucus carota</i>
10.	Chillies	<i>Capsicum frutescens</i>
11.	Cluster bean	<i>Cyamopsis tetragonolobus</i>
12.	Coriander	<i>Coriandrum sativum</i>
13.	Cowpea	<i>Vigna sinensis</i>
14.	Cucumber	<i>Cucumis sativus</i>
15.	Daincha	<i>Sesbania bispinosa</i>
16.	Garlic	<i>Allium sativum</i>
17.	Ginger	<i>Zingiber officinale</i>
18.	Guduchi	<i>Tinospora cordifolia</i>
19.	Holy basil	<i>Ocimum tenuiflorum</i>
20.	Horseshoe vitex	<i>Vitex negundo</i>
21.	Indian mulberry	<i>Morinda citrifolia</i>
22.	Ipomoea	<i>Ipomoea sp.</i>
23.	Ladies finger	<i>Abelmoschus esculentus</i>
24.	Milk weeds	<i>Calotropis procera</i>
25.	Neem	<i>Azadirachta indica</i>
26.	Nerium	<i>Nerium oleander</i>
27.	Papaya	<i>Carica papaya</i>
28.	Prickly fan plant	<i>Sida spinosa</i>
29.	Prosopis	<i>Prosopis juliflora</i>
30.	Pumpkin	<i>Cucurbita moschata</i>

31.	Purging Nut	<i>Jatropha curcas</i>
32.	Radish	<i>Raphanus sativus</i>
33.	Ridge/ ribbed gourd	<i>Luffa acutangula</i>
34.	Squash	<i>Cucurbita pepo</i>
35.	Sunhemp	<i>Crotolaria juncea</i>
36.	Sweet flag	<i>Acorus calamus</i>
37.	Thumbai	<i>Leucas aspera</i>
38.	Tomato	<i>Lycopersicon esculentum</i>

APPENDIX – IV

COMMON AND SCIENTIFIC NAMES OF INSECTS

Sl. No.	English Name	Scientific Name
1.	Amaranthus weevil	<i>Hypolixus truncatulus</i>
2.	Aphids	<i>Myzus persicae</i>
3.	Army worm	<i>Spodoptera litura</i>
4.	Bhendi shoot and fruit borer	<i>Earias vitella, E. insulana</i>
5.	Brinjal fruit and shoot borer	<i>Leucinodes orbonalis</i>
6.	Chilli thrips	<i>Scirtothrips dorsalis</i>
7.	Cucumber – Fruit fly	<i>Bactrocera cucurbitae</i>
8.	Epilachna beetle	<i>Epilachna borealis</i>
9.	Fruit borer	<i>Helicoverpa armigera</i>
10.	Hoppers	<i>Cestius phycitis</i>
11.	Ridge gourd- stem borer	<i>Melittia eurytion</i>
12.	White fly	<i>Bemisia tabaci</i>
13.	Yellow spider mite of chilli	<i>Polyphagotarsonemus latus</i>

APPENDIX-V GLOSSARY OF TECHNICAL TERMS

ALIEN SPECIES: Species that do not naturally occur within an area and that have usually arrived in the area as a result of human intervention. Alien species often have adverse effects on native species as a result of competition.

ANTHESIS: The process of dehiscence (splitting) of anthers and the period of pollen distribution - See also Dehiscence.

CROSS POLLINATION: When the pollen of one flower gets deposited on the stigma of another flower either on the same plant or on a different plant of the same kind.

CULTURAL PRACTICE: The oldest and effective method of pest suppression. Practices like, deep ploughing and burning of crop residues, synchronous planting of crop fields, planting trap crops, intercropping, crop rotation, tillage and use of pest-free seeds and planting material are examples of cultural practices.

DAMPING OFF: An infection of the basal portion of the nursery seedlings and young plants caused by fungus, resulting in decomposition of the plants.

DEHISCENCE (DEHISCE): Act of anthers becoming ripe and bursting to discharge the dry pollens. The time when this takes place is called anthesis.

DESICCATE: Process of drying seeds completely in order to preserve it.

ECONOMIC THRESHOLD LEVEL (ETL): The economic threshold level is the density of a pest at which a control treatment will provide an economic return.

EXOTIC SPECIES: A species that has been introduced from another geographic region to an area outside its natural range.

FUMIGATION: The application of smoke, vapour or gas for the purpose of disinfecting or destroying pests or microorganisms.

GENETIC UNIFORMITY / PURITY: A variety that has all the unique characteristics of its mother. It can be maintained by isolation of a crop by a specified distance from other varieties (or) contaminants. See varietal purity.

GLUME: The two chaffy basal bracts of a paddy spikelet.

GREEN MANURE CROPS: Plants that can absorb atmospheric nitrogen with the help of certain microorganisms found in their root nodules and convert it into a form, which can be used by the soil. Eg. Most of the Leguminosae members.

OPEN POLLINATION: Pollination occurring by insects, birds, wind, or other natural mechanisms. The seeds of open-pollinated plants will produce new generations of those plants.

PANICLE: When axis of raceme branches and the flowers are borne not directly on the axis but on its branches then the inflorescence is called a panicle.

THINNING: The process of removing additional seedlings to improve the growth rate or health of other seedlings.

PUBESCENCE: The hairy growth on the surface of the plant body.

ROGUING: The act of removing undesirable plants. The removal of individual plants, which deviate in a significant manner from the normal or average type of a variety. A step in the maintenance of purity in an established variety or in the attainment of purity in a new variety.

SEED DORMANCY: A period in the seed life history where development is temporarily suspended.

SEED DRILL: An agricultural implement that makes furrows into which it drops seeds.

SEED VIABILITY: The capacity of a seed to germinate.

TIME ISOLATION: Separation of varieties / species / contaminants by adjusting the sowing date in such a way that both crops do not come to flowering at the same time. The crossing is prevented and genetic purity is maintained.

UNISEXUAL: Flowers having either stamens (Androecium) or stigma (gynoecium) are said to be unisexual. If they have only the androecium, they are male flowers. If the flowers have only the gynoecium, they are said to be female flowers. Eg. Cucurbit, Castor.

VARIETAL PURITY: Maintenance of true to type nature of the plant / seed. The plant / seed resembles its mother in all features (i.e.) from seed to plant to seed.

VOLUNTEER PLANTS: Unwanted plants growing from the seeds that remain in the field from a previous crop.

WINNOWING: A method by which the chaff is wafted away from the seeds after tossing into the air. By this method the calyxes, stems, old petals, husks and dead reproductive organs of the flowers and fruits etc. could be separated from the seeds.