



GENERAL PLANT CARE AND PEST CONTROL

Zea mays

DISCLAIMER:

This protocol has been developed by members of the Integrated Plant Growth Facility at the Donald Danforth Plant Science Center, St. Louis, MO. Recommendations provided herein assume that plants are (1) grown in facilities within the Midwestern United States, (2) within greenhouses and/or growth chambers under the artificial light and environmental conditions stated below, and (3) produced for research purposes only.

LAST EDITED: FEBRUARY 2024

Introduction

The following protocol is designed for the growth of inbred maize lines. Both plants produced in tissue culture and commercial hybrids will need some modifications to accommodate the relative differences in plant size.

Environmental Conditions

1. **Day length:** 14-16 hours
2. **Temperature:** 28°C day, 22°C night
3. **Humidity:** minimum 40% RH
4. **Light:** Supplemental LED lights turn on when the sunlight is below 600 W/m² during daytime hours.
5. **Shading:** The shade curtain automatically closes only when required for extra cooling.

Seed Germination

1. **Containers:**
 - a. If you plan to transplant to a larger container two weeks after sowing (recommended):
 - i. and have 32 or less seeds to sow, use #250 pots plus a #250 carry tray and place into a 10 X 20 flat without holes (aka a No Hole tray).
 - ii. and have more than 32 seeds to sow, use a deep 50-star plug tray in a 10 X 20 flat without holes (aka a No Hole tray).
 - b. If you plan to transplant to a larger container three weeks after sowing, use deep 1801 pots plus an 1801 carry tray and place into a 10 X 20 flat with holes.
2. Fill the pots to the top with **ProMix BX** soilless media. Do **not** compact the soil and brush off excess so that soil is level with top of pots.
3. Moisten soil so that it is wet all the way to the bottom.
4. Sow seed 1.5 cm. deep with the embryo pointed downwards and cover with soil.
5. Place flats in the location assigned by your approved space request.
6. Seedlings will be watered as needed after emergence. (Plug trays get bottom watered.)

Transplanting

1. Maize seedlings are transplanted two weeks after planting (stage V3 or V4). Fill a 2.5-gallon pot approximately $\frac{1}{2}$ to $\frac{3}{4}$ full of Berger BM7-35% soilless media. Smaller inbreds (A188, H99, HiII) will do better in 2-gallon pots. Tap the pot lightly to settle the soil – do not compact.
2. Take seedling out of container and put into pot. Set the seedling so that the first leaf collar is positioned 3-4 cm below the top rim of the pot. The stem below the first leaf collar will be completely buried after the soil settles.
3. Add soil until it is 1-2cm below the rim. Lightly rock pot to settle soil – do not compact.
4. Top dress with True Organics Tomato and Vegetable Food (replaced Tomato Maker 11/29/23), 15-9-12 Osmocote, and chelated iron on the soil surface, avoiding contact with the stem. The amounts to apply per pot size are listed on the fertilizer containers in the potting rooms. (See below for more information.)
5. Place plants in the location assigned by your approved space request.
6. Lightly water the pots with tempered water until soil in the top half of the pot is moistened.
 - a. Do not saturate the entire pot – this can cause the soil to dry too slowly and cause health issues for the young plants. Please contact DDPSC PGF Staff if you would like assistance or a demonstration.
 - b. The soil will settle to be about 4-5 cm. below the rim to allow head space for watering.

General Plant Care

Watering

1. Until the plants reach the rapid growth stage (approximately V8), they are watered only when the pots are very light in weight. This provides the conditions necessary for good root establishment. Plants should stay on raised tables until they are well rooted and can be lifted by the stalk (approximately V8). This takes about 18-25 days after transplanting depending on the season.
2. The pots are then moved to tables on the floor to prevent tassels from getting too close to the lights. Now in the rapid growth stage, plants are watered generously as the reproductive stage approaches. Plants are lifted by the stalk to determine water loss by feeling the weight and watered when slightly below container capacity.
3. After pollination, water use decreases, but pots are still kept very moist for the first two 2 weeks.
4. The pots are allowed to get increasingly dry during the 3 – 4 weeks post-pollination, until watering is stopped on day 28.

Fertilizer

1. Maize plants are fertilized at every watering during the week since they dry down at different rates, using Jack's 15-5-15 Ca-Mg diluted to 200 ppm nitrogen. (See next page for more

(*Zea mays*)

information.) Plants are fertilized throughout their life cycle. Tempered water is used on the weekends to flush excess salts.

2. Some corn plants may develop rippled or “torn” edges on the leaves due to an environmentally induced calcium deficiency. In severe cases the leaves wrap tightly around each other and eventually rot. Plants can also be stunted. Careful avoidance of overwatering of young plants will help. This occurs more commonly during the winter when conditions favor low evapotranspiration. Certain varieties are more susceptible (such as tip whorl rot in young B104 and “buggy-whipping” of older B73.)

Pollination

Pollinations are the responsibility of the researcher. PGF staff can do pollinations on a contractual basis.

1. Cover emerging ears with a shoot bag before the silks are exposed. Snug the bag down tightly to prevent it from blowing off during pesticide sprays.
2. Begin preparation for pollination when the tassel begins to shed pollen. New anthers will continue to open and shed pollen over several days. During this time, choose and prepare ears for crossing.
3. Silks may be emerging from the primary ear concurrent with pollen shed or the tip of the ear may need to be cut off for silks to emerge over the next 1-2 days. On the morning of the day before pollination, cut the emerging bunch of silks to about one inch in length. If silks have not emerged, but are developed in the husk, cut the top of the ear off about one-half inch past the tip of the cob and replace the shoot bag. Clean the scissors with ethanol wipes between plants. The next day a “brush” of silks should be emerged and ready for pollination.
4. On the afternoon of the day before pollination, bag the tassel with a 401, 402, or 404 bag. Fold the bag in half lengthwise and place it over the tassel. With the stem pressed into the crease of the bag, pull both the bottom corners together, and fold them together back towards the stem into a triangle. Staple or paperclip the folds closed tightly against the stem to prevent pollen from falling out.
5. The day after bagging the tassel, fresh pollen will develop. Pollen grains are viable for 3-4 hours and are usually shed in the late morning, depending on temperature and humidity, therefore pollinations are best made before noon. Viable pollen is white to pale yellow and has a shiny appearance. Carefully bend the tassel sideways and tap the bag to knock the pollen off the anthers. Some corn varieties (such as B73) have stiff stems that easily break when bent, so the entire plant may need to be tilted to collect pollen. Open the bag to remove the tassel.
6. Tap the bag so the anthers and pollen fall into the center fold. Tip the bag down and tap so that the lighter weight anthers fall out of the bag ahead of the pollen.
7. Pour the pollen on the silks and immediately replace the shoot bag. If repeated pollinations are desired over the next 1-2 days, re-bag the tassel. At the time of the final pollination, use the tassel bag to cover the ear. **Record the date** and the cross information on the bag with a black Sharpie (doesn't fade) and snug the bag down securely between the ear and the stalk. This helps the bag stay on during pesticide sprays. Recording the pollination date clearly helps PGF staff irrigate each plant appropriately based on the time since each pollination.

Seed Maturation

1. Check developing ears at least weekly for smut and mold.
 - a. Beginning one-week post-pollination, ears should be inspected for the presence of smut galls. Feel the ear for any swellings inside the husk that are significantly larger than a developing kernel. If found, please immediately contact PGF staff for removal and devitalization.
 - b. If mold is growing on the silks or top of the ear, partially peel back the husks and remove moldy growth.
2. Two weeks after pollination, bags should be removed from around the ears to allow for better mold and pest control. Continue to inspect for smut galls. The bag can be folded flat and either snugly slipped between the leaf sheath and the stalk or wrapped around the stalk above the ear and stapled to itself.
3. Please have the pollination date easily visible so staff can water according to days after pollination.
4. Three weeks after pollination, husks may be peeled back completely to prevent seed from molding.

Harvesting

1. At four weeks post-pollination, irrigation is discontinued, but the ears are not yet fully mature. Over the next 7-12 days, the seeds will continue to receive nutrition. Full maturation is evidenced when the milk line disappears and a black line at the seed base forms.
2. When the seeds are fully mature, harvested ears may be placed in the dryer for a few days, or shucked immediately. The PGF has a seed moisture meter that can be borrowed to determine % moisture. For long term storage, we recommend a moisture content of 12-13%. ¹
3. Promptly discard the remaining corn plants into a biowaste container.

Pests/Diseases

The greenhouse staff routinely scouts for pests. Biological control agents (BCAs) are released every two weeks. Pesticides may be sprayed weekly in entire houses or small outbreaks of pests may be spot treated with pesticides as needed.

Common pests:

1. Two-spotted spider mite. The predatory mite, *Neoseiulus californicus*, provides good control. Occasional sprays of miticides may be used. Oils and soaps can cause phytotoxicity to maize and are not used.
2. Thrips. Western Flower thrips, chilli thrips, and *Echinothrips* can be problems, especially on young plants. *Amblyseius swirskii*, *Orius insidiosus*, *Stratiolaelaps scimitus* and *Dalotia coriaria* are used to attack different parts of the thrips life cycle. Pesticides are also used.
3. Aphids. Bird cherry oat aphids and corn leaf aphids occur sporadically and can interfere with pollinations and proliferate under shoot bags. Small infestations can be treated by hosing plants

(*Zea mays*)

and spraying foliar pesticides. Widespread infestations are treated with systemic insecticides applied as a soil drench. Biological controls, such as *Aphelinus abdominalis*, can limit populations but do not control aphids to acceptable levels.

Disease: Sporadic infections by the fungus *Ustilago maydis* (common corn smut) may infect the ears, causing the kernels to develop into gray galls. As the gall develops, it swells and eventually bursts emitting masses of black spores. Early detection and removal of galls before they sporulate is the key to preventing further outbreaks. Signs with Danforth procedures for smut control are posted on the inside of corn greenhouse doors. (See below for more information). While the greenhouse staff can monitor plants for developing galls, it is the responsibility of the researcher to check all ears under bags for galls beginning 7 days post pollination, and at least twice weekly after that.

Additional Information

Lights: Supplemental light is supplied by FLUENCE VYPR 2p LED lights with PhysioSpec Greenhouse spectra.

Supplemental fertilizers:

True Organic Tomato & Vegetable Food

[Tomato & Vegetable Food - True Organic](#)

Osmocote® 15-9-12, 3-4 month

https://multisite-assets.icl-growingsolutions.com/wp-content/uploads/sites/12/2023/01/09195710/A903206_Osmocote_Plus_15-9-123-4M.pdf

Sprint® 330 10% chelated DTPA iron chelate

<https://betterplants.basf.us/products/sprint330.html>

Fertilizer Top Dressing for Maize Transplants	
Pot Size (gallons)	Tomato Maker Osmocote 15-9-12 Sprint 330
1	1/2 tsp. each
2	2/3 tsp. each
2.5	3/4 tsp. each
3	1 tsp. each

(*Zea mays*)

Fertilizer for constant liquid feed (CLF):

JR Peters 15-5-15 Plus Ca & Mg (@200ppm N) and Sprint 330 (@14ppm Fe)

<https://www.jrpeters.com/15-5-15-ca-mg-lx>

<https://betterplants.basf.us/products/sprint330.html>

Containers:

T.O Plastics trays and pots, <https://www.toplastics.com/horticulture>, or similar

2.5" pot: SVD-250 product code 700003C

2.5" carry tray: SPT-250-32-PF product code 705104C

50 Star plug tray: PL-50-STAR-DP-VH product code 720568C

3.5" deep sheet pots: SOP-18-DP product code 730649C

Standard no hole flat: STF-1020-HW-NH product code 710240C

Standard flat w/holes: STF-1020-OPEN product code 710245C

<http://nurserysupplies.com/traditional-nursery-products/blow-molded-nursery-containers/blow-molded-classic-line>

Procedures to Reduce Common Corn Smut Disease



Reduce infection routes:

- Bag all ears, including secondary ears, before silks emerge.
- Disinfect scissors before every cut using Physan 20 (provided in a spray bottle).

Limit spread of inoculum:

- Inspect ears for galls daily beginning 7 days post-pollination.
- Mark pots of infected plants with red plant labels and notify greenhouse staff the same day.
- Do not remove galls. Greenhouse staff will remove and package galls for autoclaving.
- At harvest, place labels, soil, and plants in red bags before removing from the greenhouse.

(*Zea mays*)

References

1. SDSU Extension iGrow Corn Best Management Practices, Chapter 6: Corn Seed Testing, p. 2. 2019