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A guide to good agricultural practices for commercial production of ginger under field conditions in Jamaica

A guide to good agricultural practices for commercial production of ginger under field conditions in Jamaica

by

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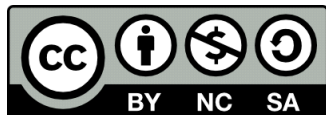
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Foreword

The certification of ginger production in Jamaica is geared towards establishing a system of standardized protocols. These protocols can assist stakeholders in the ginger value chain in achieving optimal levels of production through the provision of healthy planting material. This is in an effort to address the production constraints now being experienced due to the “ginger rhizome rot” disease.

The material contained in this manual introduces the utilization of the single bud technology in field production systems. This technology provides a means of multiplying the limited available clean planting material and its propagation under nursery conditions. This technology forms the basis of the ginger certification programme and when supported by Good Agriculture Practices (GAPs) as described herein should help ginger growers boost their levels of production.

This information has been compiled predominantly from locally validated investigations and accepted norms in the ginger industry worldwide. It incorporates the use of technologies such as drip irrigation, integrated nutrition management and integrated pest management. The aim of this manual is to provide the user with a

step-by-step process flow and thorough understanding of the processes and inputs involved in the application of the single bud technology in ginger field production systems. Please note that this system of production is new to Jamaica and warrants that interested growers receive training and conduct evaluations of this system first in their own environment. Care must be taken to ensure that the recommended practices are followed to achieve the desired result. It is advised where inputs stated are not locally available that the local extension service provider RADA or the MoAF Research and Development Division be contacted.

Dr. Lisa Myers Morgan



Acknowledgements

The Research and Development Division in the Ministry of Agriculture and Fisheries (MoAF) extends its heartfelt thanks and appreciation to the Food and Agriculture Organization of the United Nations (FAO) for funding the project “Support for the development of the Ginger Value Chain in Jamaica” TCP/JAM/3602 (D) valued at USD 212 000. Through this project, FAO provided two International Consultants: (i) Dr. Duraisamy Saravanakumar - Plant Pathologist who provided technical support to improve systems for producing certified ginger and improve production practices for increased productivity by reducing the risks to ginger rhizome rot and (ii) Ms. Bree Romuld - Marketing Value Chain Specialist, who conducted the ginger value chain analysis to identify gaps in the chain that need to be addressed.

Many thanks to Dr. Saravanakumar for his relentless efforts to put this manual together, Dr. Vyjayanthi Lopez, FAO Plant Production and Protection Officer, Mrs. Michelle Sherwood, Deputy Research Director, Crop and Plant Protection Unit, Research and Development Division (R&DD) and Dr. Lisa Myers Morgan, Principal Research Director, R&DD, for providing technical feedback in editing this document.

It is anticipated that this document will prove useful to the Officers of the Rural Agricultural Development Authority (RADA), the Jamaica Agricultural Commodities Regulatory Authority (JACRA) as well as ginger farmers across the island. In the coming years this information will be required in the development of the ginger subsector to create that paradigm shift needed in how certified ginger is grown in Jamaica which can match or exceed the productivity of other ginger produced in countries such as China and India.

Acronyms

CO₂ - Carbon dioxide

FAO - Food and Agriculture Organization of the United Nations

GAP - good agricultural practices

JACRA - Jamaica Agricultural Commodities Regulatory Authority

MoAF - Ministry of Agriculture and Fisheries

pH - potential of hydrogen

R&DD - Research and Development Division

RADA - Rural Agricultural Development Authority

RH - relative humidity

Introduction

Ginger is one of the horticultural spice crops in Jamaica for local and export market. The quality of Jamaican peeled dried ginger is considered among the best in the world, and in the past fetched higher prices on the global market.

Ginger is added as spice and fresh ingredient in recipes. A range of value-added products such as beverages, bakery items, candies, curry powder, ice creams, liqueurs, sauce are prepared from ginger. Ginger reportedly has many nutraceutical properties.

Constraints in the ginger sector include low field productivity, occurrence of the dreadful rhizome rot disease, competition at the global level and requirement of standards for exporting ginger and its products to foreign markets. The Jamaican sector needs to revisit its traditional ginger value chain, in particular the field production system.

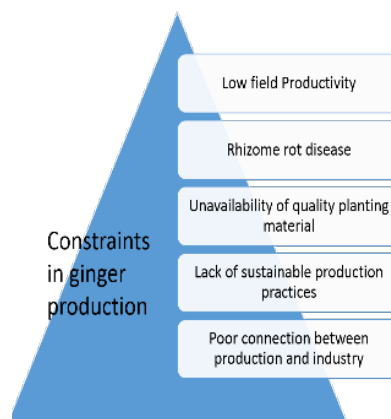
Growing concerns among local and overseas consumers of pesticide use and residues, food-borne pathogens, quality of produce, safety of the producer and the environment, and resource conservation have also mandated the production and processing industries to exercise best practices for quality ginger production in Jamaica.

In this context, this manual has been prepared to provide guidelines on Good Agricultural Practices for cultivation of Ginger in Jamaica.



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Jamaican ginger has high local and export value



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Rhizome rot is one of the major constraints in ginger production in Jamaica

**A guide to good
agricultural Practices
for commercial production
of ginger under field
conditions in Jamaica**

Objectives



Primary objective of this manual is to provide GAP guidelines

The objectives of this manual are to:

- provide on-farm guidelines on Good Agricultural Practices for production of quality ginger in Jamaica for local stakeholders.
- inform the local and export market of standard on-farm GAP practices.

However, the practices presented in this manual are not exhaustive for quality ginger production.

Best practices can be continually evolved through innovative research and practice by the key stakeholders and local authorities. Periodically updating this manual with such best practices would be of benefit to the ginger industry in Jamaica.

Scope

Good Agricultural Practices (GAP) are the guidelines set out for producing safe food and quality produce which are free from physical (soil particles, dirt), chemical (pesticides, heavy metals) and biological (microbial contamination) hazards.

Besides these, the health and safety of personnel involved in agricultural practices and environmental conservation are taken into account in setting out these guidelines.



GAPs are mandated to produce safe and quality produce without compromising environment and personal safety.

This manual has been prepared by integrating general GAPs with the specific practices of ginger cultivation under open field conditions in Jamaica. It includes practices starting from pre-planting to post-harvest processing of ginger. Some practices suggested in this manual may be applicable to specific cases: these are indicated wherever possible. Producers are strongly advised to liaise with local extension agency (RADA) and Research and Development Division (R&DD), MoAF for specific information on the practices.

Field selection



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- Fields selected for planting ginger should be free from contamination such as industry effluents, hospital wastes, heavy metals and pesticide accumulation.

- If a cultivation site has a history of contamination, soil testing needs to be done in accredited laboratories for determining the possible presence of contaminants and mitigating measures (if any) that may need to be applied.



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- Identify new or virgin land area (if possible) for planting ginger to avoid rhizome rot incidence and to increase productivity.

- Ensure that any disturbance from the new planting area to the environment is at an acceptable level. If any adverse risks affecting the environment are anticipated, then develop preventive and mitigation measures.

***Avoid contaminated sites.
Identify new land area***

- Plant ginger at higher altitudes (500 metres above sea level) for better production and productivity.
- Develop field lay out and map the location.



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Sand loam or clay loam with good drainage is suitable for ginger

Soil properties

- Analyse soil samples for pH and nutrient profile in designated soil testing laboratory.
- Plant ginger in sandy loam or clay loam and well-drained soil.
- Soil pH ranging from 5.5 - 8.5 and rich in humus favors ginger cultivation.
- Slightly acidic (pH: 6.0-6.5) soils highly favor rhizome growth.
- Water logged and poorly drained soils should be avoided.



Partial shade and high humidity is favoured by ginger.

Climate requirements

- Plant ginger during late May to early August.
- Grow ginger in locations where warm and humid weather exists.
- Ginger cultivation favours temperature of 19-28°C & Humidity of 70-90%.
- Performance of ginger is better in partial shade. Therefore, growing of ginger in coconut and coffee plantations is encouraged.

Land preparation



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Prepare Raised bed or ridges and furrows.



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Ensure machineries are clean and free from soil dirt before entering field



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Establish ponds and check-dam to harvest rainwater

- Prepare the field to a fine tilt employing 2-3 times of ploughing after receipt of early showers.
- Avoid over-tillage to reduce soil erosion.
- The use of raised bed or ridge and furrow system is recommended.
- When the land has a slope of more than a 20 degree angle, avoid mechanical land preparation
- Prepare contour-based land for steeper hills to avoid soil erosion.
- Before allowing tractor and other machineries inside the land for preparation, make sure they are clean and free from soil particles and dirt from other fields.
- Provide proper drainage to avoid water stagnation in flood prone areas.
- Establish community ponds around ginger cultivation areas to harvest and store rain water for irrigation.
- Establish check-dam in the watershed areas to recharge ground water level near ginger farming areas.
- If there are any chances of entering contaminated water (sewage drain water, waste water from poultry and other industries) into ginger cultivation area, prepare land accordingly to prevent the entry of dirty sewage water.

Soil Solarization



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Practice soil solarisation with clear poly-sheets



Properly dispose of the poly-sheets after use

- Practice soil solarization where the field has a history of rhizome rot disease incidence.
- A raised-bed system is suitable for soil solarization.
- Soil solarization should be done before planting and during long, dry sunshine hours.
- Wet the soil to saturation (either by irrigation or rainfall), seal it with clear polythene sheet and allow for 5-6 weeks of exposure to sunlight.
- Soil solarization is more amenable for small size farming system, where seedlings are prepared in the nursery using single bud technology. Solarization could be implemented during the 5-6 weeks of seedling preparation in nursery without losing cropping time.
- Soil solarization enhances ginger productivity through suppression of disease incidence and enhanced availability of nutrients and organic carbon for crop growth.
- After solarization, ensure proper collection and disposal of poly sheets.

Manuring

- Apply mature organic manure or farmyard manure before planting.
- Check reliability and source of the manure before applying to the field to avoid chemical and microbial contamination.



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Apply organic manure or composting before planting.



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Apply vermicomposting for better production.

- Growing green manure on-farm and incorporation into soil is recommended to enrich soil nutrient status.
- Application of neem cake at the rate of 2 tonnes per ha at the time of planting is recommended for fields with a history of rhizome rot disease and nematode problem.
- Application of vermicompost or compost is recommended at the time of planting (2.5 tonnes / ha) to improve the soil health status and crop growth.
- Do not apply manure from human waste (sludge) to the ginger field.

Planting material

- Source planting material (seed rhizome / ginger seedlings) from certified producers.
- In case of seed rhizome, check for uniformity of rhizome and presence of signs and symptoms of pests and disease.
- Avoid sourcing and use of planting material from disease-affected areas / parishes.



- Liaise with the local extension authority (RADA) for availability and sourcing of quality planting material.
- Store seed rhizome in mesh bags in ventilated storage facility, free from dirt, moist and mould.
- Use a single ginger variety for genetic uniformity.
- Select one of the following local varieties based on the market demand and purpose
- Yellow or white ginger (Rhizome has vibrant yellowing tinge, very aromatic, strong pungency, Moderately fibrous)
- Blue (Royan, Frag) ginger (Rhizome has bluish tinge, is harder and more fibrous than yellow)
- China blue ginger (Rhizome is white with a pale blue ring beneath the skin, very robust and bulky, fibrous, up to 2 cm thick, much larger than but less pungent than traditional cultivar).



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Source certified seed rhizome or seedlings for planting.



©C. Webster

L-R: Hawaiian Blue, Jamaica Yellow & Jamaican Blue

Preparation of planting material

- In traditional rainfed cultivation, seed rhizomes of 30 to 60 g with 2-3 buds are used for planting.
- Spacing of 25-30 cm between plants and 60-75 cm spacing between beds is recommended for seed rhizome planting in the field.
- However, an innovative technology has been developed to raise ginger seedlings in nursery using a single bud to reduce seed rate and rhizome rot disease. ***The single bud seedlings are well-suited***

for the irrigated field cultivation of ginger.

- However, for rain-fed cultivation of ginger, seedlings produced from rhizome with 2-3 buds is ideal.
- Farmers are encouraged to raise seedlings in a nursery using single bud technology for transplanting in the field.
- Otherwise, farmers could source seedlings from certified nursery producers, when these become available.
- Verify nursery certification and permit for selling seedlings when sourcing from nursery producers.



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Use single bud technology for reduced seed rate and disease free planting material.

Single bud technology for production of ginger seedlings in nursery

- A shade house (60% shade) facility is required to produce seedlings using single bud technology.
- Source quality and disease-free rhizomes from certified producers.
- Wash seed rhizome with clean water.
- Treat seed rhizomes with a fungicide registered for use to manage rhizome rot disease.
- Prepare fungicide solution as per recommended dosage.
- Immerse seed rhizomes in the fungicide solution for 30 minutes and shade-dry in a ventilated area.



©G. Mignott

Establish shade house for seedling preparation.



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Prepare single bud rhizomes using sterile sharp knife.

- Cut the fungicide-treated rhizomes into single buds with a size of approximately 5 g using a sharp, sterilized knife.
- Immerse single buds in fungicide solution for 30 minutes.
- Plant single buds in nursery trays (pro-tray) filled with grow-mix - check the source and quality of grow mix before purchase.
- Use locally-available composting materials and technology to prepare grow mix, so as to reduce input costs.
- Apply the recommended dose of fungicides (do not overdose).
- Treat single bud rhizomes with biopesticides (microbial inoculants / biostimulants) if available instead of using a chemical fungicide.
- Place seedling trays sown with single buds under shade house facility.
- Apply need-based irrigation with nursery watering can or suitable sprinklers.
- Do not overwater and cause dampness in the growth media.
- Foliar application of a locally available and registered micronutrient is recommended for 20-day-old seedlings.
- Monitor seedlings for uniformity and freedom from



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Treat single buds with fungicide before planting.



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Plant single buds in trays filled with grow mix/coir and cover the buds with grow mix.



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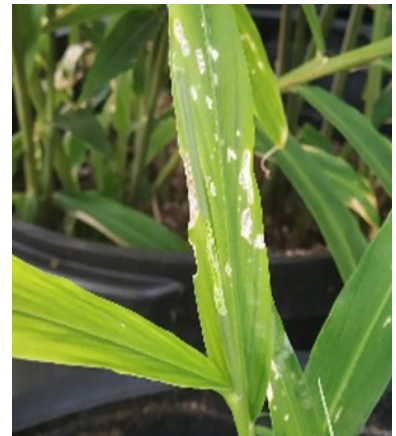
Place trays in shade and monitor for emergence of seedlings.

pest and disease incidence.

- Remove any off-type (abnormal) seedlings from the lot.
- Seedlings should be ready for transplanting at 35-40 days after planting rhizome buds.

Pest and disease on seedlings

- During seedling preparation, ensure that the shade house is clean and fully enclosed to prevent entry of insects (such as worms and leaf feeders).
- Be vigilant for occurrence of *Phyllosticta* leaf spot disease.
- Look for ash-grey coloured, water soaked lesions, round to spindle shaped: if caused by leaf spot disease, these may eventually lead to shot hole symptoms.
- If leaf spot disease severity is more than 3-5%, then application of locally available and registered safe foliar fungicide is recommended.
- Based on availability and efficacy, biopesticides use in ginger is recommended for application, rather than inorganic pesticide, throughout the cultivation process.



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Monitor for insect damage on seedlings.



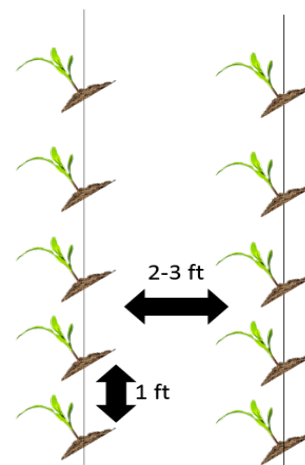
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Apply fungicide to control leaf spot disease

Transplanting of ginger seedlings

- If seedlings need to be transported from nursery to planting (field) area, transportation during morning or in the evening hours is advised.

- Make sure the transport vehicle and hold facility to carry seedlings are clean.
- Make a hole / pit using a stick / pipe for the transplanting of ginger seedlings.
- Use 30 cm (1 ft.) plant to plant spacing in a row and 60-75 cm (2-3 ft.) spacing between rows for providing proper drainage and aeration.
- For best performance, ***it is critical that ginger seedlings raised from single bud technology are provided with irrigation facility in the field.***



Proper spacing and drainage facility must be adopted

Phyllosticta leaf spot

- As mentioned previously, the management of this leaf spot is recommended.

Water quality



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Ensure water free from microbial, pesticide and heavy metal contamination. Test the water for possible presence of Pythium, Fusarium and Ralstonia pathogens.

- Before planting ginger, identify water source for irrigation.
- Water used for irrigation, fertigation and pesticide application should be free from microbial, biological and heavy metal contamination.
- Water used for foliar treatments (fertilizers, pesticides) must be of post-harvest (potable) quality.
- Check the water for possible presence of rhizome rot, yellowing and wilt (Pythium, Fusarium, Ralstonia,

nematode) pathogens.

- Testing of water is recommended for contaminants twice per cropping period for ginger.

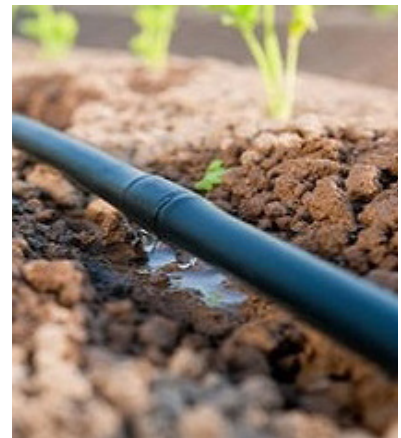
Irrigation

- Analyse the source and quality of irrigation water for pH and electrical conductivity (EC).
- Use drip irrigation to prevent spread of rhizome rot and wilt pathogen, as water use efficiency is increased in drip irrigation.
- Install solar-powered drip irrigation system (renewable energy powered) or gravity based drip irrigation system, if the farm location permits.
- Irrigation is critical for ginger during seedling stages (early weeks after transplanting), rhizome initiation (90 days after planting) and rhizome development stages (135 days after planting).
- Avoid use of sprinkler irrigation in ginger production system.
- Rainfed cultivation of ginger is quite possible with intermittent, well-distributed rainfall patterns. However, irrigated conditions (water made available in dry periods) provide better productivity than rainfed farming.



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Use a gravity based irrigation system.



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Use a drip irrigation system.

Nutrient management

- Ginger is a nutrient-exhaustive crop and therefore requires intensive application of nutrients at the right time.
- Active vegetative growth 60-90 days after planting is followed by slow vegetative growth and rhizome development from 130-190 days after planting.
- Nitrogen-based fertilization is recommended during active vegetative growth (60-90 days after planting) to promote tillering.
- Potassium-based fertilization is recommended during rhizome development (130-190 days after planting).
- Calcium-based fertilization is recommended for better growth and development of the rhizome.
- Apply recommended dose of fertilizers based on nutrient analysis of field soil samples in designated laboratories.
- Liaise with local extension authorities to obtain information on laboratory testing services.
- Application of organic fertilizers is recommended after confirming that they are free from any possible microbial and chemical contaminants as described in **manuring section**.
- For ginger, a blanket recommendation of 150:50:50 kg NPK / ha is advised for better crop growth. This needs to be reduced when organic manure/compost/ green manure are applied.



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Analyse the soil samples for pH and nutrient profiles. Test soil for presence of Pythium, Fusarium, Ralstonia and Nematode pathogens.



Organic manuring and integrated nutrient management is recommended.

- Apply full dose of P as basal application.
- Apply N in three splits, $\frac{1}{3}$ dose at planting, $\frac{1}{3}$ at 45 days after planting and $\frac{1}{3}$ at 90 days after planting.
- Apply $\frac{1}{2}$ dose of K at planting and $\frac{1}{2}$ at 90 days after planting
- Foliar spray of micronutrient mixture at 30 and 60 days after planting is recommended.
- Integrated nutrient management practices are strongly recommended from pre-planting to harvest.
- For organic cultivation, application of organic fertilizers is permitted. Liaise with certifying agency and local extension authorities for guidelines on the use of fertilizers in the organic cultivation of ginger.



Apply N, P, K fertilizer based on soil nutrient profile. Apply N and K splits, while P as basal.

Hilling / Earthing up / Moulding



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Practice hilling for better tillering and rhizome development

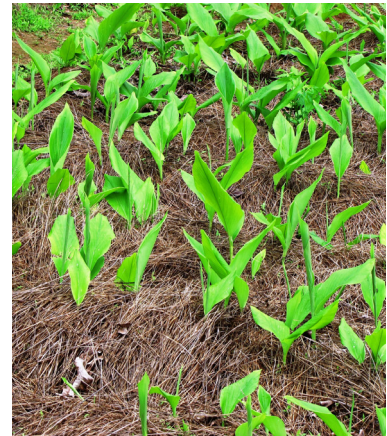
- Hilling is a significant agronomic practice, which provides favourable conditions to increase tillers and rhizome initiation and development.
- Hilling is recommended during fertilizer application.
- First hilling at 45 to 90 DAP and second hilling after 135 DAP are recommended for better yield.

Pest and disease

Weed management

Mulching

- Practice mulching to reduce the weed growth and increase the soil organic content
- Mulching is most suitable for weed management in ginger cultivation.
- Mulching is recommended at 4-6 weeks after planting
- Use cane trash, banana leaves or mango leaves for mulching
- Judicious use of herbicides for the control of weeds on an at-need basis is advised.



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Practice mulching using cane trash, banana or other leaves for better weed control.

Disease management

Rhizome rot, yellowing & wilt disease

- Diseases affect ginger plants from 60 days after planting to harvest. Therefore, vigilance of crop during rhizome development stage is critical.
- Heavy rainfall and water stagnation during the rhizome development stage are indications for possible disease occurrence.



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- Young sprouts are more susceptible.
- Yellowing and wilting of leaves are the symptoms of rhizome rot disease.
- Pathogenic fungi (Pythium, Fusarium) and bacteria (Ralstonia) plus nematode complex are responsible for this disease in ginger.
- White thread like structure on soft rhizome indicates the fungal infection, while oozing of milky white substance from rot rhizome reveals bacterial infection.

Management of rhizome rot and wilt disease

- Do not re-plant ginger in the same field / plot year after year. This practice helps prevent the occurrence of rhizome rot disease. Continuous cultivation of ginger in the same field also results in exhaustion of soil nutrients.
- Rotate ginger with non-host crops to rhizome rot disease to reduce disease incidence and to enrich soil health.
- Non-host crops include cassava, taro, sweet potato and legumes
- **Do NOT** rotate or intercrop with wilt- and rot-favouring crops such as **tomato, hot-pepper, sweet pepper, banana / plantain and turmeric.**
- Intercropping with legumes, Amaranthus (Callaloo), okra, peanut, maize, coconut and corn is encouraged as best companion crops under irrigated conditions.



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Monitoring for wilt and rot during rhizome development is critical. Pythium rot is diagnosed based on the white mycelium on rhizome



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Bacterial rot infection.



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Milky ooze from infected rhizome: streaming test.

- Intercropping of yellow marigold (Tagetes) is recommended for reduction in nematode population. Marketing opportunities for marigold should be established.
- Apply biopesticides from 45 days after planting to harvest at 30 day intervals for the control of rhizome rot disease.
- Depending on the disease severity and coincidence of rainfall with rhizome development, the frequency of application of biopesticides could be increased.
- Use locally available and registered biopesticides (Trichoderma, VAM and Bacillus) as preventive measure for the management of rhizome rot disease.
- In case of severe disease incidence, one or two soil drenches with suitable fungicide (registered in Jamaica) can reduce the disease.
- In addition to application of pesticides, all management practices mentioned in other sections of this manual relevant to rhizome rot disease should be followed for integrated and improved control of this disease.
- Diseased rhizomes should be carefully disposed of, either by safe burning outside the planting area or through collection of infected materials in a community for sterilization / incineration in the designated labs before disposal.
- The infected site should be drenched with suitable fungicide as recommended by the relevant authorities to prevent spread of the pathogen propagules to healthy plants.



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Monitor for lesions caused by nematodes on rotten rhizome.



Dispose infected material through proper sterilization.



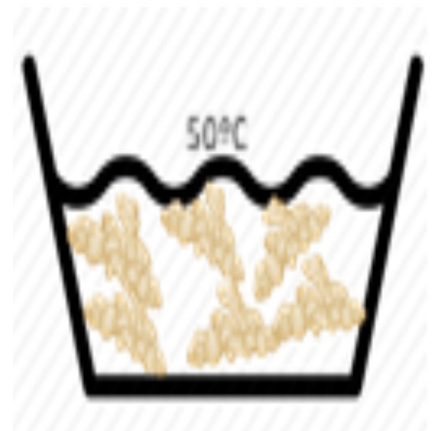
Drench the infected site to prevent spread of pathogens.

Caterpillars & rhizome scale

- Monitor leaves for damage caused by caterpillars.
- Use of neem based and Bacillus thuringiensis (Bt) based products are recommended for the control of caterpillars.
- In the absence of biopesticides and the event of high infestation, apply suitable (registered) insecticides as recommended by the relevant authorities to reduce the damage.
- Hot water treatment (50°C for 10 minutes) before the storing of rhizomes is recommended for prevention and removal of scale infestation. Ensure proper drying after hot water treatment.
- Monitor scale infestation after harvest and during storage of ginger.
- The pesticides registered for use in insect and disease control in Jamaica are given in Annex 1.



Use neem based and Bt based biopesticides for the control of caterpillars



Treat rhizomes in hot water to avoid scale infestation before storage.

Harvesting



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Practice manual harvest in small farms.

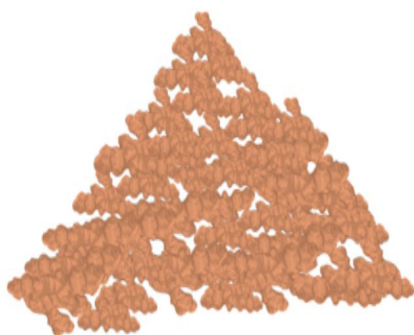
- The purpose for which the ginger is produced determines the stage of harvest.
- For dry ginger, harvest fully matured ginger at 210-240 days after planting.



Use mechanical harvest on larger farms.

- The purpose for which the ginger is produced determines the stage of harvest.
- For dry ginger, harvest fully matured ginger at 210-240 days after planting.
- Turning of leaves to yellow and further drying are indications of fully matured ginger.
- For vegetable purpose, harvest ginger at 180 days.
- Irrigation should be stopped one month before harvest.
- Manual harvest is preferred in small farming systems.
- During manual harvest, loosen the soil around rhizome and lift the rhizome using a digging fork.
- Mechanical harvest on larger farms requires the use of a harvester that is drawn by tractor or power-tiller.

Care at harvesting



Ensure that no soil, dirt and other foreign matter is mixed with rhizome.

- Ensure that no soil, dirt and other foreign matter is mixed with the harvested rhizome.
- When harvest occurs in wet conditions, transport rhizomes immediately to a drying shed.
- Ensure harvesters and machineries used are clean and properly adjusted to reduce contamination from soil and other materials.



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Care must be taken to prevent damage to rhizome.



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Use a power nozzle to remove dirt

After harvest

- Trim roots from the rhizome using a sharp knife.
- Trim foliage about a half inch above the spot where it meets the rhizome.
- Leaving a longer stem helps in drying of rhizomes faster.
- Be careful while trimming the root and stem from rhizomes to avoid damaging the rhizome fingers.
- Wash harvested rhizomes to remove the soil.
- Use a power nozzle attached to a hose to wash soil particles adhering to the rhizomes.
- Use clean and potable water for postharvest washing of ginger.
- Do not break the hands apart if the rhizome is required as a whole.
- After trimming and washing, allow rhizomes to dry fully for an hour or more.

Transportation of harvested ginger



Use clean baskets and transporting holders to avoid contamination.

- Transport harvested ginger in clean and dry conditions.
- Place ginger in clean baskets/dry jute sacks/trailers/well-aerated containers to transport to the processing facility.



Between loads, clean the inside of vehicles used for transportation.

- All carriers used at harvest should be kept clean and contamination-free from previously-harvested plant products and other foreign materials.
- When using plastic containers pay attention to the retention of moisture that could lead to the growth of mould.
- Ensure that the containers are appropriately washed, sterilized and dried between harvests / loads
- Vehicles used for transporting bulk plant materials from the place of production to the place of storage for processing should be cleaned between loads.

Cleaning and grading

- Clean the ginger prior to packaging to obtain highest quality and price.
- Use grading tables, flotation tanks and screens to ensure quality standards.
- Use air screen separator to remove dead insects, excreta and extraneous matter. A rotary knife cutter with a screen separator can help to remove residual insects and other unwanted materials.
- In case of export, strictly adhere to quality and cleanliness specifications required by the importing countries.
- The specifications for grading of ginger are provided in Annex 2



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Use a machine operated washer for cleaning.



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Grade ginger for quality purposes.

Curing



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Use solar drying for better quality ginger and to prevent contamination.

- When ginger is intended for storage, it should be cured by air-drying at 22-26°C and 70-75% RH for up to 14 days to allow the skin to thicken and the cut surfaces to heal.
- Solar drying is preferred compared to sun drying.
- Solar drying minimizes the loss of quality and eliminates microbial contamination.

Packaging and labelling



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Use cart board box or aerated bags for proper packing of ginger.

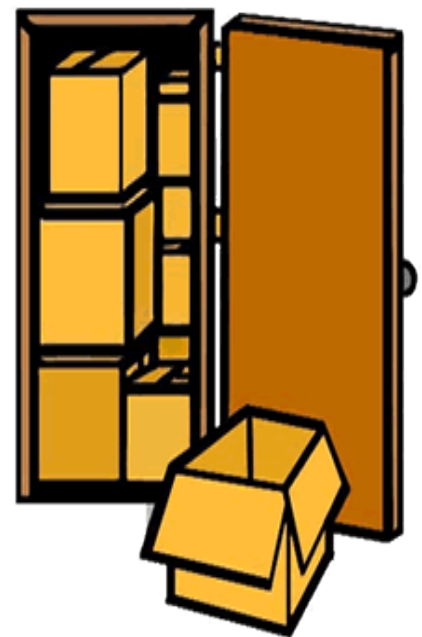
- Prevent mechanical damage during harvest, packing and transporting.
- Discard (and safely dispose) rotten and damaged rhizome at harvest, packing, transportation, storage and processing in order to avoid contamination and loss of quality.
- Use new / clean bags for storing ginger: never use empty fertilizer bags.
- A label affixed to the packaging should clearly detail the name of the ginger variety, the place of production, harvest date and names of the grower, the processor, and any other quantitative information.

- Labeling packages helps handlers to keep track of produce as it moves through the postharvest system, and assists wholesalers and retailers in using proper handling and storage practices.
- Brand labeling packages can aid in advertising for the producer, packer and/or shippers.

Storage facilities and practices

Storage facilities

- Use quality storage both on- and off-farm, with cool stores and warehousing facilities linked to postharvest crop management.
- The room should be fumigated with registered fumigant before storage.
- Fumigation against pest infestation should be carried out only when necessary, and should be carried out by licensed or trained personnel.
- All fumigation, fumigation chemicals agents, and dates of application should be documented.
- Ginger being stored should have moisture levels of 10% or below.
- Store harvested rhizome in a clean dry place, free from insects, birds, rodents and other pests, and inaccessible to livestock and domestic animals.



Keep storage area clean and free from insects, rodents and birds.

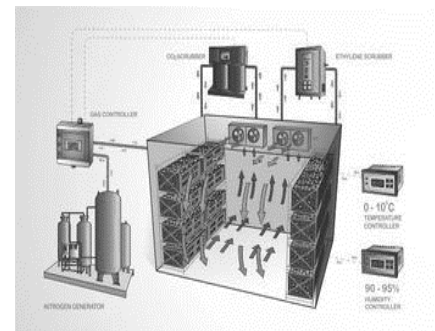
- Install automated devices to regulate humidity, temperature and ventilation, including a dehumidifier to maintain a dry atmosphere and eliminate mould.
- Fresh ginger for use as a spice / condiment can be wrapped in paper towels, placed in a plastic bag and refrigerated up to three weeks. The same package can be tightly wrapped and frozen for up to two months.
- Dried ginger should be kept in a cool, dark space in an airtight container.

Storage temperature

- Ginger can be successfully stored for several months, once healthy, undamaged rhizomes are selected and appropriate postharvest handling and storage procedures are utilized.
- The optimal temperature for storing and transporting ginger is 12°C.
- Holding ginger at ambient temperatures (25°C to 30°C) will result in high moisture loss, surface shrivelling and sprouting of the rhizome.
- Ginger is very sensitive to chilling injury and should not be stored below 12°C.

Storage humidity

- Optimum humidity for storage of ginger is 70-75%
- Dehydration is a common problem when ginger is

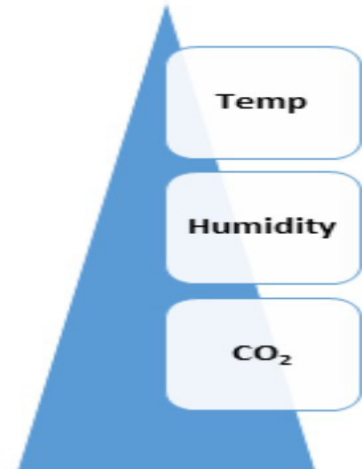


Controlled modified atmosphere facility enhances storage of ginger without loss of quality.

stored below 65% humidity, while humidity above 90% encourages mould infection.

CO₂ in storage

- Due to increased intensity of respiration and associated oxygen consumption, fresh ginger has a tendency to self-heat and to elevate CO₂ concentrations in the hold.
- Ventilation measures are required to counter this problem.
- The supply of fresh air should be controlled with chilled goods in such a way that CO₂ concentration in the storage facility does not exceed 0.4% by volume.



Maintain the temperature, humidity and CO₂ for better storage of ginger

Practices in storage

- Inspecting stored produce and cleaning storage structures on a regular basis will help to reduce losses by minimizing the build-up of pests and discouraging the spread of diseases.
- When inspecting stored produce, any spoiled or infected produce should be removed and destroyed.
- Reusable containers and sacks should be disinfected in chlorinated or boiling water before reuse.
- Placing materials on the floor beneath sacks or cartons of produce prevents dampness from reaching produce. This helps to reduce the chance of fungal infection, besides improving ventilation and sanitation in the storeroom.



Inspect storage at regular intervals for cleanliness and that it is free from pests and spoilage from disease.

Safe handling and disposal of pesticide containers



Triple rinse the pesticide container.



***Quarter fill the container with water
Close the container and shake for
30 seconds.***

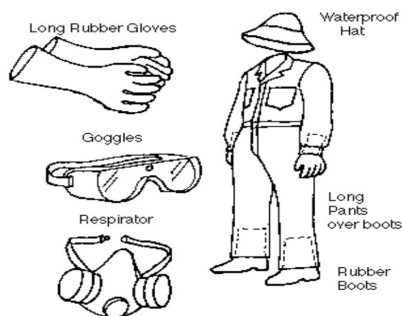
- Source pesticides only from registered sale agencies.
- Store pesticides in their original, labelled containers.
- Read the label carefully and follow all the manufacturer's instructions.
- Do not store pesticides with food, animal feed, seeds, fertilizers, packaging material, water and other material that they could contaminate.
- Store pesticides at room temperature and away from light.
- In case of production for export, do not apply pesticides banned by importing country.
- Use proper sprayer and other equipment (e.g. protective gear) for application of pesticides.
- Regularly check and calibrate the sprayers.
- Clean sprayer and equipment after every use and dispose of the rinse water safely without causing adverse effects to the environment.
- Practice triple rinsing of the pesticide containers before disposal.
- Puncture the pesticide container to avoid any further use.



Empty the container by transferring rinse to pesticide tank.

- Make community arrangements for collection (or use arrangements made by the authorities) and safe disposal of unused/obsolete pesticides and pesticide containers.
- Only trained and licensed pesticide operators should be allowed to apply the pesticides.
- Always operate on the windward direction to avoid contamination and drift to adjacent fields.
- Always adhere to the recommended dose of pesticides.

Safety of pesticide operator



Use personal protective equipment for pesticide operation.

- While applying pesticides, wear personal protective clothing and equipment (hat, mask, google, boots, gloves etc).
- Shower with soap after application of pesticides.
- Change used clothing after application of pesticides.
- Launder used clothing separately from regular clothes.
- The pesticide operator should undergo medical examination once a year to ensure his/her health and well-being.

Personal sanitation and caution

- Persons working in production and after harvest processes should aware of the personal hygiene.



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Provide basic amenities for personal hygiene when processing ginger.

- If not, train persons on hygiene especially in handling of ginger after harvest to avoid microbial contamination.
- Provide proper hand wash stations, toilet and other amenities for workers involved in the production and processing of ginger.
- Persons who are sick should not work in the processing of ginger to prevent contamination. However, this needs to be verified with the supervisor.
- Train farm owner and workers on GAPs of Ginger.

Storing of inputs



Establish storage facility for inputs.

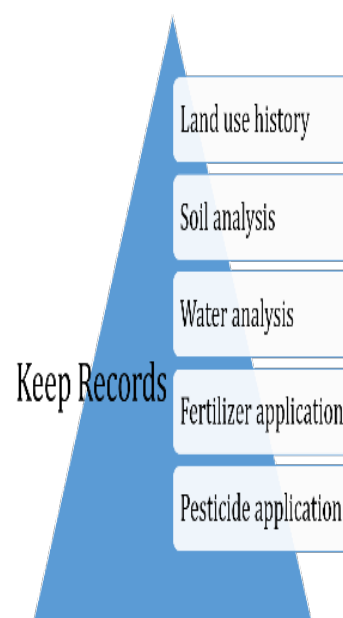
- Establish storage facility for inputs
- Keep fertilizers in a dry, clean and sheltered place.
- Keep pesticides stocks separately with labels.
- Do not allow children and pregnant women into this area.

Record Keeping

Keep record of details of all practices:

- A map and lay out of ginger production plan.
- Land use history for the past three years.

- Water analysis.
- Soil analysis.
- All inputs and cultural practices such as seeds/ planting material (variety), supplementary nutrients, manuring, mulching, intercropping etc.
- Organic and inorganic fertilizer application including dose and date.
- Biopesticide and pesticide application including dose, date, and justification.
- Fresh and dry ginger yield.
- Personal hygiene.
- Medical examination of operator.
- The Records should be retained for a period of three years or as required by national regulatory authorities.
- Farmers are encouraged to contact RADA officers for more information on record keeping.



Maintain farm records as part of good practices.

Traceability

- Traceability allows tracing back to the field production area / producer in case of food safety issues (e.g. above Maximum Residue Level (MRLs)) to investigate causes and to perform corrective action in order to prevent recurrence.

- Assign lot numbers with harvest date and code to ginger in holding, moving and packing for distribution.
- Record market place and buyer and quantity sold.

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Glossary

Biostimulant: Any substance or microorganism applied to a plant to enhance plant growth and mitigate biotic and abiotic stresses.

Biopesticide: Any pesticide made up of, or derived from the biological organism is a biopesticide.

Climate: Weather conditions required for the optimum growing of ginger.

Green manure: Growing of crops and ploughing back into the soil as a supply of nutrients to the main crops.

Grading: Classification or grouping of ginger based on distinct quality, size and/or favourable features.

Hazard: An agent that can pose a potential harm to the human, animal or environment.

Hilling: A practice in ginger where soil is heaped around the ginger plant to encourage tillering and rhizome development.

Irrigated ginger: Growing of ginger with the artificial supply of water using drip irrigation.

Manure: Organic matter derived from farm wastes through composting.

Mulching: The process of covering soil with dry leaves to reduce weed growth.

Rainfed ginger: Growing of ginger crop based on rainfall.

Record keeping: Recording day today activities of the farm practices in a register to keep track of the good practices.

Annex 1. List of pesticides

The following products are registered in Jamaica and contain active ingredients approved for use on ginger destined for US Market April, 2020

Pests	Active ingredient	Trade Name	Toxicity Class	Maximum Residue Level (MRL) - PPM / USA
Coleoptera, Lepidoptera larvae	Indoxacarb	Indox 15 SC	II	0.01
Lepidoptera larvae, whiteflies, leafminers	Acetamiprid	Caprid 20SL	II	0.01
Aphids, leafhoppers, whiteflies, leaf miners	Imidacloprid	Confidor 70WG	III	0.4
Scale insects and mealybugs	Thiamethoxam	Actara	IV	0.02
Armyworms, cutworms, aphids	Carbaryl	Sevin 80 S	II	2.00
Mites, whiteflies & psyllids	Spiromesifen	Oberon 24 SC	III	0.02
Moths, aphids, mites, thrips, leafminers, mealybugs	Abamectin	Cure 1.8 EC	III	0.01
		New Mectin 1.8 EC		
Thrips, flies, moths	Deltamethrin	Definite 2.5 EC	II	0.04
Armyworms, cutworms, worms, beetles, stinkbug and mealybugs	Spinosad	Tracer	IV	0.02
Nematodes: root knot, sting, lesion and burrowing	Oxamyl	Vydate Blue	I	0.1

List of Registered Fungicides for Control of Ginger Rhizome Rot

Disease	Active ingredient	Trade Name	Maximum Residue Level (MRL) PPM USA
Rhizome rot	Etridiazole Thiophenate methyl	Banrot	
Rhizome rot	Etridiazole Thiophenate methyl	Topsin-M 70% WP	N/A
Rhizome rot	Matalaxy mancozeb	Ridomil Gold MZ 68 WP	0.5
Leaf spot	Pyraclostrobin/ Boscalid	Bellis	0.04-0.05
Leaf spot	Difenconazole	Score	4.0
Leaf spot	Azoxystrobin	Amistar	8.0

List of biofungicides for the management of Ginger Rhizome Rot

Disease	Active ingredient	Trade Name	Maximum Residue Level (MRL) PPM USA
Rhizome rot	Trichoderma harzianum	Trichozam 8.3 WP	N/A

**Herbicides registered in Jamaica and Contain Active Ingredients that are Approved for Use on Ginger Destined for USA / Canada/
United Kingdom & Japan Market [May 28, 2019]**

Trade name	Active ingredient	Toxicity Class	Weeds controlled	Maximum Residue Level (MRL) ppm	Remarks
Roundup Ultra	Glyphosate	IV	Broad spectrum (Post-emergent)	0.2	
2,4-D Amine 480 G/L	2,4-D	II	broadleaf weeds (Post-emergent)	0.1	Applied to actively-growing weeds. REI 48 hrs. Use 150-200 litres of water/ha
Reglone 20 SL	Paraquat dichloride	II	Shame old lady, spanish needle, white top, corn grass	0.02	Restricted
GAI-QUAT 200 EC	Paraquat dichloride	II	Grasses, broadleaf weeds	0.5	Local Restricted: Spray when weeds are young and less than 15 cm (6 inches).
Lavax 20 SL	Paraquat dichloride	II	Weed species	0.5	REI 24 Hrs. Do not use in sugarcane fields
Gramoxone Super	Paraquat dichloride	III	Non-selective control of grasses and broadleaved weeds.	0.5	Registered for use in Ja (not on mangoes). Gramoxone super is most effective with complete coverage especially when weeds are over 6 inches tall. Rainfall 30 minutes after application will not significantly affect efficacy; controls most weeds in 3-4 days
Paraquat	Paraquat dichloride	II	Non-selective control of grasses and broadleaved weeds. (Pre-plant)	0.5	Restricted. REI 48hrs. Apply to weeds less than 6inches high for best results.

Annex 2. Specifications for grading of ginger

Characteristics	Grade 1	Grade 2	Grade 3
Size	Not less than 180 g in weight	Not more than 150 g in weight	Not more than 140 g in weight and not less than 100 g
Colour	Skin gray brown and glossy. Flesh light yellow	Skin gray brown and glossy. Flesh light yellow.	Skin gray brown and glossy. Flesh light yellow.
Shape	Thick rhizome with maximum of 3 to 4 branches.	Thick rhizome with maximum of 4 to 5 branches.	Note more than 6 branches
Firmness	Tough rhizome with no surface shrivelling	Tough rhizome with no surface shrivelling	Tough rhizome with slight surface shrivelling
Appearance	Rhizome shall be well trimmed. Completely free from decay, bruises, sprout, pest, green discolouration damage, blemishes and any other defects	Rhizome shall be well trimmed. Completely free from decay, bruises, sprout, pest, green discolouration damage, blemishes and any other defects	Rhizome shall be completely free from decay, sprout and green discolouration.

Rhizome rot: A complex disease caused by a fungi, bacteria and nematode in ginger.

Single bud technology: Establishment of seedlings in nursery using single buds (5-6 grams) of rhizome.

Shade house: A physical structure established using shade nets to produce ginger seedlings using single bud technology.

Soil solarization: The process by which soil temperature is increased to eliminate the pathogenic propagules in the soil by covering it with a clear polythene sheet.

Tillage: Preparation of land for planting of ginger using mechanical force.

Traceability: The process by which the origin of food or ginger could be traced.

Vermicompost: Organic matter derived from farm waste using earth worms.

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