



GOOD Agricultural Practices

Chilli



ICAR- All India Coordinated Research Project on Spices
ICAR-Indian Institute of Horticultural Research
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CHILLI

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Good Agricultural Practices are a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while considering economic, social and environmental sustainability as defined by the Food and Agricultural Organization (FAO). GAP recommends addressing environmental, economic and social sustainability for on-farm production and post-production processes resulting in safe and healthy food and non-food agricultural products. A broadly accepted approach using GAP principles, generic indicators and practices will help guide debate on national policies and actions and on the preparation of strategies to ensure that all stakeholders participate in and benefit from the application of GAP in the food chain. The aim of GAP is to promote Sustainable Agriculture and Development and with effective input use, are one of the best ways to increase smallholder productivity. GAP in addition to improving the yield and quality of the products, also has environmental and social dimensions.

Practising GAP improve the safety and quality of food and other agricultural products and it helps to reduce the risk of non-compliance with national and international regulations, standards and guidelines set by Codex Alimentarius Commission, World Organisation for Animal Health and the International Plant Protection Convention IPPC regarding permitted pesticides, maximum levels of contaminants food and non-food agricultural products, as well as other chemical, microbiological and physical contamination hazards. Moreover, adopting GAP promotes sustainable agriculture and contributes to meeting national and international environment and social development objectives. Its social dimension would be to protect the agricultural workers' health from improper use of chemicals and pesticides. It is a particularly opportune time to promote GAP when second generation of reforms in agriculture which would have a Critical impact on Indian agriculture, are planned by the Indian Government. However, farmers need to be adequately informed, technically prepared and organised to meet this new challenge with governments and public agencies playing a facilitating role.

GOOD AGRICULTURAL PRACTICES FOR CHILLI

Chilli is one of the most valuable spice crop. India is the largest producer, consumer and exporter of Chilli, contributing about 40 % of the World's chilli production. In India, Andhra Pradesh is the leading state in Chilli production followed by Karnataka, West Bengal and Odisha .Chilli belongs to the genus *Capsicum* under Solanaceae family and in India, only two species viz. *Capsicum annum* and *C. frutescens* are widely known and most of the cultivated varieties belong to the species *Capsicum annum*. Chilli is widely used in many cuisines as a spice to add hot flavor to dishes and sauces. The hot flavor in chilly is due the compound capsaicin and related derivatives capsaicinoids.

SITE SELECTION

The information on soil condition, water logging, industrial waste and effluents, source of irrigation water and meteorological data need to be available with the farmers before starting chilli cultivation.

Climate and soil

Chilli being a subtropical crop comes up well in warm humid climate and can be grown under varied agro-climatic conditions. Excess irrigation/rainfall and moisture stress during flowering/ fruit set is detrimental. Dry climate during fruit maturity and ripening is ideal and facilitates quality harvest. Black soils are best suited for chilli cultivation. Irrigation can be taken up in light (red loams/ sandy loams/ chalka soils) and alluvial soils. Soils with poor drainage are not suitable

SEEDS AND PROPAGATION MATERIAL

Selection of a variety

Variety has to be selected based on purpose for which it is cultivated, local market preference, climatic conditions, soil type, irrigation facilities and pest and disease incidence in the locality.

Procurement of quality seeds

Variety/ F1 hybrid seeds to be procured from the reliable or authenticated source

Seed requirement

- Varieties: 250 g/acre (for transplanted crop)
500g /acre (for direct sowing)
- Hybrids: 80-100g/acre

Seed treatment

Hybrid and OP seeds marketed by private sector are usually treated with insecticide and fungicide to avoid sucking pests and preventing damping off disease. However, in all the other cases, the seed procured must be treated with *Trichoderma viride* @4g/kg or *Pseudomonas fluorescens* @10g/kg.

SOIL CONDITIONS/MANAGEMENT

- The soil analysis report of the selected site and analytical report on irrigation water should be available especially with respect to heavy metals and pesticide residues contents.
- The quantity, quality and type of soil amendments used for the selected site need to be recorded.

Nursery management

Nursery management must ensure quality seedlings with high initial vigour which helps in faster establishment and a healthy crop. The following points must be taken care of in case of raising the nursery in a traditional way which is widely practiced for open pollinated varieties.

- Raised nursery beds with soil mixed with well pulverized organic matter.
- Apply neem cake powder @1kg per 40m² area.
- Avoid application of chemical fertilizers in nursery bed. If necessary use foliar nutrients.
- To protect against damping off, drench the nursery bed with copper oxychloride (3g/L) at 9th day after sowing (DAS) and 15th DAS.
- Recommended raising F1 hybrid seedlings in protrays filled with sterilized cocopeat in insect proof net to produce healthy seedlings (net of 5m x 4.5m x 2m size accommodates 100-120 protrays (98 cell) to produce ~10,000-12,000 seedlings which is sufficient for an acre)
- Weekly sprays of systemic insecticides with alternate sprays of neem/ pongamia oil or soap is recommended to control vectors

CROP MANAGEMENT FOR CULTIVATION

- The spacing for the crop, in terms of row to row and plant to plant distance need to be adopted as per the agronomic requirement.
- Gap filling of plants to compensate mortality losses should be carried out within a reasonable timeframe.
- Based on the soil analysis and crop requirement, organic manure preferred for the crop supplemented with mineral nutrition through inorganic source need to be applied.
- Application of mineral supplements must be based on complete soil analysis in a competent laboratory.
- Specialized nutritional application for distinct needs viz., root production or enhancement of leaf bio mass need to be taken up as per the requirement of the crop.
- In order to optimize water usage and to reduce wastage of water irrigation management plan need to be prepared for the crop.
- Efficient system for irrigation need to be adopted so as to conserve water for the whole cropping season and to reduce the water usage.
- Records need to be maintained for irrigation schedules, fertigation application and water requirement.
- Depending on the nature and stage of the crop, inter-cultivation practices need to be adopted to reduce the incidence of weeds.
- Comprehensive package of pest and disease management schedules including prophylactic measures required for the crop need to be adopted to minimize the crop loss and its quality.
- In order to reduce pesticide residue in produce, correct dose of pesticides, time of application and mode of application need to be ensured and recorded correctly.
- Use of bio control agents and bio pesticides is preferred and plans for this should be available.

Sowing/ Planting

Direct sowing : July to August

Nursery : July

Transplanting : August-September

Integrated nutrient management

Soil problems and micronutrient deficiencies in chilli are mainly due to the excess use of chemical fertilizers and limited or no application of organic fertilizers. Improving the soil health by soil conservation methods, Green leaf manuring, crop rotation and application of bulky organic manures will not only improve availability of nutrients to the crop but also improves soil microflora and fauna. To avoid soil nutrient depletion, crop rotation should be incorporated in the cropping pattern. Follow crop rotation: Greengram - Chilli rotation is a good example without sacrificing chilli crop.

Deep ploughing in summer to maintain soil condition as well as to reduce hibernating pest population. Chilli plants in compacted soils experience stress both during wet and dry periods than plants in soils with good tilth. Application of diverse organic manures–FYM (25t/ha) or vermin compost (5t/ha) enriched with bioagents. Apply liberal doses of diverse organic manures such as crop residues, FYM, compost, vermin compost, green manure, neem cake etc to improve soil organic carbon and physical condition. FYM enrichment - Multiply biofertilizers & biopesticides using neem cake and add to FYM. Application of biofertilizers & bioagents (Phosphobacteria, *Bacillus subtilis* and Mycorrhiza, *Pseudomonas*, *Trichoderma* etc) to the soil to build up beneficial microbial population.

Raising green manure crops like *Crotalaria* in acidic soils or *Sesbania* (dhaincha) in alkaline soils. Use of green manure reduces the incidence of thrips, aphids and whitefly. Root rots and leaf diseases are reduced with active organic matter. Apply neem cake powder @ 250kg/ha.

Apply recommended dose nitrogen and potassium fertilizers as per the recommendation of the region (300 kg N and 120 kg K/ ha in 4-5 splits for Andhra Pradesh and Telangana) and as per soil test results. Avoid urea and prefer SOP (sulphate of potash) instead of MOP (muriate of potash) for red ripe fruit harvest. Apply entire phosphorus as basal in the form of single super phosphate (SSP) and avoid split and excess doses of P fertilizers. Region, soil and

farming situation based fertilizer recommendations should be followed for better fertilizer use efficiency. Micronutrient spray at the time of fruit formation improves fruit quality.



Weed management

Critical stages are:

- Direct sown crop : 90DAS
- Transplanted crop : 60DAP
- Avoid excess use of herbicides
- Avoid directed spray of herbicides which are not recommended
- Inter-cultivation must be preferred over the use of herbicides

Crop management

Transplanting 40-45 days old seedlings on beds or ridges & furrows method at 60x30cm spacing. Preferably transplant hardened seedlings in the late afternoon in moist soil. Raised beds of 3ft wide & 1ft high with 2ft wide furrows, use drip and agrimulch is preferred. Mulching the field with film (30 micron agri-mulch) along drip and fertigation system is recommended. Paired row system on raised bed of 90cm, of rows 60cm (2ft) apart and plants 45cm (1.5ft) apart; and with 60cm (2ft) channel between the beds. Sprinklers during early period of the crop then convert to drip allowing early inter- culture. Keep the field free from weeds by inter-culture and manual weeding.



PLANT HEALTH MANAGEMENT

- Farmers are advised to identify the pest properly with the help of plant protection experts and to follow IPM strategies for sustainable production.
- Farmers shall keep a record of the plant protection chemicals used during the cropping season.
- Proper precautions should be taken while spraying chemicals to avoid contamination beyond the application area.
- Preparation of spray fluids should be carried out in a designated area away from any natural water bodies, drinking water sources, human dwellings etc.
- It is advisable to use protective clothing, face mask and gloves while preparing and applying pesticides.
- Plant protection chemicals must be stored in a dry, well ventilated facility with displayed information on hazardous chemicals inaccessible to children and unauthorized people.
- Farmers should follow the waiting period recommended by authorized Institutes for repeated application of pesticides and advised not to mix pesticides.
- Spray should not be done during peak period of bee activity to protect bees.

It is advised to spray pesticides in the afternoon hours avoiding strong windy condition and rains.

- Avoid carrying bulk pesticides (dust/granules) on head shoulders or on the back.
- Avoid eating, drinking, smoking or chewing while preparing spray solution and the containers, buckets etc used for mixing pesticides should not be used for domestic purpose.
- Select right kind of sprayer with appropriate nozzles for spraying. It is advised not to blow/clean clogged nozzle with mouth.
- Left over spray solution and empty containers should not be disposed in ponds, water bodies etc.
- Combustible containers can be burnt if the container labels permits burning.
- Containers made of paper, cardboard & plant materials can be disposed off by burning. Non combustible containers should be broken or deformed by punching holes at several places to prevent reuse.

Chilli crop is usually attacked by sucking pests (thrips, white flies, aphids and mites) and borers (*Helicoverpa* and *Spodoptera*). At any stage of the crop, the crop typically experiences pest complex attack leading to panic by the farmers resulting in indiscriminate use of insecticides. Many a times, thrips and mites attack the crop thus making majority of control measures ineffective. Most sucking pests in chilli not only cause direct damage but also transmit viruses. Aphids transmit Cucumber Mosaic virus, whiteflies transmit Leaf Curl Virus (Gemini virus) and thrips transmit Peanut Bud Necrosis Virus. A general guideline is to contain the pest load rather than aiming at absolute control of the pest, as this approach is currently known to cause high pesticide residues in the harvested produce.

The following are some of the important measures under IPM

- Seedling dip in pesticide/fungicide solution before planting
- Raising border crops like sorghum, maize to check sucking pests
- Keep the plot clean (weed control in time is must)
- Planting trap crops like marigold and castor against borers and nematodes
- Use of pheromone traps for control of borers and sticky traps against sucking pests. Provide poison bait with carbaryl 1.25 kg, rice bran 12.5 kg, jaggery 1.25 kg and water 7.5L/ha
- Provide bird perches
- Sprinklers at pre flowering stage to check whitefly/ thrips infestation
- Avoid fruits touching the soil and getting infested with fungal diseases
- Avoid water stagnation and provide proper drainage
- Avoid combination of more than two pesticides and avoid repeated use of same pesticide (rotation of pesticides)
- Enhance the usage of botanicals viz., Neem and Pongamia oil @2mL/L along with recommended pesticides
- Avoid applying pesticides after flowering to pod formation period, wherever possible
- Timely use of recommended dosage of branded pesticides and fungicides
- Avoid use of tonics of unknown composition

Insect pest and disease management schedule

Activity	Stage of crop	Management option
Seed treatment	Sowing time	<i>Trichoderma viride</i> @4g/kg or <i>Pseudomonas fluorescens</i> @ 10 g/kg. Apply neem cake powder in seed bed @1 kg / 40m ² area.
Management of sucking pests in nursery	Nursery	Spinosad 0.3 mL/L of water
Sowing guard crop	At the time of transplanting	3-4 rows of maize or sorghum as guard crop.
Installation of pheromone traps and live bird perches.	At the time of transplanting	10traps/acre,5 for <i>Helicoverpa</i> sp.and 5 for <i>Spodoptera</i> sp. About 10 maize live perches /acre
Management of thrips in main crop	Transplant to one month before harvest	Overhead irrigation with sprinklers Spinosad 0.3 ml/L of water or Fipronil @2 mL / L
Management of mites	In the nursery and main crop	Over head irrigation with sprinklers, Spray once in the nursery and second time in the main crop with wettable sulphur 3 g / L or vertimec 0.5 mL / L or pegasis 1 g / L
Management of pod borers at initial stage	Flowering Stage	Application of neem cake powder @ 10 kg \ acre NPV @ 250 L / acre, Bt, (dipel 4 mL \ L) <i>Trichogramma pretiosum</i> 3 lakh adults / acre
Management of pod borers at later stage	Fruiting stage	Spray indoxacarb @1 mL/L or spinosad @ 0.3 mL /L
Arresting immigrating <i>Spodoptera</i>	Crop maturity stage	Erecting polythene fence (4 inches above ground) or raising guard crop; Keep poison baits.
Gall Midge	Flowering / fruiting	Spinosad @ 0.3 mL /L NSKE 2% @5ml/L
Aphids	Vegetative, Flowering stages	Spinosad @ 0.3 mL /L <i>Lecanicillium lecanii</i> 2 g/L
Root grub	Soil application at early stage	<i>Metarhizium anisopliae</i> Soil application with neem powder @1 kg/acre.
Anthraxnose	Green fruit stage	Thiophonate methyl 1g/L, mancozeb 2.5g/L, propiconazole 1 ml/L propineb 2 g/L
<i>Choanephora</i> blight	Flowering and fruiting stage	Copper oxychloride 3 g / l
Powdery mildew	Flowering and fruiting stage	Dinocap 1 ml / L, wettable sulfur 3 g/L
Leaf spots	Flowering and fruiting stage	Propineb 2.5 g / L, chlorothalonil 2.5 g / L
<i>Phytophthora</i> root rot	Flowering and fruiting stage	Raised bed cultivation, avoiding water stagnation, crop rotation, fungicides (metalaxyl and fixed copper)

Important insect pests of chilli



Aphid



Thrips



Yellow mite



White fly



Fruit borer
Helicoverpa



Tobacco cutworm
Spodoptera

Important diseases in chilli



Damping off



Cercospora leaf spot



Anthracnose fruit rot



Powdery mildew



Alternaria leaf spot



Phytophthora root rot



Leaf curl begomovirus



**Cucumber mosaic cucurbit virus &
Chili vein mottle potyvirus**

HARVEST AND POST HARVEST MANAGEMENT

- Harvesting season is determined and followed on the basis of qualitative parameters set for the end product rather than the total vegetative yield.
- Clear instruction should be available for farm worker to use proper cutting devices and avoid harvest of unwanted plants.
- A documented procedure should exist for cleaning containers and avoiding mixed up and contamination of produce.
- Washing and cleaning methods need to be ensured for the freshly harvested materials to ensure removal of soil particles adhering to the materials.
- Processing area must be clean with a proper platform and shade.
- Proper drying techniques need to be adopted for drying and storage of harvested crop produce. Drying procedure and the temperature employed should be in conformity with the quality needs of the farm produce.
- Sorting procedure need to be carried out after the completion of drying phase and before the material is packed.
- Selection of packaging material must be based on the quality requirements and possible length of storage before consumption/processing and need to be kept clean, dry and undamaged.
- Storage area must be kept clean and free from insect pests. Proper separation need to be implemented to keep different products of the crop separately.

Chilli invariably contains high moisture content (60-85%) at the time of harvest, which must be brought down to 8-12%. The majority of Chilli produced is dried in open space. The major change during drying is weight reduction which amounts to a reduction of 20- 15% of total weight of the pods. Losses also occur during farm processing. These are spillage in field (1-10%), wastage during farm assembling (5-10%) and wastage during transportation and handling (2-5%). Proper post-harvest management not only helps to reduce the post-harvest losses but also improves quality and shelf life of the final produce. If chillies are not properly dried, 35-50% post-harvest losses may occur when the produce moves along the supply chain.

- Timely pickings improve quality.
- Harvest at right maturity for maximum flavour, oil and colour content.
- Heap the harvested pods overnight to get uniform colour
- Avoid insecticide sprays before picking
- Use clean bags and baskets for harvesting.
- Bring moisture level to 10-11% to avoid aflatoxin contamination.
- Use cement platform and tarpaulin sheets to avoid aflatoxin contamination.
- Drying area should be protected by fencing to avoid contact with animals.
- Keep the produce free from dust and other foreign material

Encourage multipurpose polyhouse solar dryers for quick drying and such closed dryers help to develop high quality produce with minimum contamination and protect from rains. Use polyhouse solar drying for achieving high quality produce. Bapatla (ANGRAU) model poly house solar dryer is of size 7.5m×4m×3m to dry about 10 quintals of ripe chillies. The dryer consists of an arch type poly house to hold chillies in two tiers. The drying time is 5-8 days to reduce moisture from 75 to 10 % in comparison with 15-20 days required to dry chillies in traditional open yard sun drying.

Grade and sort out damaged and whitened pods. Grading should be done with proper hygiene. Pack in clean, new gunny bags and label with natural colours. Store at 4-7°C in cold storage. Cold storage helps to retain colour. Avoid the use of Rhodamine to label the chilli gunnies. Avoid sprinkling water on dry chilli while packing in gunnies. Restricting animals, including livestock, poultry or pets, to roam in crop areas, especially near harvest time. Exclude ingredients, Insects and other pests from growing areas. Providing appropriate hand-washing instructions and clean toilet facilities for field workers. Cleaning and sanitizing harvest containers before use. Excluding field debris from packing and storage facilities by cleaning the outsides of harvest bins and requiring workers to wear clean clothes in these areas. Using new and unused bags to pack products for further transport and sale.

TYPES OF POST-HARVEST LOSSES IN CHILLIES AND ITS PREVENTION

Type of loss	Reason	Prevention
Discolouration	Prolonged sun drying	Mechanical drying
	Harvesting of immature fruits	Harvesting of matured fruits
Mould growth	Improper drying	Proper drying
	Poor storage condition	Proper storage
Loss of seed	Physical injury	Gentle handling
	Improper packing	Careful packing
	Loose stalk	Selection of variety
	Pod borer	
Wrinkling of fruits	Prolonged sun drying	Mechanical drying
	Over drying	optimum drying
	Delayed picking	Correct picking

IDENTIFICATION AND TRACEABILITY

- The final produce need to be legibly labelled with the product name, month and year of harvest and the name of farmer/farming agency.
- If the produce was tested before, an appropriate label may be used indicating quality approval.
- The products need to be traceable back to the registered farm (and other relevant registered areas) from where it has been grown.

PERSONNEL AND EQUIPMENT

- Key resource persons engaged at the site (such as farm owner/ supervisor) must be familiar with all aspects related to the crop such as, quality requirements of the end product, crop husbandry etc.
- The personnel engaged in cultivation should have basic exposure to subject matters like safety and hygiene.



Protective clothing for workers

- The machinery used for fertilizer and pesticide application must be calibrated at prescribed schedules and calibration certificates / records should be maintained.
- Equipments must be clean and mounted wherever applicable, in an easily accessible manner. Scheduled servicing procedures must be adhered to keep them in working order. Additional care should be taken for cleaning those machine parts that get into direct contact with the harvested produce.
- Workers need to be equipped with suitable protective clothing. Complete sets of protective clothing, (e.g. rubber boots, waterproof clothing, protective overalls, rubber gloves, face masks, etc.) with label instructions and legal requirements as authorized by a competent authority need to be complied.
- All workers handling and/or administering plant protection chemicals, disinfectants, biocides or other hazardous substances and all workers operating dangerous or complex equipment should have certificates of competence .

Permanent and legible signs indicating potential hazards, e.g. waste pits, fuel tanks, workshops, access doors of the plant protection product / fertiliser / any other chemical storage facilities as well as the treated crop etc. must be made available.



Inputs storage shed

Toxicity class of fungicides / insecticides recommended for chilli cultivation

Mancozeb		Slightly toxic
Wettable sulphur		Slightly toxic
Propiconazole		Moderately toxic
Thiophante methyl		Moderately toxic
Copper oxy chloride		Moderately toxic
Chlorothalonil		Moderately toxic
Spinosad		Moderately toxic
Fipronil		Highly toxic
Indoxacarb		Highly toxic

