



Primula Season Primer

Sakata Ornamentals





Table of Contents

Sakata Primula Genetics.....	1
Plug Stage.....	2
Transplanting/Media.....	3
Light Quality.....	4
Fertilizer.....	5
Initiation.....	6
Scheduling.....	7
Height Control.....	8
Physiological Disorders.....	9
Pests & Diseases.....	10

Primrose Trivia

Native to western and southern Europe

Usually heralding spring, the primrose often signifies eternal love, youth and purity. They were sometimes used in love potions.



Sakata Seed Primula genetics

- Sakata offers a wide selection of Primula acaulis and polyanthus genetics with outstanding features and benefits.
- More than 50 years of breeding experience with research stations in both Japan and Denmark, offering options to growers in both warm and cool climate areas.



Danova Mix

Primula Breeding Goals

- Uniformity in plant habit
- Excellent seed quality
- Compact, strong and healthy plants
- Dark green leaves
- A uniform rosette without side shoots
- Large flowers
- Clear colors
- Non stretching flower stems
- Short flowering window



Danova Yellow w/Eye

Sakata Seed Primula acaulis Lovely Series

- Extra early flowering, semi-miniature type bred in Japan.
- Extra dwarf and compact plants with small leaves. The plant height is approximately 3.25 inches/8 cm.
- Under low light intensity, plants remain dwarf and compact and do not show excessive overgrowth
- Flowers are 1.5 inches/4 cm. in diameter and are borne in great abundance
- An ideal item for production in small pots, 3 inch /7.5 cm.
- Saves valuable greenhouse space due to their compact growing habit
- Seed sown in mid-June will flower for early December through January sales



Lovely Mix

Sakata Seed Primula acaulis Pageant Series

- Extra early type bred in Japan to flower with a minimum exposure to low temperatures
- From a May/June sowing with night temperature of 40-45°F/5-7°C, Pageant flowers from December to mid-January
- Flowering season and plant habit are extremely uniform
- Very compact plants with small foliage
- Ideal for early sales
- Highly economical and popular for commercial growers
- Extra early flowering habit means substantial savings in heating costs
- Compact habit saves valuable greenhouse space
- Hybrid vigor - seed can be sown in August for February shipping.



Red Bicolor



Mix

Sakata Seed Primula acaulis Dawn Series

- Early flowering series bred in Denmark blooming 2 weeks earlier than Danova.
- Offers a high percentage of marketable plants
- Extremely uniform in plant habit
- Consistent, large flower size
- Short flowering window
- High germination standard, 90% +
- Greatest number of useable seedlings for improved profitability
- Colorful pot and bedding plant for patio containers and garden displays.



Mix

Sakata Seed Primula acaulis Danova Series

- World market leading series bred in Denmark for the early to mid-early sales season.
- Offers the highest percentage of marketable plants
- Extremely uniform in plant habit
- Consistent, large flower size, 2-2½ inches/5-6 cm. in diameter
- Largest assortment of pure, bold colors making it easy to compose highly saleable mixes
- Very high germination
- Colorful pot and bedding plant for patio containers and garden displays



Danova Mix

Sakata Seed Primula acaulis Danova Series

- Center flowering for a beautiful bouquet of gorgeous large flowers.
- Unbeatable impact for impulse sales!



Sakata Seed Primula acaulis Designer Mixes



Fairy Dust Mix (Daniella)



Wishing Well Mix (Danova)

Sakata Seed Primula acaulis Designer Mixes



Sunburst Mix (Danova)



Painted Ladies (Danova)

Sakata Seed Primula acaulis Designer Mixes



Fireworks Mix (Danova)



Paint Box Mix (Danova)

Sakata Seed Primula acaulis Meteor / Bicolor Series

- For the early to mid-early sales season bred in Denmark.
- Eye-catching bi-colored supplement to the Danova series.
- Beautiful vibrant bicolors to complement the pure colors of the Danova series
- Consistent, large flower size, 2-2½ inches/5-6 cm. in diameter
- Same excellent seed quality as Danova
- Same outstanding earliness and uniformity as Danova
- Slightly more vigorous plant habit than Danova
- Colorful pot and bedding plant for patio containers and garden displays



Meteor Mix

Sakata Seed Primula acaulis Delight Series

- Mid-early segment bred in Denmark.
- A unique new series with delicate colors that matches Danova's flowering window.
- Under cool temperatures the foliage develops a bronze tone.
- All flowers feature a signature red ring in the center .



Cherry – Almond Blossom

Blueberry - Strawberry

Rhapsody in Blue



Danova Sky Blue, Danova Blue, Delight Blueberry

Sakata Seed Primula acaulis Daniella Series

- A quality leading series for mid-season to late-season sales bred in Denmark.
- Targeted to flower 2 weeks after Danova
- Same excellent seed quality as Danova
- Same outstanding uniformity and plant habit as Danova
- Consistent, large flower size, 2-2½ inches/5-6 cm. in diameter
- Eye-catching color range.



Daniella Scarlet



Daniella Pink Imp.



Daniella Blue



Daniella Mix



Daniella Apricot

Sakata Seed Primula acaulis Daniella Series



Daniella Neon Rose - *New*

Sakata Seed Primula acaulis Rosanna Series

- Mid-season type bred in Japan that flowers along with Daniella.
- Highest number of marketable plants
- Beautiful, large rose bud flowers sure to create impulse sales
- Unique eye-catcher for patio plantings and gift plant sales
- Vibrant, attractive color range.



Rosanna Mix

Sakata Seed Primula polyanthus SuperNova Series

- Early season F1 hybrid, bred in Denmark, that flowers along with the Dawn series.
- Highest number of marketable plants.
- Large showy umbels on strong, multiple stems.
- Wide range of color choice.
- Continuous, colorful flowering.
- Multiple uses, including pot plants, patio containers and garden plants.
- Well suited for landscaping and winter flowering in moderate climatic regions.
- Easy maintenance for landscape gardening.



SuperNova Red

Sakata Seed Primula polyanthus SuperNova Series

- Multiple uses, including pot plants, patio containers and garden plants.
- Makes colorful autumn sales possible.
- Flowers are held higher on the plant so they do not get splashed with mud from heavy rains.
- Highly visible from a distance or in a fast moving vehicle.



SuperNova Mix

Sakata Seed Primula polyanthus SuperNova Fire

- Beautiful intense red outer petals contrasted by intense bright gold center.
- SuperNova Fire flowers 7-10 days later than other SuperNova colors with a thinner plant habit.
- Ideal for color bowls.



SuperNova Fire

Primula polyanthus 'SuperNova'

- SuperNova was developed for the early fall season and requires 2 weeks less than Danova for flower bud initiation.
- SuperNova is less sensitive to higher temperatures (65-70°F/18-21°C nights) during the initiation phase.
- Being an F1 hybrid, it features larger flowers, wider color range and more abundant flowering.
- Developed in northern Europe under lower light levels. Pacific Giants was selected under higher light levels in Japan.
- Recommended to flower under 3,000 foot candles/32,000 lux to maximize stem length.



SuperNova vs. Pacific Giants



Left - SuperNova Right - Pacific Giants

Seattle, Washington

Primula polyanthus SuperNova and light level.

Flower stem elongation is a function of genetics and light intensity.



SuperNova Blue, Seattle, Washington



SuperNova Blue, Morgan Hill, California

Primula polyanthus SuperNova



SuperNova Purple Bicolor

Plug Phase: Stage 1 (germination)

- Days 1-14
- Well aerated media, a 60% fine peat/25% perlite/15% vermiculite blend works well. EC <0.6 mmhos (1:2 slurry).
- pH 5.5-6.0
- Optimum temperature is 59°F/15°C day and night.
- Keep the media moderately moist for the first week. If germinating in the greenhouse, apply a light cover of medium vermiculite to maintain sufficient humidity.
- Primula requires light to germinate.
- In the greenhouse supply 400-1,000 foot candles/4,300-11,000 lux. If using a germination chamber, supply 10-100 foot candles/110-1,100 lux of light to improve germination and prevent stretch.
- Seed germinates in 5-7 days depending on conditions.



Vermiculite Covering



Vermiculite should be sized (2-3mm) with sieve (mesh) before cover

Plug Phase: Stage 2 (until first true leaf development)

- Days 15-29
- When cotyledons are fully expanded, reduce humidity levels to 70% but do not allow the media to dry out. A light mist 2-3 times a day is beneficial to keep the plants cool.
- Supply a light level between 1,000-2,000 foot candles/11,000-22,000 lux to avoid damaging the tender seedlings.
- Fertilize 50 ppm N using a well balanced calcium nitrate based formulation to prevent marginal burn of cotyledons.
- Maintain soil EC <0.6 mmhos (1:2 slurry) and <10 ppm NH₄.



Irrigation timing



Watering regularly applied



Watering applied after the media surface became light tan in color

Plug Phase: Stage 3 (true leaf development)

- Days 30-45
- The first true leaves have formed.
- Maintain cool temperatures (59-65°F/15-18°C) and sufficient humidity.
- Fertilize the plants with 50-75 ppm N as needed to maintain EC level around 0.8 mmhos (1:2 slurry).
- Alternating between a Cal/Mag formulation and 20-10-20 works well to maintain optimum pH.
- Potassium is important for strong growth. Fertilizer formulations like 15-3-20 and 15-5-25 are good options.



Plug Phase: Stage 4 (toning for transplant or shipping)

- Days 46-50
- The plants have 3-4 true leaves and are now ready for transplanting.
- Applying 200 ppm N a week before transplanting helps the plants make the transition from the plug tray to the final container.



Sowing under high temperature conditions – key points

- Maintain seedling house as cool as possible.
- Use white vermiculite to reflect heat.
- Use fog system or evaporative cooling to reduce temperature.
- Use white colored trays.



Black plastic plug trays raise media temperature by 6-12°F / 3-6°C



Transplanting - Media

- Use a well-aerated sterile media that is high in organic matter.
- Optimum pH is between 5.5-6.0
- Optimum light level is 2,500-3,000 foot candles/27,000-32,000 lux. Do not exceed 3,500 foot candles/37,500 lux.
- The planting depth should be the same as the seedling flat to avoid crown rot and other diseases.



Benefit of a well-aerated media



Long fiber peat vs. Peat lite Mix

Benefit of a well-aerated media



Peat moss with large particles of pumice creates a well-aerated media with healthy thick white roots for optimum nutrient uptake.

Ellepots showing excellent root development



Ellepots can be used for making mixed containers with spring flowering bulbs or for landscape customers.

Iron deficiency due to high pH



Optimum pH is 5.5-6.0.

High pH (>6.2) induces iron deficiency characterized by chlorosis of upper foliage.

Low pH (<5.5) results in excess zinc characterized by leaf edge necrosis of lower foliage.

HOW HOT!!



It is over 104F / 40C at quarter past two.

Shading Control



Adjusting light levels by plug stage. Ideally using a retractable shade system allow for maximum light availability and more compact plants.

Light measurements

- Foot candles are a measure of how many lumens fall in a square foot. Lux is a measure of how many lumens fall in a square meter. Both read light in terms of its brightness or how the human eye perceives light.
- Watts per square meter measures light energy.
- Light, when considered as a wavelength or frequency can be viewed as a stream of particles or photons. Units can be expressed in moles (photons) per square meter per second ($\text{mol m}^{-2} \text{s}^{-1}$). Moles measure how plants perceive light, and best calculates the light calories received throughout the day.

Light Quality

- Optimum light level is 2,500-3,000 foot candles/27,000-32,000 lux. Do not exceed 3,500 foot candles/37,500 lux.
- Target 10 moles of light per day



Light Measurement Tool

- The Weather Tracker, by Spectrum Technologies, records high and low temperatures and the moles of light received in a 24 hour period.



Fertilizer

Select a cal/mag fertilizer, such as 15-2-20, at 100-150 ppm N to supply major and minor elements.

Alternate with 20-10-20, as needed, to maintain optimum pH.

Supplemental magnesium in the form of $MgSO_4$ at 30 ppm (4 oz/100 gallons) is recommended in areas with high calcium in the irrigation water.

Potassium promotes high bud count and a more compact plant. It is recommended to supply a N:K ratio of 1:1.5



Nitrogen excess



Excess nitrogen results in overgrowth of plants.

Calcium deficiency

- Calcium is taken up passively via transpiration instead of being actively absorbed. Therefore, it is important to promote high transpiration activity.
- Low light and cool conditions with high atmospheric humidity results in less transpiration pull.
- A media that is poorly aerated or overly saturated produces less root hairs, resulting in less calcium uptake.
- Option to apply calcium chloride at 200-400 ppm Ca with a spreader-sticker compatible with primula.



Magnesium deficiency

- Magnesium is a macro element that is translocated from lower leaves to upper leaves if a deficiency occurs.
- Characterized by interveinal chlorosis (often a Christmas tree shape) ending in necrosis beginning at the leaf margin.
- Supply magnesium in the fertilizer or as a periodic drench of $MgSO_4$ every 14 days.



Stages of development

- **Juvenile Stage** - plant is not capable of responding to a flowering stimulus.
- **Mature Stage** – plant is capable of responding to a flowering stimulus.
- Often measured by the number of leaves that must be unfolded.
- In recent years breeders have targeted shorter juvenile periods to reduce crop times.

Juvenile Phase – Sowing to 6-8th true leaf stage, around 12 weeks



Initiation stage, well rooted with 6-8 leaves



Flower bud initiation

When the plants have 6-8 leaves and a well-established root system, they are receptive to flower bud initiation.

The standard recommendation is to lower the temperature to 45-50°F for 5-9 weeks (depending on cultivar grown).

Research has shown that *primula acaulis* is both a facultative long day plant and facultative irradiant plant.

Exposing the plants to a 14 hour day length, 10 moles of light and 55-60 F induces quicker flower initiation, reducing crop time.

Indication of flower bud initiation



A pale green color on the new leaves is a sign of flower bud initiation.

Often, a grower mistakes this for underfed plants; especially during hot summer weather.

It is best to wait 1 week to see if the pale green color is due to flower bud initiation, as it recovers a normal green shade before applying extra fertilizer.

Indication of flower bud initiation



- A pale green color on the new leaves is a sign of flower bud initiation.
- These plants had insufficient plant bulking in the juvenile stage.
- A chemical growth regulator application at this point would be inappropriate..

Traditional Schedule for Sakata Primula

Schedule in Weeks	Plug: 59°F / 15°C	Vegetative: 59°F / 15°C	Vernalization: 39 – 45°F / 4-7°C	Flowering: 52 – 57°F / 11-14°C
Lovely acaulis	8	4	4	3
Pageant* - Dawn acaulis	8	4	5	3
SuperNova polyanthus	8	4	5	3
Danova acaulis	8	4	7	3
Daniella – Rosanna acaulis	8	4	9	3

*for Pageant bicolors follow schedule for Danova

Effects of light intensity and photoperiod on flowering response in primula

- In the following slides one will see the effects of light intensity and photoperiod on primula flowering. This creates various opportunities for growers and markets.
- Option to **reduce time to flower in cool regions** where greenhouse space is at a premium.
- Option to **expand the primula market into warmer climatic areas** that do not traditionally produce primula.
- Option to **sow primula later in the season** for late spring sales

Days to flower initiation in *Primula acaulis* 'Danova type'

		<u>Irradiance (mol day¹m²)</u>		
<u>Photoperiod</u>		2	10	18
(hours)				
46°F/8°C	8	201 days	49 days	42 days
	11	80 days	43 days	35 days
	14	58 days	36 days	30 days
54°F/12°C	8	73 days	35 days	35 days
	11	60 days	33 days	28 days
	14	50 days	33 days	33 days

Days to flower initiation in *Primula acaulis* developing at 46°F/8°C or 54°F/12°C and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day¹m².



Days to flower initiation in *Primula acaulis* 'Danova type'

		<u>Irradiance (mol day⁻¹m⁻²)</u>		
<u>Photoperiod</u>		2	10	18
(hours)				
60°F/16°C	8	47 days	39 days	43 days
	11	45 days	33 days	37 days
	14	44 days	26 days	32 days
68°F/20°C	8	108 days	52 days	56 days
	11	71 days	42 days	44 days
	14	73 days	34 days	48 days

Days to flower initiation in *Primula acaulis* developing at 60°F/16°C or 68°F/20°C and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day⁻¹m⁻²



Days to flower color from transplant in *Primula acaulis* 'Danova type'

		<u>Irradiance (mol day¹m²)</u>		
<u>Photoperiod</u>		2	10	18
(hours)				
46°F/8°C	8	143 days	132 days	101 days
	11	133 days	126 days	86 days
	14	142 days	89 days	85 days
54°F/12°C	8	118 days	88 days	()
	11	120 days	83 days	85 days
	14	112 days	81 days	87 days

Days to flower color from transplant in *Primula acaulis* developing at 46°F/8°C or 54°F/12°C and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day¹m² for 8 weeks and moved to 60°F/16°C, 11 hour day length and 10 mol day¹m² to complete the development.



Days to flower color from transplant in *Primula acaulis* 'Danova type'

		<u>Irradiance (mol day¹m²)</u>		
<u>Photoperiod</u>		2	10	18
(hours)				
60°F/16°C	8	104 days	90 days	86 days
	11	103 days	86 days	87 days
	14	103 days	83 days	87 days
68°F/20°C	8	126 days	121 days	110 days
	11	120 days	112 days	96 days
	14	115 days	86 days	105 days

Days to flower color from transplant in *Primula acaulis* developing at 60°F/16°C or 68°F/20°C and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day¹m² for 8 weeks and moved to 60°F/16°C, 11 hour day length and 10 mol day¹m² to complete the development.



Flower initiation recommendation

- For rapid flower bud initiation, a long day length (14-16 hours) is beneficial. When natural day length is less than 12 hours, extending the day to 16 hours or utilizing a 4-hour night interruption at a minimum of 10 foot candles/110 lux* is recommended. **At 54°F/12°C primula initiated earlier at 10 moles of light across all photoperiods.**
- Primula flower initiation is a function of plant age and stimuli to transition the plant from a juvenile phase into a reproductive mode. Flower initiation was identified in plants with 6-26 leaves. At 46°F/8°C, 10 moles** of light and an 11 hour photoperiod, plants with six leaves initiated flowers in 72 days from seeding. At 68°F/20°C, 2 moles of light and an 8 hour photoperiod, plants initiated flowers in 126 days but had 26 leaves.
- Understanding primula production in terms a 3 life phases (plug, juvenile and reproductive) allows a grower to optimize his/her primula production. Meeting the plant's needs at each stage is the key to success.

* If the night temperature is above 65°F/18°C some stretching may occur.

** 1,700 foot candles/18,000 lux for eight hours or 800-1,000 foot candles/8,600-10,750 lux for 14 hours.

Length of the longest leaf (cm) in *Primula acaulis* 'Danova type'

		<u>Irradiance (mol day¹m²)</u>		
<u>Photoperiod</u>		2	10	18
(hours)				
46°F/8°C	8	1.1	2.9	3.2
	11	2.3	2.6	4.8
	14	2.4	4.4	4.7
54°F/12°C	8	2.6	4.0	3.8
	11	2.9	4.8	3.8
	14	4.5	4.8	3.3

Length of longest leaf (cm) after 8 week of growth from transplant in *Primula acaulis* developing at 46°F/8°C or 54°F/12°C and 8, 11, or 14 hour photoperiod at 2, 10 or 18 mol day¹m².



Length of the longest leaf (cm) in *Primula acaulis* 'Danova type'

		<u>Irradiance (mol day¹m²)</u>		
<u>Photoperiod</u>		2	10	18
(hours)				
60°F/16°C	8	4.6	5.1	6.3
	11	7.9	8.9	8.3
	14	10.2	9.7	8.5
68°F/20°C	8	4.5	6.0	6.2
	11	4.4	7.6	6.4
	14	4.9	7.8	6.3

Length of longest leaf (cm) after 8 week of growth from transplant in *Primula acaulis* developing at 60°F/16°C or 68°F/20°C and 8, 11, or 14 hour photoperiod at 2, 10 or 18 mol day¹m² .



Length of leaves

- A correlation between long, unsightly leaves to long days or night break has been suggested and therefore avoided. However, temperature appears to be more critical than day length for plant morphology. In polyanthus, more and smaller leaves were recorded at 68°F/20°C than at 50°F/10°C. High fertilizer levels and nitrogen in the ammonium form are also likely factors contributing to larger plants and leaves.

Plant height (cm) in *Primula acaulis* 'Danova type'

		<u>Irradiance (mol day¹m²)</u>		
<u>Photoperiod</u>		2	10	18
(hours)				
46°F/8°C	8	1.2	3.1	3.0
	11	1.7	2.5	4.6
	14	3.0	4.2	4.1
54°F/12°C	8	2.2	3.9	2.9
	11	2.1	3.7	3.4
	14	4.4	3.8	3.3

Plant height (cm) after 8 weeks of growth in *Primula acaulis* developing at 46°F/8°C or 54°F/12°C and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day¹m².



Plant height (cm) in *Primula acaulis* 'Danova type'

		<u>Irradiance (mol day⁻¹m⁻²)</u>		
<u>Photoperiod</u>		2	10	18
(hours)				
60°F/16°C	8	4.7	4.6	4.2
	11	4.6	6.0	3.4
	14	5.8	7.8	2.5
68°F/20°C	8	4.8	4.2	5.1
	11	4.6	5.2	5.0
	14	4.3	7.0	5.2

Plant height (cm) after 8 weeks of growth in *Primula acaulis* developing at 60°F/16°C or 68°F/20°C and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day⁻¹m⁻².



Chemical Plant Growth Regulation

- **Plug Stage:**

Apply B-Nine (daminozide), if needed, at 0.25 - 0.5% / 2,500 – 5,000 ppm

- **Finished Production:**

When plants are well rooted and the leaves are touching the edge of the container assess the plant's development stage.

Options include foliar applications of B-Nine at 0.2 – 0.5% / 2,000-5,000 ppm or Tilt* (propiconazole) at 0.3 ml/L and Bonzi (paclobutrazol) drenches at ½ -1 ppm Usually, 2-3 applications are needed based on plant growth and environmental conditions.

It is best to make frequent applications at lower rates for best control, as a sudden change in the weather can accelerate flower initiation, limiting plant growth potential. Do not base rates on the previous year or anticipate future growth by applying a high rate.

*Tilt is a fungicide with growth regulation effects.

Danova flowering guide

- E - early / initiate ahead of the curve so avoid over application of PGR's
- M - medium / initiate with the main pack of Danova's
- L - late / initiate behind the curve so may need more regulation.

- Danova
- Blue - E (though early it can be a bit vigorous)
- Pink - E
- Purple - E
- Rose - E
- Bicolor Rose and White – E (thought early it can be a bit vigorous)

- Lemon Yellow - M
- Yellow w/Eye - M
- Light Violet - M
- Cream Yellow - M
- Velvet Red - M
- Wine Red - M
- Wishing Well Mix - M (Blue, Lt. Violet, Sky Blue, White)

- Cherry w/Edge - L (though late it is a bit more compact)
- Golden Yellow - L
- Salmon Orange - L
- Red w/Yellow Edge - L
- Rose Lavender Shades - L
- Copper - L
- Red Rose Shades - L
- Scarlet Improved - L
- Sky Blue - L

PGR – Over application



Danova Yellow w/Eye at without growth regulation.



Yellow w/Eye treated with $\frac{1}{2}$ ppm drench of Sumagic and several drenches of Bonzi at 5-6 ppm.

PGR – Over application



Danova Cherry w/Edge



An over application of Bonzi and Sumagic caused an excess regulation of growth and a failure of flower stems to elongate sufficiently.

PGR – Over application

- Base PGR applications on stage of plant development.
- If initiation occurs earlier than normal (due to higher light levels) the plants will be over regulated.
- More of an issue on extra early flowering varieties.



PGR – Controlling plant habit via culture



Growth regulation is possible by controlling moisture, temperature and fertilizer.

PGR – Well grown plants with moderate amounts of Bonzi.



Danova Velvet Red



Danova Yellow w/Eye



Danova Red w/Yellow Edge



Physiological Disorder - Blindness

Causes

- Short day length
- Insufficient cooling or inconsistent temperatures (cooling followed by warm periods) that confuse the plant.
- Plugs were stressed from a late transplant.
- Excess nitrogen promotes an exaggerated "vegetative" plant response.
- End result is a rosette (resting stage to ensure survival of the species).



Physiological Disorder - Rosette



- The plants exhibit multiple layers of foliage with large leaves.
- If the plants receive sufficient cooling they will set a high amount of buds, (the plant senses that it is the species only chance to survive so it needs to produce many seeds).
- In some cases the plants will never recover.



Physiological Disorder – Bolting



Due to high heat and long day conditions.



Physiological Disorder – Bleaching of upper foliage



Bleaching of upper foliage due to cool soil conditions which inhibits iron uptake. Most often seen in white flowering varieties.

Pests and diseases

- 1) In general, Primula is not attractive to pests, but aphid, thrip, whitefly and cut worms are the major concerns.
- 2) Problems with fungus gnat or shore fly are common during the germination and plug stage.
- 3) Primula requires cool conditions and high humidity to produce good quality plants, both of which favor the development of botrytis.
- 4) Good sanitation, watering early in the day and good air movement all help control and prevent disease.

Pests - Insect biting damage



Leaf damage from cut worm

Set fans for good air flow



Air flow, especially under the trays, aids in preventing diseases and pests. Avoid placing flats on the ground if possible.

Raise flats on risers when setting directly on the ground.

- Allowing air movement below flats reduces disease pressure.
- If possible, use risers to raise up flats for better drainage and air movement.



Disease – Gray Mold (*Botrytis cinerea*)



Botrytis due to excess moisture, poor air movement and dead tissue (possibly from nitrogen deficiency).

Disease - Gray Mold (*Botrytis cinerea*)



Disease - Gray Mold (*Botrytis cinerea*)

- Gray mold (*Botrytis cinerea*), on the upper part of the plants and flower petals, usually appears toward the middle to final growing stages due to insufficient ventilation and excess nitrogen fertilization in the early growing stages.
- If you find infected plants, please remove them straight away and increase ventilation.
- The most effective method of preventing this disease is ventilation and temperature control. Gray mold can not spread in conditions of low humidity and temperatures under 54°F/12°C. Also, greenhouse films that block near ultra-violet rays are effective in controlling botrytis.
- iprodione, thiophanatemethyl and polyoxins are effective in controlling gray mold.

Disease – CMV (*cucumber mosaic virus*)



Disease – CMV (*cucumber mosaic virus*)

- CMV is a common virus disease and is carried by aphids and through plant contamination (plant touching).
- Primary symptom of CMV is stripes on flower petals and leaves.
- If you find infected plants in fields, please remove the whole plant, including the roots, to prevent the spread of the disease.
- It is required to weed in and around the greenhouse and to use a preventative insecticide spray program.
- DDVP, nicotine-sulfate, benfuracarb are effective in controlling CMV.

Disease - Bacterial soft rot (*Erwinia carotovora*)



Disease - Bacterial soft rot (*Erwinia carotovora*)

- Caused by high temperature (>76°F/24°C), high humidity and high moisture soil conditions.
- This disease infects the basal part of plant and is characterized by a dark green color rot, resulting in the basal part becoming thinner and finally the wilting of the whole plant.
- This disease can be controlled by soil sterilization with chloropicrin or dazomet prior to planting and by using subirriation to keep the soil surface dry.
- If these fungus disease occurs even once, sterilization of soil, pot, bench and production materials is essential if cultivation of primula is to continue.
- Drenching copperoxychloride is effective against bacterial soft rot.

Disease - Leaf spot (*Alternaria sp.*)



Disease - Leaf spot (*Alternaria sp.*)

- Leaf spot (*Alternaria*) appears on the leaves in conditions of high humidity, excess nitrogen fertilization or lack of fertilizer and insufficient ventilation during all stages of primula growth; especially when producing outdoors in open field areas.
- This disease infects the lower and middle leaves of primula due to splashing of mud and produces gray-brown color spots with a deep-brown margin on the surface of the leaf.
- This disease can be controlled by soil sterilization prior to planting and by providing good ventilation.
- It is recommended to use a preventative spray program with a fungicide and apply fertilizer moderately.
- thiophanatemethyl, zineb, polycarbamate, chlorothalonil and captan are effective against alternaria leaf spot.

Disease – Leaf spot (*Ramularia primulae*)



A fungus that causes brown and yellow discoloration of leaves.

Disease – Leaf spot (*Ramularia primulae*)



Disease – Leaf spot (*Ramularia primulae*)

- *Ramularia* appears on the leaves in conditions of high humidity, over fertilization of nitrogen or lack of fertilizer and insufficient ventilation during all stages of primula growth, especially when producing outdoors in open field areas.
- This disease infects the leaves of primula due to splashing of mud and makes brown color spots with yellow margin on the surface of the leaf.
- This disease can be controlled by soil sterilization prior to planting, by providing good ventilation and applying fertilizer moderately.
- thiophanatemethyl, zineb, polycarbamate, chlorothalonil and captan are effective against ramularia leaf spot

Disease – Bacterial Leaf Spot (*Pseudomonas syringae*)



Pseudomonas is a bacteria that can infect any part of the plant. Usually, weakened, undernourished plants are most affected.

Disease - Bacterial leaf spot (*Pseudomonas syringae*)



Disease - Bacterial leaf spot (*Pseudomonas syringae*)

- Soil infection and high humidity conditions produce this disease in Primula, especially in an outdoor fields.
- This disease infects the lower leaves of primula due to splashing of mud at the beginning and spreads over other leaves via overhead irrigation (or rainfall) and makes brown color spot with a yellow margin on the surface of the leaf.
- This disease can be controlled by soil sterilization prior to planting, avoiding cultivating in an outdoor field and by subirrigation to keep soil surface dry.
- copperoxychloride, oxine-copper and kasugamycin with copperoxychloride are effective against bacterial leaf spot.

Disease - Bacterial rot (*Pseudomonas marginalis*)



Disease - Bacterial rot (*Pseudomonas marginalis*)

- Soil infection, high humidity and high temperature (over 76°F/24°C) conditions produce this disease in Primula, especially in an outdoor field.
- This disease infects the leaves of Primula due to splashing of mud at the beginning and spreads over other leaves via overhead irrigation (or rainfall) and makes deep brown color rotting with yellow margin on the surface of the leaf.
- This disease can be controlled by soil sterilization prior to planting, avoiding cultivating in an out door field and by irrigating from bottom of pot to keep soil surface dry.
- copperoxychloride, oxine-copper and kasugamycin with copperoxychloride are effective against bacterial rot.

Disease – Root rots (*Pythium spp.*, *Phytophthora spp.*)



Pythium and *Phytophthora* due to over watering, poorly drained media or standing water.

Disease – Root rots (*Pythium spp.*, *Phytophthora spp.*)

- Use pathogen-free seeds, cuttings and plugs.
- Use new or sterilized potting media and pots.
- Use a potting medium with good drainage characteristics to maintain aeration to the roots.
- Grow plants on raised benches when possible to limit splashing spores from the native soil.
- Avoid splashing water between pots or contamination due to runoff.
- Do not apply excessive amounts of water or fertilizer.
- Thrives in oxygen depleted media.
- Do not re-circulate water, if possible, or else sterilize it with UV, sand or copper ionization.
- etridiazole ,fosetyl-Al, mefenoxam and propamocarb are effective against these pathogens.

Disease – Slime Mold (*Physarum gyrosum*)



Disease – Slime Mold (*Physarum gyrosum*)

- It is not a parasite, and will do no injury unless it occurs in immense quantity (when it might be washed away by spraying).
- The early or plasmodium condition develops in darkness, and finally creeps up anything, organic or inorganic, for the purpose of forming its spores in a position where they might be readily dispersed by rain and wind after maturing.

Acknowledgements:

- I would like to acknowledge Dr. Meriam Karlsson of the University of Alaska for her research on the effects of temperature, light intensity and photoperiod on primula development and flowering.
- The data presented on *Primula acaulis* Danova type is her research.



Danova Sky Blue