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Short Note

Tiller Dynamics, Light Interception Percentage and Yield of Rice Cultivars Under System of Rice Intensification (SRI) as Influenced by Nursery Techniques and Spacing

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Field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore to find out the tiller dynamics, light interception percentage of rice cultivars under system of rice intensification as influenced by nursery techniques and spacing. The experiment was laid out in a split plot design. The main plot treatments include two nursery techniques such as mat and conventional nursery to raise seedling for SRI and two cultivars *viz.,* CORH 3 hybrid and ADT 43 variety and sub plot consisted three square crop geometry levels viz., 25 x 25 cm, 30 x 30 cm and 35 x 35 cm, with three replications. The results revealed that, tillering behaviour, phyllochron and grain yield did not vary due to nursery techniques. Regarding crop spacing tillering behaviour, phyllochron and rate of leaf appearance was faster in widely planted rice cultivars compared to 25 x 25 cm spacing. Light interception percentage was higher in CORH 3 and also closer spacing intercepted the more light than wider spacing. Regarding yield the performance CORH 3 was superior over ADT 43 as it produced 16.9 per cent higher yield and 25x25 cm for variety (ADT 43), 30x30 cm for hybrid (CORH 3) is optimum for obtaining higher grain yield.

Key words: Tillering behaviour, leaf emergence rate, light interception, grain yield.

System of rice Intensification (SRI) is an innovative system of rice cultivation where 20-30 percent increased yield could be obtained. How ever, there is limited study on the tiller dynamics and phyllochron change in rice especially in Indian condition. Phyllochron or leaf emergence rate, which has been used to characterize the growth dynamics of cereals is defined as the time interval of leaf emergence (Nemoto *et al.*, 1995). Rice tillering in a major determinant for panicle production and as a consequence affects the total yield. Tillering of rice depends on the cultivars and resources available for growth. On the other hand, excessive tillering lead to high tiller abortion, poor grain setting, small panicle size and finally reduced yield as reported by Dun *et al*. (2006). Study of tillering pattern and leaf emergence rate of rice cultivars is a crucial need for selection and improvement of productivity. Based on the above views an attempt was made to study the tiller production and phyllochron at regular interval with different crop geometry levels, light interception and their influence on grain yield of rice cultivars.

Materials and Methods

The field experiment on rice cultivars was conducted during *Kharif,* 2008 at Tamil Nadu Agricultural University, Coimbatore. The experimental site is geographically located at -11° N latitude and 77° E longitude at an altitude of 427 m above mean sea level. The soil of the experimental field was clay loam, medium in available N (252 kg ha^{-1}), medium in available P (22 kg ha^{-1}) and high in available K (482 kg ha^{-1}). The electrical conductivity of soil was 1.02 dSm^{-1} and the pH 8.05. The experiment was laid out in split plot design with three replications. Two factors viz., nursery techniques at two levels (mat and conventional nursery) and cultivars (hybrid CORH 3 and variety ADT 43) were fitted in main plot. Three levels of crop geometry (25 x 25, 30 x 30 and 35 x 35 cm) were assigned to sub plot. Crop management practices were carried out as per the recommendations (CPG, 2005) . Five plants were randomly selected, tagged and tiller initiation and phyllochron was observed on each treatment. Number of tiller produced from the individual hills was recorded in alternate days from the initiation of first tiller to physiological maturity stage. From that phyllochron interval and tillering behaviour was computed. The measurement of light was done between 1200 and 1300 hr of the day using a quantum meter (LI -COR model LI-185 A) with 1.0 m line quantum sensor. In each plot, the light incident above the canopy was measured at three places at random by holding the sensor above the crop canopy. Light transmitted through the crop canopy was measured by holding the sensor below the crop canopy. Light measurements were taken at tillering, panicle initiation, flowering and maturity

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stages and the mean value was worked out. The percentage of light intercepted by crop canopies were worked out and expressed in percentage.

$$PLI = \frac{(LI - LT)}{LI} \times 100$$

Where,

PLI - Percentage of light intercepted, LI - Light incident above the canopy, and LT - Light transmitted below the canopy.

Plants were harvested at maturity stage and the grain yield was recorded at 14 percent moisture level.

Results and Discussion

Tillering behaviour

Tillering capacity is the most important characteristic of rice cultivars. In general, tiller production starts slowly in the beginning, increased steadily and attained to its peak and then started to decline. Total number of tillers per unit area was not significantly affected by nursery techniques. However, cultivars and crop geometry levels had shown significant effect on the tillering behaviour (Fig 1, 2).

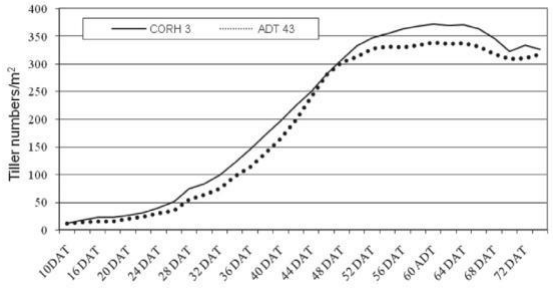

Fig 1. Performance of rice cultivars on tillering behaviour

Cultivars exhibited significant difference on tiller production up to 42 DAT and there after showed no variation. The peak tiller production was attained early (52 DAT) in closer planting and it was extended when the plants were placed at wider crop geometry levels.

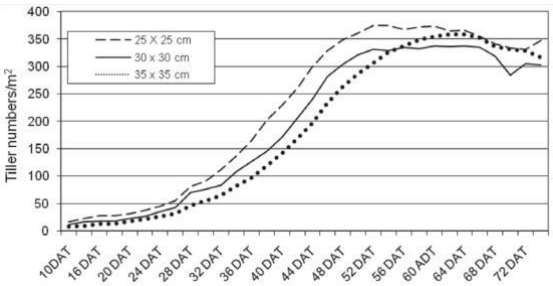

Fig 2. Rice cultivars on tillering behaviour at different crop geometry

Delay in peak tiller production was noticed in 35 x 35 cm (64 DAT). The enhanced availability of resources for the individual culms under wide spacing would have extended the duration of tiller production. Increased crop geometry levels resulted in a decrease in tiller number m^{-2} in both cultivars, evidently due to less number of hills at the wider crop geometry levels as reported by Jayawardena and Abeysekera (2002).

Profuse tillering due to lower plant density was noticed under wider crop geometry compared to closer geometry. A wider crop geometry level (35 x 35 cm) had given more number of tillers $plant^{-1}$ at all growth stages compared to 30 x 30 and 25 x 25 cm. The individual plants could have effectively utilized the available resources such as space, foraging area for root system**,** light utilization etc. and thus enhanced the tiller production in wider spaced treatments. Similarly increased number of tillers $hill^{-1}$ in the crop under wider spacing was very well documented by Watanable *et al*. (2005) and Awan *et al*. (2007).

The dynamic of leaf emergence on the main tiller was similar for both hybrids and variety with different crop geometry levels. Yoshida (1981) reported that most early to medium duration rice cultivars produce 10 to 18 leaves on the main culm. Similar result was also found in this study where cultivars produced on an average 13.3 leaves on main culm (Table 1).

Plant density is one of the main factors that determine the leaf appearance rate. The observation indicated that the plant density affected the leaf appearance rate; higher the density, slower is the rate of appearance. Leaf appearance rate was highly correlated with relative growth. With increasing densities, RGR lowered and leaf appearance slowed down. This might be due to higher level of competition between plants in higher densities. Increasing densities shortened tillering phase and lengthed reproductive phase. This result is in accordance with findings of Murthy and Murthy (1980). Under decreased plant density, the rate of leaf appearance was higher and eventually resulted in the production of 4^{th} and 5^{th} row tillers on the main culm. This might be the actual reason for production of more tillers with wider spacing, at particular duration and correlated to yield.

Light interception percentage

Light interception percentage increased steadily upto flowering and decreased towards harvest stage (Table 2, 2a). Light interception by the canopy was greater at flowering stage compared to other growth stages (tillering, panicle initiation and maturity). Hybrid CORH 3 intercepted more light than ADT 43 variety at all growing stages due to the vigorous growing nature of hybrid to produce more dry matter than variety and its potential to harness resources more efficiently. There were significant differences among the crop geometry level. Higher the hill density, larger the rate of interception of light. Light interception decreased with increase in spacing. Closer planting of rice at 25x25 cm intercepted more light than 30x30 and 35x35 cm. Similar results were also reported by Faisul *et al.* (2010).

Table 1. Influence of nursery techniques and crop geometry on leaf emergence (days) of rice cultivars

Treatment	3_{rd}-4_{th}	4_{th}-5_{th}	5_{th}-6_{th}	6_{th}-7_{th}	7_{th}-8_{th}	8_{th}-9_{th}	9_{th}-10_{th}	10_{th}-11_{th}	11_{th}-12_{th}	Total no.of phyllochron
Nursery techniques										
N_1 (Mat nursery)	4.3	4.8	4.8	4.4	4.9	4.8	5.2	5.7	8.1	13.3
N_2 (Conventional)	4.4	4.9	5.3	4.8	5.2	5.3	4.9	5.8	7.8	13.1
SEd	0.1	0.1	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.2
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cultivars										
C_1 (CORH 3)	4.5	5.0	4.9	4.5	4.8	4.8	4.9	5.6	7.9	13.1
C_2 (ADT 43)	4.3	4.8	5.2	4.7	5.3	5.3	5.1	5.8	7.9	13.3
SEd	0.1	0.1	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.2
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Crop Geometry										
S_1 (25 x 25 cm)	4.5	5.0	5.3	5.1	5.5	5.8	5.8	6.5	8.1	12.9
S_2 (30 x 30 cm)	4.3	4.8	5.2	4.6	5.1	4.9	5.0	5.4	8.0	13.3
S_3 (35 x 35 cm)	4.4	4.9	4.7	4.2	4.5	4.3	4.3	5.3	7.6	13.3
SEd	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3
CD (P=0.05)	NS	NS	NS	0.59	0.74	0.73	0.63	0.72	NS	NS

Interaction: Absent

Yield attributes and yield of rice

The results of the experiment revealed that there was not much difference between mat and conventional nurseries on yield attributes like total and productive tillers, grain filling and yield of grain. The reason might be that both nursery methods produced quality seedling at the age of 15 days for planting with one seedling per hill (Table 2, 2b). There was not much difference between the rice hybrid (CORH 3) and the variety (ADT 43) in the

Table 2. Influence of nursery techniques and crop geometry on light interception and yield of rice cultivars

Treatment	Light interception (%)				Yield attributes and yield			
	Tillering	Panicle initiation	Flowering	Maturity	Productive tillers (No.m^{-2})	No. of filled grains $panicle^{-1}$	Spikelet sterility percentage	Grain yield (kg ha^{-1})
Nursery techniques								
N_1 (Mat nursery)	32.1	53.7	71.6	63.4	303	130.8	8.5	6013
N_2 (Conventional nursery)	31.7	55.9	68.8	60.8	290	129.4	9.0	5921
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Cultivars								
C_1 (CORH 3)	33.8	59.0	74.3	66.4	303	138.7	7.7	6516
C_2 (ADT 43)	30.0	50.6	66.1	58.0	289	121.6	9.9	5417
CD (P=0.05)	3.1	4.4	5.8	4.2	NS	4.9	0.55	379
Crop Geometry								
S_1 (25 x 25 cm)	40.0	62.9	77.6	69.2	312	119.4	9.8	6321
S_2 (30 x 30 cm)	34.5	55.2	71.0	63.4	294	130.0	9.2	6212
S_3 (35 x 35 cm)	21.2	46.4	62.1	53.7	284	140.9	7.4	5368
CD (P=0.05)	2.7	3.0	3.5	2.5	22.1	3.1	0.57	256
Interaction	S	S	S	S	NS	S	S	S

production of total and productive tillers per unit area. However CORH 3 hybrid produced significantly more number of grains per panicle and filled grains than the variety. The hybrid vigour is an added advantage in the performance compared with variety. Accordingly the grain yield of hybrid was significantly higher than the variety. Similar result was reported by Yang *et al*. (2007).

As the spacing increased the total and productive tillers per unit area decreased; but the effect was not phenomenal with progressive increase in crop spacing. Decrease in number of panicles per hill was observed under closer spacing which might be due to tillering mortality caused by mutual shading during pre flowering stage of the crop as reported by Kewat *et al.* (2002). A reverse trend in total and filled grains per panicle was observed when the population per unit area was reduced by altering geometry. Higher number of filled grains was achieved with the spacing of 35x35 cm compared to other spacings. Wider spacing might be one of the reasons for reduced competition (nutrients, water and micro climatic factors) for better grain filling, higher grain weight and number of filled grains and panicle m^{-2}. Under wider spacing better partitioning of dry matter, which lead to increase in

the number of filled spikelets and decrease in spikelet sterility (Krishna *et al.,* 2008). Less number of tillers and filled grains per unit area with wider spacing of 35x35 cm, showed that the plant populations was not sufficient enough to reach to that of 30 x 30 cm and 25 x 25 cm. Similar results were also reported by Singh *et al.,* 2012.

Yields of rice varieties did not change when planting distance was maintained below 35x35 cm (IRRI, 1967). Planting geometry of 25x25 cm produced higher yield closely followed by 30x30 cm. The interaction effect of cultivars and crop geometry revealed that the hybrid (CORH 3) produced the highest grain yield of 6976 kg ha^{-1} at 30x30 cm closely followed 25x25 cm (6797 kg ha^{-1}). For the variety, ADT 43 the planting geometry of 25x25 cm was found to be the best for achieving higher level of productivity (5845 kg ha^{-1}). Under wider spacing in case of SRI, the growth potential of the hybrid was fully expressed.

Table 2a. Influence of cultivars x crop geometry interaction on light interception (%) of rice

Treatment	Tillering			Panicle initiation			Flowering			Maturity		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
S_1	44.1	35.9	40.0	68.9	57.0	62.9	83.4	71.7	77.5	75.1	63.3	69.2
S_2	35.4	33.6	34.5	59.7	50.6	55.2	75.9	66.1	71.0	68.2	58.7	63.4
S_3	21.9	20.5	21.2	48.5	44.3	46.4	63.6	60.5	62.1	56.1	51.2	53.6
Mean	33.8	30.0		59.0	50.6		74.3	66.1		66.4	57.7	
C at SCD(P= 0.05)	4.4	5.6	7.1	5.1								

Table 2b. Influence of cultivars x crop geometry on yield attributes and yield (kg/ha) of rice cultivars

Treatment	Filled grains panicle^{-1}			Spikelet sterility percentage			Grain yield (kg ha^{-1})		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
S_1	126	113	119	9.3	10.4	9.8	6797	5845	6320
S_2	141	119	130	7.6	10.8	9.2	6976	5448	6212
S_3	150	132	141	6.3	8.4	7.4	5777	4959	5368
Mean	139	122		7.7	9.9		6516	5417	
C at SCD(P= 0.05)			6.2			4.8			480

Conclusion

It can be concluded that little variability was observed among the cultivars, the wider crop geometry levels would changes the phyllochron or leaf emergence rate resulted more number of tillers per hill and m^{-2}. Light intercepted by 25 X 25 cm spacing were more compared to wider crop geometry. Plant development models that are based on phyllochron are only as accurate as their ability to predict the phyllochron and achieving higher productivity for different climatic condition. Regarding yield, spacing of 25x25 cm for variety (ADT 43) and 30x30 cm for hybrid (CORH 3) is optimum for obtaining higher grain yield.

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