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Chronology of tiller emergence and tiller orientation in rice(*Oryza sativa* L.)

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ABSTRACT

The rice plant produces different number of tillers including primary, secondary and tertiary tillers which emerge at different stages of growth. The conventional concept that high tillering rice plants produce more yield is being replaced by a new plant type concept in which optimization of tillering is the objective. A study was conducted to analyze the chronological sequence of tiller emergence and the pattern of tiller orientation in rice varieties Cherumodan, IR36, Ponni and Chitteni grown under uniform experimental conditions. The varieties showed specific periodicity for the emergence of primary, secondary and tertiary tillers intercepted by gap periods. Primary and secondary tillers were produced by all the four varieties but tertiary tillers were produced by IR36 only. Tertiaries and late emerged secondaries were in their juvenile growth stage when the plants were ready for harvest and hence not contributed to grain yield. The varieties showed certain specificities in the alternate axial origin of tillers and their development and orientation.

Key words: *Primary tillers, secondary tillers, tertiary tillers, tiller emergence, tiller orientation*

The seedling stage of rice is followed by the tillering stage which starts with the appearance of the first tiller from the axil of one of the lowermost nodes. Tillers emerging from the mother tiller are the primary tillers. After the emergence of a few primary tillers, secondary tillers emerge from the early primaries. At this stage, the plant rapidly increases in length and number of tillers. Besides, tertiary tillers emerge from the secondaries in some varieties. Modern rice varieties produce 20-25 tillers including primaries, secondaries and tertiaries under favourable growth conditions. Only 14-15 of them produce panicles and the rest remain unproductive. Unproductive tillers compete with the productive ones for solar energy and nutrients (Khush, 2000). Reduced tillering also facilitates synchronous flowering, maturity and uniform panicle size (Khush, 2000). Genotypes with lower tiller number produce a larger proportion of heavier grains (Padmaja Rao, 1987). The present study was designed to analyze the chronology of tiller production and tiller orientation in rice so that the status of each tiller at the time of harvest can be assessed.

MATERIALS AND METHODS

Seeds of four known rice varieties, Cherumodan, IR36, Ponni and Chitteni were sown in separate shallow pans and one week old seedlings of each variety were transplanted in 30 cm pots filled with soil and farmyard manure in 3:1 proportion. Two plants were planted pot^{-1}. 1 gm of Factamphose plant^{-1} was applied on 30th day and 60th day. Tillers were tagged from the day of emergence and observed periodically. Five plants of each variety were observed for this purpose. Range of tillering days was calculated based on the first day of emergence of a particular category of tillers and the last day of emergence of the particular category of tillers (Table 1). Mean values were calculated from the data on five plants each in the case of the four varieties (Table 2 and 3). Figure showing the chronology of tiller production has been drawn based on the mean values. The experiment was conducted in the experimental nursery of the Genetics and Plant Breeding Division of the Department of Botany of Calicut University of Kerala State, India.

RESULTS AND DISCUSSION

Tillering started on the 19th day in Cherumodan, 28th day in IR36, 24th day in Ponni and 27th day in Chitteni and extended up to 42nd day in Cherumodan, 69th day in IR36, 69th day in Ponni and 58th day in Chitteni

Table 1. Range of tillering days in respect of different tillers in the rice varieties.

Variety	Range of tillering days				Days to first flowering
	Primary tillers	Secondary tillers	Tertiary tillers	Total	
Cherumodan	19-42	36-40	—	19-42	51
IR 36	28-53	35-66	66-69	28-69	77
Ponni	24-48	59-69	—	24-69	103
Chitteni	27-53	53-58	—	27-58	166

Table 2. Mean days taken for emergence of tillers in the rice varieties.

Tillers	Rice varieties			
	Cherumodan	IR36	Ponni	Chitteni
P1	19	28	24	27
P2	20	30	24	32
P3	42	31	34	33
P4	—	35	48	48
P5	—	48	—	53
P6	—	53	—	53
P7	—	53	—	53
P1S1	36	35	59	53
P2S1	36	36	61	53
P1S2	38	63	60	53
P2S2	40	63	62	53
P3S1	—	63	63	54
P3S2	—	63	64	55
P4S1	—	—	68	58
P4S2	—	—	69	58
P1S3	—	65	—	—
P2S3	—	64	63	—
P1S4	—	65	—	—
P2S4	—	66	—	—
P1S1T1	—	66	—	—
P1S1T2	—	66	—	—
P2S1T1	—	68	—	—
P2S1T2	—	68	—	—
P1S1T3	—	—	—	—
P2S1T3	—	69	—	—
Total duration of tillering (days)	24	42	46	32
Total tillers produced	8	23	14	16
Days to first flowering	51	77	103	166

(Table 1). The chronological sequence of tiller emergence in these varieties is detailed in Table 2 and Fig.1. The tillering phase consisted of periods of intensive tillering interrupted by gap periods (Table 3). Tillering showed a sequence from primary tillers to secondaries to tertiaries with synchronous emergence among later emerged tillers. Majority of primary tillers emerged during the first intensive period of tillering, secondaries during the second intensive period of tillering and tertiaries in the third period of tillering.

In Cherumodan, primary tillers started to emerge 19 days after sowing whereas secondary tillers started to emerge on the 36th day. Three primary tillers and four secondary tillers were produced. No tertiary tillers were produced by the variety. In Chitteni, primary tillers started to emerge 27 days after sowing where as secondary tillers started to emerge on the 53rd day. No tertiary tillers were produced. In Ponni, primary tillers started to emerge 24 days after sowing and secondary tillers after 59 days. No tertiary tillers were produced here also. In IR36, primary tillers started to emerge on the 28th day followed by secondary tillers on the 35th day. In this variety, tertiary tillers were also produced from the 66th day.

Cherumodan is a short duration upland rice variety and it initiated flowering on the 51st day. Ponni, a widely cultivated variety initiated flowering on the 103rd day and IR36, an improved rice variety, initiated flowering on 77th day when planted in the first crop season of Kerala State of India. Chitteni is a photosensitive native variety and it started flowering on the 166th day when planted simultaneously.

The above observation shows that many of the secondary tillers in Ponni and IR36 and all the tertiary tillers produced by IR36 were juvenile at the time of flower initiation by the plants hence showing non contributing nature towards effective grain yield. More over, such tillers flourish utilizing the food and energy being absorbed by the other tillers. Recent studies by other workers also have indicated the inability of late emerging tillers to contribute towards grain yield in rice (Padmaja Rao, 1987; Khush, 2000).

Table 3. Mean gap periods in days during tiller production in the rice varieties

Gap periods in days	Rice varieties			
	Cherumodan	IR36	Ponni	Chitteni
Mother tiller-primary gap period	19	28	24	27
Primary-secondary gap period	17	7	35	26
Secondary-tertiary gap period	—	31	—	—
Inter primary gap period	11	4	8	4
Inter secondary gap period	2	3	1	1
Inter tertiary gap period	—	1	—	—

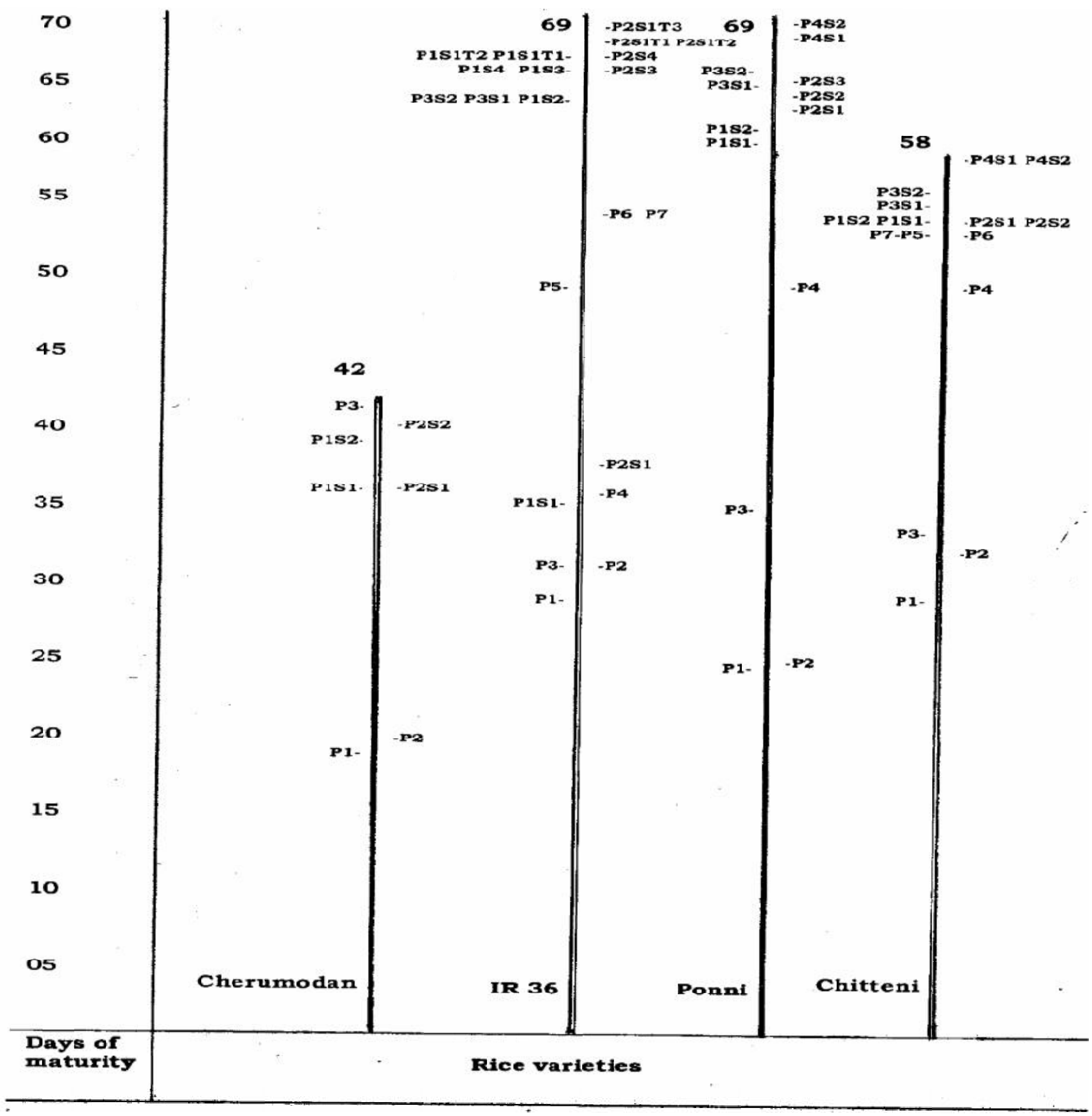

Fig. 1. Chronology of tiller emergence in the rice varieties studied.

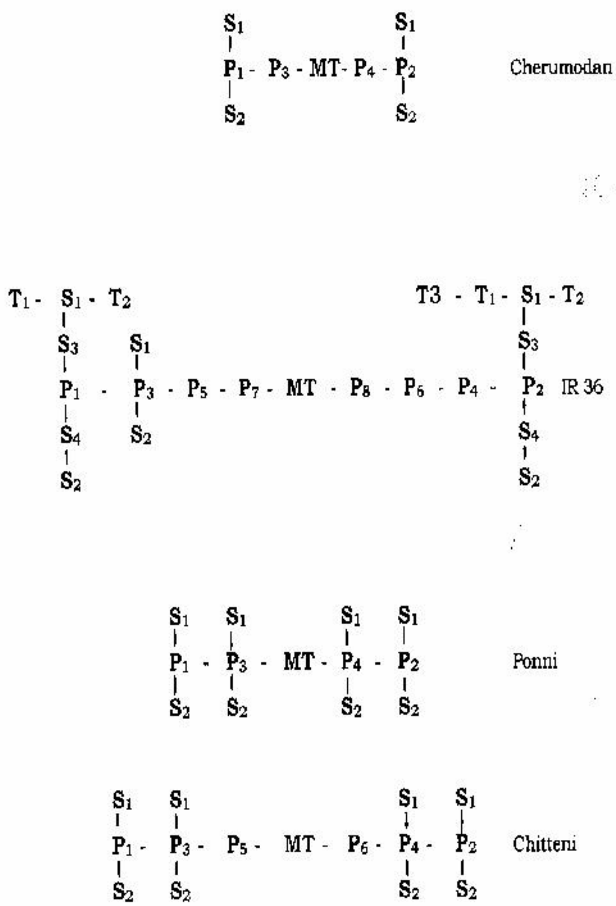

Fig. 2. Pattern of tiller orientation in the rice varieties studied.

The range of tillering days was high in IR36 and Ponni with 41 and 45 days respectively, while Cherumodan and Chitteni showed 21 and 31 days respectively (Table 1). De Datta (1981) has reported sequential emergence of primary, secondary and tertiary tillers in rice and the increase of tertiary tillers continuing up to a point designated as the maximum tiller stage and the decline and levelling off of the number of tiller thereafter. The present observation revealed the emergence of primary tillers, secondary tillers and tertiary tillers following specific sequence intercepted by gap periods and synchrony of emergence of the tillers in later periods of the tillering phase. Further, a critical examination of the gap periods during the tillering phase in respect of the different tillers revealed that inter primary gap period (the mean gap between the emergence of the subsequent primary tillers) was higher than inter secondary gap period and inter tertiary gap period (Table 3). The genotypic variation then in the gap periods between different categories of tillers and the chronology of emergence of different types of tillers show that breeding programmes should be focussed on the pattern of minimizing the gap periods and also on optimizing the emergence of primary tillers.

Tillering in rice varieties showed certain specificity in the alternate axial origin of tillers and the development and orientation of different categories of tillers, in spite of the general pattern of chronological sequence of tiller emergence (Pavithran, 1978; De Datta, 1981). The present study showed that the primary tillers emerged alternatively from the subsequent nodes of the mother tiller, pushing the older one to the exterior (Fig. 2). The secondaries subsequently emerged from the primaries in a similar manner at right angle to the plane of emergence of the primaries. The tertiaries emerged from the alternating nodes of the corresponding secondaries at right angles to the plane of emergence of the secondaries. This pattern of tiller development and orientation is said to be the peripetal origin and orientation of tillers (Rajan, 1989).

Further studies on tiller emergence, tiller orientation and relative contribution of different categories of tillers towards grain yield may lead to the development of a more suitable plat type for rice.

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