



# AGRICULTURE AND FOOD AUTHORITY

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## HORTICULTURAL CROPS DIRECTORATE

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## WATERMELON (*Citrullus lanatus*) GROWERS MANUAL

## PREFACE

Kenya has been endowed with an enabling environment for production of horticultural crops that attracts high demand both in the domestic and international markets. Production is mainly by smallholder farmers, many of whom require skills and knowledge on good agricultural practices (GAP) to produce and handle the fresh produce. According to the Economic Survey 2022 published by the Kenya National Bureau of Statistics (KNBS), horticulture is among the leading sub sectors in agriculture. Therefore, enhancing the capacity of these producers could be of immense beneficial to the Kenyan economy.

Agriculture and Food Authority – Horticulture Crops Directorate (HCD) is a government agency mandated to Regulate, Promote and Develop the horticulture industry in Kenya. In carrying out its mandate, the Directorate through the Technical and Advisory Services department (TAS) has developed this grower's manual for its stakeholders. The manual has been designed with a simple language and where necessary photos have been used to highlights all processes from plough to plate. HCD envisages that by using this grower's manual, its stakeholders especially the smallholder farmers, extension staff and trainers would upgrade their knowledge and skills to enable them increase production of the crops thereby improving on food security, household health, as well as create employment and generate income.

The content has largely been developed from the TAS field staff experiences in the 26 stations spread across the country (*Collins & Dinah – Nairobi [NHC], Antonina – Nakuru, Miriam - Nandi, Grace – Homabay, Barnabas- Eldoret & Iten, Carol - Bungoma, Peter- Busia, Charles -Kisumu, Irene - Narok, Lal – Kisii, Victor – Mombasa, Crispin – Kibwezi, Esther Ngutho– Kitui, Esther Kabatha – Nyandarua, Susan – Taveta, Syphrosa – Machakos, Catherine – Yatta, James – Kitale, Julius – Kajiado, Amedeo & Brenda – Meru, Mary – Kericho, David & Delphina – Mwea, Fridah – Nyeri, Emma – Sagana, Sarah – Limuru*), some content were reviewed from literature and images used properly acknowledged. Technical editing and reviewing of the manuals were done by Mary Chacha, Syphrosa Wanyama, Barnabas Kiptum, Antonina Lutta, Carol Soita, Amedeo Muriungi, Peter Mwanja, Victor Omari, Emma Ndirangu, Esther Kabatha, David Makori, Dinah Karimi, Collins Otieno, Dr Jacqueline Oseko the acting Deputy Director, Technical and Advisory Services department and Director Benjamin Tito all of Horticulture Crops Directorate.

# WATERMELON (*Citrullus lanatus*) GROWERS MANUAL

Common name: Tikiti maji (Swahili)



## Introduction

Watermelons are very important fruits in the Cucurbitaceae family mainly grown for the local market. Their natural sweetness is bundled with water, vitamins and minerals which nourish the body. L-citrulline, a natural substance in watermelon (specifically in the white part of the rind), has been shown to improve artery function and lower blood pressure by helping blood vessels relax and improving circulation.

Watermelon varieties include Charleston Grey, Crimson Sweet F1, Sunday Special, Princess F1 Sukari F1, Scarlet F1, Pato F1 and Ndovu F1. In Kenya, the crop is mainly grown in Machakos, Kajiado, Makueni, Tana River, Homabay, Lamu, Baringo, Kilifi, Kwale, Elgeyo Marakwet, Meru and Taita Taveta counties.

## Ecological requirements

1. Temperature range – 22°C to 28°C.
2. Rainfall - Annual 400mm-600mm
3. Soils - Well drained and slightly acidic sandy loam, pH 6.0 -6.8.
4. Altitude- 0-1500m Above Sea Level

## Good Agricultural Practices (GAP)

Horticulture industry in Kenya is guided by a code of practice (KS1758-2016 part II) which is a food standard for vegetable, fruits, herbs and spices for both local and export market. The standard aims at ensuring food safety, environmental sustainability and social accountability by following good agricultural practices from production, processing, transportation and marketing of fresh produce. It is essential to keep accurate records for all operations for traceability purposes.

## Soil testing

Soil testing is recommended before planting to guide on fertilizer and manure application.

## Land preparation

Land preparation involves clearing of vegetation, first ploughing and harrowing.

## Planting

Well composted manure should be broadcasted at the rate of 8 tons per acre then worked into the soil 1-2 weeks prior to sowing. Alternatively, apply a handful per planting hole before sowing. Watermelon Seeds are usually planted directly in the field. However, it is also possible to first raise them in a seedbed and transplant into the main field although this can cause disturbances to their root systems. Watermelons can also be grown in containers with appropriate potting mix blended with compost. The seeds are soaked overnight to hasten germination. 80 kg per acre of TSP or DSP is applied into the planting hole and mixed with soil after which, the seeds are sowed at a spacing of 100 – 150 cm between rows and 90 – 100 cm between plants. The recommended seed rate is 0.6 – 1.2 kg per acre depending on variety and spacing.

## Irrigation

There are three critical periods where watermelons need sufficient moisture:

1. After planting to allow fast and even emergence.
2. At early bloom to prevent poor fruit set and misshapen fruit.
3. During fruit development to ensure good melon size. Application of **too much water** should be **avoided** as it may result into fruit splitting and fungal infections.

## Weeding and mulching

Hand weeding should be done regularly to keep the field clean. Avoid injuring the plants when weeding. Mulching of newly established plants is essential using straw and dry leaves.

## Top dressing

CAN is applied in 2 splits:

1. The first split is applied when the plants start spreading, at the rate of 40 kg per acre.
2. The second split is applied when plants are about to flower, at the rate of 80 kg per acre.

## Pollination




Watermelons produce separate male and female flowers. Male flowers are produced initially, followed by production of both sexes usually at a ratio of 1 female to 7 males. The flowers are viable for only one day. Therefore, it is important that an adequate population of pollinating insects (bees) are present every day during the flowering period.





## Fruit pruning





During pruning, remove any dead, diseased, yellowing, infested leaves or shoots at the joint where they are connected to the main stem. Deformed and blossom-end rot fruits should also be removed. Maintain 2-3 vines and remove extra vines. If the market demands larger melons leave 3- 4 well shaped melons per plant. **Do not** prune when vines are wet.

## Pests, symptoms and Control

Integrated crop management (ICM) is the best option for food safety. These methods include scouting for pests, field hygiene, proper spacing, physical methods like use of traps, pheromones, biological methods and others that will only give use of pesticides as a last option.

Watermelon pests, symptoms and control		
Pests	Symptoms	Control
<p><b>Melon Fruit Fly</b> (<i>Bactrocera cucurbitae</i>)</p>  <p>Photograph by Scott, Bauer, USDA</p>  <p><a href="https://agrostar.in/articles?language=hi&amp;state=chhattisgarh">https://agrostar.in/articles?language=hi&amp;state=chhattisgarh</a></p>	<ul style="list-style-type: none"> <li>▪ Larvae usually tunnel into the fruit causing a watery ooze to form on the surface that can later turn brown and resinous.</li> <li>▪ Exit holes by the larvae (2 – 3 holes) are visible on fruit surface.</li> <li>▪ Affected fruit will rot and often fall from the plant prematurely.</li> <li>▪ Larvae can also feed on flowers and plant stems.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Use of pheromone traps and Methyl Eugenol used together with Malathion.</li> <li>▪ Wrap fruits with eco-bags</li> <li>▪ Remove fruits with dimples and oozing clear sap.</li> <li>▪ Kill the maggots by burning, burying or tying collected fruits in black plastic bags.</li> <li>▪ Chemical control is difficult since larvae feed inside the fruit – Use of pesticides, such as Deltamethrin and Trichlofon</li> </ul>
<p><b>Aphids</b> (<i>Myzus persicae</i>)</p>  <p><a href="https://plantvillage.psu.edu/posts">https://plantvillage.psu.edu/posts</a></p>	<ul style="list-style-type: none"> <li>▪ Colonies of green to blackish aphids are found on tender shoots, mainly on the lower leaf surface, where they suck sap.</li> <li>▪ The growth of the attacked shoots is stunted and the leaves are curled and twisted. -Aphids excrete honeydew, which leads</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ensure plants are not water stressed.</li> <li>▪ Biological control e.g., by use of ladybird beetles and parasitic wasps.</li> <li>▪ Use of insecticidal soaps, horticultural soap or neem oil.</li> <li>▪ Crop rotation with non -host plants.</li> </ul>

	to growth of sooty mould, and may attract fruit flies.	<ul style="list-style-type: none"> <li>Proper weed control.</li> <li>Use of pesticides, such as Azadirachtin and Deltamethrin</li> </ul>
<p><b>Red Spider Mites</b> (<i>Tetranychus urticae</i>)</p>  <p><a href="https://extension.msstate.edu/newsletters">https://extension.msstate.edu/newsletters</a></p>	<ul style="list-style-type: none"> <li>Attacked leaves show white to yellow speckling</li> <li>Where there is high infestation, plant is covered with orange cloud of mites and webs.</li> </ul>	<ul style="list-style-type: none"> <li>Adequate irrigation.</li> <li>Mulching to conserve water.</li> <li>Predatory mite.</li> <li>Spray with miticides, such as: Bifenthrin</li> </ul>
<p><b>White Flies</b> (<i>Bemisia tabaci</i>)</p>  <p><a href="https://rajendra07112.weebly.com/silverleaf-whitefly.html">https://rajendra07112.weebly.com/silverleaf-whitefly.html</a></p>	<ul style="list-style-type: none"> <li>Sucking sap.</li> <li>Vector of viral diseases (Cucurbit Yellow Stunting Disorder)</li> </ul>	<ul style="list-style-type: none"> <li>-Use yellow sticky traps.</li> <li>-Use of pesticides such as Lambda-cyhalothrin and Thiamethoxam</li> </ul>
<p><b>Root-knot Nematodes</b> (<i>Meloidogyne spp.</i>)</p>  <p><a href="https://www.researchgate.net/figure/Root-knot-nematode">https://www.researchgate.net/figure/Root-knot-nematode</a></p>	<ul style="list-style-type: none"> <li>Stunting, general weakness, premature wilting, and slow recovery to improved soil moisture conditions</li> <li>Root symptoms cause swollen areas (galls) on the roots of infected plants which result from exposure to multiple and repeated infections.</li> <li>Yellowing of leaves.</li> </ul>	<ul style="list-style-type: none"> <li>Crop rotation of less susceptible crops.</li> <li>Use resistant varieties</li> <li>Use of tolerant varieties e.g. Crimson sweet.</li> <li>Use adequate amount of manure</li> <li>Use of Ethoprophos</li> <li>Use of neem extracts</li> </ul>
<b>Diseases, symptoms and control</b>		
<p><b>1. Powdery mildew</b></p> 	<ul style="list-style-type: none"> <li>White powdery growth starts on lower leaf surface and later on the upper surface.</li> <li>At advanced stage necrotic areas develop on the leaves</li> </ul>	<ul style="list-style-type: none"> <li>Use of fungicides, such as – Sulphur</li> <li>Famoxadime+Cymoxanil– Azoxystrobin + Difenconazole</li> </ul>

<p><b>2. Anthracnose</b></p>  <p><a href="https://www.ipmimages.org/browse/detail.cfm?imgnum=1234189#">https://www.ipmimages.org/browse/detail.cfm?imgnum=1234189#</a></p>	<ul style="list-style-type: none"> <li>▪ Round to angular reddish-brown spots on older leaves. The spots may dry, turn black and tear out</li> <li>▪ Sunken spots on the rind of fruits which may produce pinkish colored ooze</li> </ul>	<ul style="list-style-type: none"> <li>▪ Crop rotation.</li> <li>▪ Plant clean seeds.</li> <li>▪ Use of fungicides, such as: <ul style="list-style-type: none"> <li>▪ Copper Oxychloride when vines start to run, Mancozeb and Azoxystrobin + Difenconazole.</li> </ul> </li> </ul>
<p><b>3. Downy Mildew</b></p>  <p><a href="https://plantpath.ifas.ufl.edu/u-scout/cucurbit/downy-mildew.html">https://plantpath.ifas.ufl.edu/u-scout/cucurbit/downy-mildew.html</a></p>	<ul style="list-style-type: none"> <li>▪ Small, irregular, chlorotic spots on upper leaf surface becoming brown and necrotic; entire leaf may become blighted.</li> <li>▪ Infected leaves tend to curl upward from the margins</li> <li>▪ Gray to purple downy growth may be visible on underside.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reduce canopy density</li> <li>▪ Mancozeb</li> <li>▪ Propineb + Cymoxanil</li> <li>▪ Dimethomorph + Mancozeb</li> </ul>
<p><b>4. Fusarium wilt</b></p>  <p><a href="https://content.ces.ncsu.edu/fusarium-wilt-of-watermelon">https://content.ces.ncsu.edu/fusarium-wilt-of-watermelon</a></p>	<ul style="list-style-type: none"> <li>▪ Wilt symptoms develop from one or few runners</li> <li>▪ Brown coloration on Vascular tissue of lower stem and roots</li> </ul>	<ul style="list-style-type: none"> <li>▪ Crop rotation.</li> <li>▪ Uprooting and destruction of diseased plants.</li> <li>▪ Plant in well drained soils and avoid water logging.</li> <li>▪ Use of certified seeds.</li> <li>▪ Use of well decomposed manure and compost.</li> </ul>
<p><b>5. Gummy Stem Blight (black rot)</b></p> 	<ul style="list-style-type: none"> <li>▪ Brown round or irregular lesions on leaves.</li> <li>▪ Lesions on stem are brown and later turn white.</li> <li>▪ Gum oozes from stem cracks. Affected fruits are soft and discolored</li> </ul>	<ul style="list-style-type: none"> <li>▪ Use of chemical, such as Copper Oxychloride</li> </ul>

## 6. Watermelon Mosaic Virus



<https://extension.usu.edu/vegetableguide/watermelon>

- Mottling of leaves
- Stunted growth, shortened internodes with bushy erect growth for some runner tips.
- Mottled appearance on fruit surface.

- Field sanitation: removal of weeds (act as alternative hosts)
- Control aphids

## Harvesting

Harvesting usually begins 3-4 months after direct planting and 2-3 months for potted seedlings. The watermelon fruit stalk should be cut and not pulled from the vine to avoid damage to the stem end.

Maturity indicators include:

- A dull hollow sound when the fruit is tapped.
- The change from white to cream or pale yellow of the skin area where the melon has been resting on the soil.
- Shrivelling of tendrils on nodes to which melons are attached.
- Slight ribbing on surface of fruit can indicate maturity in some varieties.
- The Brix test is the most objective way of testing maturity. It assesses the total soluble solids of the melon flesh.

## Transport

Packing and transportation of watermelons should be done to maintain quality as per the Crops (Horticultural Crops) regulations 2020.

## Storage.

Watermelons do not store well as they are susceptible to chilling injury and are subject to decay at higher temperatures. Under the ideal conditions 10-15°C and a relative humidity of 80 to 90 % melons can be stored for up to two weeks.

## Gross Margin Analysis.

Gross Margin Analysis (Per Acre)				
Item	Unit	Quantity	Cost/unit	Total cost
Gross income (GI)	kg	30,000	15/kg	450,000
<b>Variable costs</b>				
<b>Inputs</b>				
Seeds	kg	1	30,000	30,000



Manure	tons	8	2,000	16,000
Fertilizers (planting)	kg	80	120/kg	9,600
Fertilizers (topdressing)	kg	120	80	9,600
Fungicide	kg	5	1,500	7500
Insecticide	3lts	3	2,000	4000
Melon fly traps	Pcs.	8	800	6,400
Irrigation costs	-	12x3	1,500.00	54,000
<b>Labor costs</b>				
Land preparation	Acre	1	8,000	8,000
Planting	Man days	6	500	3,000
Irrigation	Man days	12	500	6,000
Weeding	Man days	6	500	3,000
Topdressing	Man days	4	500	2,000
Spraying	Man days	8	500	4,000
Harvesting	Man days	3	500	4,800
Marketing costs	-	-	-	7,000
<b>Total variable costs (TVC)</b>				<b>164,400</b>
<b>Gross margin GM= GI-TVC</b>				<b>450,000-164,400=257,200</b>

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