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Importance of Growth Stages of Rice

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Abstract

Growth of a crop goes through several process and stages until it is fully developed and reached maturity. Similarly, rice growth progresses through distinct stages: germination, seedling, tillering, panicle initiation, booting, heading, flowering, and maturity. Each stage plays a vital role in determining yield potential and is influenced by environmental conditions, water availability, nutrient management, and pest control. During germination and seedling stages, proper moisture and temperature conditions ensure uniform emergence. The tillering stage enhances canopy development and determines the number of productive shoots. As the plant transitions to the reproductive phase, panicle initiation and booting mark the beginning of grain formation. Heading and flowering are critical for pollination and fertilization, directly affecting grain setting and yield. The maturity stage signifies physiological completion, where grains harden and reach harvest readiness. Effective management of irrigation, fertilization, and pest control throughout these stages ensures optimal growth, minimizes stress, and maximizes productivity. Understanding the growth stages of rice is crucial for improving crop management strategies and ensuring sustainable rice production.

1. Introduction

Rice is one of the most important staple foods, feeding over half of the world population. It is a versatile cereal crop grown primarily in tropical and subtropical regions, with Asia being the largest producer and consumer. Renowned for its adaptability, rice thrives in diverse environments, from flooded paddies to upland fields. Beyond its significance as a food source, rice plays a vital role in cultural traditions, livelihoods, and global economies. It is a source of calorie intake and protein for majority of the people in developing countries. Its nutritional value, culinary diversity, agricultural importance and the raising industrial value such as cosmetics, paper, chemicals etc. has made it a cornerstone of food and economic security worldwide. Between 2008 and 2022, global rice consumption increased by over 80 million metric tons, and the global rice market reached up to 696.3 Billion$ in 2024. So, owing to the importance of rice as a staple crop and its resource consumption, we must know the life cycle, the changes that happens in the crop at various phases to

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have a holistic idea of the crop. Rice under transplanted condition is known for its huge water consumption and heavy feeder of nutrients especially, nitrogen (N). Climate is changing affecting the growth of crops decreasing the yield of our staple food. Once, we have a proper knowledge about the stages of the crop, we can intervene at different stages for managing resources whenever required. In short, it is the key to achieve the quantity and quality of rice that we desire, as a successful crop management always go in toto with precise observation of the crop growth stages. The situation can include application of water at the critical stages like panicle initiation, booting and flowering. Similarly, management of weed at 20-40 days after transplanting and 15–60 days after sowing to reduce crop-weed competition, which is a main problem in upland rice (Mukherjee et al., 2008). Knowledge about growth stages will help us in management of the crop and resource efficiently, while addressing the problems faced in crop cycle. Moreover, it aids in making informed decisions, predicting crop growth. Growers can optimize conditions for tillering, panicle formation, and grain development, ultimately improving yield and ensuring the production of a well-nourished plant. In this chapter, we will elaborately see the different stages of growth, phenotypic changes that occurs in rice and its significance.

2. Growth Stages of Rice

Growth is the process of gradual increase or development in size, volume, or mass of a cell or organ or whole organism over time. It is accompanied by metabolic process i.e, anabolic and catabolic processes, that occurs at the expense of energy.

There are 3 growth stages: vegetative, reproductive and ripening stage. The time required for each of these stages is dependent largely on the choice of variety, management practices, and other environmental conditions.

2.1. Vegetative stage

2.1.a. Seedling stage (Nursery stage)

Germination to transplanting, seeds start to germinate, roots and first 4–6 leaves starts to develop. At this stage the food reserve is almost exhausted. Adequate moisture and phosphorus fertilizer should be applied for germination, early seedling development and root development.

2.1.b. Active vegetative stage (Transplanting to maximum tillering stage)

Table 1: Different growth stages of rice

Vegetative (50-60 days)	Starts with seed germination to initiation of primordium • The seedling develops into the main stem. At tillering, the primary tillers develop in the axils of each leaf beginning with the second leaf. Tillers typically begin to appear at about the fifth leaf stage. The period from maximum tillering to initiation of flowering primordial is referred as vegetative lag phase.
Reproductive (35 days)	Culm elongation, decline in tiller number, emergence of flag leaf, booting, heading and flowering • Anthesis normally occurs between 08.00 and 13.00hrs and fertilization takes place between 5-6 hrs later. • Within the same panicle it takes 7-10 days to complete anthesis in all spikelets.
Ripening (25-35 days)	• It is characterized by leaf senescence and grain growth • It follows fertilization and it is divided into milky, dough, yellow-ripe and maturity stages.

This includes sub stages *viz.*,

a) Recovery stage

b) Rooting stage

c) Maximum tillering stage

➢ The transplanted seedlings need/require about 9 days to recover from the shock of uprooting during transplanting after which new roots appear.

➢ It is also known as recovery and rooting stage.

➢ Once the plants have good established roots, tillers develop rapidly and increases to a maximum number.

➢ Tiller height and straw weight also increases during this stage.

➢ The tiller number increases until maximum tiller number is reached, after which some tillers die and tiller number declines and then levels off.

➢ Adequate water and balanced N application should be there to promote production of tillers.

➢ Rice produces 350-400 tillers/m^2 and maximum tillering occurs at 35-40 days after transplanting.

2.1.c. Vegetative lag stage [Maximum tillering to panicle initiation (PI)]

(i) Effective tillering stage

(ii) Non effective tillering stage

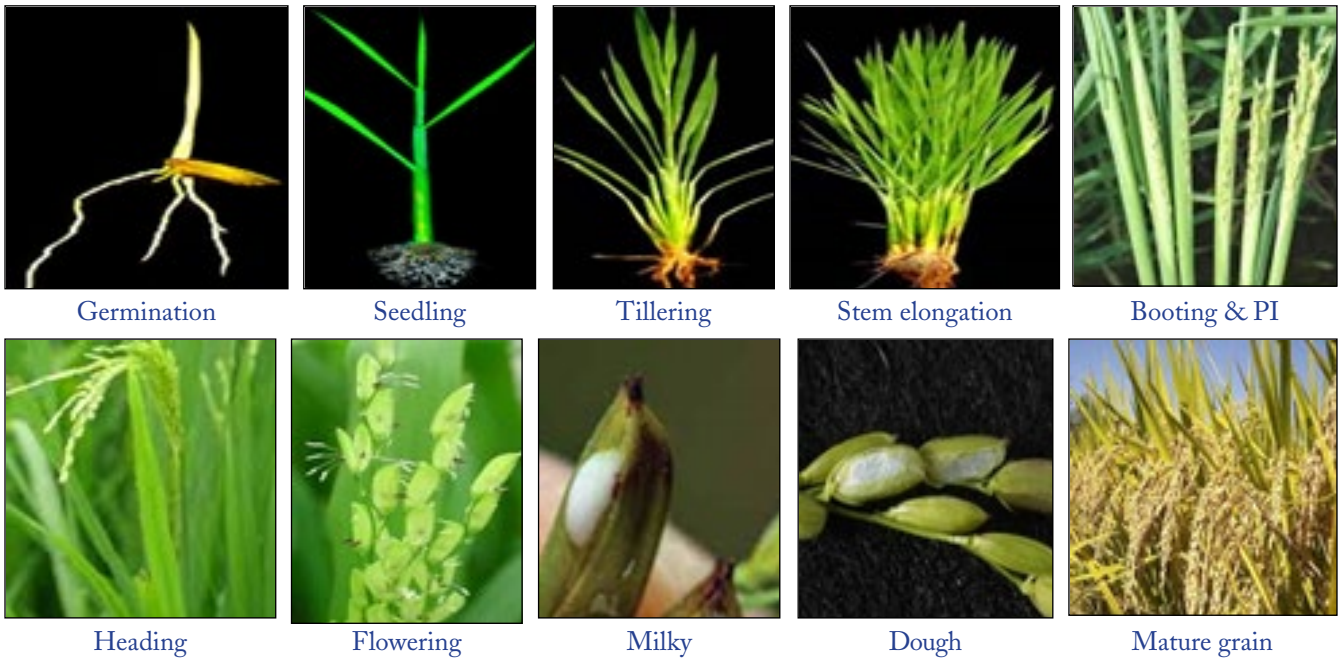

Figure 1: Growth stages of rice

➢ During this stage weak tillers begin to die each strong tiller bears a panicle primordium.

➢ The number of these potential productive (ear bearing) tillers come to be fixed at this stage which is known as "Effective tillering stage".

➢ Tillers that develop subsequently do not bear panicles and die ultimately. This is the "non effective tillering stage".

➢ The visible elongation of lower internodes may begin considerable earlier than the reproductive phase or at about the same time.

Vegetative lag phase is absent in early maturing varieties but occurs in long duration varieties. The phase lasts for 10-20 days.

2.2. Reproductive stage (PI to Flowering)

➢ Panicle development continues and young panicle primordium becomes visible to naked eye in a few days as a transparent structure 1 to 2 mm long with a fuzzed or spongy like structure.

➢ The developing spikelets then become distinguishable.

➢ Bulging to booting and panicle emergence from flag leaf and sheath is called "heading".

➢ Anthesis or flowering/blooming begins with the protrusion of the first dehiscing anthers in the terminal spikelets on the panicle branches.

➢ With the initiation of panicle primordium, the internode elongates. The sheath of the flag leaf bulges due to the developing panicles within its. This is the "booting stage".

➢ The reduction division of pollen mother cells and embryo sac mother cell takes place at this time. The young panicle emerges from the "boot". Anthesis takes place (self), fertilization follows. This is known as "Heading & Flowering".

➢ A large amount of water is consumed in the major part of the reproductive growth period.

➢ Drought during panicle primordial initiation to flowering stage impairs panicle formation, heading, flowering and fertilization and leads to increased sterility and ultimately decrease yield.

➢ Fertilizer mainly N application is crucial as it this stage as it will regulate flowering, producing filled grains and leading to good yield.

➢ Potassium fertilizer can be applied for stress tolerance and to improve quality of grain.

➢ Pollination and fertilization follow after flowering. The development of the fertilized egg and endosperm becomes visible a few days following fertilization.

2. 3. Ripening state (Flowering to harvest)

➢ This includes the sub-stages of grain *viz.*, milk, soft

dough, hard dough & fully ripe stages (milky ripe, soft ripe, waxy ripe and fully ripe stages). Panicle weight increases rapidly. Straw weight decreases.

➢ During vegetative growth period, a relatively small amount of water is needed. Therefore, shortage at this period does not greatly affect the yield, except at the recovering and rooting stages.

➢ Stages after panicle primordial development, especially booting, heading and flowering stages need sufficient water.

➢ Water should be drained out 7-10 days before harvesting to facilitate harvesting conditions and the grain moisture content should be monitored.

3. Duration of Growth Stages of Rice Plant (Approximately)

Table 2: Duration of growth stages of rice

Sl. No.	Growth Stages	Duration (days)		
		Low	High	Medium
1	Emergence to transplanting	30	25	20
2	Active vegetative stage (transplanting to maximum tillering)	25	25	25
3	Vegetative lag phase (maximum tillering to PI)	25	15	5
4	PI to heading	33	33	33
5	Heading to flowering	7	7	7
6	Flowering to maturity	35	30	25
	Total	155	135	115

4. Optimum Temperature Required at Different Growth Stages

Table 3: Optimum temperature required at different growth stages of rice (Source: Yoshida, 1981)

Growth stages	Optimum temperature (°C)
Germination	18–40
Seedling emergence	25–30
Rooting	25–28
Leaf elongation	31
Tillering	25–31
Panicle initiation	20–22
Blooming	26.5–29.5
Anthesis	30–33
Ripening	20–25

5. Importance of Growth Stages

Growth stages in plants are crucial for effective management, crop optimization, and research.

➢ Understanding these stages allows for efficient resource allocation, such as the precise application of water, fertilizers, and pesticides at the right time.

➢ It ensures that critical agricultural practices, including planting, irrigation, and harvesting, are carried out optimally to maximize yield and quality

➢ Growth stages also help in pest and disease management, as certain phases are more vulnerable to attacks, allowing for timely and targeted interventions.

➢ Additionally, they play a vital role in plant breeding and research by providing standardized markers for selecting desirable traits and making experimental comparisons.

6. Conclusion

A comprehensive idea about the growth stages of rice is essential for effective agricultural management, as each phase, from germination to maturation requires specific care and resources. Timely interventions in irrigation, fertilization, and pest control not only optimize plant health but also enhance yield and grain quality. By aligning farming practices with these stages, farmers can improve efficiency, reduce resource waste, and ensure sustainable production, ultimately contributing to better economic and environmental outcomes.

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