Rice *(Oryza sativa)*

Rice can be cultivated under a variety of climatic and soil conditions. Rice cultivation is conditioned by temperature parameters at the different phases of growth. The critical mean temperature for flowering and fertilization ranges from 16 to 20^0C, whereas, during ripening, the range is from18 to 32^0C. Temperature beyond 35^0C affects grain filling. Rice comes up well in different soil types. For normal growth, a PH range of 5.0-8.0 is suitable.

It is recommended to follow organic farming practices in toto for *Pokkali, Kaipad* and *Koottumundakan* rice as well as medicinal and scented rices. In other rice growing situations, organic farming may be followed depending on the availability of organic resources and an assured market for organic produce.

Ingeneral, rice can be grown as transplanted or direct sown crop during three seasons as shown below depending on the agro climatic situations.

Table . Different rice growing seasons of Kerala

Agro climatic situations	*Seasons*	*Period*	
		From	*To*
General	Virippu (I crop / autumn)	April-May	Sept-Oct
	Mundakan (II crop / winter)	Sept-Oct	Dec-Jan
	Puncha (III crop / summer)	Dec-Jan	March-April
Onattukara	Virippu (I crop / autumn)	April	August
	Mundakan (II crop / winter)	Aug-Sept	Dec-Jan
Kuttanad	Additional crop	May-June	Aug-Sept
	Puncha	Oct-Nov	Feb-March
Kole (single cropped area)	Mundakan (*Kadumkrishi*)	Aug-Sept	Dec-Jan
Pokkali	Virippu (I crop / autumn)	May-June	Sept-Oct
	Mundakan	Aug-Sept	Dec-Jan
Kaippad	Mundakan (II crop / winter)	Sept-Oct	Dec-Jan
	Puncha (III crop / summer)	Dec-Jan	March-April
High ranges	Nancha	May-June	Oct-Nov
	Puncha	Dec-Jan	April-May

Variety

The variety chosen should not only be suitable for the agro-climatic region but also resistant / tolerant to the pests and diseases predominant in that location. The seeds should be organically produced.

Table :Varieties suited for different situations

System / Region	*Season*	*Varieties*
Pokkali	Virippu	Vytilla 1, Vytilla 2, Vytilla 3, Vytilla 4, Vytilla 5, Vytilla6,Vytilla7andlocal/traditionalvarietiessuch as Kuruka, Anakkodan andPokkali.
	Mundakan	Orpandy, Oarumundakan
Kaipad	Mundakan	Traditional varieties like Kuthiru, Mundon, Orpandy, Mundon etc.
	Puncha	Orkazhama
Koottumundakan	Virippu+ Mundakan	**Traditional combinations** Chettivirippu+Mundakan(Alappuzha)Chenkayama+ Chettadi(Palakkad) **High yielding combinations** Swarnaprabha+ Makaram, Swarnaprabha+ Kumbham, Karthika+Makaram, Karthika+Kumbham
Medicinal rice	Virippu/ Mundakan/ Puncha	Njavara
Scented rice	Nancha / Puncha	Jeerakasala, Gandhakasala
	Virippu	Rajakayama, Kothampalarikkayama, Kunjikayama, Pookkilathari etc.
	Mundakan	Neycheera
Upland (*Modan* land) Purely rainfed	First crop	PTB 28, PTB 29, PTB 30, Suvarnamodan, Annapurna, Mattatriveni, Swarnaprabha, Rohini, Aiswarya
Palliyals (*Myals*) Single crop terraced	First crop	Early duration: Rohini, Annapurna, Mattatriveni, Jyothy, Kairali, Kanchana, Harsha, Karthika, Ahalya Medium duration: Aswathy, Sabari, Bharathy, Jaya, Mahsuri, Aiswarya,Aathira

System/Region	*Season*	*Varieties*
Double crop wet lands: a. Semi-dry cultivation	First crop	Early duration: Mattatriveni, Annapurna, Jyothy, Swarnaprabha, Ahalya, Varsha, Rohini, Karthika, Aruna, Makom, Revathy, Remanika, Krishnanjana, Kanchana, Harsha, Kairali, Kunjukunju Varna, Kunjukunju Priya Medium duration: Aswathy, Sabari, Bharathy, Jaya, Mahsuri, Arathy, Bhadra, Pavizham, Remya, Kanakom, Ranjini, Pavithra, Panchami, Uma, Karishma, Gouri, Aathira, Aiswarya
	Second crop (except Rohini)	Any of the varieties suggested for the first crop season Early duration: Annapurna, Mattatriveni, Jyothy, Swarnaprabha, Kairali, Kanchana, Karthika, Aruna, Makom, Revathy, Remanika, Krishnanjana, Varsha, Rohini,Ahalya,KunjukunjuVarna,Kunjukunju,Priya
b.Transplanted	First crop	Medium duration: Jaya, Sabari, Bharathy, Aswathy, Mahsuri, Aathira, Aiswarya, Pavizham, Remya, Kanakom, Renjini, Pavithra, Panchami, Uma, Karishma, Gouri. Late duration: Mangalamahsuri
	Second crop	Early duration: Annapurna, Mattatriveni, Jyothy,Kairali, Kanchana, Karthika, Makom, Revathy, Remanika, Krishnanjana, Kunjukunju Varna, Kunjukunju Priya Medium duration: Aswathy, Sabari, Bharathy, Jaya, Mahsuri, Aathira, Aiswarya, Pavizham, Remya, Kanakom, Renjini, Pavithra, Panchami, Uma, Karishma
	Third crop	Late duration: Mangalamahsuri, Pranava, Swetha, Karuna, Resmi, Nila, Makaram, Khumbham, Dhanu Early duration: Annapurna, Mattatriveni, Jyothy, Swarnaprabha, Kairali, Kanchana, Karthika, Makom, Revathy, Remanika, Krishnanjana, Ahalya, Harsha, Varsha Medium duration: Sabari, Bharathy, Jaya, Aathira, Aiswarya, Pavizham, Remya, Kanakom, Renjini, Pavithra, Panchami, Uma, Karishma, Gouri.

System/Region	*Season*	*Varieties*
Kuttanad area	Puncha	Earlyduration:Karthika,Makom,Jyothy,Mattatriveni, Annapurna, Revathy, Remanika, Krishnanjana Medium duration: Bhadra, Asha, Pavizham, Remya, Kanakom,Jaya,Sabari,Bharathy,Renjini,Pavithra, Panchami, Uma, Karishma, Gouri
	Additional crop	Early duration: Karthika, Aruna, Makom, Annapurna, Jyothy, Mattatriveni, Revathy, Remanika, Krishnanjana Medium duration:Pavizham, Remya, Kanakom, Jaya, Sabari, Renjini, Pavithra, Panchami, Uma, Karishma, Gouri.
Kole area	Mundakan	Extra short duration: Hraswa Early duration: Annapurna, Mattatriveni, Jyothy, Swarnaprabha, Karthika, Aruna, Makom, Kanchana, Kairali, Revathy, Remanika, Krishnanjana, Ahalya, Varsha Medium duration: Aswathy, Sabari, Bharathy, Pavizham,Remya,Kanakom,Jaya,Aiswarya,Renjini, Pavithra, Panchami, Uma, Karishma,Bhadra
Deep ill-drained regions ofsouth-erndistricts	First crop	Remya, Arathy
	Second crop	Kottarakkara-1, Lakshmi, Nila, Makaram, Kumbham, Mangalamahsuri
Waterlogged and flooded areas	First crop	IR-5, Pankaj, Jagannath, H4, Mahsuri, Neeraja, Mangalamahsuri
Oorumundakan	Second crop	Late duration: Sagara
Onattukara and coastal sandy areas	First crop	PTB 23
a. Where HYVs do not come up	Second crop	PTB 20
b. Where HYVs come up well	First crop	Early duration: Annapurna, Mattatriveni, Jyothy, Bhagya, Rohini, Onam, Chingam, Aruna, Makom, Karthika, Revathy, Remanika, Krishnanjana Medium duration: Jaya, Sabari, Bharathy, Aswathy, Pavizham,Remya,Kanakom,Arathy,Renjini,Pavithra, Panchami, Uma, Karishma,Gouri.

System/Region	*Season*	*Varieties*
	Second crop	Early Duration: Annapurna, Mattatriveni, Makom, Jyothy, Karthika, Revathy, Remanika, Krishnanjana Medium duration: Jaya, Sabari, Bharathy, Aswathi, Pavizham,Remya,Kanakom,Dhanya(seasonbound), Renjini,Pavithra,Panchami,Uma,Karishma,Gouri.
	Third crop	EarlyDuration:Annapurna,Mattatriveni,Rohini, Makom, Revathi, Remanika,Krishnanjana. Medium duration: Jaya, Sabari, Bharathy, Aswathy, Pavizham, Remya, Kanakom, Renjini, Pavithra, Panchami, Uma, Karishma, Gouri.
Poonthalpadam		Makom, Mattatriveni, Neeraja
High altitude area: a. Single crop areas		WND-1, WND-2, Aswathy, Jaya, Sabari, Mahsuri, Bhadra, IR 8, Aathira
b. Double crop areas	First crop	Aswathy, Jaya, Sabari, Bharathy, Bhadra, Deepthi, Aathira, IR 8
	Second crop	Aswathy, Jaya, Sabari, Bharathy, Bhadra, Deepthi, Aathira, IR 8
c. Eastern lateritic regions of Kollam & Alappuzha districts	Second crop	Lakshmi
Chitoor black soil	First crop	ASD 16, ASD 17, Mahsuri, Varsha, ADT 43
	Second crop	Ponni, Vellaponni, Ponmani, ASD 16, ASD 17, Pranava, Swetha, Bhadra, Renjini.

Seed rate

Transplanting- 60-85 kg / ha
Broadcasting- 80-100 kg / ha
Dibbling –80-90 kg / ha

(In Pokkali cultivation, for Vytilla varieties 100 kg/ha may be sown on the beds or mounds formed in the field.)

Seed treatment

Dry seed treatment - Dress the seeds with the talc based formulation of *Pseudomonas fluorescens* (P1 and P14) @ 10 g / kg seed at the time of sowing.

Wet seed treatment – Soak the seeds for 12 to 16 hours in a solution of *P.fluorescens* (P1 and P14) prepared @ 10 g / litres of water / kg seed

Nursery

For transplanting, healthy seedlings have to be raised in seed beds. Adopt wet or dry method for raising seedlings. The choice depends primarily on the availability of water.

Wet method

The wet method can be adopted in areas where water is available. Prepare raised beds of 5-10 cm height, 1-1.5 m width and of convenient length with drainage channels between the beds. The total seed bed area should be 1000 m^2 for each ha of the field to be transplanted. Apply vermicompost @ 500g / m^2 and rice husk ash @ 100 g / $m^2$of the nursery bed and mix well with the soil at the time of preparation of the field. Application

of vermicompost reduces the incidence of thrips. If vermicompost is not available, apply compost or cattle manure@1kg/m^2and100 g of rice husk ash/$m^2$of the nursery bed and mix well with the soil at the time of preparation of the field.

Dry method

This method is practiced in areas where sufficient water is not available and the time of planting is uncertain. Prepare raised beds of 1-1.5m width15cm height and of convenient length. Apply vermicompost @500g/m^2 and rice husk ash @100g/m^2 of the nursery bed. If vermicompost is not available, apply compost or cattle manure@1kg/m^2 and100g of rice husk ash/m^2 of the nursery bed and mix well with the soil at the time of preparation of the field. Sow the seeds treated as described under dry seed treatment method, evenly over the bed and cover with fine sand /soil.

Manuring

Option 1

Local varieties- Apply 5 tonnes of FYM /compost /green leaf manure or 2.5 tonnesof vermicompost as basal + 300-500 kg oil cakes (ground nut cake, neem cake etc.) / ha half as basal and half as top dressing at active tillering stage.

Short duration varieties –Apply 5tonnes of FYM /compost /green leaf manure or 2.5 tonnes of vermicompost as basal +500-750 kg oil cakes (ground nut cake, neem cake etc.) / ha half as basal and half as top dressing at active tillering stage.

Medium duration varieties - Apply 5 tonnes of FYM/ compost/ green leaf manure or tonnes of vermicompost as basal + 600-800 kg oil cakes (ground nut cake, neem cake etc.) / ha half as basal and half as top dressing at active tillering stage.

Methods of Green manuring

Leguminous green manures used in rice based cropping system include *Sesbania aculeata, Sesbania rostrata, Sesbania speciosa* and *Crotalaria juncea*. These are grown during the pre rice season between April and June and the biomass is incorporated into the soil before rice is transplanted. Wherever limited irrigation facilities are available, grain legumes such as green gram, black gram and cow pea can be grown in summer season.

In situ green manuring

Farmers can choose the green manure crop according to their local availability and agroclimatic conditions. Daincha (*Sesbania aculeata*) is the commonly used and ideal green manure crop for rice fields. Usually after the harvest of *rabi* crop, daincha is sown with the receipt of summer showers and it is ploughed and incorporated 8-10 weeks after sowing. Among the green manure crops, *Sesbania aculeata* is the one, which can supply highest amount of biomass and nitrogen. It is fairly drought tolerant and resistant to water logging. It is suitable for loamy and clayey soils. One crop of daincha can add 10-20 tonnes of biomass per ha. For sowing one ha area, 20-25 kg of seed is required. It can fix about 75-80 kg N per ha depending on the environmental conditions.

Intercropping with cowpea

During *kharif* season, when dry sowing is practised in low lands, cowpea seeds may be mixed with paddy seeds @ 12.5 kg / ha. It is necessary that a non-trailing type of cowpea should be used. Cowpea will be grown as an intercrop and with the onset of monsoon, when the rice field gets submerged, cow pea gets decayed and incorporated in the soil adding substantial quantity of green manure.

Option 2

One tonne of farm yard manure and one tonne of green leaf manure, dual culture of Azolla and application of biofertilizers like *Azospirillum*, phosphobacteria, potassium mobilising bacteria and PGPR mix1.

Option 3

Substitution of one-third of recommended dose of fertilizer by FYM, one third by vermicompost , one third by neem cake + Azospirillum 2kg/ha and P solubilising bacteria 2 kg/ha.

Methods of application of biofertilsers

Azospirillum

Seed treatment**:**

Mix the carrier based inoculums 200g in 200ml of rice gruel to make a slurry which is sufficient to treat 10 kg of seed. The seeds are mixed in the slurry so as to have a uniform coating of the inoculum over the seeds and then shade dried for 30 minutes. The shade- dried seeds should be sown within 24hours.

Main field application

2 kg *Azospirillum* is mixed with 50 kg of dried powdered farm yard manure and then broadcast in one ha of main field just before transplanting.

Phosphorus Solubilising Bacteria (PSB)

Carrier based phosphobacteria can be applied as seed treatment and field application as in the case of *Azospirillum.*

Potassium mobilizing bacteria

Mix 500 ml of liquid formulation of potassium mobilizing bacteria (*Fraturiaaurentia*) with 50 kg of FYM for field application in one ha.

PGPR mix 1

It is a biofertilizer that provides N, P and K. Apply as:

1. Seed treatment
2. Dip the root in PGPR mix110% solution for10 minutes before transplanting
3. Field application @2.5kg/one litre in100kg organic manure for one hectare.

Azolla

Azolla can be applied as green manure for rice before transplanting. For this, Azolla is grown15-20 days before transplanting of rice by applying 1-2t fresh inoculums per ha in a well prepared field. Rock phosphate is applied @ 62.5 kg/ha in three equal splits at an interval of seven days. After the formation of thick mat, water is drained out and the field is ploughed for incorporating Azolla.

Dual culture**:**

Fresh biomass of Azolla is applied in the main field 7-10 days after transplanting rice. Inoculation of fresh biomass of Azolla @ 200 kg / ha could multiply faster and cover the rice field in 2-3weeks period with15-20 tonnes biomass accumulation. Azolla is incorporated at the time of first weeding. It can be done with a weeder or leave it for self decomposition. Azolla decompose in the flooded rice field in 2-3 weeks period. During the incorporation of Azolla, the left over fronds float on water surface which multiply and cover the rice field. Again 2-3 incorporation is possible. The cultivation of Azolla not only supplies biomass and N, but also contributes K, P, Ca, S, Zn, and Fe.The suppression of weed grow this another added advantageof Azolla cultivation along with rice.

Management of pests

Varietal resistance/ tolerance

Cultivation of tolerant varieties is one of the easy, eco-friendly and economical methods of pest management. Many rice varieties are having multiple resistance/ tolerance to pests. While selecting the varieties for organic farming, emphasis should be given to multiple resistance / tolerance to major pests of that locality. Use of a variety with some degree of genetic resistance, combined with other non chemical methods can manage the pests effectively.

Rice varieties with multiple tolerance to major pests

Aruna,Aathira,Aiswarya,Nila,Revathy, Remanika, Karishma,Krishnanjana.	- BPH and gall fly
Nila(PTB48)	- Thrips, PH , gall midge, stemborer
Kanakom,Karthika	- BPH , stem borer andgallfly
Makom,Reshmi	- BPH, stem borer, gall fly andleaf
Aruna	- BPH, stem borer, gallmidge
Jayathi	- BPH, GLH and leafroller
Bhagya	- BPH,WBPH
Kanchana	- Stem borer, gallmidge
Sagara,Deepthi	- Stem borer, leafroller
Varna(VK1)	- leaf folder, whorl maggot and stemborer
Lakshmi	- BPH, Stem borer and leafroller
Dhanya	- Stemborer,gallmidge
Kairali	- Leaf roller and gallfly

Cultural Control

Some of the cultural practices that can be adopted by the farmers are:

i) Field sanitation by incorporation of stubbles immediately after harvest will help to destroy over wintering population of insect pests like stem borer and gall midge. Deep ploughing after harvest is recommended.

ii) Optimum seed rate and spacing: High seed rate and closer planting cause thick population which favours the pests like leaf folder, BPHetc.

iii) Timely sowing or planting is important to avoid pest incidence. Altering the dates of sowing/transplanting preferably not coinciding the favourable climate for pest outbreak..

iv) Weed control: Many of the weeds will serve as alternate and collateral hosts of several pests. Destruction of weeds in the field and bunds will help in reducing the population build up of the pests.

v) Water management: Draining the field for two days will help to reduce case worm incidence. Since it is semi aquatic pest, draining is the most effective method for its management. The incidence of thrips can be reduced by flooding the field for 24hours.

Mechanical control

Removal of egg masses of stem borer from the plant will help to reduce the pest population.

Light traps:

Installation of light traps in the field would attract and kill the moths of leaf folder, stem borer, BPH, gall fly and rice bug.

Pheromone traps*:*

Pheromones have been found effective for the management of yellow stem borer and can be utilized for monitoring as well as for direct control through male annihilation either by mass trapping or by disrupting mating communication.

For monitoring stem borer population, three traps should be installed at an inter trap distance of 60 m in a triangular pattern in one acre field. Male moth catch is recorded at three days interval. Sudden increase in the average catch of the trap coincides with the emergence of adults. Weekly catch of 30 males per trap can be taken as the capture threshold which precedes borer damage.

Mass trapping of stem borer by installing pheromone traps @ 20 numbers / ha can effectively reduce the stem borer damage. The pheromone trap is retained throughout the crop stage by replacing 3-4 times the 5mg lure at 20 day intervals. Pheromone traps can be installed in the nursery also.

Biological control

Biological control is the use of bioagents for the control of pests. This strategy has gained considerable attention and appears to be a promising and viable supplement or alternative to chemical control.

Conservation of natural enemies in the rice ecosystem

Organic farming favours conservation of natural enemies in the rice field, which in turn help to keep the pest population low. The common natural enemies found in the rice ecosystems are:

1. Dragon flies and Damselflies

Adult dragon flies fly in large numbers above the plant canopy and catch the pests on plants. Damselflies normally fly below the rice canopy in search of flying insects as well as hoppers on plants. Their nymphs are aquatic and can climb on the plants in search of hoppers.

2. Spiders

Spiders are general predators found in the rice ecosystem. Wolf spider, Lynx spider, Jumping spider, Longjawed spider, Dwarf spider and Orb spider are some of the important spiders commonly seen. Both spider links and adults are voracious feeders of all types of pests.

3. Predatory bugs

Mirid bugs: Mirid bugs are egg predators of plant hoppers and leaf hoppers. They can also feed on first instar nymphs.

Waterbugs:Water bugsfeed on plant hopper nymphs whichfrequentlymovethrough the surface of water. The nymph also feeds on other small soft bodied insects. Both nymphs and adults of water striders feed on rice hoppers, moths and larvae that drop into water surface.

4. Predatory beetles Ground beetle*:*

Adults and larvae feed on larvae of leaf folder. Adults feed on plant hoppers also. Each predator can consume 3-5 larvae per day.

Rove beetle: Rove beetles are found on rice plants, water, ground surface and active during night searching for leaf hoppers, plant hoppers and larvae of leaf folder and hairy caterpillar.

Lady bird beetles: They feed on small and slow moving insects and exposed eggs. The grubs are more voracious than the adults.

5. Predatory Grasshopers:

Predatory grasshoppers can be distinguished from other grasshoppers by its long antennae which are more than twice as long as its body length. They feed on the eggs of rice bug and stem borer as well as on the nymphs of plant hoppers and leaf hoppers.

6. Eggparasitoids

Egg parasitism of stem borer and leaf folders by *Trichogramma, Telenomus* and *Tetrastichus* is very high in nature. The female wasp lays eggs into the host egg and kills the latter by feeding on the host egg contents and they emerge as free living adults. *Gonatocerus* and *Anagrus* are small wasps which parasitize eggs of plant hoppers and leaf hoppers.

7. Larvalparasitoids

Cotesia, Stenobracon, Macrocentrus, Xanthopimpla and *Charops* are some of the larval parasites found in the rice fields. Dark coloured wasps lay eggs on the caterpillars feedingonvariouspartsoftheplant.Theemergingyoungonesfeedontheinternalcontent ofthepestcaterpillarandgraduallykillsit.

Innundative release of Parasitoids

The egg parasitoid *Trichogramma* is a widely used biocontrol agent in rice throughout the country for the control of stem borer and leaf folder. *Trichogramma japonicum* is effective against stem borer and *Trichogramma chilonis* is effective against leaf folder. 5 cc egg card is sufficient for installation in one hectare. Six releases of these parasitoids at weekly intervals is required for a crop season. For the control of stem borer, the egg cards have to be installed in the field starting from the first week after transplanting and for leaf folder, the installation has to be startedfrom20 days after transplanting or when the moths of these pests are observed in large numbers in the field.

Use of biopesticides

Microbial pesticides

Bacillus thuringiensis formulations are specific to insect pests and comparatively safe to humans, natural enemies of insect pests and non target organisms. Some of these are effective against leaf folder and moderately effective against stemborer.

Botanical pesticides

Utilisation of botanical formulations especially neem formulations is an ecofriendly method of pest control in rice.Neem formulations act as feeding deterrents, grow thretardants, oviposition deterrents and reproductive inhibitors. Application of 2% neem oil or10% neem cake extract can control rice thrips.

Pocket application of biopesticides may be adopted in heavily in fested areas to control further spread of the pests and to conserve the existing natural enemy population. Careful monitoring of the field is very important to adopt proper pest management practices in a timely manner.

Diseases

The major diseases of rice are blast, sheath blight, brown spot, sheath rot and bacterial blight. “Udbatta” disease is found to occur in high altitude areas like Idukki and Wayanad districts. Other minor diseases are narrow brown leaf spot, leaf scald and false smut.

Disease management

Varietal resistance

Select varieties with built in resistance to major diseases.

Blast: Rohini, Bharati, Mattatriveni, Jayathi, Neeraja, Kairali, Kanchana, Nila, Aathira, Aiswarya, Harsha, Kanakom, Renjini, Remanika, Lakshmi, Onam, Dhanya, Sagara, Deepthi, Ahalya.

Sheath blight : Reshmi, Mattatriveni, Nila, Kairali, Karthika, Aathira, Aiswarya, Pavizham, Karthika, Aruna, Makom, Remya, Kanakom, Gouri, Lakshmi ,Bhagya, Onam, Dhanya and Sagara .

Cultural practices

- Deep summer ploughing of the fields.
- Use properly dried, disease free seeds.
- Follow optimum time for sowing/planting.
- Apply rice hull ash @100g/m^2 which will help to reduce the incidence of blast in the nursery.
- Destroy /remove disease harbouring weeds from the field.
- Give optimum spacing.
- Follow proper water management.Water logging favours diseases like sheath blight. Draining the field for one or two days will help to reduce the spread of the disease.
- Avoid clipping of leaf tips at the time of transplanting in bacterial blight endemic areas.

Note: Incorporation of green manures like *Pteorocarpus marsupium* (Ungu), *Eupatorium odoratum* and *Mangifera indica* (Mango) @ 5t / ha or application of leaves of plants such as *Lawsonia inermis, Calotropis, Azadiracta indica, Datura stramonium* and *Glyricidia* @ 2.5 t / ha will also reduce incidence of sheathblight.

Bio-control agents

Application of *Pseudomonas fluorescens* P1 in different ways viz., seed treatment, seedling root dip, soil application or foliar spray will effectively control fungal diseases and bacterial diseases..

Seed treatment: Treat the seeds with talc based formulation @ 10 g per kg of seed. If wet sowing in practised, treated seeds are soaked in water for 12 hours. Drain the excess water and keep for sprouting.

Seedling root dip: Dip the roots of the seedlings before transplanting in solution of *P. fluorescens* (20 g / litre) for 30 minutes. Seedling root dip can be easily done in the field itself. Water is to be impounded in the field by taking pits or making bunds and mix the talc based formulation in water. The pulled out seedlings are to be kept in such a way so as to immerse the roots in *P.fluorescens* mixed water. After half an hour seedlings are planted in the main field. For dipping the seedlings for one ha, 2.5 kg talc based formulation is required.

Soil application: Apply talc based formulation of *P. fluorescens* @ 2.5kg per ha one week after transplanting or 30-40 days after sowing for the direct sown crop. Mix 2.5kg of *P. fluorescens* with 50 kg dried cow dung or sand and broadcast in the field. De water the field before the application of the culture.

Foliar spray: *P. fluorescens* canbe sprayed on the foliage @20g/litre of water. Spraying can be repeated depending on the disease severity. The application of *P. fluorescens* for a minimum of three times like seed treatment, seedling root dip and one foliar spray or seed treatment, soil application and foliar spray will be very effective in providing protection to rice crop from disease incidence.

PGPR mix II: Root dip and foliar application of PGPR mixII give effective protection against fungal and bacterial diseases.

Foliar spray of cow dung slurry is also effective for the management of bacterial blight of rice. Fresh cow dung @ 20 g / litre is mixed in water and the supernatant is used for spraying. The bacteriophages present in the cow dung act against the pathogenic bacteria present on the plant. 500 litres of cow dung liquid is needed for one hectare.

VEGETABLES

AMARANTH *(Amaranthus spp.)*

Amaranth is the most popular leafy vegetable of Kerala. Though it can be grown throughout the year, summer is found to be the best season.

Varieties

Red	:	Kannara local, Arun, KrishnaSree
Green	:	Co-1,Co-2,Co-3andMohini
Mixedtype	:	RenuSree
Seedrate	:	1.5 to 2kg/hectare

Method of planting:

Direct sowing and transplanting

Nursery

Solarization of the nursery bed before sowing and seed treatment with *Pseudomonas* (10g/kg seed) can control nursery diseases. Apply FYM 10kg enriched with Trichoderma, Neem cake 50 g, PGPR mix 1- 100 g and AMF 200g/m^2.

Main field

Prepare the land by ploughing or digging followed by levelling. Shallow trenches of width 30-35cm are made at 30cm apart. Transplant 20-30 days old seedlings in the shallow trenches at a distance of 20 cm in two rows. During rainy season, planting shall be done on raised beds.

Before planting, dip the roots of the seedlings in a solution containing *Pseudomonas* 20 g/litre for 20 minutes.

Manuring

Apply FYM or compost @25t/ha as basal dose. *Trichoderma*, PGPR mix 1 @2.5 kg /ha each are mixed with FYM and kept for 10-15 days at cool atmosphere. These are applied to the soil as basal dose. Top dressing can be done with any of the following manures at 7-10 days interval.

1. Soil application of fresh cow dung slurry@1kg/10litres(50kgha)
2. Application of bio gas slurry@1kg/10litres(50kg/ha)
3. Application of cows urine 500 litres/ha (8 times dilution)
4. Application of vermiwash-500 litres/ha(8times dilution)
5. Application of vermicompost-1t/ha
6. Application of groundnut cake-1kg/10litres(50kg/ha)

Foliar spray can be given with cow dung slurry/ vermiwash/ cow's urine after each harvest.

Plant protection

Pests

Leaf webber and leaf roller can be controlled mechanically by collecting and destroying them. Apply 4%leaf extract of neem, .

Diseases

Leaf spot is a serious disease in rainy season and it can be controlled to a certain extent through an integrated approach.

1. Grow leaf spot resistant varieties like Co-1
2. Seed treatment with *Pseudomonas* 8g/kg of seed.
3. Soil application of *Trichoderma* as enriched cowdung- neem cake manure.
4. One kg of fresh cow dung is put in 10 litres of water and the clear solution after filtering the supernatant liquid is sprayed at regular intervals.
5. Soil application of green manures like sunn hemp/glyricidia+ neemcake(100kg/ha)+ *Trichoderma* (1-2 kg/ha) is found to be effective against leaf spot disease.

OKRA (*Abelmoschus esculentus*)

The three main planting seasons for okra are January-February, May-June and September-October.

Varieties

Green/light green fruited: Pusa Sawani, Kiran, Salkeerthi, Susthira, Arka Anamika Red fruited: Co-1, Aruna Yellow vein mosaic resistant /tolerant varieties : Arka Anamika, Arka Abhay, Susthira, P7, Varsha Uphar (all green fruited)

Seed rate

The seed rate is 8.5kg/ha for the summer crop sown in January-February and7kg/ha for *kharif* crop.

Sowing

Sow the seeds at a spacing of 60cm between rows and 45cm between plants for *kharif* crop and 60cm X 30cm for summer crop. 45cm x 45cm spacing is also found ideal.

Seed treatment with *Pseudomonas* (8g/kg of seed) improve germination and vigour of seedling.

Manuring

Apply lime @500 kg/ha based on the acidity of soil 15 days before sowing. Apply FYM or compost @25t/ha as basal dose. *Trichoderma*, PGPR mix1@2.5kg/ha each are mixed with the FYM and keepfor15days at cool atmosphere. These are applied to the soil as basal along with *Pseudomonas* @ 2kg/ha.

Top dressing

Top dressing can be done at 10-15 days interval with any one of the following

1. Soil application of fresh cow dung slurry @1kg/10litres (50kg/ha)
2. Application of biogas slurry @1kg/10litres (50kg/ha)
3. Application of cow'surine500 litres/ha (8 times dilution)
4. Applicationofvermiwash-500litres/ha(8timesdilution)
5. Applicationofvermicompost-1t/ha
6. Applicationofgroundnutcake1kg/10litres(50kg/ha)

Foliar spray can be given with supernatant solution of cow dung slurry/ vermiwash/ cow's urine upto flowering.

Plant protection

Pests

The important pests are jassids, fruit and shoot borer and root knot nematode.

Jassids

Use neemoil-garlic mixture (2%) / nimbicidine(2ml/litre) / econeem(2ml/litre) / uneem(2ml/litre).

Lemongrass suspension (10%) can also be used for the control.

Fruit and shootborer

1. Remove and destroy affected shoots and fruits
2. Spray with neem kernel suspension (5%)/ginger suspension(10%)/neem leaf extract (4%)
3. Use *Trichogramma chilonis* and *Trichogramma japonicum* @1 card each/5 cents followed by *Bacillus thuringiensis* spray (Delphin/Bioasp/Halt-0.7ml/litre)
4. Apply *Beauveria bassiana*10% WP

Bhindi leaf roller

1. Collect and destroy the leaf rolls
2. Apply *Beauveria bassiana* 10%WP

Root knot nematode

1. Apply neem leaves or *Eupatorium* leaves @ 250 g/plant in basins one week prior to planting and water daily. The effect of this treatment persists upto 75 days after sowing in summer season.
2. Apply neem cake/castor cake@1t/ha or growing of marigold(trap crop)in between okra plants.
3. Seed treatment with *Bacillus macerans*@3%w/w(2.5kg/ha) and in heavily infested area, seed treatment with *B. macerans* @ 3% w/w and drenching *with B. macerans* @ 3% solution 30 days after sowing.

Diseases

Yellow vein mosaic

Vein clearing and vein chlorosis of leaves are the characteristic symptoms.

1.Spraying neem oil-garlic mixture (2%) or nimbicidine/ econeem (2ml/litre).

2.Use of disease resistant varieties (Arka Anamika, Arka Abhay and Susthira) and

3. Destruction of host weeds (*Croton sparsiflora* and *Ageratum sp*.) are also effective.

CUCURBITACIOUS VEGETABLES

Bittergourd, snakegourd, pumpkin, ashgourd, cucumber, watermelon, bottlegourd, littlegourd and ridge gourd are the important cucurbitaceous vegetables cultivated in Kerala. The details of varieties, season, seed rate and spacing of these crops are given in the following table.

Table:Varieties, season, seed rate and spacing of different cucurbitacious Vegetables

Crop	*Varieties*	*Season*	*Seed rate (kg /ha)*	*Spacing*
1	2	3	4	5
Bittergourd (*Momordica charantia*)	Priya, Preethi, Priyanka	Rainfed-May-August Irrigated-January- March & September-December	5-6	2m x 2m
Snakegourd (*Trichosanthes cucumerina*)	Kaumudi, Manusree, Baby,TA – 19	Irrigated-January-March & September-December	3-4	2 m x 2 m
Cucumber (*Cucumis sativus*)	Seethal, Swarna Purna, Poinsette, Pusa Sanyog, Poona	Irrigated-January-March & September-December	0.5-0.75	2m x 1.5m
Oriental Pickling Melon (*Cucumis melo var.conomon*)& Culinary melon (*Cucumis melo var.acidulus*)	Khira- salad purpose. Mudicode, Arunima, Saubhagya Oriental - pickling melon.			
Water melon (*Citrullus lanatus)*	Sugar Baby, Arka Jyothi, Arka Manik	December-April	1-1.5	3m x 2m
Bottlegourd *(Lagenaria siceraria)*	Pusa Summer Prolific Long, Pusa Summer Prolific Round and Arka Bahar	Rainfed-May-August Irrigated-January- March & September-December	3-4	3m x 3m
Pumpkin *(Cucurbita moschata)*	Ambili, Suvarna, Saras	Rainfed-May-August Irrigated-January-March &September-December	1-1.5	4.5m x 2m

1	2	3	4	5
Ashgourd *(Benincasa hispida)*	KAU Local, Indu	Rainfed-May-August Irrigated-January-March& September-December	0.75-1	4.5m x 2m
Littlegourd *(Coccinia grandis)*	Sulabha, Padappai	Planting time-May-June & September-October	Stem cuttings with 3-4 nodes from female plants @ 2-3 cuttings/pit	4m x 3m
Ridgegourd (*Luffa acutangula)*	Haritham, Deepthi, Pusa Nasdhar	December-March & May-August	2.5-3	2m x 2m

Sowing/planting

Pits of 60 cm diameter and 30-45 cm depth are taken. Well rotten FYM or other organic manure(12t/ha)is mixed with top soil in the pit and seeds are sown at the rate of 4-5 per pit. For Little gourd plant stem cuttings with 3-4 nodes from female plants @ 2-3 cuttings/pit. Unhealthy plants are removed after two weeks and only 3 plants are retained per pit.

Manuring

Table:. Additional Manurial requirement (apply any one of the following manure depending upon the availability)

Nutrient source	Quantity
FYM / Cow dung/	8 t/haa
Compost/	8 t/ha
Vermicompost/	4 t/ha
Greenleaf	8 t/h

Manures are applied in 2 splits at winding and flowering stage. Apply fresh cow dung slurry @ 1 kg/litre of water at fortnightly intervals starting from flowering.

Plant protection

Pests

Fruit fly *(Bactrocera cucurbitae*)

1. Cover the fruits.
2. Remove and destroy infested fruits.
3. Apply neem cake 250 kg/ha(100g/pit)at planting and one month later.
4. Apply *Beauveria bassiana* 10% WP and *Paecilomyces lilacinus* 5% WP
5. Spraying of leaf extract of *Ailanthus* 10 % and cashew 10% in combination is effective against fruit fly in bitter gourd.

Aphids, Green Jassid, Whitefly and Mite

1. Spray 2% neemoil+ garlic emulsion spray.
2. Dissolve 60g soap in150ml warm water, add soap solution to neem oil and castor oil slowly and mix well. Dilute with 6 litres of water. Add 120 g garlic paste. Take the extract and spray.
3. Apply1.5% fish oil soap.

Leaf and flower feeder (*Diaphania* sp.)

1.Collect and destroy larvae.

2.Spray, solution containing 1litrecow's urine+10g bird chilli+9 litres water.

3.Apply*Beauveriabassiana*10%WP and *Paecilomyceslilacinus*5% WP

4.Spraying of 10% leaf extract of *Ailanthus* and cashew is effective against fruit fly in bitter gourd.

American Serpentine leaf miner

Spray neem seed kernel emulsion (4%) before 8'O clock in the morning

Epilachna beetle

1. Remove and destroy egg masses, grubs and adults occurring on leaves.
2. Use predator (*Chrysocariesjohnsoni*) of larvae and pupae.
3. Apply *Beauveria bassiana*10% WP and *Paecilomyceslilacinus* 5%WP
4. Spray leaf extract of ailanthus and cashew (10%).
5. Neem oil + garlic emulsion spray (2%).

Diseases

Mosaic

1.Uprooting and destruction of affected plants and collateral hosts should be

2.done. Spraying neem based insecticide (2%) to control the vector

SOLANACEOUS VEGETABLES

Chilli, brinjal and tomato are the important solanaceous fruit vegetables grown in the state.

Table : Seed rate, time of planting, varieties and spacing of different solanacious vegetables

Crop	*Seed rate*	*Time of planting*	*Varieties*	*Spacing*
Chilli (*Capsicum annuum*)	1.0 kg/ha	May-June (before south-west monsoon)/ Sept.-October (for an irrigated crop). Can be grown throughout the year.	Jwalasakhi	45cm x 45 cm / 75cm x 45-60cm
			Jwalamukhi	45cm x 45 cm
			Jwala	45cm x 45 cm
			Pant C-1	45cm x 45 cm
			K-2	45cm x 45 cm
			Ujwala	45cm x 45 cm
			Anugraha	45cm x 45 cm
Brinjal (*Solanum melongena)*	370-500 g/ha	May-June (before south-west monsoon)/ Sept.-October (for an irrigated crop). Can be grown throughout the year.	Surya	60cm x 60 cm.
			Swetha	60cm x 60 cm
			Haritha	75-90cm x 60 cm
			Neelima	75-90cm x 60 cm
			Pusa Purple	60cm x 60 cm
			Cluster	
Tomato *(Lycopersicon esculentum)*	400 g/ha	October-November (for an irrigated crop)	Sakthi	60cm x 60 cm
			Mukthi	60cm x 60 cm
			Anagha	60cm x 60 cm

Nursery

Solanaceous vegetables are transplanted crops .Seeds are sown in the nursery and one month old seedlings are transplanted to the main field. An area of ($0_2$01ha) is required for raising seedlings for one hectare. For sowing the seeds, raised seedbeds of 90 to 100 cm width and convenient length are prepared in open space with fertile top soil to which well decomposed organic matter has been incorporated. Care should be taken to prevent incidence of damping off in the nursery. For this add one kilogram of *Trichoderma* to 100kg of dried farmyard manure and 10 kg of neem cake spread under shade to which water is sprinkled for maintaining moisture.

Manuring

Apply lime @ 500 kg/ha based on the acidity of soil 15 days before transplanting. Apply FYM or compost @ 25t/ha as basal dose to which *Trichoderma* and PGPR mix 1 each@2.5kg/ha are mixed and kept for 15 days in shade. Apply *Pseudomonas* and AMF at the time of transplanting. Instead of FYM, poultry or powdered goat manure@1t/ha can be applied. Dip the roots in 2% Pseudomonas or PGPR mix 1 before transplanting to the field.

Top dressing

Top dressing can be done at 7-10 days interval with any one of the following

1. Soil application of fresh cow dungs lurry @1kg/10litres(50kg/ha)

2. Soil application of biogasslurry@1kg/10litres(50kg/ha)
3. Soilapplicationofcow'surine500litres/ha(8timesdilution)
4. Soil application of vermiwash-500litres/ha(8timesdilution)
5. Soil application of vermicompost / poultry/powder goat manure-1t/ha
6. Soil application of ground nut cake1kg/ 10litres (50kg/ha)

Foliar spray can be given with cowdung slurry/ vermiwash/ cow'surine.

Table :Pests and their control

Crop	*Pest*	*Control measures*
Chilli	Aphids	Spray tobacco decoction or neem oil -garlic emulsion (2%) or *Nattapoochedi* (*Hyptis suaveolens*) emulsion (10%). Spray *Verticillium lecanae* or *Fusarium pallidoroseum* (10^{10}conidia/litre). Release green lacewing bugs @ 50,000 eggs/ha.
	Jassids	Spray neem oil-garlic emulsion (2%) or lemon grass/ginger extract (10%)
	Thrips	Spray Kiriyath (*Andrographis paniculata*) extract(10%),
	Mite	Apply neem oil 5% or neem oil + garlic emulsion 2%.Spray diluted rice water once in 10 days against mite.
Chilli & tomato	White fly	Spray *Verticillium lecanae* (10^{10}conidia/ litre) or garlic emulsion (2%). Place Sticky yellow traps.
Brinjal fruit borer	Shoot and	Protecttheseedlinginthenurserywithnet.Mechanicalhand picking and destruction of the affected part along with the larvae. Place pheromone traps @ 100nos./ha. Spray neem-garlic emulsion (2%). Spray Bt available as Dipel, Delphin, Halt, Bioasp, Biolep (0.7ml/litre). Use S-NPV (250 LE/ha). Spray leaf extract of ailanthus and cashew(10%).
	Red spider mite	Spray water using sprayer. Spray rice gruel water on under surface of leaves. Spray castor oil-soap emulsion or neem oil- garlic emulsion (2%).
	Hopper	Spray neem-garlic emulsion (2%)or products like Nimbicidin/ Econeem/Uneem (2ml/litre). Spraying of lemongrass/ ginger extract (10%) is also effective.
	Epilachna beetle	Spray soap-garlic-castor oil emulsion (2%). Collect and kill all stages of the pests. Spray Clerodendron plant extract 4-8% or Custard apple seed extract 2-5%
Tomato	Fruit borer	Spray Neem seed kernel extract 5%.Use H-NPV (250 LE/ha). Spray Bt. Spray Pongamia oil (2%). Apply Pongamia or neemcake250kg/hectareatplantingandrepeat2or3times at 30 to 45 daysinterval
	Serpentine leaf miner	Spray Neemoil-garlic emulsion (2%) before 8'O clock in the morning. Apply neem cake to soil (250kg/ha). Spray neem oil, marotti oil or illupai oil 2.5% or spray neem seed kernel extract 4%.

Crop	*Pest*	*Control measures*
Chilli, brinjal & tomato	Nematode	Apply Eupatoriumand neem leaves, neemcake, rice husk, wood shavings, castor cake @ of 100g/m^2. Apply VAM, Plant Growth Promoting Rhizobacteria, Paceilomyces to soil @ 2kg/ha. Seed treatment with *Bacillus macerans* @ 3% w/w (2.5 kg/ha) and drenching *with B.macerans* @ 3% solution 30 days after sowing.

Table :Diseases and their control

Crop	*Disease*	*Control measures*
Chilli, & tomato	Damping off	Sow the seeds in raised beds prepared in brinjal open area during summer months. Pre inoculation of AMF in furrows @ 200g/m^2. Apply lime in nursery bed. Use *Trichoderma*, *Pseudomonas fluorescens* and PGPR mix II. Neem cake can be applied @ 250 kg/hectare to reduce soil innoculant.
	Leaf spot	Spray *Pseudomonas fluorescens* (2%) Spray Bordeaux mixture (1%).
	Bacterial	Cultivate resistant varieties (KAU). Use lime in the field. Cultivatewiltmarigoldinfieldpriortotomatocultivation.Soil application of *Pseudomonas fluorescens* or PGPR mix II@ 20g/litreat15daysinterval.Seedlingrootdipandfoliarspray of *Pseudomonas fluorescens*1-2%.
Chilli	Leaf curl virus	Spray neem based insecticides (2ml/litre) to control the vectors. Grow resistant varieties like Punjab Lal & Pusa Sadabahar.
Tomato		Sprayneembasedinsecticides(2ml/litre)tocontrolthevectors. Grow 5-6 rows of maize around the crop atleast 50 days before transplanting tomato. Keep the plot weedfree.

LEGUMINOUS VEGETABLES

VEGETABLE COWPEA

Vegetable cowpea includes bush type (*Vigna unguiculata* subsp.*unguiculata***)** and yard long bean (*Vigna unguiculata* subsp.*sesquipedalis***)**

Cowpea can be grown throughout the year under Kerala conditions. It can be grown as a pure crop in single-crop and double-crop rice fallows during *rabi* and summer seasons.

Cowpea can be grown in any season. As a rainfed crop, sowing is done in the month of June. The most suitable time is after the first week of June. During the second crop season, sowing can be done during September-October. During summer, cowpea can be sown during January- February.

Varieties

a. Bush type: Bhagyalekshmy, Pusa Barsathi, PusaKomal
b. Semitrailing:Kairali,Anaswara,Varun,Kanakamony,ArkaGarima
c. Yardlongbean:Sharika,Malika,Vaijayanthi,Lola,VellayaniJyothika

Sowing / Spacing

Plough the land thoroughly 2-3 times and remove weeds and stubbles. For bush vegetable type, spacing of 30 cm between rows and 15 cm between plants is suitable. For semi-trailing varieties, provide a spacing of 45cm x 30cm.Trailing varieties can be sown in pits (@3plants/pit) at 2m x2m spacing for trailing on pandal or inchannel sat 1.5mx45 cm spacing for trailing on trellis.

Seed inoculation and seed pelleting

Cowpea seeds should be inoculated with Rhizobium (250 to 375 g/ha) .

Manuring

FYM – 20t/ha

Lime – 250 kg/ha or dolomite 400 kg/ha.

Lime may be applied at the time of the first ploughing.

In addition, apply as supplement FYM / Cowdung @ 2 t/ha +Rock phosphate 100 kg/ha

*The additional organic manures can be applied in splits at fortnightly interval.

Bio fertilizers: AMF / Phosphorus solubilising micro-organisms @1g per plant at the time of sowing increases the P availability.

Growth promoters: Foliar application of growth promoters like panchagavyam or vermiwash at fortnightly intervals increases marketable yield.

Plant Protection

Pests

1. Pea aphid (*Aphiscraccivora*)

This is a major sucking pest. Spray Neemazal T/S 1% @ 2 ml / litre at fortnightly intervals for managing pea aphid in cowpea.

The fungus *Fusarium pallidoroseum* can be used for controlling pea aphid. Bran based fungus can be applied @ 3 kg per 400 m^2 immediately after infestation is observed. Only one application is necessary. *Hyptis suaveolens* extract (1 litre) + 60 g soap (in ½

litre water), dilute the mixture 10 times and spray.

General measure: Spray leaf extract of *Strychnos nuxvomica* + soap. Dilute with water and spray.

2. Jassids and whiteflies

Spray neem seed kernel extract 5%.

3. AmericanSerpentineleafminer(*Liriomyzatrifolii*)

This is the major pest of cowpea. Adoption of the following methods will reduce the infestation of the pest.

Destruction of the weed host plants viz. *Achyranthus aspera, Amaranthus viridis, Cleome viscosa, Heliotropium indicum* and *Physalis minima.*

Need based application of neemoil, marotti oil or illupai oil

@2.5%. Cultivate tolerant accession (VU-12)

4. Pod borers

Spray diluted cow's urine+ asafoetida+ chilli extract.

Apply neem cake @ 250 kg/ha atflowering.

Apply neem seed kernel extract 5%

5. Leaffolder

Collect leaf folds and destroy the larvae.

6. Podbugs

Collect with sweep net and destroy different stages of the bug.

Wet the crop canopy to destroy young ones.

Destroy weed host plants.

Spray amruth neem 5ml/ litre.

Spray nimbicidin 2 ml / litre or neemazal 2 ml / litre or neem seed kernel extract 5%.

7. Pea stemfly

Increase seed rate in endemic areas.

8. Red spidermite

Apply neem oil 5% / neemoil garlic emulsion 2% / garlic emulsion 2% / fish oil soap 2.5%

9. Root knot nematode and reniform nematode

Apply neem or *Eupatorium* leaves @ 15 t/ha, two weeks before sowing.

10. Pulse beetle

Smear the seeds with coconut oil or ground nut oil 1:100 (W/W)

Apply dry, powdered rhizome of *Acorus calamus* @1kg/ 100kg seed.

Diseases

1. Soil borne diseases and nematodes

Follow soil solarisation using 150-gauge clear polythene sheets. Cover the soil with these sheets in sunny summer days after slightly moistening the soil. The soil temperature will reach as high as 52°C. Continue the polymulch for 1 week during which the soil temperature will rise and kill the soil borne fungi, bacteria, nematodes and weeds near the soil surface and thereby reduce the soil inoculum load. Soil drenching with 1% Bordeaux mixture or 2% Pseudomonas protects the crop form fungal diseases.

2. Collar rot and web blight (*Rhizoctonia solani)*

1.Apply neem cake @ 250 kg/ha

2.Reduce soil moisture

3.Use organic manure enriched with *Trichoderma viride* and drench with 2% *Pseudomonas*

3. Fusarium wilt *(Fusarium oxysporum)* . Seed treatment with *Trichoderma viride* @2 g/ kg seed + soil application of 2.5kg /ha at 30 DAS coupled with soil application of neem cake @150kg/ha at the time of land preparation reduce the incidence of *Fusarium* wilt.

4. Dry root rot

Treat the seeds with *Trichoderma viridae* @ 4g/kg, *Pseudomonas fluorescens* @10g/ kg or soil application of neem cake @ 250kg/ ha. Soil drenching with 2 % (20 g /litre)

General

Spray 1% Bordeaux mixture to protect the crop form fungal diseases.

This will also avoid the entry of white flies which transmit the various viral diseases.

DOLICHOS BEAN (*Dolichos lablab*)

Dolichos bean is a hardy crop and suitable for cultivation in home .Pole and bush varieties are available.

Season

The pole types are short day types and sown during July-August. The bush types can be grown throughout the year.

Varieties

Pole type: Pusa Early Prolific, Hima, Grace

Bush type: Arka Jay, Arka Vijay

Sowing

Pole varieties are sown in pits (three plants / pit) at a spacing of 1.25m x 0.75 m and bush types are sown in ridge and furrow system at a spacing of 60cm x 15 cm. The pole types are trailed over pandals, trellis or stakes.

Manuring

FYM – 20 t/ha as base.

In addition, apply supplement

FYM / Cow dung @ 4 t / ha + Ash125 kg / ha + Rock phosphate 300 kg / ha

(Note:The additional organic manures may be applied in several splits at 10-14days interval .Quantity of Rock phosphate can be reduced to 50% by priming it with the manures).

Biofertilizers

Seeds should be inoculated with Rhizobium and pelleted with lime. Application of AMF/ Phosphorus solubilising micro-organisms @1g per plant at the time of sowing increases the P availability

Growth promoters

Foliar application of growth promoters like panchagavya vermiwash at fortnightly intervals increases marketable yield.

Plant protection

The control measures recommended for cowpea are effective in this crop also.

WINGED BEAN (*Psophocarpus tetragonolobus*)

Winged bean is suitable for cultivation in homesteads.

Season: The winged bean is a short day crop and sown during August - September. The bush types can be grown throughout the year.

Varieties

Revathy, PT 62, PT 16, PT 2

Sowing / Spacing

Seed rate: 15- 20 kg/ha

Spacing: 1.25m x 0.50m. They are trailed over pandals, trellis or stakes.

Manuring

FYM – 20 t/ha

In addition, apply supplement as

FYM / Cowdung @ 4 t / ha + Ash125 kg / ha + Rock phosphate 300 kg / ha

(Note:The additional organic manures may be applied in several splits at 10-14 days interval.

Biofertilizers

AMF / Phosphorus solubilising micro-organisms @1g per plant at the time of sowing increases the P availability

Growth promoters

Foliar application of growth promoters like panchagavya , vermiwash at fortnightly intervals increases marketable yield.

Plant protection

The crop is comparatively free from pests and diseases.

CLUSTER BEAN (*Cyamopsis tetragonoloba*)

Cluster bean is a hardy crop suitable for cultivation under adverse soil and climatic conditions.

Season: The cluster bean seeds are sown during February – March and June – July.

Varieties

Pusa Naubahar and Pusa Sadabahar.

Sowing

Seed rate: 10- 12 kg/ha

Spacing: 45 – 60cm x 20- 30 cm.

Manuring

FYM – 25t/ha

In addition,apply supplement as FYM / Cowdung 2 t / ha + Ash 750 kg / ha

(Note:The additional organic manures may be applied in several splits at fortnightly interval.

Biofertilizers:

AMF / Phosphorus solubilising micro-organisms @1g per plant at the time of sowing increases the P availability

Growth promoters:

Foliar application of growth promoters like panchagavya vermiwash at fortnightly intervals increases marketable yield.

Plant protection

The crop is comparatively free from pests and diseases.

PERENNIAL VEGETABLE

DRUMSTICK (*Moringa oleifera* L.)

Drumstick is a traditional multipurpose vegetable of Kerala. It thrives in almost all the soils of Kerala. However, it prefers well drained loamy soils. It is better to avoid heavy clayey soils and water stagnated areas.

Varieties / Cultivars

There are two types

a) Propagated by limb cuttings: MO-144, Jaffna, Palmuringa

b) Seed propagated : AD-4(TNAUvarietiessuchasPKM1and PKM 2 are suited for adjoining dry border regions of Kerala such as Erithiyampathi, Chittoor, Menonpara)

Seed rate

Cuttings : 625nos. / ha

Seeds : 325 g/ha

Spacing

Both types of drumsticks can be planted at a spacing of 4m x 4m

Manuring

Apply the following organic manures at the time of planting and repeat the application every year during April –May

Powdered cow dung	10 to 15 kg/ pit
Neem cake	1.5 to 2 kg/pit
Rock phosphate	0.50kg/pit
Wood ash	1.0kg/pit

Plant protection

Green caterpillar and hairy caterpillar are the common pests which can be controlled by neem based insecticides (2ml/litre) and tobacco decoction.

Stem borer is a problem in some areas and it can be managed by Bt formulations such as Dipel /Delphin / Halt (0.7%).

For the control of *Fusarium* wilt, soil application of *Trichoderma* (2.5kg/ha) and drenching with 2% *Pseudomonas* are effective.

FRUITS

BANANA (*Musa* spp.)

Banana prefers tropical humid low lands and is grown from the sea level to 1000 m above MSL. It can also be grown at elevations up to 1200m, but at higher elevations growth is poor. Optimum temperature is 27°C. Soils with good fertility and assured supply of moisture are best suited.

Season

Rainfed crop: April - May

Irrigated crop: August -September

Varieties

Nendran (clones)

Nedunendran, Zanzibar, Chengalikodan, Manjeri Nendran II*

Table varieties

Monsmarie, Robusta, Grand Naine, Dwarf Cavendish, Chenkadali, Poovan, Palayankodan, Njalipoovan**, Amritsagar, Grosmichel, Karpooravalli**, Poomkalli, Koompillakannan**, Chinali, Dudhsagar*, BRS-1*, BRS-2*, Poovan, Red banana

Culinary varieties

Monthan, Batheesa, Kanchikela**, Nendrapadathy

*Less susceptible to sigatoka leaf spot disease

**Less susceptible to bunchy top disease

Njalipoovan, Palayankodan, Robusta, BRS-1 and BRS-2 are particularly suitable for intercropping in coconut gardens both under rainfed and irrigated conditions. Dudhsagaris highly resistant to major pests and diseases. The variety Boldles Altafort is recommended for high range region.

Manuring

1. FYM or compost or green leaves @ 10 kg/plant at the time of planting.
2. 500g of lime in the pit and allow to weather.
3. Vermicompost@2kg/pit at the time of planting.
4. Groundnut cake/ neem cake @ 1 kg /pit at the time of planting.
5. N, P and K biofertilizer -PGPR mix I @50-100 gm/ pit should be applied at the time of planting. The biofertilizer should be mixed with 5 kg FYM.I t should been sured that there is enough moisture in the soil at the time of application.
6. Panchagavya 3% as foliar spray three times at 3rd, 6th, and 9th months after planting

After planting banana, sow sunn hemp/ daincha /cowpea adopting a seed rate of 50kg/ha (20gm per plant). In corporate the crop into the soil 40 days after sowing. Repeat sowing of green manure crop and incorporate into soil 40 days after sowing.

Compost made from banana leaves and bunch stalk is rich in potassium content. *Insitu* vermicomposting is a novel technology for organic banana.

Additional nutrient requirement for different varieties

Varieties	Quantity / Plant		
	FYM/Compost(kg)	Rock phosphate (g)	Ash (kg)
Nendran	20	200	1
Palayankodan	10	300	2.0
Other varieties	15	300	1.5

It is preferable to apply organic manures in two equal split doses at 2nd and 4th month after planting.

Inter cropping

Amaranth, colocasia and elephant foot yam can be profitably intercropped with banana by adopting organic method of cultivation for all crops in the field.

Plant protection

Pests

Banana pseudostem weevil (*Odoiporus longicollis)*

Pseudostem weevil is a serious pest of banana. It attacks the crop from 6th month onwards. It weakens the pseudostem and it collapses in due course.

1. Field sanitation – remove all dried leaves over the pseudostem.
2. Remove severely infested plants with rhizome in full and destroy by burning the life stages of the insect.
3. Destroy pseudostem of harvested plants.
4. Remove the loose dry sheaths of the pseudostem of plants from 5th month onwards and follow any of the methods.

a) Swab mud slurry around the pseudostem:

If infestation is noticed, then mix neem oil emulsion @3% in the mud slurry (30ml/ litre) used for swabbing.

b) Spray neemazal (1%EC)on the psuedostem and fill the leaf axils at monthly intervals starting from 5th month on wards:

Spray application on the pseudostem and leaf axil filling with entomopathogens, namely, *Beauveria bassiana* or *Metarhizium anisopliae* @ 1 x 10^7 spores/ml.

c) Place split pseudostem pieces of 2 ft long in the ground when plants are 5 months old. Collect weevils in the trap and destroy daily.

Banana Rhizome Weevil (*Cosmopolites sordidus)*

Adult females puncture the rhizome and insert eggs through the holes. Grubs feed on the tissues and damage the rhizome. When growing point is damaged, the plant is killed. Symptoms are death of un opened pipe leaf, delay in emergence of new leaves and reduction in leaf number and bunch size.

1. Select only healthy, pest free planting material.
2. Deep plough the land so as to remove old rhizomes and expose inner soil layer to sun.
3. Cut and remove outer layer of rhizome (Parring) to remove eggs and young ones of weevils. Dip suckers in a slurry made of cow dung and ash and dry inshade.
4. Keep split pseudostem in the field to attract adult weevils. Collect and destroy the adult weevils daily.

5. Use pheromone trap with Cosmolure / Cosmolure $^{+}$ (an aggregation pheromone) to attract both sexes of weevil. Keep the trap throughout the year, changing the site when the number of weevils collected is reduced. Change pheromonesachet in every 45days.
6. Drench soil around plants or spray the plants with entomopathogens *Beauveria bassiana* or EPN s (dosage same as for pseudostem weevil). The quantity needed will depend on stage of the crop.
7. Apply crushed neem seed to the pit @1kg/plant

Aphid (*Pentalonia nigronervosa)*

Aphid acts as a vector for the transmission of viral diseases of banana. The fungal biocontrol agent *Verticillium lecanii* is pathogenic to the aphids. Spray the spores of *V. lecanii* @ 1 x 10^{7} spores/ml, whenever aphid population is noticed.

Nematodes

Major species attacking banana are burrowing nematode (*Radopholus sp)*, root knot nematode (*Meloidogyne incognita)*, root lesion nematode (*Pratylenchus coffeae)* and cyst nematode (*Heterodera oryzicola)*. Reduction in the number of leaves, bunch weight and number of fingers are the symptoms.

1. Parethe rhizomes and dip in hot water at 45-50°C for 20 minutes will control nematodes.
2. Apply neem cake @ 1kg/plant at the time of planting.
3. Sunn hemp or marigold to reduce nematode population.

Fungal diseases

Sigatoka leaf spot (*Mycosphaerella* sp.)

1. Cut and burn all severely affected leaves.
2. Need based sprayings are to be given depending upon the severity of the disease.
   i) Spray1% Bordeaux mixture soon after the appearance of the initial symptoms of the disease. The disease appears with the commencement of south west monsoon.
   ii) Power oil (Mineral oil) 1% emulsion is effective in controlling the disease.
   iii) Bioagents like *Pseudomonas fluorescens* 20g/litre (2%) or *Bacillus subtilis* 5g/ litre is effective against sigatoka leaf spot disease.
3. Grow reistant/ less susceptible varieties such as BRS-1, BRS-2 and Dudhsagar. Among Nendran, the selection Manjeri Nendran II is least susceptible.

Panama Wilt (*Fusarium oxysporum* f. sp. *cubense)*

1. Remove and destroy affected clumps along with corms
2. Apply lime @500g per pit and allow to weather
3. Apply neem cake@1kg per pit at the time of planting and give irrigation.
4. Varieties such as Palayankodan, Robusta and Nendran are less susceptible to the disease
5. Application of soil based inoculums of AMF 500g (soil based inoculums containing 40 spores per gm of soil), *Trichoderma harzianum* (50g) and *Pseudomonas fluorescens* (50g) or PGPR mix 1 is effective.
6. Dip the planting material in 2% *Pseudomonas* before planting

Virus diseases

Bunchy top disease

Virus disease of banana transmitted by aphids

1. Use disease free suckers for planting.
2. Eradicate disease affected plants.
3. Spraying neem based insecticide on the pseudo stem to control the vector.
4. The fungal biocontrol agent *Verticillium lecanii* is pathogenic to the aphids. Spray the spores of *V. lecanii* @ $1x10^7$ spores per ml whenever aphid population is noticed.
5. Varieties such as Karpooravally, Kanchikela, Njalipoovan and Koompillakannan are tolerant

Banana Bract Mosaic Disease (Kokkan disease)

Virus disease transmitted by aphids

1. Use disease free healthy suckers for planting.
2. Eradicate disease affected plants as and when noticed.
3. Spray neem based insecticide to control the vector.

Infectious Chlorosis (Cucumber Mosaic Disease)

1. Use disease free suckers for planting
2. Eradicate infected plants.
3. Use neem based insecticide to control the insect vector.
4. Avoid growing cucurbitaceous vegetables as intercrop in banana.

PINEAPPLE (*Ananas comosus*)

Pineapple is mostly grown at low elevations in areas with a temperature range of 15 to 30 ^{0}C. Pineapple is tolerant to drought because of the special water storage cells. It can be grown as a pure crop on plantation scale or as an intercrop in coconutgardens.

Varieties

Kew-recommended for processing industry

Mauritius-recommended for commercial cultivation for table purpose and distant marketing, due to its shorter duration, better fruit quality, keeping quality and transportability.

Season

Main season of planting is April-May and August-September

Manuring

Apply compost / FYM @ 500 g per plant at the time of planting. Also apply rock phosphate @ 20 g per plant and bone meal @ 50 g per plant. It will be ideal to apply the compost/ FYM, rock phosphate and bone meal in the pits taken for planting. Six weeks after planting, apply 250 g cow dung or vermi compost, 50 g neem cake, 50 g groundnut cake, one gm azospirillum and one gm phosphobactor or PGPR mix 1 for each plant and mildearthingupisdone.Apply1.5gofsulphateofpotashinliquidformalongwithcowdung solution at an interval of 6,10,14,18,22 and30 weeks after planting for each plant.

Plant protection

Pests

Mealy bugs (*Dysmicoccus brevipes / Pseudococcus bromeliae*)

Apply *Verticillium* @1g per plant in liquid form for the control of mealy bug.

Diseases

Root rot / heart rot / fruit rot

Caused by *Phytophthora* sp., *Pythium sp*., *Fusarium sp*., etc. The fruits at the soil level rot and emit foul smell. The stem at the soil level also show rotting symptoms. Providing drainage is most essential. The water table should be at least 60 cm below the soil surface. Badly affected plants should be destroyed. To prevent disease problems biocontrol agents can be used. Two weeks after planting, apply *Pseudomonas fluorescens* or PGPR mix II as 2% spray and drenching. Repeat its application if any diseases are observed.

Ratoon cropping

The plant crop after harvest can be retained as ratoon crop for two more years. After the harvest of the plant crop, chopping the side leaves of the mother plant should be done for easy cultural operations. The suckers retained should be limited to one or two per mother plant. Excess suckers if any should be removed. Earthing up should be done.

MANGO (*Mangifera indica*)

Varieties

Alphonso,BennetAlphonso,Neelum,Kalapady,Bangalora,Mundappa,Banganapally, Mulgoa, Prior, Suvarnarekha, Muvandan, Chandrakaran

Hybrids

Ratna (NeelumxAlphonso), HybridNo.45(BennetAlphonsoxHimayuddin), Hybrid No.87(Kalapadyx AlampurBenishan), HybridNo.151(KalapadyxNeelum)

Season

Stone grafting is successful in mango. August is ideal for the operation.

Manuring

For organic mango production FYM or compost may be applied along with 50-100g of PGPR mix I from first year onwards and the quantity should be increased as the tree grows, as shown in the table below.

Age of plant (years)	*FYM / Compost(kg/plant/year)*
1 – 2	15
3 – 5	30
6 -7	50
8-10	75
0ver 10	100

Compost or FYM can be partially or completely substituted with Vermicompost and in this case the quantity required will be only about50%.

Green leaves (25 kg / plant), Oil cake (10 kg / plant) and wood ash (10-15 kg / plant) may be applied additionally. Apply organic manures in May-June with the onset of monsoon. Apply the manures in trenches 30 cm deep taken at a distance of 2.5 to 3 m from the base of the tree.

Plant protection

Important pests of mango are hoppers, stemborers, shoot midges, leaf feeding insects, fruit flies and mealy bugs. The common diseases are the powdery mildew, anthracnose and dieback.

Under organic production system, to protect the orchard and the trees, following steps can be practiced.

- Keep the orchard and tree surroundings clean by proper sanitary measures.
- Lime brushing on tree trunks will help to control some of the pest
- Cuts and wounds on plant parts should be pasted with coal tar, used engine oil or Bordeauxpaste.
- Smoking in low intensities in the orchard during flowering season will reduce the number of pests including the hoppers.
- Spraying *Pseudomonas fluorescens* (10 g / litre) on trees before flowering .
- To control Stemborer: apply paste made of crude carbolic acid(130ml), soft soap(1 kg) and hot water (3.7 litres) to holes in the bark and plug theholes.
- Against sucking insects (Mealy bugs, Thrips, Mites etc.) spray with neem oil (0.5 to 1%)–soap emulsion. Sticky bands or stem traps with mud slurry, jack latex, vaseline, greece, coal tar or gel will prevent the upward movement of the pests from soil.
- To control dieback of twigs and branches, cut the affected twigs below the infected region and spray 1% Bordeaux mixture.
- T control pink disease remove the bark at the point of infection and 30cm above and below the point of infection and apply 10% Bordeauxpaste.

PLANTATION CROPS

COCONUT (*Cocos nucifera*)

Coconut requires an equatorial climate with high humidity. The ideal mean annual temperature is 27ºC with 5-7ºC diurnal variation. The palm does not withstand prolonged spells of extreme variations. A well-distributed rainfall of 1300-2300 mm per annum is preferred.

Cultivars

1. West Coast Tall(WCT)
2. Lakshadweep Ordinary(Chandrakalpa)
3. Philippines Ordinary(Kerachandra)
4. AndamanOrdinary
5. Java
6. CochinChina
7. Kappadam
8. Komadan

Hybrids

1. Lakshaganga (Lakshadweep Ordinary xGangabondam)
2. Anandaganga (Andaman Ordinary xGangabondam)
3. Keraganga (West Coast Tall xGangabondam)
4. Kerasankara (West Coast Tall x Chowghat OrangeDwarf)
5. Chandrasankara (Chowghat Orange Dwarf x West CoastTall)
6. Kerasree (West Coast Tall x Malayan YellowDwarf)
7. Kerasoubaghya (WCT xSSA)
8. Chowghat Green Dwarf x West CoastTall
9. Chandralaksha (Lakshadweep Ordinary x Chowghat OrangeDwarf)

***Tender nut variety*: Chowghat Orange Dwarf**

Note: (1) Hybrids Anandaganga, Keraganga and Kerasankara are recommended for general cultivation both under rainfed and irrigated conditions.

(2) Other hybrids especially Chandrasankara are recommended for ideal situations and where good management practices areadopted.

(3) Since the performance of Chandrasankara is markedly superior to that of WCT in root (wilt) affected areas, cultivation of Chandrasankara is preferred in such areas.

(4) Chandralaksha,LakshagangaandChandrakalpaarerecommendedforcultivation under drought proneareas

Spacing

Spacing depends upon the planting system, soil type etc. In general, the following spacings are recommended under different systems in sandy and laterite soils. In lateritic gravelly soils, under rainfed conditions of north Kerala, a closer spacing to accommodate 250 palms per ha is more economical.

Table:.Spacing for coconut

Planting system	Spacing	Approximate number of plants/ha
Triangular	7.6 m	198
Square	7.6 to 9 m	170-120
Single hedge	5 m in the rows 9 m between the rows	220
Double hedge	5m x 5m in rows 9 m between pairs of rows	280

Time of planting

Planting the seedlings during May, with the on set of pre-monsoon rain is ideal.

Manuring of adult palms

Apply FYM /cowdung 50kg + ash 5kg + *Azosprillum* 200 g / palm / year or PGPR mix 1.

Note: 1. Under irrigated conditions, manures can be applied in 3-4 equal split doses.

2. In the case of low-lying areas, apply manures in one single dose after water table recedes or in two split doses as conditions permit.

3. The application of organic materials such as forest leaves, cattle manure, coir dust or coconut shredding @10kg per pit along with PGPR mixI (100-200g) in the first three years will be useful to obtain better establishment of coconut.

Plant protection

Pests

Rhinoceros beetle *(Oryctes rhinoceros)*

1. Boil castor cake and groundnut cake with a little quantity of water. Keep in earthern pots near light source to attract beetles, which can be collected and killed.
2. Mixs and (250g) and neem seed powder(100g)and fill inner leaf sheath of youngest leaves.
3. Release *Baculovirus oryctes* infected adults @ of 10-15 / ha to bring down the pest population.
4. Inoculation of breeding sites with entomo pathogenic fungus *Metarrhizium anisopliae var.major*(@5x10^{11}spores/ml)gives effective control.

Red palm weevil *(Rhyncophorus ferrugineus)*

Use of pheromone trap for attracting and killing adult weevils @ one trap per 2ha.

Leaf eating caterpillar *(Opisina arenosella)*

1. Arrange for the release of larval / pupal parasitoids, *Goniozus nephantidis, Elasmus nephantidis* (brown species) and *Brachymerianosatoi.*
2. Mix extract of 2kg neem seed kernel and 200g soap in 200 litres of water and spray followed by the release of larval pupal parasites.

Cockchafer beetle *(Leucopholis coneophora)*

1. Apply sugar solution in coconut basin near root zone.
2. Wherever possible, light traps may be set up to attract and trap adult beetles.

Coried bug *(Paradasynus rostratus)*

Grow neem as alternate host to attract the bugs and destroy the bugs.

Mealy bug

Remove and destroy all dried up in florescence and unproductive buttons. Neemgarlic emulsion 2% applied on infested bunches checks button mealy bugs.

Diseases

Bud rot *(Phytophthora palmivora)*

1. Spray 1% Bordeaux mixture on spindle leaves and crown of disease affected as well as neighbouring palms, as a prophylatic measures.
2. Drench crown with *Pseudomonasfluorescence* 2% suspension or PGPRmixII.

Mahali *(Phytophthora palmivora)*

Spray 1% Bordeaux mixture on the crown of palms, once before the monsoon and once or twice later on at intervals of 40 days.

Leaf rot *(Colleototrichum gleosporiodes, Exserohilum rostratum and Fusarium* spp.*)*

1. Remove the rotten portions from the spear and the two adjacent leaves.
2. Spray crowns and leaves with 1% Bordeaux mixture in January, April-May and September. While spraying, care has to be taken to spray the spindleleaf.
3. Application of *Pseudomonas fluorescence* 2% suspension in the leaf at the initial stage ofinfection.

Stem bleeding (*Thielaviopsis paradoxa)*

1. Apply neem cake@5kg per palm in the basin along with other organics. Irrigatethe palm during summer season and avoid water stagnation during rainy season.
2. Apply *Trichoderma* @ 50g/palm along withFYM.

Grey blight (*Pestalotia palmarum)*

Remove severely affected older leaves and burn. Spray the trees with 1% Bordeaux mixture.

Tanjore wilt (*Ganoderma lucidum)*

1. Apply organic manure @ 50 kg /palm.
2. Apply neem cake @ 5 kg / palm /year.

CASHEW (*Anacardium occidentale*)

Cashew is adapted to warm humid tropical conditions. It can be grown in almost all types of soils from sandy to laterite and upto an elevation of 600-700 m including wastelands of low fertility. It grows and yields best in well-drained red sandy loams and light coastal sands. Heavy clay soils, poor drainage conditions, very low temperature and frost are unsuitable for the crop.

Varietal choice

Table: Varieties according to their susceptibility to tea mosquito bug

Varieties/ hybrid/types	Mean yield (kg/tree/ year)	Nature of bearing	Susceptibility status to TMB
Anakkayam-1 (BLA 139-1)	12.00	Early	Susceptible
moMadakkathara-1 (BLA 39-4)	13.80	Early	Moderately susceptible
Vridhachalam-3 (M 26/2)	11.68	Early	Moderately susceptible
Kanaka (H-1598) (BLA 139-1 x\H 3-13)	12.80	Mid	susceptible
Dhana (H-1608) (ALGD 1-1 x K 30-1)	10.66	Mid	Moderately susceptible
K-22-1	13.20	Mid	Moderately susceptible
Dharasree (H-3-17) (T 30 x Brazil 18)	15.02	Mid	Moderately susceptible
Priyanka (H-1591) (BLA 139-1 x K-30-1)	16.90	Mid	susceptible
Amrutha (H-1597) (BLA-139-1 x H 3-13)	18.35	Mid	Moderately susceptible
Anagha (H-8-1) (T 20 x K30-1)	13.73	Mid	Highly susceptible
Akshaya (H 7-6) (H4-7 x K30-1)	11.78	Mid	Moderately susceptible
Madakkathara-2 (NDR 2-1)	17.00	Late	susceptible
Sulabha (K 10-2)	21.90	Late	Moderately susceptible
Damodar (H 1600) (BLA 139-1 x H3-13)	13.36	Mid	Apparently tolerable
Raghav (H 1610) (ALGD-1-1 x K-30-1)	14.65	Mid	Moderately susceptible
Poornima (BLA 139-1 x K 30-1)	14.10	Mid	-

Planting materials

Cashew can be propagated by seedlings, air layers and softwood grafts

Nutrient management

Cashew is generally grown in soils with low fertility status and water holding capacity. To ensure supply of sufficient nutrients leading to optimum growth and yield in organic cashew, an integrated approach consisting of growing leguminous green manure/ cover crops, recycling of crop residues, application of organic mixtures and bio-fertilizers is to be followed, which is agronomically and economically effective. If all the organic materials available in the orchard are fully utilized, it can meet a major portion of the nitrogen and a part of other macro and micro nutrient needs.The organic materials available in the plantation can be best used through composting, more efficiently through vermi-composting. It was found that the leaf litter and cashew apple residue could be effectively used for vermicomposting which will be ready in 95 days. Growing of leguminous cover/ green manure crops are highly beneficial particularly in young

plantations where intercrops are not raised. Apart from its positive effect on soil fertility status, by contributing dry matter to the tune of 2 to 4 tonnes/ha, cover cropping prevents soil erosion and conserves water; also suppresses weed growth in early years.

When organic manures are used, around 25 kg poultry manure, 60 kg FYM or 30 kg vermicompost may be used per adult tree. Apply1/5th dose of the organic manure during the first year, 2/5th dose during second year and progressively reaching full dose from fifth year onwards.

Combined application of *Azotobacter* and *Azospirillum* each @150gorPGPRmixI per adult tree is beneficial for increased yield.

Plant protection

Tea Mosquito Bug (TMB)

This is the most serious pest affecting cashew. The pest usually appears with the emergence of new flushes and panicle. Drying of inflorescence and dieback of shoots are the symptoms.

Spray either neem oil (0.5-1%)or *Pongamia* oil (2%) during flushing, flowering and fruiting phases. Add teepol/ soap. Repeated sprayings at fortnightly intervals may be required in specific situations such as heavy infestations young plantations.

Cashew stem and root borers

This is a serious pest, which is capable of destroying the cashew tree. Main symptoms of attack are yellowing of leaves, drying of twigs, presence of holes at the base of stem with exuding sap and frass.

Prophylactic measures

1. Phytosanitary measures such as removal of dead and dried branches of trees, dead trees and trees at advanced stages of infestation at least once in six months help in reducing the spread of stem and root borers.
2. Roots should not be left exposed in the field.
3. Swab mud slurry or coaltar and kerosene (1:2) for adult trees or neem oil 5% (50ml neemoil in 1 litre of water + 5g of bar soap)on the tree trunk up to1.0 m height, thrice in a year, from September onwards, at an interval of two months. Commercial formulations may also be used in place of neem oil, after ensuring their quality.

Diseases:

Diseases affecting cashew nursery

Damping off, seed rot, seedling blight and root rot are the diseases that cause serious damage in the nursery ,particularly during rainy season ,which can be effectively managed with integrated control measures as given below.

1. The seedling diseases could be prevented by providing proper drainage facilities in the nursery. Provide enough drainage holeson the bags used for raising seedlings.
2. Raise seedlings in solarised potting mixture. Potting mixture has to be solarised for one month using 150 gauge transparent polythene sheets.
3. After filling the potting mixture in the polythene bag, use *Trichoderm*a enriched manure for potting mixture.
4. Incorporate *Mycorrhiza* @ 10g/kg and PGPR mix I 5g/kg potting mixture before sowing the seeds.

5. Remove and destroy the disease affected seedlings.
6. Never re-use contaminated potting mixture.
7. Provide sufficient spacing in the nursery to ward off excess humidity.
8. Never raise cashew nurseries in heavily shaded areas.
9. Drench the nursery bag with 1% Bordeaux mixture or Copperoxychloride (0.2%) or. While drenching, care should be taken to drench sufficient quantity of fungicide to soak the entire potting mixture in the polythene bag. Selection of the above fungicides should be based on the type of the pathogen.
10. Spray the seedlings with 1% Bordeaux mixture as a prophylactic measure to prevent aerial infection.

Reference:

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