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Phenological Growth Stages of Strawberry (Fragaria ananassa) cv.“Winter dawn”

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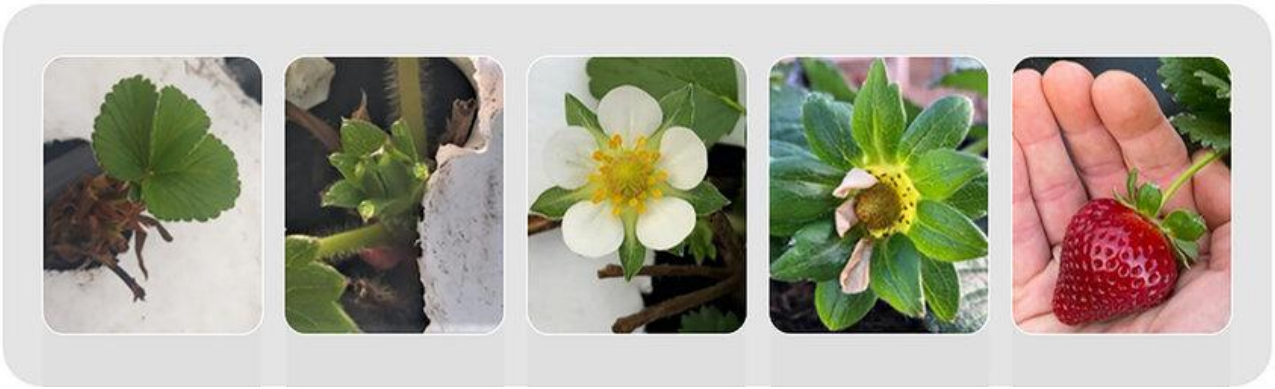
Introduction: Phenological Growth Stages are the stages of plant from emergence of a bud to fruit formation or Stages, how a bud is transformed into fruit.



Different phenological growth stages of strawberry:

Stage 1: Close Bud Stage (Principal Growth Stage) from the bud appearance until bud opening starts. The "close bud stage" of a strawberry plant refers to a developmental stage where the flower buds are formed but have not yet opened into flowers. At this stage, the buds are typically small and tightly closed, showing no signs of petals or bloom. In terms of growth, the close bud stage precedes the flowering stage. Once the buds start to open and reveal petals, the plant enters the flowering stage, eventually leading to fruit development if pollination is successful. The timing of this stage remains for 3-4 days depends on the variety and the climatic conditions.

Figure 1. (a) Closed buds

Figure 2. (b) Bud Burst stage

Time interval taken: 4 days

Stage 2: Open Flower Stage from the beginning of the flower opening until it starts to lose the first petals. The "open flower stage" of a strawberry plant refers to the phase in its development when the flower buds have fully opened, revealing the petals and reproductive structures such as stamens and pistils. At this stage, the flowers are fully visible and accessible for pollination. Pollination is crucial for fertilization and subsequent fruit development in strawberries. Bees and other pollinators typically visit open flowers to transfer pollen between plants, enabling the formation of fruit. The timing of this stage remains for 7-9 days after the flower bud have opened.

Figure 2. (a) First opened Flowers

Figure 2. (b) Complete open flowers
Time interval taken: 7 days

Stage 3: Petal Fall Stage from the first petals fall until none of them are in the flower. The "Petal Fall stage" of a strawberry plant refers to the phase in its growth cycle when the petals of the flowers begin to drop off after pollination. This stage follows the blooming phase, during which the flowers are open and pollination occurs. Once the petals fall, the fertilized ovaries within the flowers develop into the fruit. In the case of strawberries, the receptacle swells and becomes the fleshy part of the fruit, while the seeds (achenes) develop on its surface. After the petals have fallen, the plant continues to focus its energy on fruit development, and it's crucial to ensure proper care to support healthy fruit growth. This includes adequate watering, nutrient supply, and sunlight exposure. The timing of this stage remains for 5-6 days after the complete set of pollination.

Figure 3. (a) Petal fall stage

Figure 3. (b) Complete petal fall

Time interval taken: 5 days

Stage 4: Green Fruit Stage From the pistils becoming brown until achenes swell and form a greenish receptacle. The "Green Fruit stage" of a strawberry plant refers to the phase in its growth cycle when the fertilized ovaries have developed into small, green fruits. At this stage, the strawberries are still immature and not yet ready for harvest. The fruits will continue to grow and ripen over time. During the green fruit stage, it's important to continue providing the plant with proper care, including adequate water, nutrients, and sunlight, to support the development of healthy and flavorful strawberries. As the fruits mature, they will gradually change color, typically shifting from green to white or pale yellow, and eventually to their characteristic red color when fully ripe. The timing of this stage remains for 12-14 days after the petal fall.

Figure 4. (a) Green fruit stage

Figure 4. (b) Developed green fruit

Time interval taken: 12 days

Stage 5: Fruit Development Stage : During fruit development, the ovaries, which are initially small green structures, undergo significant growth and changes. The receptacle, or the swollen part of the flower where the seeds (achenes) are embedded, expands and becomes fleshy, forming the bulk of the fruit. The achenes themselves develop on the surface of the receptacle. As the strawberries progress through the fruit development stage, they undergo various physiological and biochemical changes. These changes include the accumulation of sugars, organic acids, and other flavor compounds, as well as changes in texture and color. The fruits typically transition from green to white or pale yellow, and eventually to their characteristic red color as they ripen. In this stage fruit changes its color from green to light yellow and remains in this stage for 15-18 days.

Figure 5. Fruit Development Stage:

(a) Green stage

Figure 5. Fruit Development Stage:

(b) White stage

Figure 5. Fruit Development Stage:

(c) Turning stage

Stage 6: Maturity Stage & Ripening Stage from when the berry starts to ripen until it is completely mature. The "ripening maturity stage" of a strawberry plant refers to the phase when the fruits have reached full ripeness and are ready for harvest. This stage comes after the fruit development stage and encompasses the final steps of maturation that result in the strawberries achieving their optimal flavor, texture, color, and sweetness.

Figure 6. Fruit maturity & Ripening Stage:

(a) Turning stage

Figure 6. Fruit maturity & Ripening Stage:

(b) Red stage Time interval taken: 4 Days

During the maturity & ripening stage, strawberries undergo several changes:

- **Beginning of Maturity then Ripening:** Most fruits are white in colour.
- **Color:** The berries typically transition from green to white, then to various shades of red, depending on the variety. This color change indicates ripeness.
- **Texture:** The strawberries become softer as they ripen. They develop a juicier and more tender texture.
- **Main Harvest**: More fruits exhibit colour & **Second Harvest**: Additional fruits are coloured.
- **Flavor:** The sugar content increases, leading to a sweeter taste. At the same time, acidity may decrease, resulting in a more balanced flavor profile.
- **Aroma:** The strawberries emit a characteristic fruity aroma when fully ripe.

Conclusion: Conclusively, understanding the phenological growth stages of strawberries is crucial for successful cultivation and management practices. From dormancy to flowering, fruiting, and ripening, each stage presents unique challenges and opportunities. Additionally, knowledge of phenological stages allows researchers to develop improved varieties and cultivation techniques tailored to specific environmental conditions and market demands. Overall, a comprehensive understanding of strawberry phenology empowers growers to make informed decisions and achieve sustainable success in strawberry production.