Primula Production Tutorial

Sakata Ornamentals

SAKATA®

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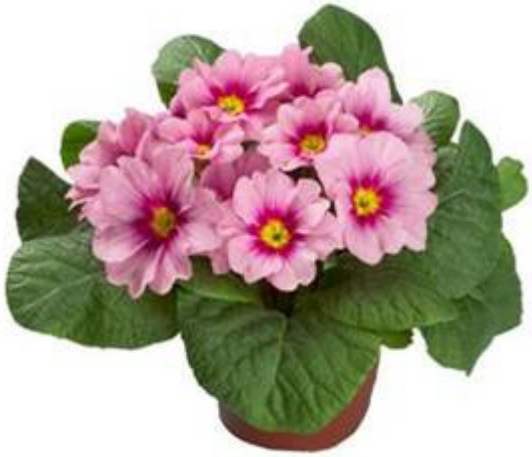
Primrose Trivia

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.



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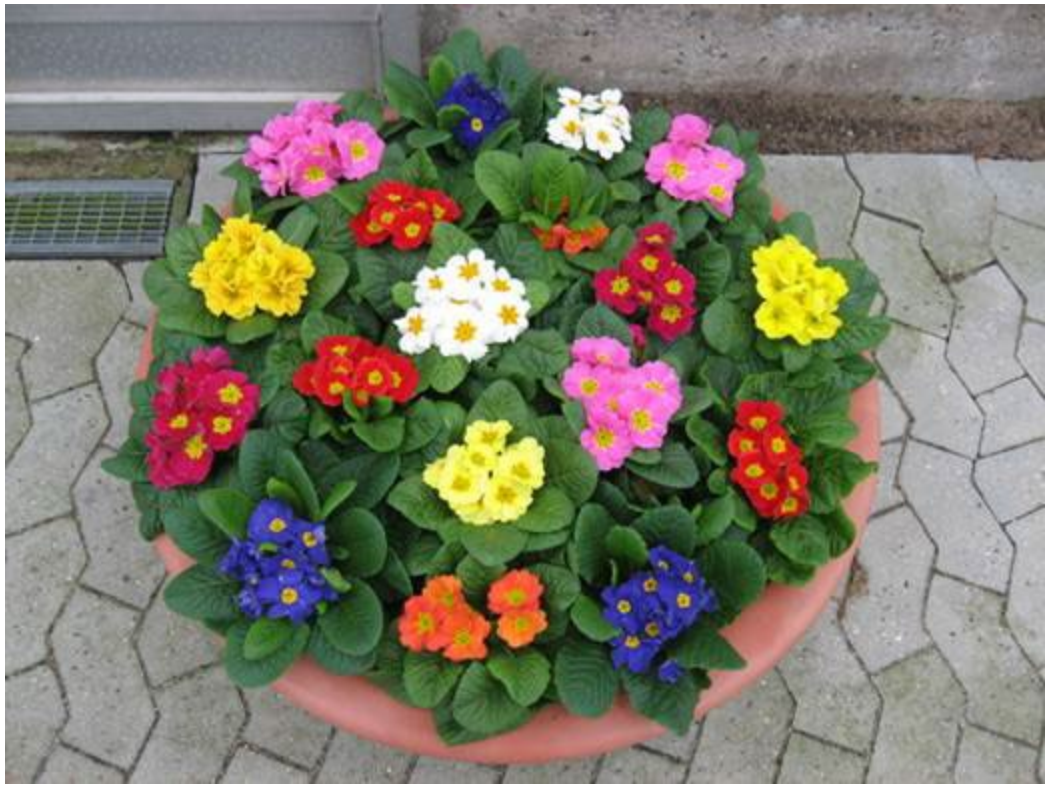
Sakata Seed Primula genetics

- 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

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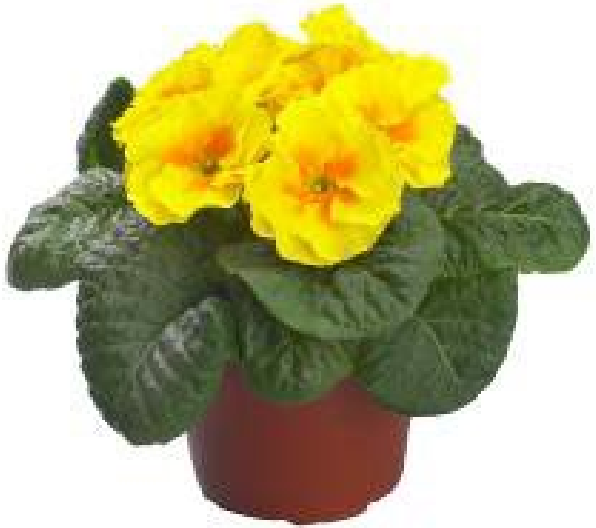
Primula Breeding Goals

- 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

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Sakata Primrose Naming Guide

Primula acaulis

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Danish bred Primula acaulis

- Bred in Odense, Denmark under low light and cool conditions. In low light areas (above latitude *45° / Northwest & Northeast USA and Canada*) they should be transplanted by week 42 to avoid blindness due to low light early in production. These varieties do well in both low and high light areas as long as optimum temperatures* can be maintained. These varieties start with a Da for Danish and without a double ss in the name.
- *Dania, Danova*
- **40-55°F/5-13°C for initiation with 45-50°F /7-10°C being optimum*

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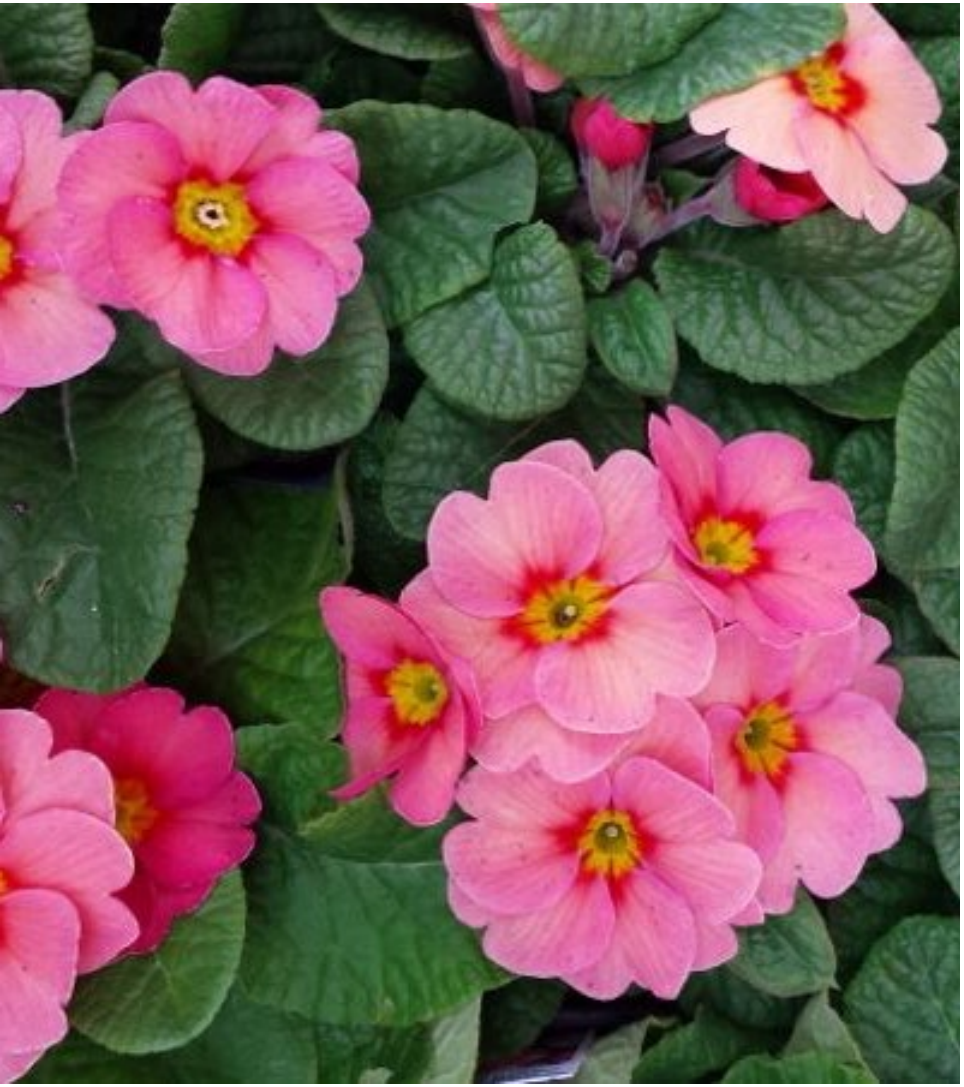

Japanese Bred Primula acaulis

- Bred in Kakegawa, Japan under high light and warm temperatures. These types of primroses are ideal for the early slot in California as they do not require vernalization to set flower buds. They also need higher light levels to avoid physiological disorders such as producing polyanthus-type flowers. Japanese bred primroses extend the option to produce primroses into the mid-south.
- Optimum temperatures for initiation are 50-59ºF /10-15ºC but will initiate at higher day temperatures (75ºF/24ºC) but there will be a bit less uniformity.

**Danessa, Princessa (double SS for Sakata Seed).*

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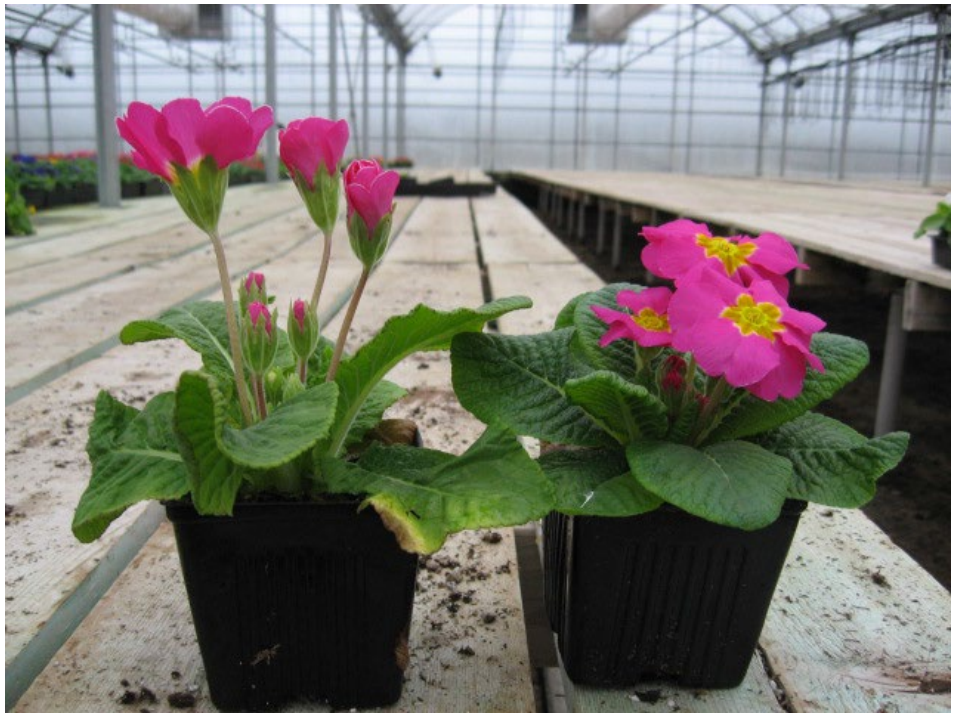
Japanese bred acaulis grown in a low light areas (Northwest & Northeast USA and Canada).



Left: Sweet Sixteen, Right: Danova Pink grown in Washington State for mid-February flowering.

- Japanese bred primroses* are selected under higher light conditions. When these genetics are grown for mid-winter production in low light areas, such as the Pacific Northwest**, they are susceptible to a physiological disorder in which the plants produce polyanthus-type flowers instead of acaulis type flowers.

**Danessa, Princessa (double SS for Sakata Seed).*

***For production in low light areas transplant by week 42 to prevent blindness due to low light early in production. After vernalization the plants may be kept cold to delay flowering for later flowering dates.*

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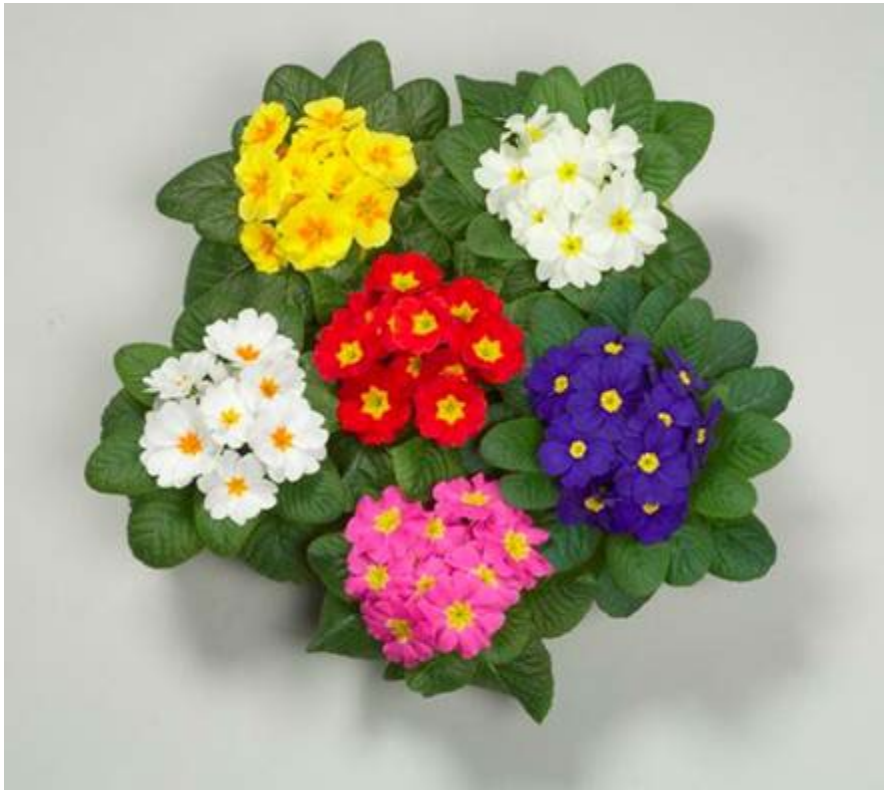
Danessa

Primula acaulis F1 Annual

The earliest series on the market that flowers 3 weeks earlier than Danova and is ideal for autumn flowering.

- Does not require cold to initiate* flowers.
- Three weeks earlier than Danova making possible production for early autumn sales.
- Bred for uniform plant habit, consistent flower size and quality.
- High usable plug count to improve profit.
- Outstanding color for pots, gardens and patio pots.

**maintain 50-75°F / 10-24°C for flower bud initiation.*



Mix

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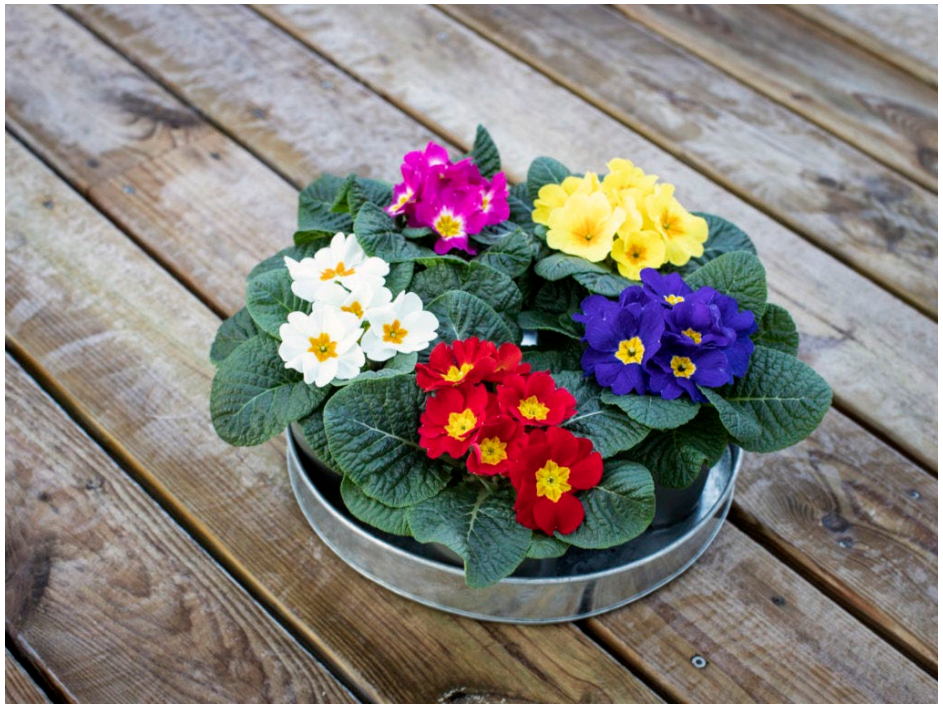
Dania

Primula acaulis F1 Annual

An ideal series for the early flowering segment for growers. A vibrant color range and good uniformity make Dania a true eye-catcher at retail.

- A quality series for early season sales.
- Compact plant habit.
- Requires little to no use of PGRs
- Early flowering segment.
- Showy flowers are eye-catchers at retail.



**maintain 45-50°F / 7-10°C for flower bud initiation.*

Mix

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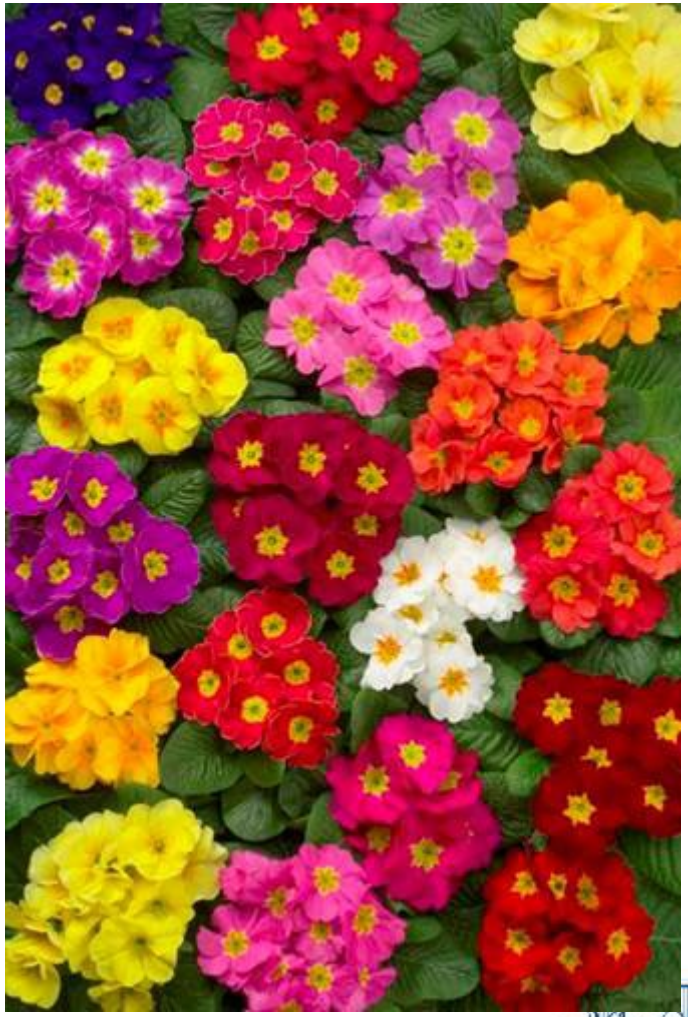
Danova

Primula acaulis F1 Annual

Danova is the most uniform flowering series on the market and the best selection for sales early and mid-season sales.

- World leading series for sales at the beginning of the season.
- The industry leader that others try to copy.
- It offers the highest percentage of salable plants
- Extremely uniform plant habit.
- Consistent large flower size of 2 - 2½ inches / 5-6 cm in diameter.
- Short flowering window.
- The largest range of pure and attractive colors which easily makes the creation of salable mixes.
- Very high germination.
- High usable plug count to improve profitability.
- Outstanding color for pots, gardens and patio pots.

**maintain 45-50°F / 7-10°C for flower bud initiation.*



Grower's Select Mix

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Primula acaulis Danova Series

- Center flowering for a beautiful bouquet of large magnificent flowers.
- Irresistible impact for impulse sales!

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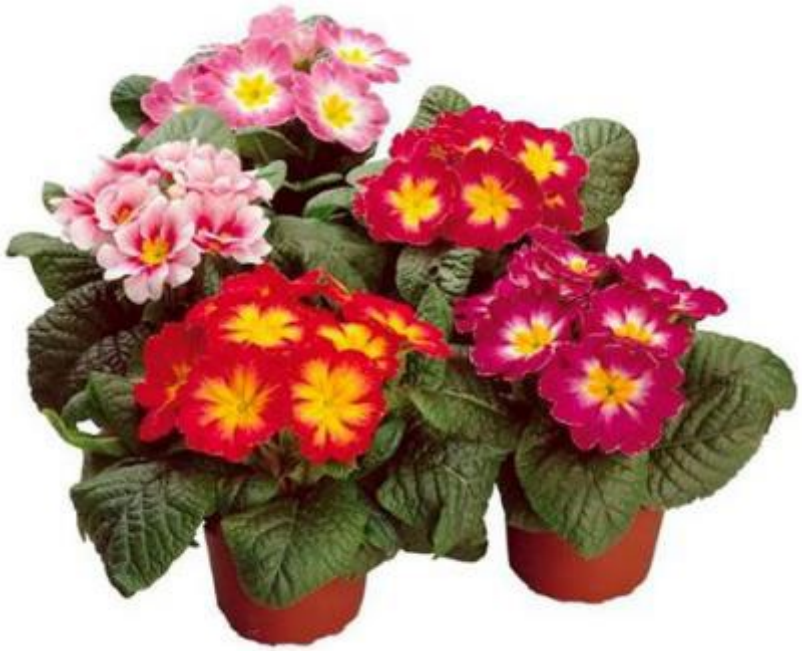
Danova Bicolor Mix

Primula acaulis F1 Annual

Increase your selection of unique colors. Slighlty more vigorous than Danova. Bicolors have the same consistent earliness and quality as Danova.

- For early and mid-season sales bred in Denmark.
- Attractive and vibrant bicolors to compliment the solid colors in the Danova series.
- Consistent flower size of 2-2½ inches / 5-6 cm. in diameter.
- The same excellent seed quality as Danova.
- The same exceptional earliness and uniformity as Danova.
- Slightly more vigorous plant compared to Danova.
- Outstanding color for pots, gardens and patio pots.



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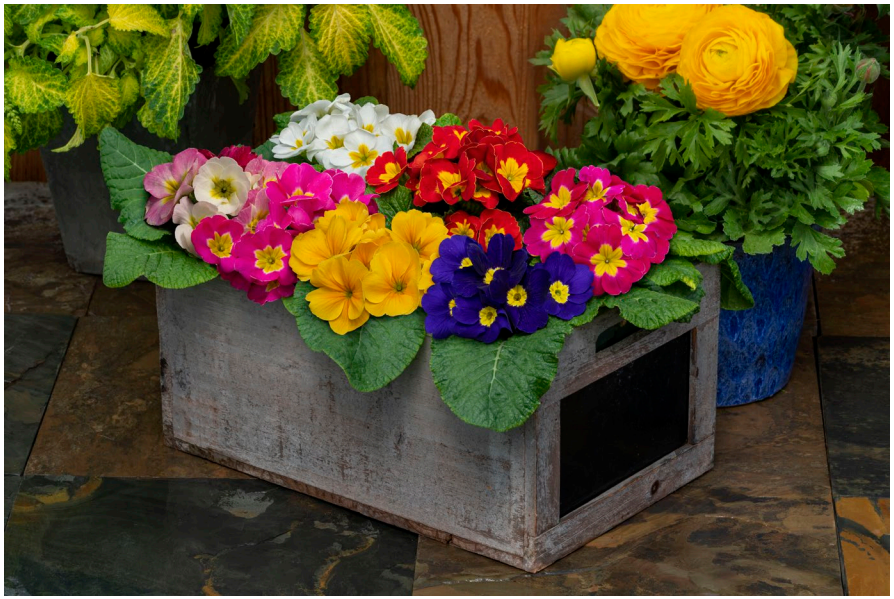
Princessa

Primula acaulis F1 Annual

Princessa features large blooms, nearly twice the size of a regular acaulis! The series features bright and cheery colors and a mix.

- Early blooming, 5+ days earlier than standard acaulis.
- Ideal or mass color plantings in large containers, baskets, mixed containers, and landscapes.
- High heat tolerance with less flower abortion under warm conditions.
- Requires no cold treatment* for flower initiation.



**maintain 50-75°F / 10-24°C for flower bud initiation.*

Mix

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Sakata Primrose Naming Guide

Primula polyanthus

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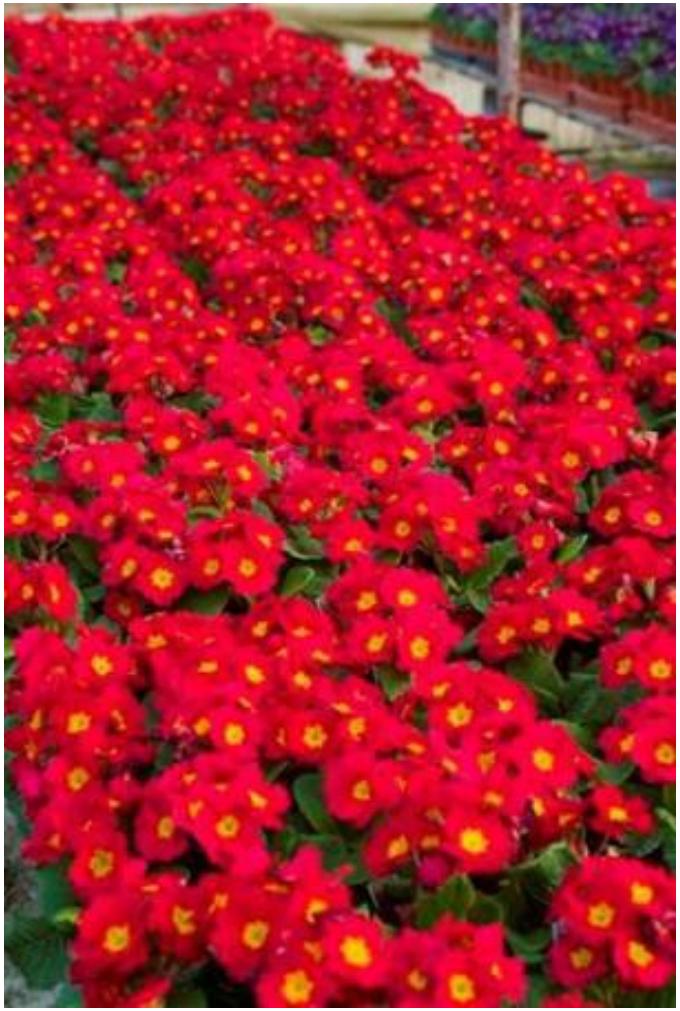
Primula polyanthus SuperNova



SuperNova Red

•Bred in Odense, Denmark under low light and cool conditions. Primroses are light accumulators so in low light areas (above latitude *45° / Northwest USA*) transplant by week 42 to avoid blindness due to low light early in production. Primrose SuperNova grows well in both low and high light areas as long as optimum temperatures* can be maintained.

•Flower stem (scape) will be longer in lower light regions than in higher light areas due to breeding selection under lower light levels.

**maintain 7-10°C for flower bud initiation*

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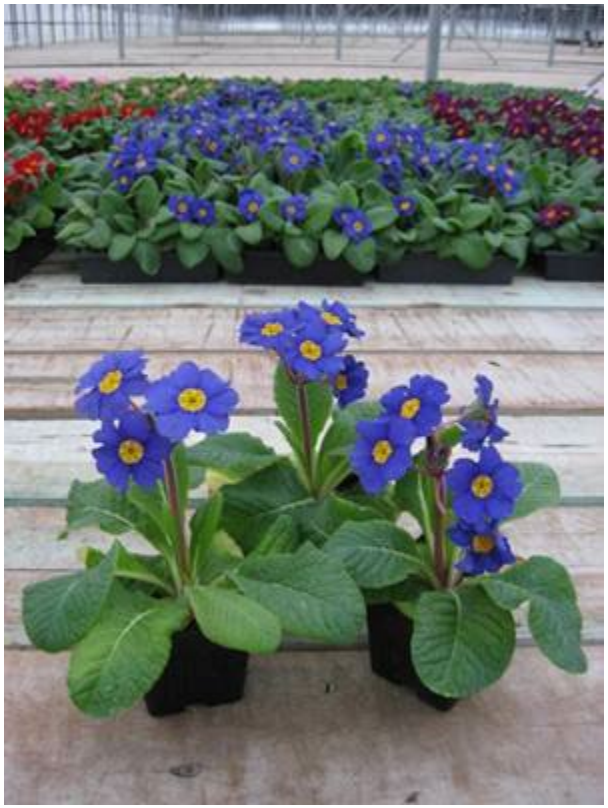
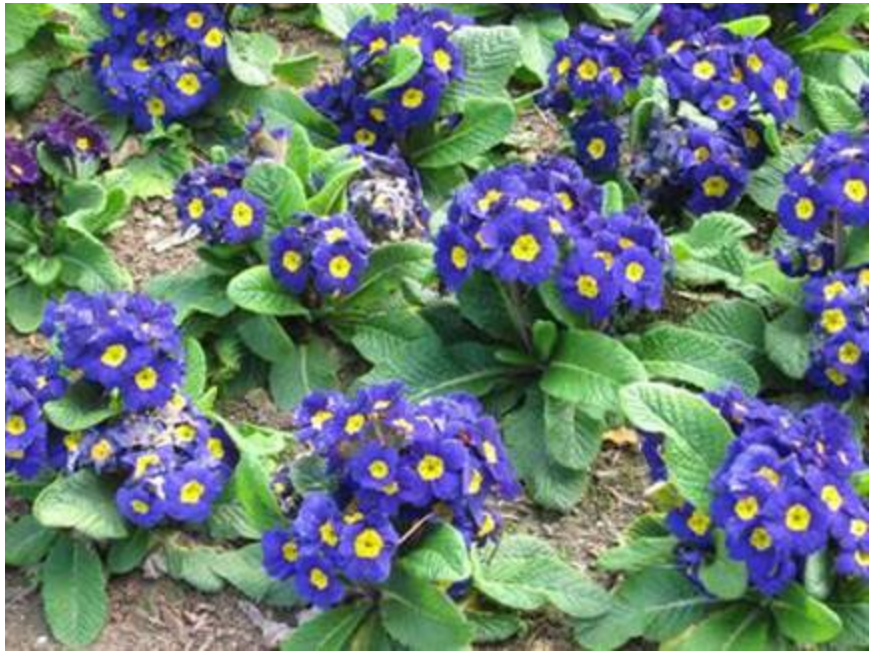
Primula polyanthus SuperNova and light level

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



SuperNova Blue, Seattle, Washington



SuperNova Blue, Morgan Hill, California

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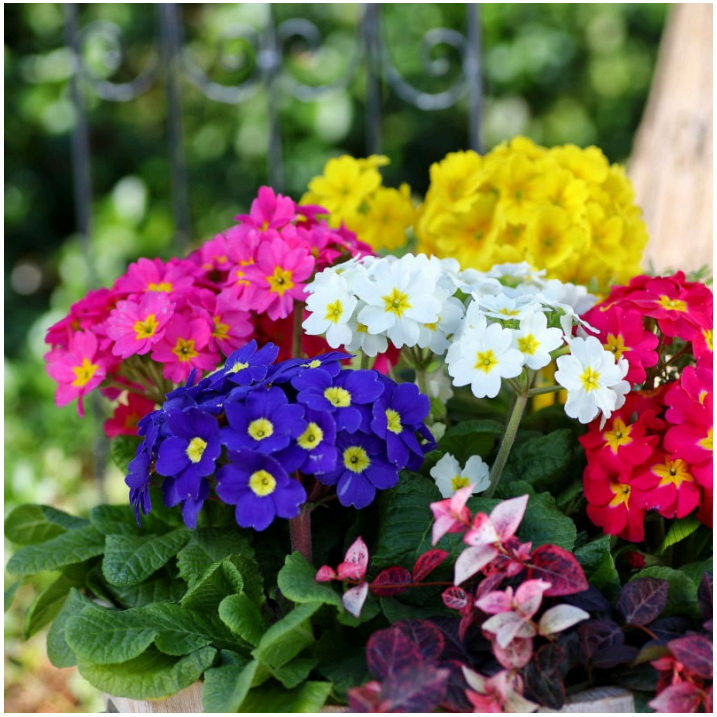
Primula polyanthus Lighthouse and Fire

Fire



Lighthouse Mix

- Bred in Kakegawa, Japan under high light and warm temperatures. These types of primroses are ideal for the early slot in California as they do not require vernalization to set flower buds. Japanese bred primroses extend the option to produce primroses into the mid-south.
- Optimum temperatures for initiation are 50-59ºF but will initiate at higher day temperatures (75-78ºF) but there will be a bit less uniformity.
- Flower stems (scape) will be longer under lower light conditions** than in higher light due to breeding selection under higher light levels.

***For production in low light areas transplant by week 42 to prevent blindness due to low light early in production. After vernalization the plants may be kept cold to delay flowering for later flowering dates.*

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SuperNova

Primula acaulis F1 Annual

- 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

maintain 7-10°C for flower bud initiation.


Blue


Cream


Golden Yellow


Orange


Pink


Purple Bicolor


Red


Rose Bicolor


Sky Blue


White Imp.


Yellow


Mix

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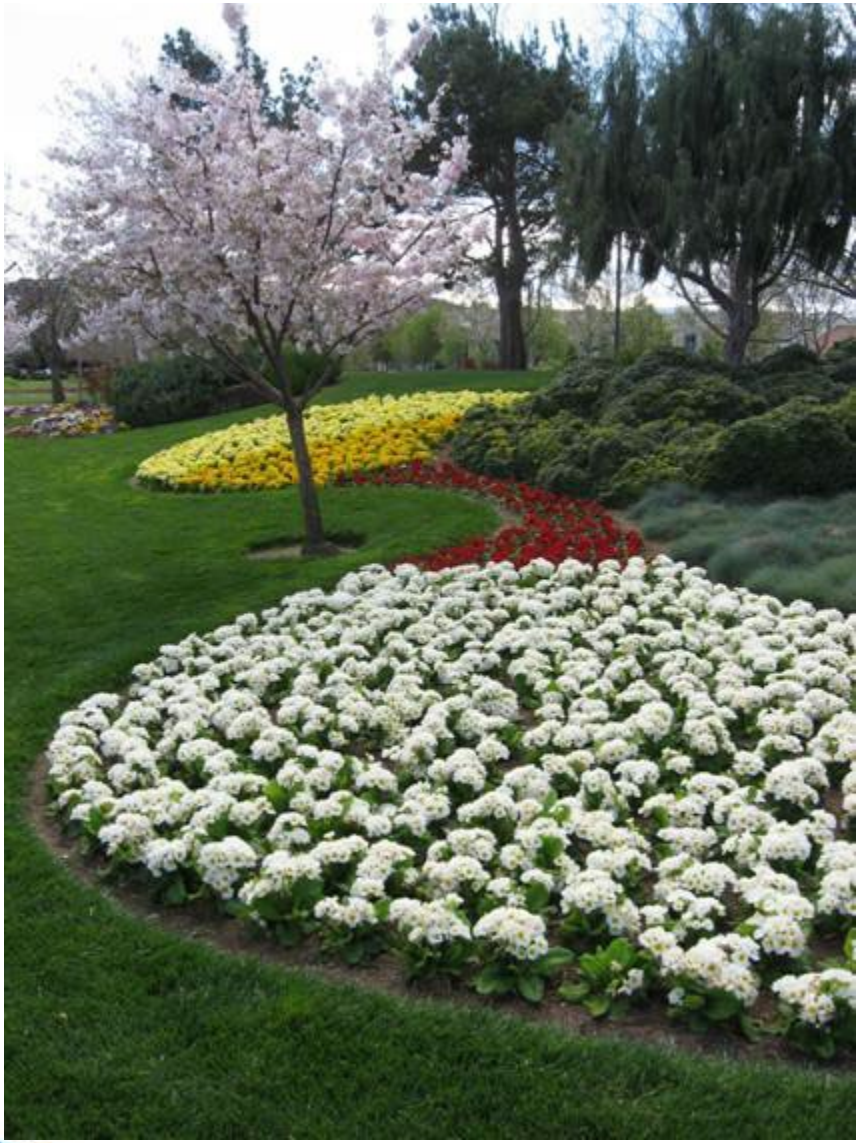
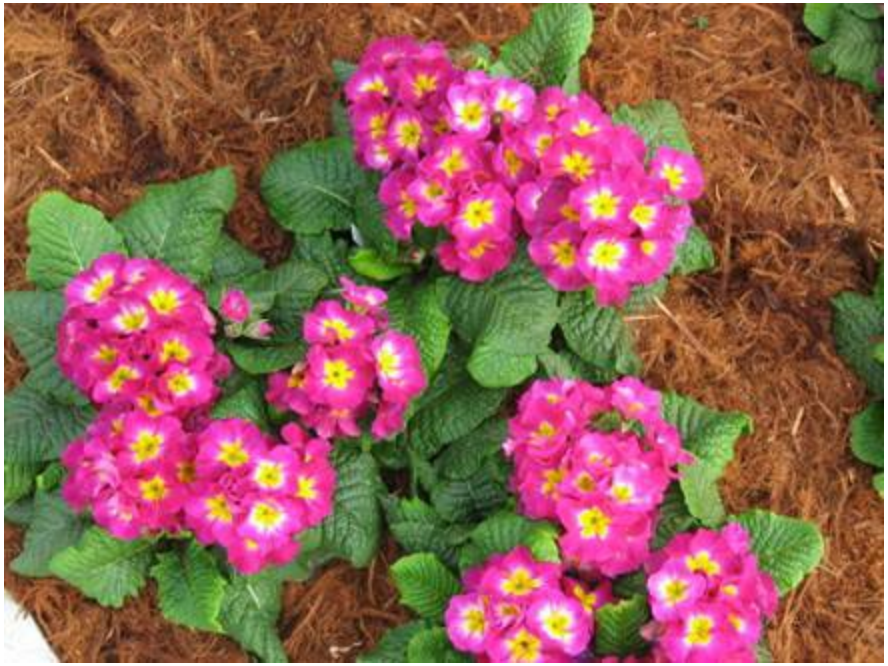
Primula polyanthus SuperNova in California





SuperNova Purple Bicolor

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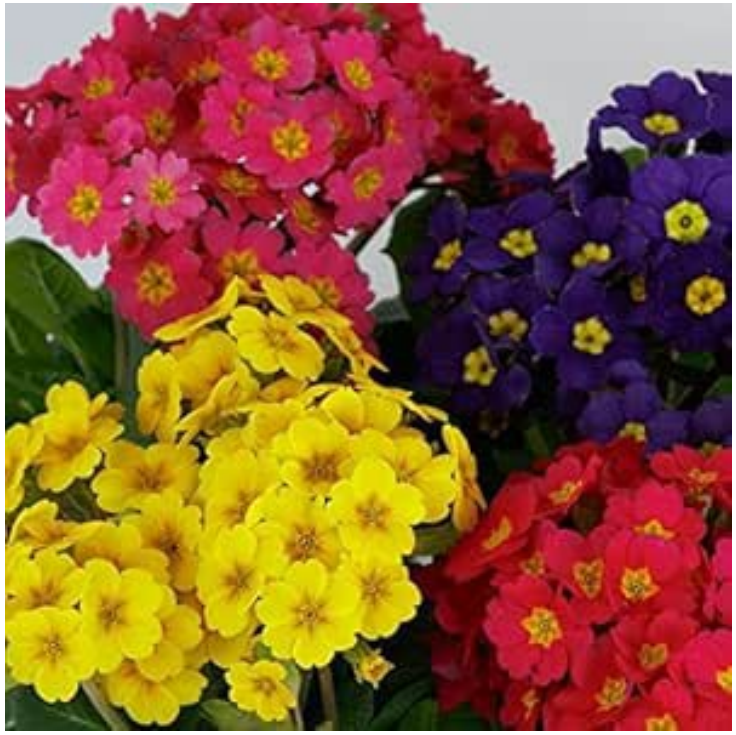
Lighthouse

Primula polyantha F1 Annual



Lighthouse Mix

A new type of Primula polyanthus with many more flowers atop multiple stems.

- Compact, uniform habit without PGRs allows for a multiple color program.
- Longer flower stem reduces the risk of botrytis for higher sell-through at retail.
- Continuous flowering means longer shelf life at retail and season extending for the consumer.

**maintain 45-50°F / 7-10°C for flower bud initiation.*

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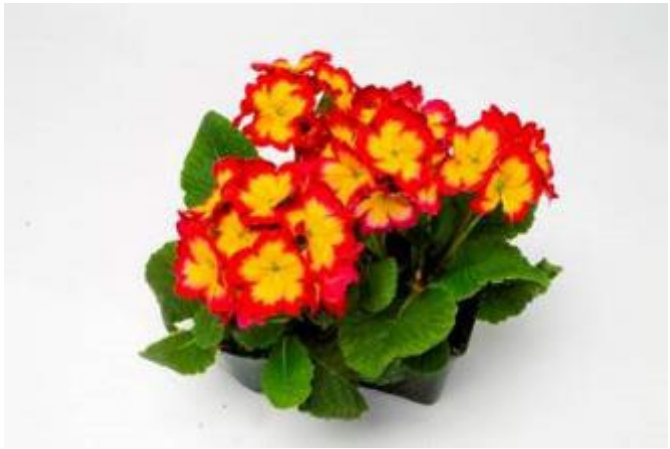
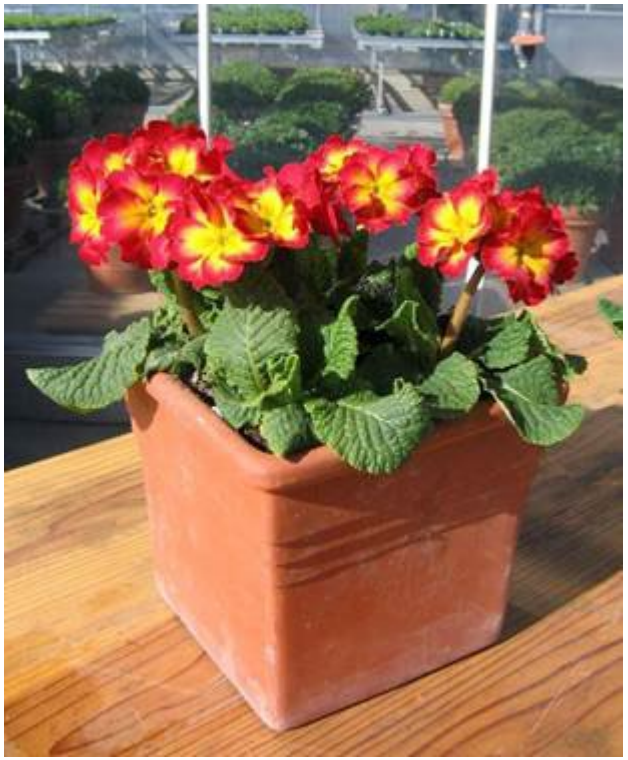
Fire

Primula polyantha F1 Annual

This type of polyanthus is truly unique and showy and a great consumer favorite.

- The outside petals are a beautiful intense red contrasted by a brilliant intense gold center.
- Primrose Fire flowers open 7-11 days later than Primrose SuperNova.
- The plant habit is also thinner than is SuperNova.
- Ideal for containers!





*maintain 45-50°F / 7-10°C for flower bud initiation.

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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 64-68ºF/18-20ºC 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.

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Vermiculite Covering

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

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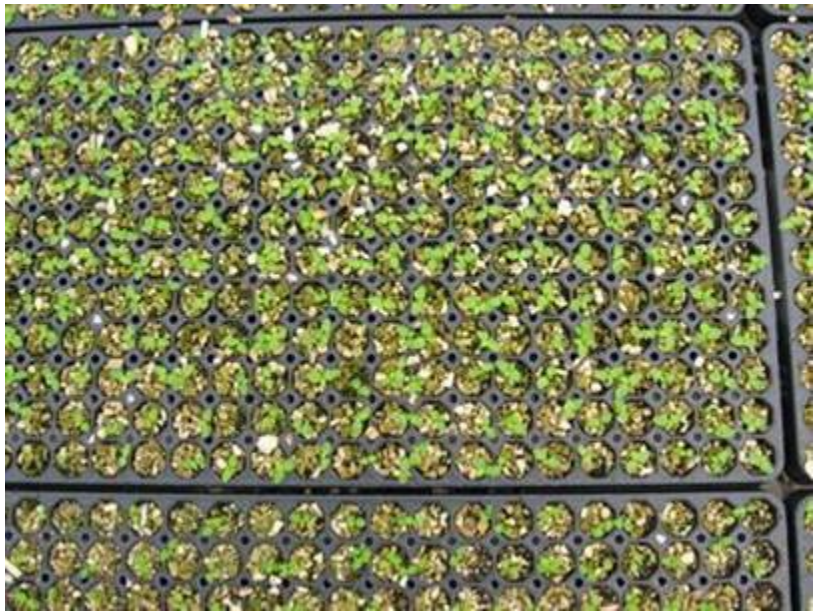
Stage 2 (until first true leaf development)

- 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.



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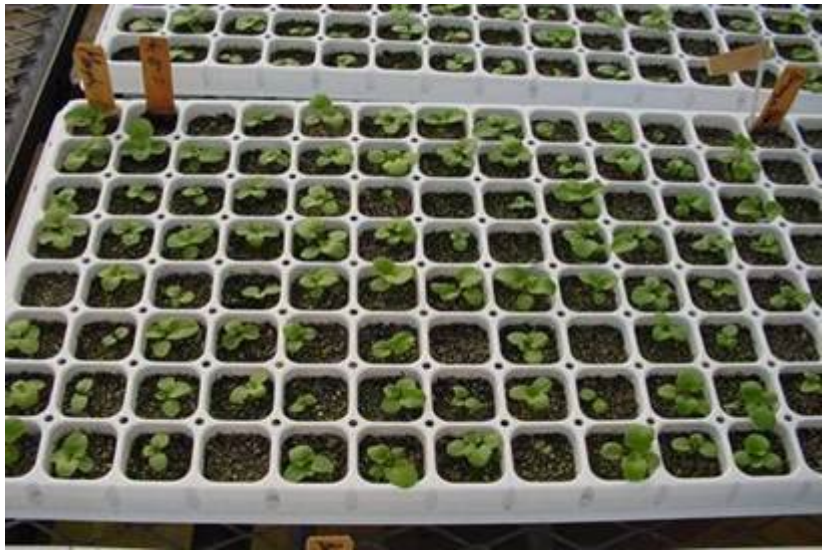
Irrigation timing



Water applied regularly without waiting for the surface to become dry.

Water applied after the media surface became a light tan color

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Stage 3 (true leaf development)

- Days 30-45
- The first true leaves have formed.
- Maintain cool temperatures (59-65ºF/15-18ºC) 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.

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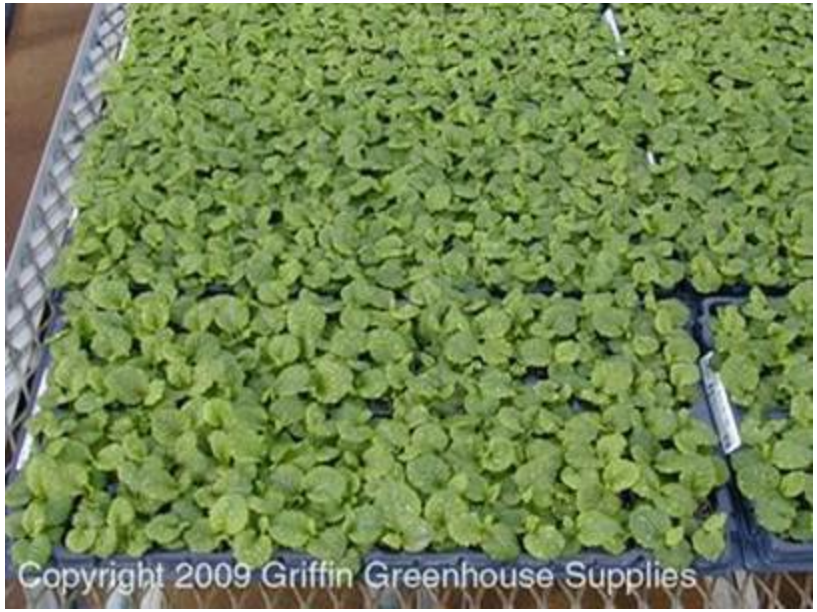
Plug Phase: Stage 4 (toning for transplant or shipping)

- 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.



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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.

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Black plastic plug trays raise media temperature by 6-12ºF/ 3-6ºC

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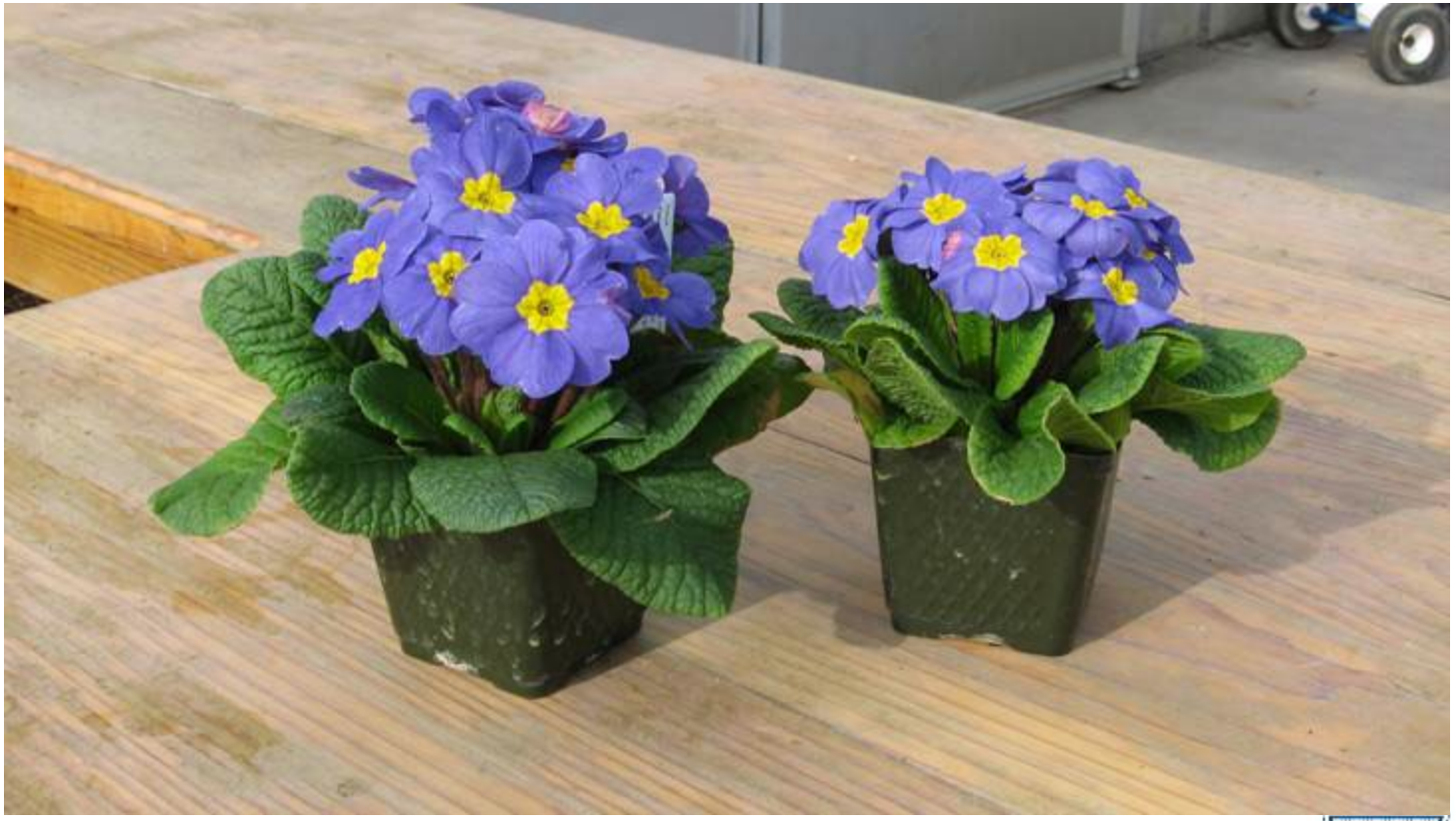
Transplanting - Media

- 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

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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.

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Ellepot showing excellent root development

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

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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.

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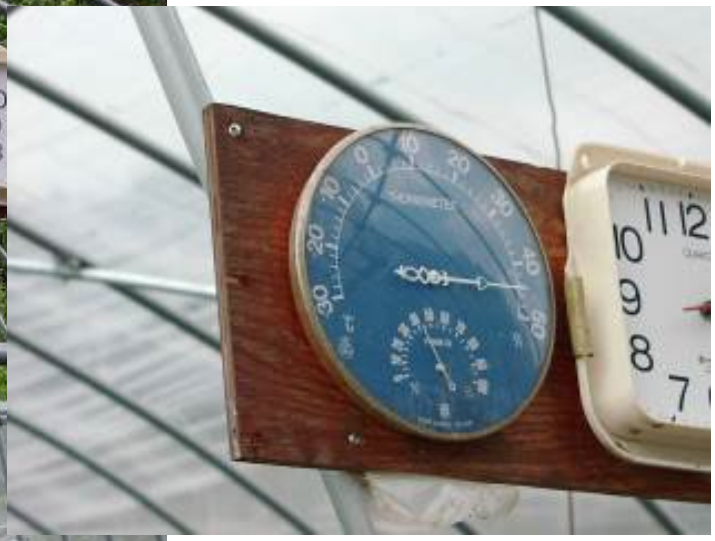
HOW HOT!!



It is over 104ºF / 40ºC 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.

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Light measurements

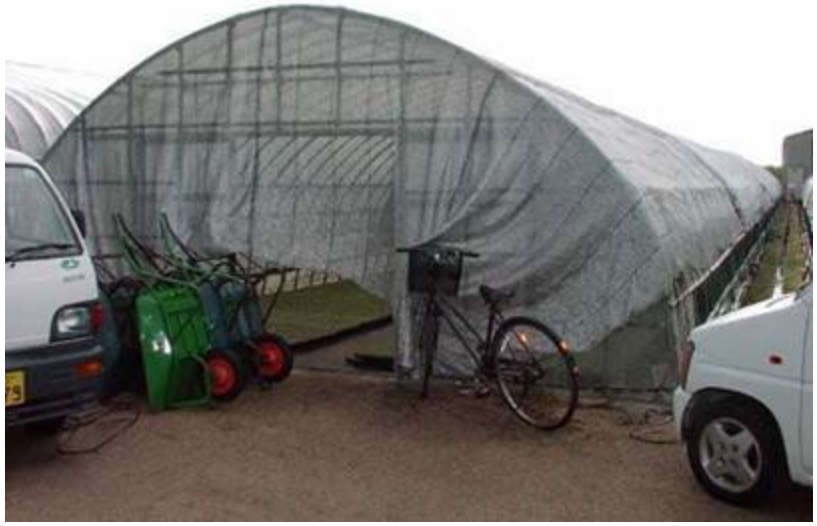
- Foot candles are a measure of how many lumens fall in a square foot. Lux is a measure of how many lumens fall in a square meter. Both read light in terms of its brightness or how the human eye perceives light.

- 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 (mol m^{-2} s^{-1}). Moles measure how plants perceive light, and best calculates the light calories received throughout the day.

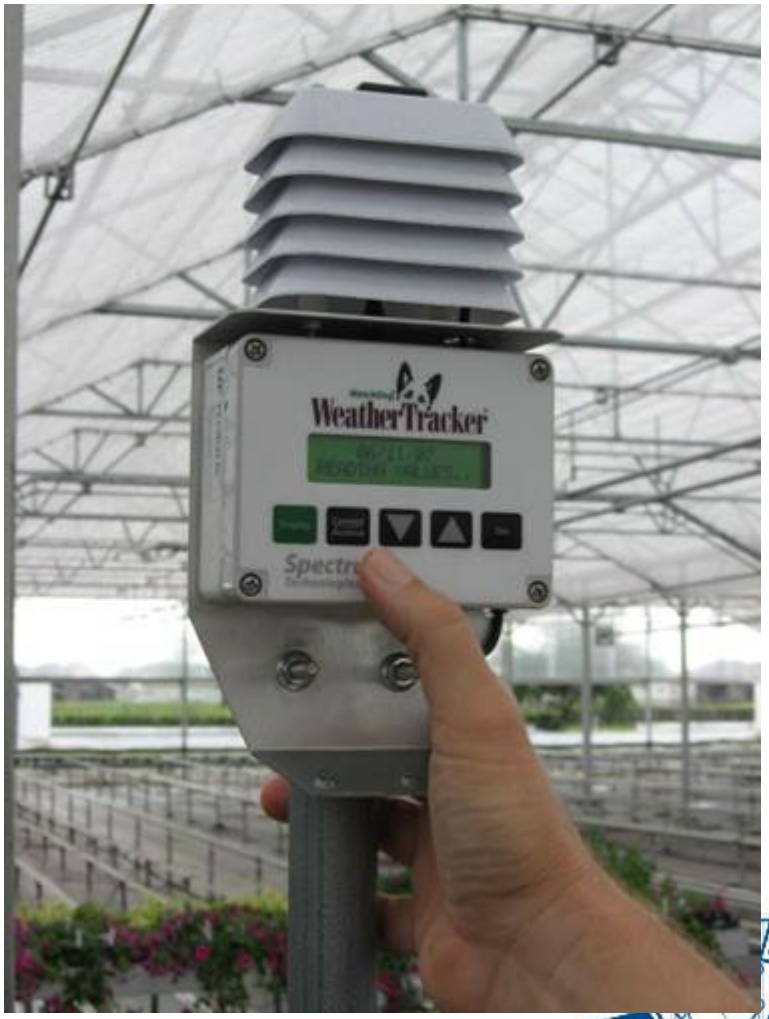
Light Quality

- 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.



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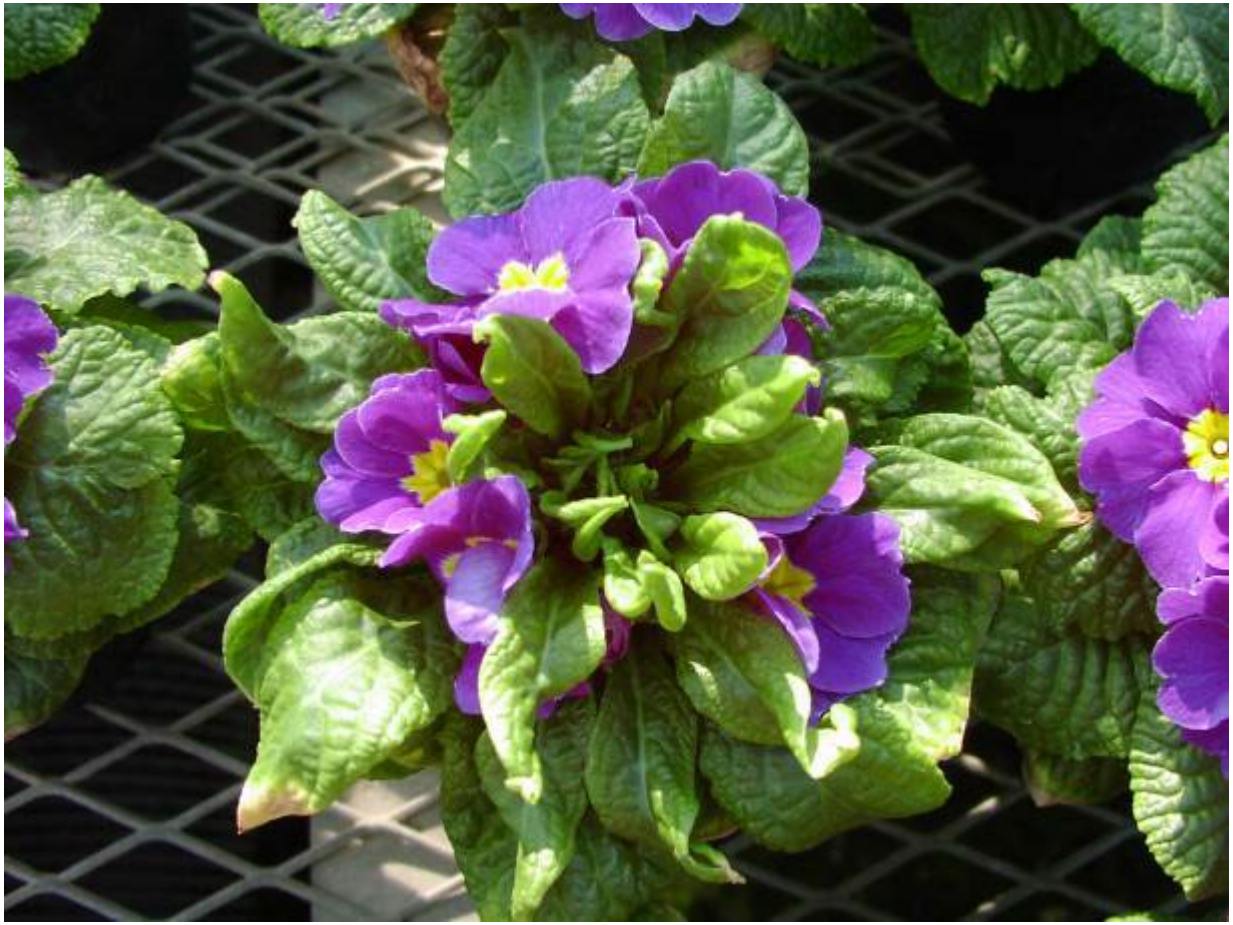
Fertilizer

- 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.

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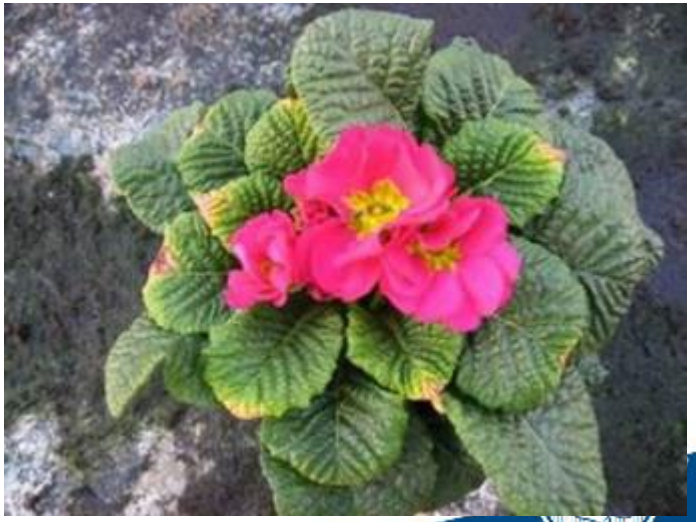
Calcium deficiency

- 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

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Initiation stage, well rooted with 6-8 leaves

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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 45-50ºF 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.

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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.

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Traditional Schedule for Sakata Primula

Schedule in Weeks	Germination: 59ºF / 15ºC Plug: 65ºF / 18ºC	Vegetative: 65ºF / 18ºC	Vernalization: 45 – 50ºF / 7-10ºC	Flowering: 59 – 62ºF / 15-17ºC
Danessa (acaulis)	**8**	**4**	**3***	**3**
Dania (acaulis)	**8**	**4**	**4-5**	**3**
Danova (acaulis)	**8**	**4**	**7**	**3**
SuperNova (polyanthus)	**8**	**4**	**5**	**3**
Lighthouse (polyanthus)	**8**	**4**	**4-5**	**3**

*initiation occurs between 50-78ºF / 10-26ºC

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Effect 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’

	Photoperiod (hours)	Irradiance (mol day^{-1}m^{-2}) 2	10	18
46ºF/8ºC	8	201 days	49 days	42 days
	11	80 days	43 days	35 days
	14	58 days	36 days	30 days
54ºF/12ºC	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 46ºF/8ºC or 54ºF/12ºC and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day^{-1}m^{-2} .

Research by Dr. Meriam Karlsson, University of Alaska.

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Days to flower initiation in Primula acaulis ‘Danova type’

	Photoperiod (hours)	Irradiance (mol day^{-1}m^{-2}) 2	10	18
60ºF/16ºC	8	47 days	39 days	43 days
	11	45 days	33 days	37 days
	14	44 days	26 days	32 days
68ºF/20ºC	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 60ºF/16ºC or 68ºF/20ºC and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day^{-1}m^{-2}

Research by Dr. Meriam Karlsson, University of Alaska.

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

	Photoperiod (hours)	Irradiance (mol day^{-1}m^{-2}) 2	10	18
46ºF/8ºC	8	143 days	132 days	101 days
	11	133 days	126 days	86 days
	14	142 days	89 days	85 days
54ºF/12ºC	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 46ºF/8ºC or 54ºF/12ºC and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day^{-1}m^{-2} for 8 weeks and moved to 60ºF/16ºC, 11 hour day length and 10 mol day^{-1}m^{-2} to complete the development.

Research by Dr. Meriam Karlsson, University of Alaska.

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Days to flower color from transplant in Primula acaulis ‘Danova type’

	Photoperiod (hours)	Irradiance (mol day^{-1}m^{-2}) 2	10	18
60ºF/16ºC	8	104 days	90 days	86 days
	11	103 days	86 days	87 days
	14	103 days	83 days	87 days
68ºF/20ºC	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 60ºF/16ºC or 68ºF/20ºC and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day^{-1}m^{-2} for 8 weeks and moved to 60ºF/16ºC, 11 hour day length and 10 mol day^{-1}m^{-2} to complete the development.

Research by Dr. Meriam Karlsson, University of Alaska.

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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 54ºF/12ºC 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 46ºF/8ºC, 10 moles** of light and an 11 hour photoperiod, plants with six leaves initiated flowers in 72 days from seeding. At 68ºF/20ºC, 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 65ºF/18ºC 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.*

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

	Photoperiod (hours)	Irradiance (mol day^{-1}m^{-2}) 2	10	18
46ºF/8ºC	8	1.1	2.9	3.2
	11	2.3	2.6	4.8
	14	2.4	4.4	4.7
54ºF/12ºC	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 46ºF/8ºC or 54ºF/12ºC and 8, 11, or 14 hour photoperiod at 2, 10 or 18 mol day^{-1}m^{-2} .

Research by Dr. Meriam Karlsson, University of Alaska.

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

	Photoperiod (hours)	Irradiance (mol day^{-1}m^{-2}) 2	10	18
60ºF/16ºC	8	4.6	5.1	6.3
	11	7.9	8.9	8.3
	14	10.2	9.7	8.5
68ºF/20ºC	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 60ºF/16ºC or 68ºF/20ºC and 8, 11, or 14 hour photoperiod at 2, 10 or 18 mol day^{-1}m^{-2} .

Research by Dr. Meriam Karlsson, University of Alaska.

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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 68ºF/20ºC than at 50ºF/10ºC. 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’

	Photoperiod (hours)	Irradiance (mol day^{-1}m^{-2}) 2	10	18
46ºF/8ºC	8	1.2	3.1	3.0
	11	1.7	2.5	4.6
	14	3.0	4.2	4.1
54ºF/12ºC	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 46ºF/8ºC or 54ºF/12ºC and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day^{-1}m^{-2}

Research by Dr. Meriam Karlsson, University of Alaska

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Plant height (cm) in Primula acaulis ‘Danova type’

	Photoperiod (hours)	Irradiance (mol day^{-1}m^{-2}) 2	10	18
60ºF/16ºC	8	4.7	4.6	4.2
	11	4.6	6.0	3.4
	14	5.8	7.8	2.5
68ºF/20ºC	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 60ºF/16ºC or 68ºF/20ºC and 8,11, or 14 hour photoperiod at 2, 10 or 18 mol day^{-1}m^{-2} .

Research by Dr. Meriam Karlsson, University of Alaska

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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 Banner Maxx* (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.

**Banner Maxx is a fungicide with growth regulator effects.*

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Danova flowering guide

- **Early - Initiate flowers earlier, therefore, avoid over regulation.**
- **Medium - Initiate flowers in the middle, therefore, apply growth regulators as necessary.**
- **Late - Initiate flowers later, therefore, greater regulation may be necessary.**

Early	Medium	Late
Bicolor Apple Blossom	Bicolor Burgundy	Bicolor Pink
Bicolor Rose & White*	Purple*	Bicolor Red & Yellow
Blue*	Bicolor Wine	Red & Rose Shades
Cherry w/Edge	Copper	
Cream Yellow	Light Violet	
Lemon Yellow*	Orange	
Lime	Pink*	
Rose	Red*	
Wine Red	Rose Lavender Shades	
	Salmon Orange	
	Scarlet	
	Velvet Red	
	White*	
	Yellow w/Eye*	

***Danova Grower Select** – is a selection of the best matching colors within the series selected for habit and flowering. Core colors that perform perfectly together.

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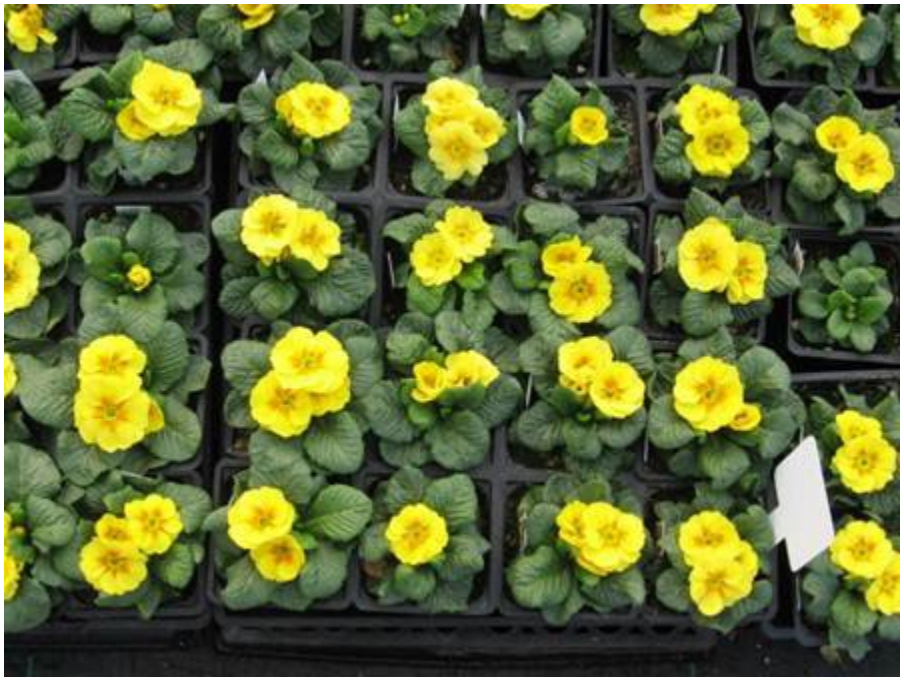
PGR – Over application

Danova Yellow w/Eye at without growth regulation.



Yellow w/Eye treated with ½ ppm drench of Sumagic and several drenches of Bonzi at 5-6 ppm.

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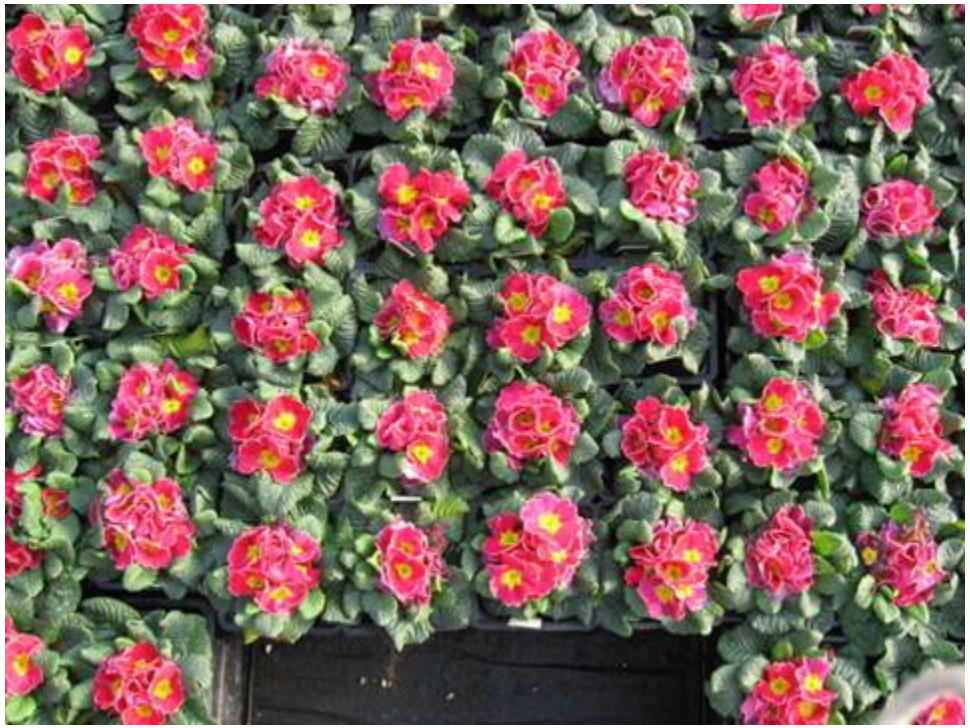
PGR – Over application



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

Danova Cherry w/Edge

PGR – Over application

- Apply growth regulator applications based on the stage of plant development.
- If initiation occurs earlier than normal (due to higher light levels) the plants will be over-regulated.
- Over regulation is more common with extra early flowering varieties.

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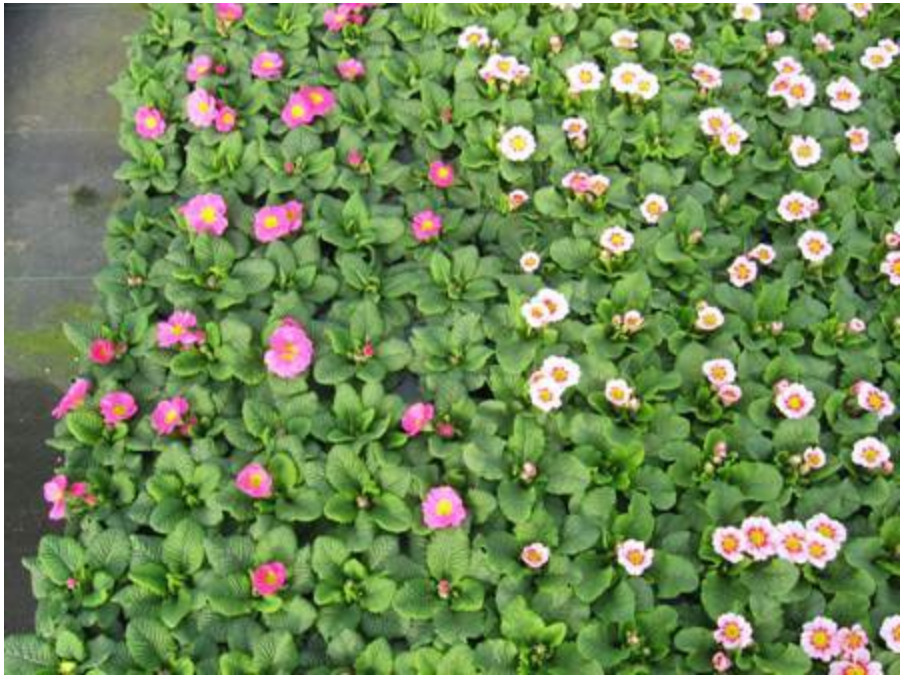
PGR – Controlling plant habit via culture



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

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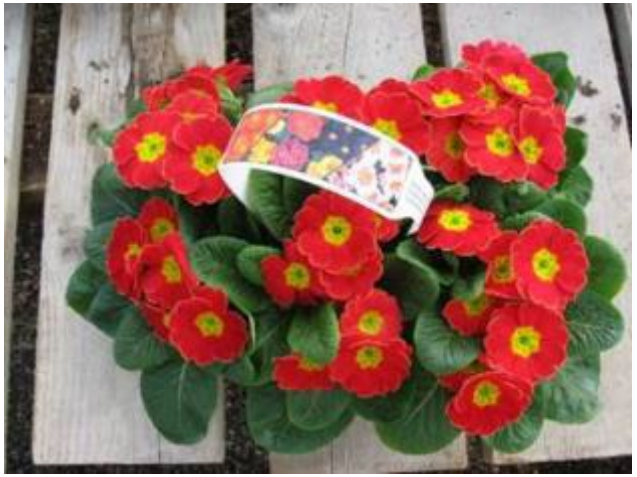
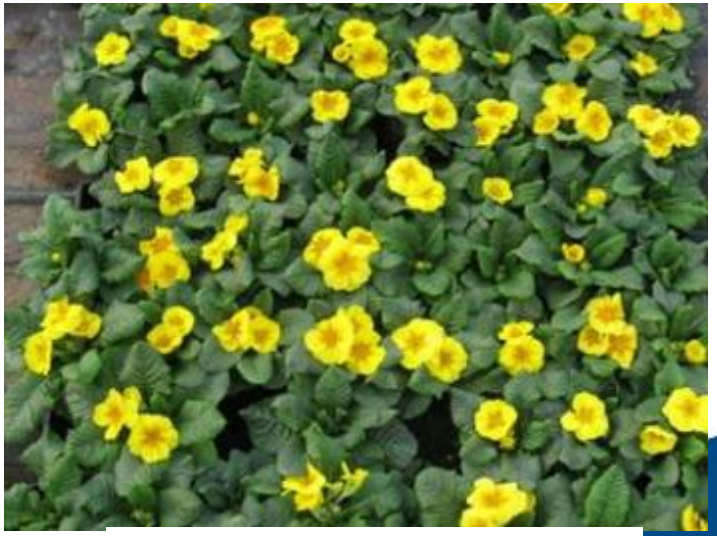
PGR – Well grown plants with moderate amounts of Bonzi.

Danova Velvet Red



Danova Red w/ Yellow Edge



Danova Yellow

Physiological Disorder - Blindness

Factors that cause blindness

- 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).

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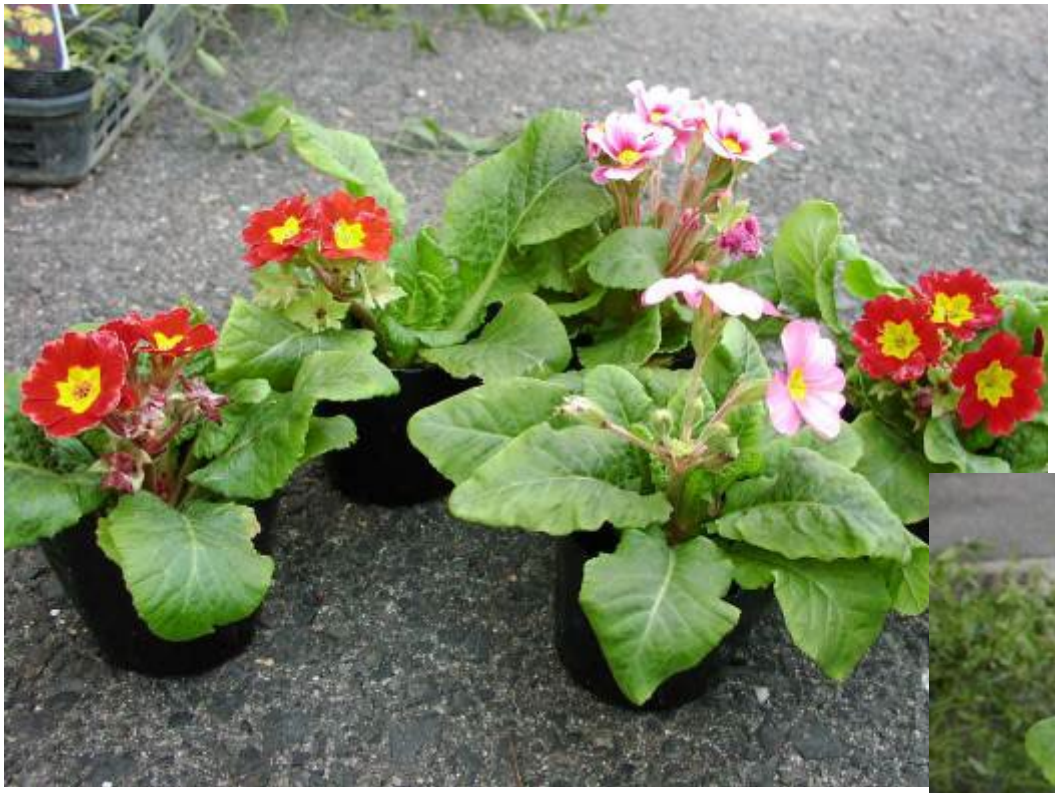
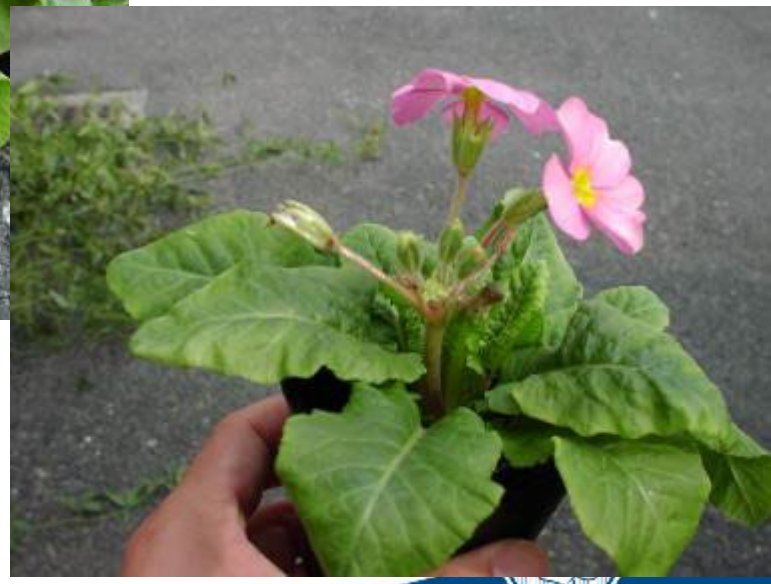
Physiological Disorder - Rosette

- The plants exhibit multiple layers of foliage with large leaves.
- If the plants receive sufficient cooling they will set a high number 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.

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Pests and diseases

1) In general, Primula is not attractive to pests, but aphids, thrips, whiteflies 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 strong air movement all help control and prevent disease.

Pests - Insect biting damage

Leaf damage from cut worm

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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.

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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.

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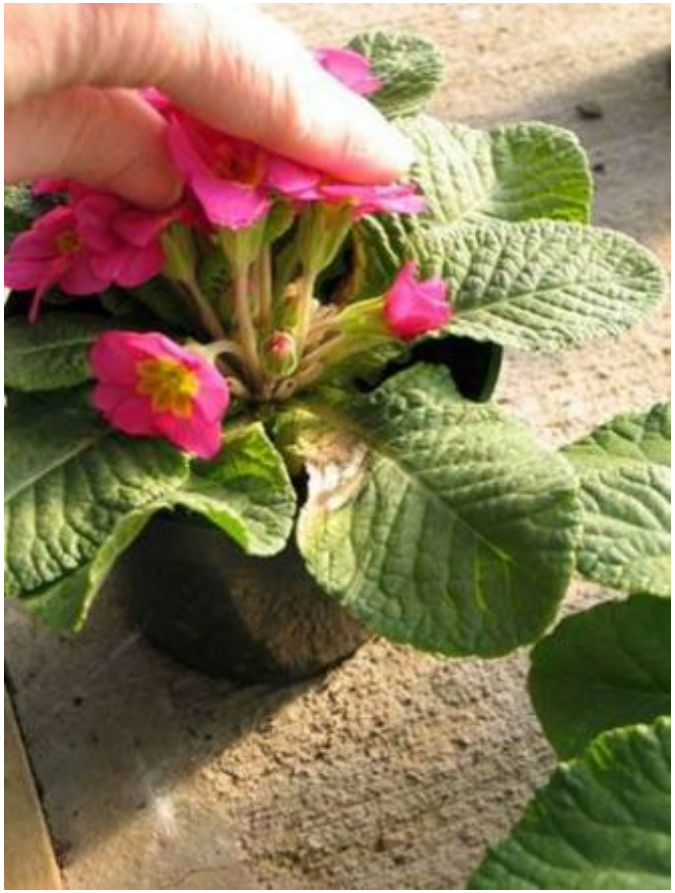
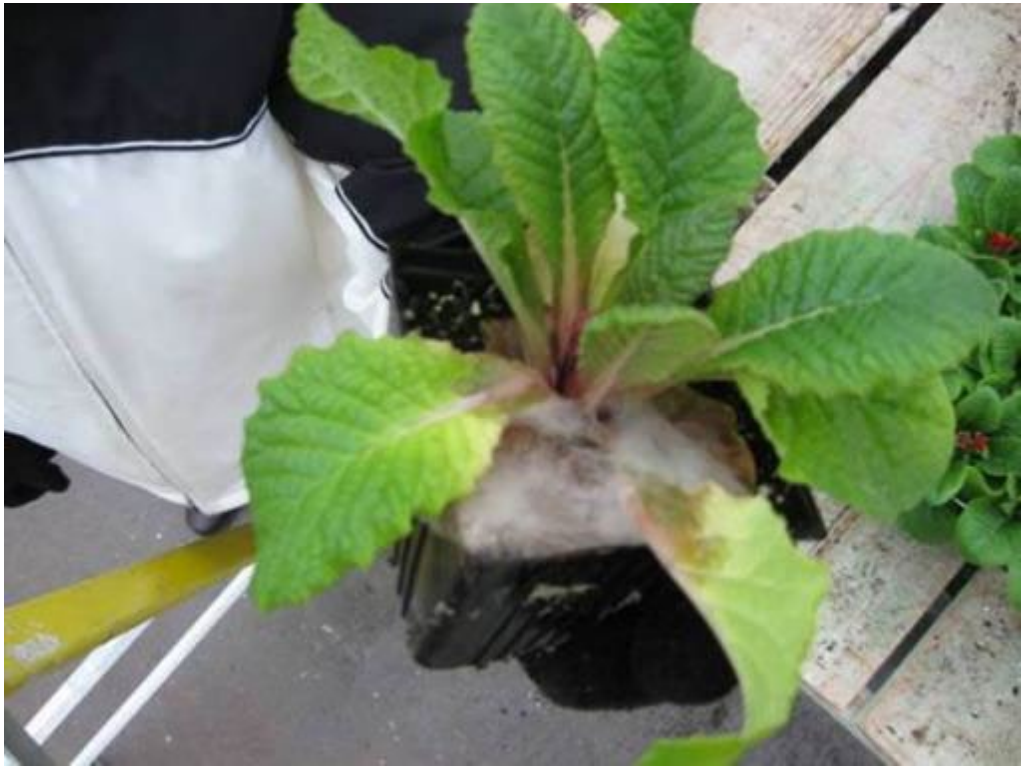
Disease – Gray Mold *(Botrytis cinerea)*





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

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Disease - Gray Mold (*Botrytis cinerea*)

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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 54ºF/12ºC. Also, greenhouse films that block near ultra-violet rays are effective in controlling botrytis.
- Iprodione, Thiophanatemethyl and Polyoxins are effective in controlling Botrytis.

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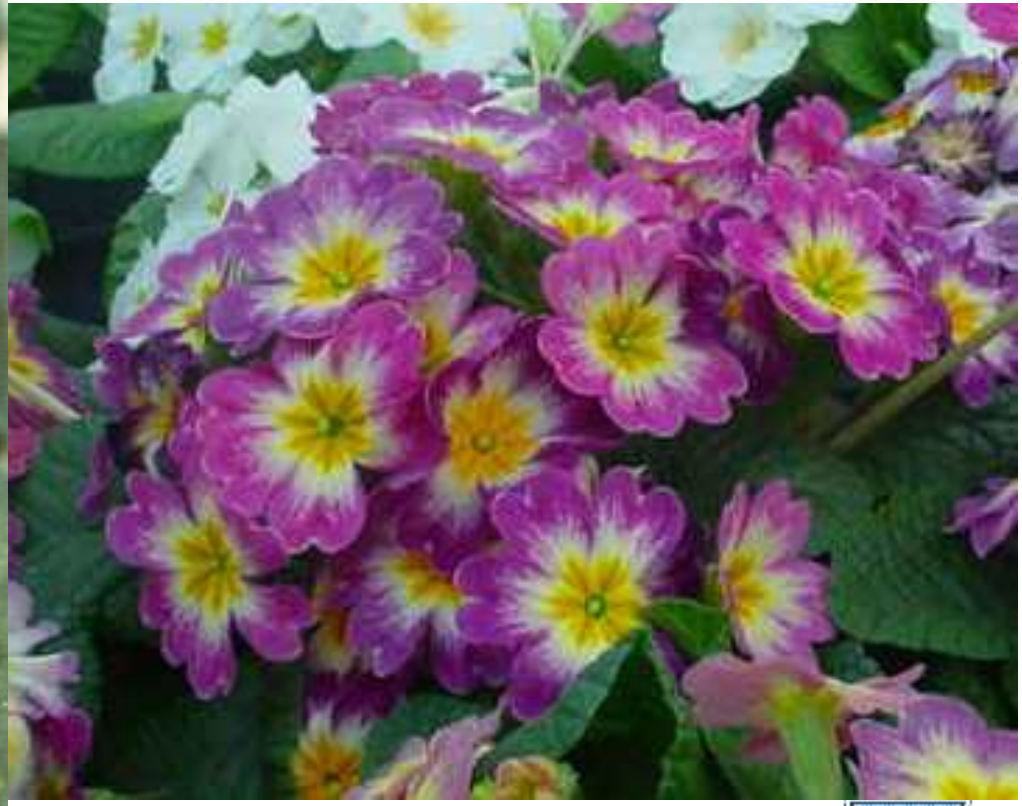
Disease – CMV (*cucumber mosaic virus*)



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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*)

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Disease - Bacterial soft rot (*Erwinia carotovora*)

- Caused by high temperature (>76ºF/24ºC), 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 with Copperoxychloride is effective against bacterial soft rot.

Disease - Leaf spot (*Alternaria sp.*)

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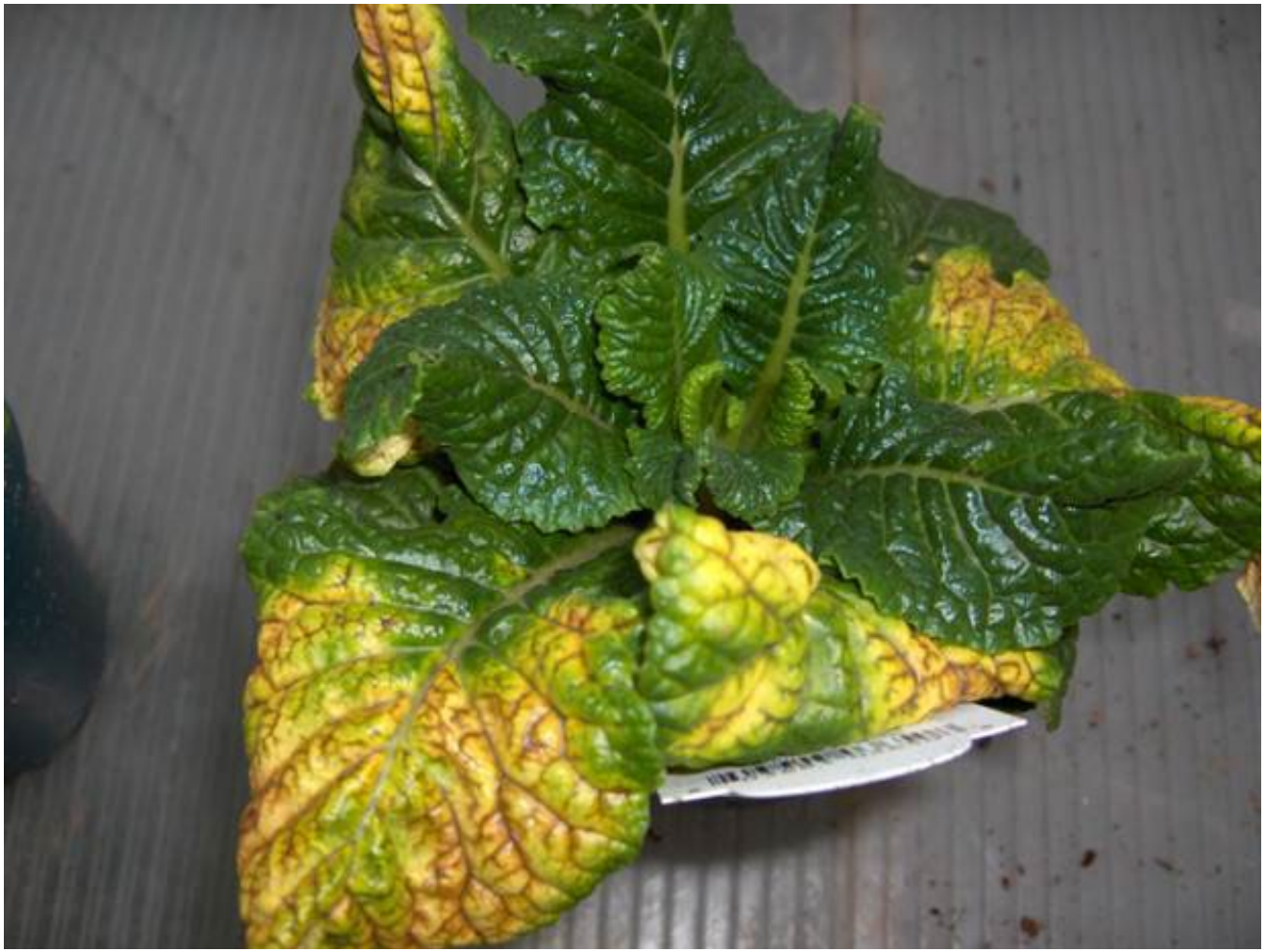
Disease - Leaf spot (*Alternaria sp.*)

- 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.

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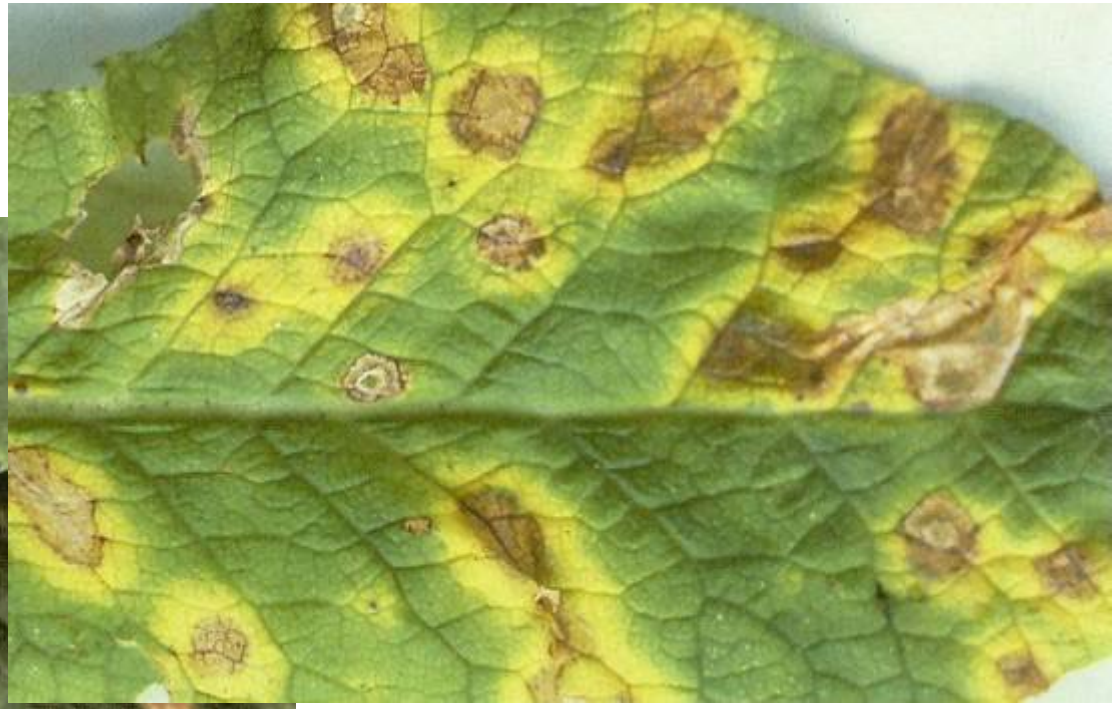
Disease – Leaf spot (*Ramularia primulae*)



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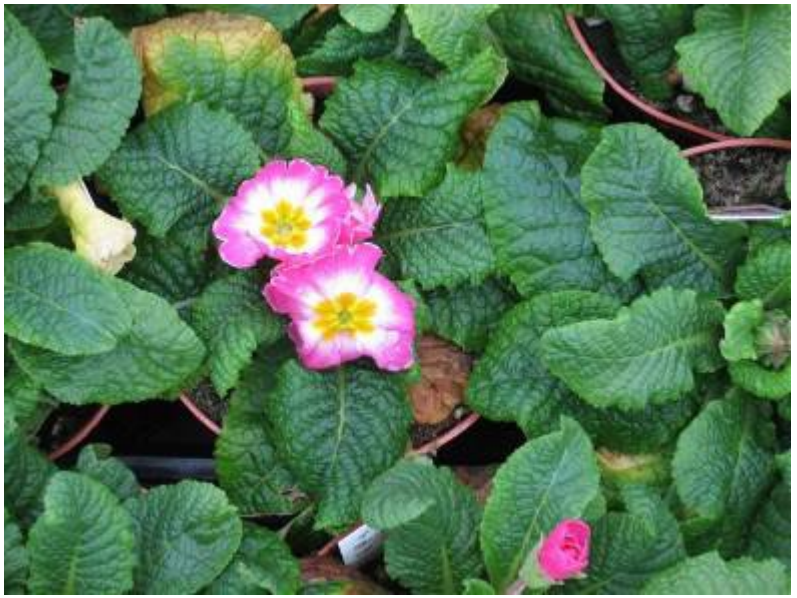
Disease – Leaf spot (*Ramularia primulae*)

- 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 (Pseudamonas syringae)



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

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Disease – Bacterial Leaf Spot (Pseudamonas syringae)

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Disease – Bacterial Leaf Spot (Pseudamonas 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*)

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Disease - Bacterial rot (*Pseudomonas marginalis*)

- Soil infection, high humidity and high temperature (over 76ºF/24ºC) 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 sp., Phytopthora sp.)*

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

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Disease – Root rots *(Pythium sp., Phytopthora sp.)*

- 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)*

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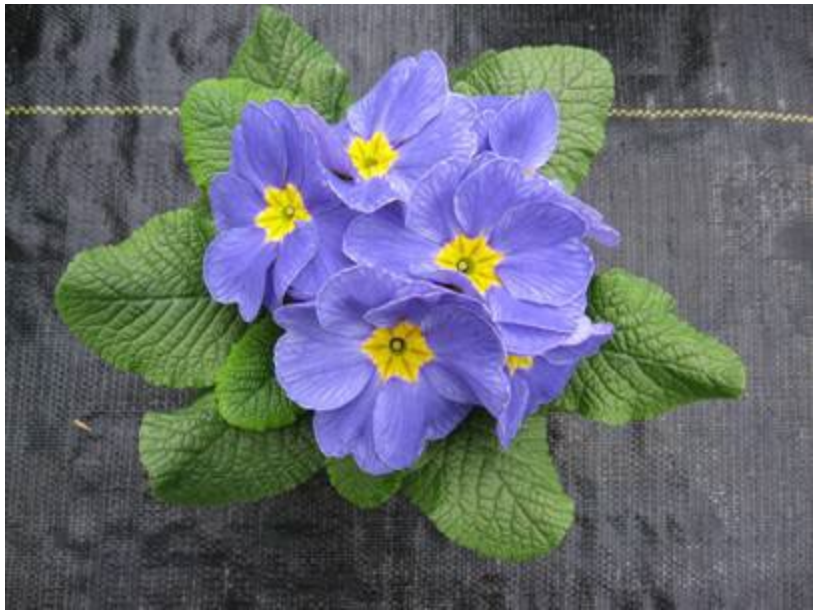
Disease – Slime Mold *(Physarum gyrosum)*

- It is not a parasite, and will do no injury unless is occurs in immense quantity (when it might be dispersed when spraying the plants with high pressure).
- The early or plasmodium condition develops in darkness, and finally attaches to 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

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