

Technics of Production Management to Improving **Orange (*Citrus spp.*) Yields among Smallholders** through Better Training

Summary

Orange production provides both nutritional and financial values to the farmers across Africa. However, these farmers do not realize the full benefits due to low yields caused by poor agronomic practices currently being applied. This guide, therefore, highlights key points that farmers need to practice for better yields. Farmers should get it right from the selection of a variety to harvesting practices for high yield and quality to be realized. Better land preparation helps in early weed control and improves water infiltration and root growth. Early weed control ensures efficiency in water and nutrient use during production. Like other plants, oranges require proper nutrition for growth and development of big fruits, both manure and fertilizer could be used depending on the availability and cost. When ready, harvesting of fruits should be careful and gentle without causing injuries.

Keywords: Harvesting practices, soil fertility management, pest and disease management, range production

1. Introduction

Orange is one of the most important fruits in the horticulture industry providing both financial and nutrition values to farmers. Currently, the crop is grown all over the world within 15-40° North and South of the Equator with as USA, Brazil, Spain, Italy, India, South Africa and Egypt leading in production [1]. Common varieties include Valencia, Blood oranges and Washington navel. The growing temperatures range from 13 to 38 °C with an annual rainfall of up to 1500 mm [2]. The crop does well in deep, well-drained soil with a pH range of 6-7.

2. Land preparation

Proper land preparation is required for better weed control and infiltration of water. Depending on the scale of production, farmers may decide to use herbicides or tractor/ oxen-drawn implements to clear the fields for planting. The use of herbicide is more applicable under a pure orange stand system compared to under mixed crop. Under the intercropping system with other annual crops, farmers should carry out 2-3 harrowing to create suitable tilth for planting and growth of such crops. Planting holes should measure 0.5 x 0.5 x 0.5 m each though it can vary from 0.4 m x 0.4 m x 0.4 m up to 0.6 m x 0.6 m x 0.6 m depending on growth stages. When making planting holes, farmers should ensure that all rocks and tree stumps are were removed.

3. Planting

Depending on the orange variety grown (dwarf vs non-dwarf), prevailing climatic condition, the farming system adopted (rain-fed versus irrigated system) and level of mechanization, an inter-row spacing of 3-8 m and intra-row spacing of 3-6 m is commonly used for orange production. Wider row spacing is applicable when considering intercropping (with other food crops, animal feed or agroforestry fruit trees) and mechanization. Planting should be done at the onset of the rains under rain-fed system or any time under irrigated system. The planting process involves;

- Removal of the polythene bag that was covering the roots then putting the seedling in the hole.
- The holes are then filled with topsoil mixed with 10-20 kg (or 0.5-1 bucket) manure/hole.
- Always, ensure that the seedling stems are not covered with soil past the level it was while in the nursery/polythene bags.
- In case of too much wind during transplanting, farmers should use sticks to support the seedlings.
- In the case of grafted seedlings, the bud union should be left about 30 cm above the ground.

- Then water the seedlings after planting. Adequate soil moisture is very important at planting to reduce any early water stress; half-full watering can and one full watering is enough if planting is done during the rainy season and dry seasons, respectively.

4. Intercropping practices

Being a perennial crop with at least about 2 years to the first production, intercropping oranges with other annual crops such as maize, beans, soybean, groundnut, banana, and pawpaw, is applicable. Intercropping ensures weeds are controlled consistently- weed-free field is guaranteed for oranges in the process of controlling weeds for the production of annual intercrops. Also, it ensures that land is utilized fully during the early periods when orange trees have not reached the maturity stage- no land is left idle. For better yields, farmers could plant agroforestry trees such as grevillea as edge plants to act as windbreaks, minimize the spread of fungal diseases and to provide shade.

5. Weed control

Weeds have great impacts on orange production through their influence on farm management operations such as pruning, harvesting pesticide application, fertilizer application, etc. Weeds increase insect populations in the plantation by acting as their alternate hosts. Presence of weeds creates a favorable environment for pathogens that infect the trunk and roots leading to yield losses. Also, weeds compete with oranges for growth factors- e.g. applied fertilizers, water and available space. For better yields, farmers should ensure that fields are weed-free either by cutting/slashing or spraying them with herbicides while carrying out shallow ring hand weeding on the areas around the trees. When carrying out the shallow ring hand weeding, care must be taken to avoid damage to the roots that would increase fungal infections. This practice is optional especially when farmers have maintained good mulch cover around the trees. Cover crops could also be used to reduce weed pressure and the need to carry out hand weeding. Note that herbicide use is only feasible under mono-cropping unless the products are super selective killing only weeds.

6. Pruning

Pruning is the proper and cautious removal of plant parts such as shoots, branches or pinching away of terminal parts to correct and maintain plant structure and increase its usefulness. There are three common types of pruning in orange production;

- Early pruning: This is done on young and growing trees for proper establishment. It involves maintaining a single stem up to a height of 0.6-1 m, then nipping the main shoot to allow for side branching. The side branches are allowed to grow and develop, then pruned, allowing 3-4 main branches for production. Any extra side branches including those growing inwards are removed.
- Mid-season pruning: This type of pruning is done throughout the season of production. It is mainly done to control diseases and pests. Any infested branch is cut, taken out the field and burned. The burning must be controlled to avoid damage to other farms.
- Annual pruning: This is done yearly to open up and maintain the canopy thereby reducing overbearing and incidences of pests and diseases. The best time to carry out annual pruning is at the end of the harvest seasons or at the beginning of the rainy season before flushing. When the trees are producing new leaves and usually accompanied with the formation of flower buds.

7. Mulching

This is the practice of adding a layer of either organic (e.g. plant materials) or synthetic materials on to the soil surface. When properly done, it significantly controls weeds and reduces water losses through evapotranspiration [3]. With organic mulches, farmers would benefit from increased soil fertility through decomposition and mineralization of the materials leading to better yields [4]. When adding mulches, ensure they are never in contact with the graft union region and orange stems to avoid infections. Mulches coming into contact with the stem create damp conditions leading to stem rot incidences and sometimes ant and termite attacks. Under normal circumstances, mulches should be about 30 cm away from the stem and spread to, at least, 1 m in diameter around the tree, though the wider the area covered the better. The depth of the mulch could vary depending on the availability of mulches and the type of

mulch used, 5 to 10 cm thick of organic materials is better.

8. Soil fertility management

Like other crops, oranges require proper nutrition for better growth and yield. Depending on availability and cost, farmers may decide to use manure or fertilizer, or both for production. Use of inorganic fertilizer is challenging due to the high cost while the use of manure is faced with quality and quantity issues. These challenges ~~using that can to highly~~ affect ~~more, the~~ resource-constrained smallholder farmers compared to large scale commercial farmers. The quality issues with locally produced manure could be due to poor storage and decomposition. A farmer may decide to go for;

- **Option 1: Use of organic manure**

This practice involves the use of manure. At planting, farmers should use a half bucket (10 kg) of manure per hole. In subsequent years, supply 1 bucket (20 kg) of well-decomposed manure per tree yearly during the rainy season [5]. Once the trees have reached the reproductive stage, the same quantity of manure should be applied 2-4 weeks before flowering every year. Use of compost encourages ~~good~~ fruit formation and development as nutrients are supplied when demanded.

- **Option 2: Use of inorganic fertilizer**

Here, farmers purely use fertilizer for production. After transplanting, fertilizers are applied in 3 splits during the rainy season- at the onset, midseason, and end-season of rainy periods. A more general recommendation is as below;

- 1st year: Supply 0.120 kg urea/tree/year
- 2nd year: Supply 0.665 kg NPK-17/tree/year
- 3rd year: Supply 1.335 kg NPK-17/tree/year
- 4th+ year: Supply 2 kg NPK-17/tree/year

Both manure and fertilizer could be used together depending on the availability and cost. When applying both manure and fertilizers every year, the rates of fertilizer should be reduced, depending on the quality of manure. The best way to get ~~greater~~ responses within economically optimum levels is to carry soil analysis use of fertilizers is to have a soil analysis done- test soil pH and available nutrients for site-specific recommendations.

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9. Pest and disease management

The prevailing tropical and subtropical climate conditions encourage the survival of several pests and diseases, that cause yield losses. Commonly found important pests include Aphids, False codling moth, Whiteflies, Leaf miners, Thrips, Fruit fly and Common spiral nematode [6]. Also, farmers should expect diseases such as *Pseudocercospora* leaf and fruit spot, *Phytophthora* spp and ~~Orange-orange~~ fruit scab, to attack oranges in the season [6]. These pests and diseases cause varied yield losses depending on the tolerance level of the variety, weather and crop management practices such as nutrition, pruning and weed control. For sustainable management of these pests, proper implementation of integrated pest management (IPM) is required. The IPM is a broad-based approach that integrates practices for economic control of pests in the most promising and environmentally safe option. The broader approach to pest management involves;

- Regular monitoring of the outbreak of pests and diseases and reporting to area specialists for immediate action.
- Use of disease/pest-free planting materials, only use seedlings sourced from a certified producer.
- Maintenance of general hygiene in the farm, keep orange fields weed-free and prune infested branches regularly.
- **Planting** of pest repellent **plants** within the trees, to help in the management of moths, aphids and other leaf miners.
- Ensuring proper water supply and nutrition of the trees, to improve their ~~disease and~~ pest tolerance levels.
- Encouraging the establishment of natural enemies to these pests through planting nectar-producing edge plants (e.g. common vetch, *Daucus carota* (PROTA), coreopsis (*Coreopsis* spp.) or simply bushy live fence and eliminating the use of broad-spectrum pesticides.
- Judicious use of selective pesticides, —The use of any chemicals should be within the recommended rates and timing. This information is provided on the product labels. In the case of

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illiteracy, farmers should seek guidance from area-based entomologist and pathologist. Always, avoid using toxic products- pesticides with acute oral $LD_{50} < 50$ mg/kg and only use pesticides with acute oral LD_{50} between 50-2000 mg/kg, when there are no acceptable alternatives. All pesticides banned for use on oranges and other food crops by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) should be avoided. When making the application, farmers should always put on personal protective equipment (waterproof apron, rubber gloves, gumboots and breathing masks). Proper disposal of chemical remnants and used containers should be guaranteed by following the guidelines outlined on the product labels and summarized by Otieno [7].

Harvesting

The maturity period of oranges varies largely depending on the variety and method of propagation (whether the crops are grafted or raised using seeds). The grafted oranges, e.g. Washington Navel orange, start bearing fruit at about 3 years from planting. Maturity of fruits is indicated by the color change from green to slightly-yellowish. When ready, harvest the fruits carefully without causing injuries—avoid rough harvesting (by shaking of trees to let fruits fall)—as this causes disease infection during storage and transportation. Under the smallholder systems, mature fruits are always hand-picked mainly by women and children who form the majority of the farm labor force.

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