



Best practices for producing rooted apical cuttings and minitubers in a screenhouse

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INTRODUCTION

A lack of access to quality planting materials is one of Cameroon's major potato production constraints. That is why the Green Innovation Centers for the Food and Agriculture sector project (ProCISA) and the International Potato Center (CIP) have worked together to increase the availability of quality seed potato in significant quantities by promoting the construction of screenhouses for seed potato production in the country. To this end, ProCISA built a screenhouse for minituber production on a seed farm managed by the Ministry of Agriculture and Rural Development (MINADER) in Bansa, in the West region. Another screenhouse was built in Bayangam by CIP and then handed over to the Institute of Agricultural Research for Development (IRAD). From these two models, and through various promotional project activities, private investors got interested. They have set up screenhouses in the country but need more knowledge of how to manage them to produce the expected results. These guidelines, therefore, describe the standard practices for apical cutting and minituber production in a screenhouse.

These guidelines provide information on the production of early-generation seed potatoes in a screenhouse.

The guidelines are intended for use by seed potato growers, screenhouse workers, students, researchers, and other interested persons.

I. GENERAL GUIDELINES

- **The minituber production facility should be a screenhouse built with an insect-proof net in an environment with appropriate temperatures (16 -20°C) and altitude for potato seed production.**
- **The screenhouse should be constructed in a location far from potato fields and easily accessible.**
- **Ideally, the screenhouse production area should be preceded by a pre-chamber such that the inner and outer doors are not horizontally aligned to minimize the entrance of insects.**
- **Access to the screenhouse should be restricted to unauthorized persons.**
- **Sanitation is critical to preventing the introduction of pests and diseases into the screenhouse.**
- **Users and visitors must disinfect the soles of their shoes in a foot bath filled with disinfectant at the entrance or wear overshoes before entry into the screenhouse.**
- **Upon entry into the pre-chamber, users and visitors must wash their hands in the sink with soap. This should never take place in the production chamber.**
- **It is also advisable to wear protective clothing, if provided, before entering the production unit..**

II. SUBSTRATE COMPOSITION AND MANAGEMENT

Seed potato multiplication in the screenhouse is done on a pathogen-free substrate. Various types of substrates are used for this purpose.

II.1. Soil-based substrate

- The most common and readily available type is the soil-based substrate. This is made of top-black forest soil, river sand, and manure mixed in the ratio 2:1:1/4; that is, two (2) wheelbarrows of soil, one (1) wheelbarrow of river sand, and a quarter (1/4) wheelbarrow of manure (preferably poultry manure). Alternatively, buckets can be used to measure the substrate components, but the proportions remain the same.
- The soil-based substrate must be steam sterilized for at least 8 hours to avoid contamination from micro-organisms.
- This substrate is used for both minituber and apical cuttings production.

II.2. Cocopeat substrate

- Another type of substrate that can be used for seed propagation in the screenhouse is cocopeat. It is a substrate produced from the outer husk of coconuts which are ground and compacted into blocks.
- The cocopeat contains a lot of sodium salts, which are not ideal for plant growth, therefore, it must be treated by first soaking it in a calcium nitrate solution for 12 hours. A 5 kg cocopeat block requires 20 L of water and 50 g of calcium nitrate.
- After soaking, cocopeat is spread on a sieve net and washed with clean running water while squeezing until the water that drains out is clear. It takes about 5 cycles of pouring fresh water through this medium to lower the salt content.
- The washed cocopeat is dried and loaded into planting pots or trays to produce minitubers or rooted apical cuttings, respectively.

- Note that the cocopeat can be amended with sterilized top black forest soil and manure. Trials are underway in the Djoro Nova screenhouse to determine the most appropriate proportions for this mix.
- For now, the cocopeat used in Cameroon is imported from Nigeria.

II.3. Other substrates

- Substrates such as peat moss could be used for the multiplication of minitubers and cuttings. However, it is expensive and not readily available.

III. POST-VIAL MANAGEMENT OF IN VITRO PLANTLETS

- Removing tissue culture plantlets from the vials or test tubes they arrive in is a very delicate process and always requires strict adherence to hygiene.
- The process is carried out in a screenhouse with an insect-proof net constructed according to the required standards.
- Upon reception from a tissue culture laboratory, in vitro plantlets are checked for possible contamination and physical damage and registered in the screenhouse logbook.
- In vitro plantlets to be used in screenhouses should not be too old.
- The plantlets can stay overnight in the screenhouse with the lids of the vessels slightly open to recover from controlled laboratory conditions. This phenomenon is called acclimatization.



Figure 1. Potato plantlets being acclimatized in the screenhouse conditions at IRAD Bayangam

- The following day, the plantlets are carefully separated from the media without destroying the roots; then, the root system is washed in a fungicide solution (for example, Penncozeb) and/or disinfected with 0.1 % sodium hypochlorite solution (La Croix). The medium from which the in vitro plantlets are removed must be discarded far from the screenhouse since it is suitable for the growth of fungi and bacteria.



Figure 2. Washing the root part of the plantlets in a fungicide solution at IRAD Bayangam

- Cleaned plantlets are transplanted into a sterilized soil-based substrate, or washed cocopeat or another appropriate substrate. The substrate composition and preparation are described in section III above



Figure 3. Washed plantlets being transplanted into a sterile substrate at IRAD Bayangam



Figure 4. Newly transplanted but old in vitro plantlets (left) and plants ten days after planting (right) in the screenhouse in Ngan-Han.

- Label the plant lots and/or varieties right before transplanting to avoid mix-ups.
- The transplants are misted and covered with a transparent polythene sheet to create a microenvironment with humid conditions. They are kept under the polythene sheet, where they are misted daily or as required for 7 – 10 days, or until they are fully established.



Figure 5. Misting (left) and covering transplants with plastic (right) at IRAD Bayangam.

IV. PRODUCTION OF MINITUBERS

IV.1. Crop management

- The plants are managed and protected throughout the crop cycle up to the maturity and the production of minitubers, and no cuttings are harvested on them.
- Once the plants are fully established, they are managed following standard agronomic practices, like a field-grown crop, including hilling up and crop protection.
- Fungal diseases can be prevented by spraying with preventive fungicides, especially during the wet season. In case pests are noticed, appropriate pesticides should be used as soon as the first ones are spotted. In addition, yellow and blue traps can be placed in the screenhouse to control insects that could be vectors of viruses or other pathogens.
- Leaf miners can cause much damage in the screenhouse. They should be controlled by using translaminar insecticides like Abalone or Biotrine.
- There should be a permanent water supply for irrigation and other uses from a clean source free of bacterial and fungal contaminations. Note that unclean irrigation water can be a source of plant diseases.
- During the crop cycle, apply NPK mineral fertilizers as recommended in the CIP seed producer manual. The most common compound NPK fertilizers have a composition of NPK 12-11-18, NPK 11-11-22, or NPK 13-13-21 and should be mixed with another N-rich fertilizer (15-0-0) at the ratio of 4:1 respectively.
- Apply recommended contact fungicides to prevent late blight or treat with systemic fungicides if symptoms are noticed.
- Upon the occurrence of *Alternaria* leaf spot disease, especially on susceptible varieties, apply Chlorothalonil-based fungicides following the manufacturer's guidelines.
- There should be a clear separation between plant lots and/or varieties to avoid mix-ups.
- The plants should be hilled-up during the growth cycle to ensure proper minituber formation and protection.
- No minituber should be exposed to the light until the plants are harvested.



Figure 6. Grown plants in the screenhouse of Bayangam

IV.2. Harvesting and Storage of Minitubers

- After 3-4 months, when the crop shows signs of maturity, the size of the minitubers can be checked. Plants should be dehaulmed one (01) to two (02) weeks before harvest to stop tuber bulking and enhance tuber skin hardening.



Figure 7. Maturing plants (yellowing of leaves) in the screenhouse of Bayangam.

- Harvested minitubers are sorted, graded, counted, and stored, preferably in a well-protected diffused light store (DLS).
- Before storage, the DLS must be well-sanitized and sprayed with pesticides to prevent disease contamination and pest damage.
- The minitubers can be stored in net or mesh bags and placed on shelves to enable airflow.



Figure 8. Minitubers harvested and stored in net bags in Bayangam.

- Ensure the bags are well labeled per variety and seed lot.
- They should be stored separately from field-grown seed potatoes, preferably in separate storage facilities.

V. ROOTED APICAL CUTTINGS TECHNOLOGY

V.1. Production of apical cuttings

- Three (03) to four (04) weeks after planting in vitro plantlets, the first apical shoots can be harvested.
- Nobody should touch plants and/or equipment unless instructed and/or trained by competent personnel.
- Sterilize scalpels or scissors with a 70 % alcohol solution before making cuttings.
- Cuttings should be done in the early morning hours or evening hours just before sunset. Cutting is not advisable during the hot hours of the day.



Figure 9. Mother plants maintained at a juvenile state with apical shoots ready to harvest.

- With a sharp scalpel blade or scissors, cut the apical shoots at the second internode from the base of the plant. This will allow new apical growth to continue from the two growth points left on the plant. Harvest at the third internode only when the plants are strong and sturdy.



Figure 10. Freshly harvested apical cuttings in the Bayangam screenhouse

- Harvested apical cuttings are prepared for planting by removing all base leaves to leave only two (02) apical leaves.
- Immediately put the freshly harvested apical cuttings into clean water in a clean plastic container to avoid dehydration.
- The cuttings must be planted within 2 hours of harvest.
- Optionally, the base of the apical stem cuttings can be dipped in a rooting hormone before planting in the sterile substrate. A 1 % solution of indoleacetic acid (IAA), indole butyric acid (IBA), or 1-naphthaleneacetic acid (NAA) can be used. Alternatively, a drop of the rooting hormone solution can be applied to each cell of the tray after planting the cuttings.



Figure 11. Rooted apical cuttings growing in trays in the Ngan-Ha (left) and Djutittsa (right) screenhouses.

- The substrate should be humid before planting and planting holes should be created in the substrate pots or beds before sticking in the cuttings.
- Mist with clean water immediately after planting cuttings in the holes to keep them moist.
- Continue misting cuttings once a day as you increase intervals until roots develop (in 10 to 14 days).
- The harvest process can be repeated every 5 to 7 days, or when apical shoots appear ready for harvesting, until the mother plant goes into senescence.
- Rooted cuttings can be stored in a hardening unit for one week or until ready to deliver to farmers.
- Be sure to wait until rooted cuttings are at the right stage – not too small and not too long – when they are taken out of the screenhouse for planting in the field.



Figure 12. Rooted apical cutting ready for field planting

V.2. Maintenance of mother plants

- For good quality apical cuttings, do not allow compound leaves to develop on the mother plants. To this end, keep cutting shoots on mother plants to ensure they maintain a simple and juvenile state. Mother plants will mature quickly if cutting shoots are not timely harvested.
- The conditions outside will determine shoot and root development: warm conditions or bright days promote rapid growth, which means shoots must be cut more frequently.
- The crates mother plants are grown in must be tall enough to permit hilling.



Figure 13. Stock of productive mother plants with juvenile leaves in the screenhouse of Bayangam.

- Remove any leaves that drop into the crate/pot during harvesting to avoid the development of fungal diseases. Also, eliminate very large leaves from the lower part of the mother plants, as these create a humid environment favorable for fungi development.
- Only cut shoots from mother plants that are green and healthy, as unhealthy shoots result in unhealthy cuttings. Yellowing is an indication of nitrogen deficiency. Therefore, mothers/sub-mothers must remain well-fed with nitrogen-rich fertilizers.
- In the propagation phase, scouting for pests and diseases must be done regularly, and treatment must be applied promptly when they are detected.
- Fungal diseases can be prevented by spraying with preventive fungicides, especially during the wet season. If pests are detected, appropriate pesticides should be used as soon as the first ones are spotted. In addition, yellow and blue traps can be placed in the screenhouse to control insects that could be vectors of diseases like viruses.
- When doing any of the processes above, disinfect hands regularly.

VI. SCREENHOUSE MAINTENANCE

- Ideally, screenhouses for seed potato production should be isolated from all field agriculture to prevent the introduction of pests and diseases.
- The two screenhouse doors shouldn't be opened simultaneously because that facilitates access of pests into the screenhouse.
- Clear all weeds from the screenhouse premises and avoid using ornamental plants to landscape near the screenhouse.
- The screenhouse and its environs should be constantly sprayed with insecticides to keep insects that could be vectors of viruses or other diseases at bay.
- Yellow and blue sticky insect traps should be used in the screenhouse to monitor the presence of aphids and thrips, respectively.
- Staff should be well-trained to manage operations in the screenhouse.
- Screenhouse workers or visitors should not enter the screenhouse if they have been working in the field. Workers can carry aphids, thrips, or other insects from field-grown plants into screenhouses on their clothes or hair.
- The entire screenhouse must be adequately sealed so that no insects can enter the production unit.
- When entering, the outer door should be opened first, and the inner door must remain closed until the outer door is shut. Open outer and inner doors at different times.
- The screenhouse should be thoroughly cleaned and disinfected after every crop cycle to prevent pest and disease infestations. In addition, floors, irrigation equipment, pots, and any other equipment used for crop production should be sanitized between cycles. This means that at least once a year, the screenhouse should be empty for thorough cleaning and maintenance.
- Dust usually accumulates on the screenhouse net, especially during the dry season. It is, therefore, imperative to wash it with clean water to remove or reduce dust particles. Clean with water the inside and outside of the insect-proof net and walls to remove dust and disinfect with a 0.25 % sodium hypochlorite solution. ALWAYS use gloves when handling sodium or calcium hypochlorite.

- The lower part of the net should be gently scrubbed with a bristle brush using soap and water. This practice removes any mold that may develop on the net during the rainy season.
- Check that there are no holes in the screens or doors through which insect pests can get in.
- In the case of the pre-chamber, it is crucial to do a thorough cleaning once a week with 0.25% sodium hypochlorite, including the floor and walls. It is also necessary to change the hypochlorite solution used for disinfecting footwear on a weekly basis.

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CIP is a research-for-development organization with a focus on potato, sweetpotato and Andean roots and tubers. It delivers innovative science-based solutions to enhance access to affordable nutritious food, foster inclusive sustainable business and employment growth, and drive the climate resilience of root and tuber agri-food systems. Headquartered in Lima, Peru, CIP has a research presence in more than 20 countries in Africa, Asia and Latin America.

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