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Influence of Plant Densities and Age of Seedlings on Radiation Use efficiency of *Kharif* Transplanted Rice (*Oryza sativa* L.) in Southern Telangana

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Abstract

Field experiment was conducted during *kharif*, 2013 at college farm, Prof. Jayashankar Telangana State Agricultural university, Rajendranagar, Hyderabad in randomized block design (Factorial) with three plant densities (1, 3 and 5 seedlings hill-1) and four age of seedlings (15, 25, 35 and 45 days old seedlings). The study revealed that the 5 seedlings hill-1 and 25 days old seedlings intercepted higher PAR at panicle initiation, heading and physiological maturity stages. But single seedling per hill obtained higher radiation use efficiency over 25, 35 and 45 days old seedlings. The estimated RUE of *kharif* transplanted rice under Southern Telangana zone was 1.12 g MJ-1.

Key words: Photosynthetically Active Radiation, Radiation Use Efficiency

Introduction

Rice is the staple food for more than half of the world's population and plays a pivotal role in food security of many countries. More than 90% of the global production and consumption of rice is in Asia (IRRI, 1997). As for India, rice is not only a food commodity but also a source of foreign exchange earning about 11,000 cores annually. At the current rate of population growth (1.5%), the rice requirement by the year 2025 would be about 120 million tons by 2025 as against 104.32 million tons to feed its one and a half billion plus population by then (RKMP, 2013). Although the productivity of rice is higher than India but it is less than the world. This is because of the late onset of monsoon, uneven distribution of rainfall and late release of water into canals forced the farmers to use over aged seedlings from the nursery and transplanting of more number of seedlings hill^{-1}. So it is necessary to use properly managed seedbeds with adequate nutrition and optimum seedling densities at appropriate age are important factors to get vigorous plant stands after transplanting. Plant densities (no. of seedlings hill^{-1}) are an important factor for rice production because it influences the radiation interception, photosynthetic rate, tiller production, nutrient uptake and other physiological phenomena and ultimately the growth and development of rice plant. The correct age of seedlings used for transplanting is of primary importance for uniform stand and seedling establishment as half of the success of rice cultivation depends on the seedling (Khakwani *et al*., 2005). Keeping these facts in view, the present investigation was carried out with better utilization of resources.

Material and Methods

The experiment was carried out during *kharif*, 2013 at college farm, Rajendranagar, Hyderabad situated at an altitude of 542.3 m above mean sea level at 17^{o}19' N latitude and 78^{o}23' E longitude. The experiment was laid out in a randomized block design (factorial) with 12 treatments comprised of four levels of different age seedlings (15, 25, 35 and 45 days old seedlings) as one factor and three levels of plant densities (1, 3 and 5 seedlings hill^{-1}) as another factor. The soil of the experiment site was sandy loam in texture, alkaline in reaction (^{pH} - 8.02), low in available nitrogen (210 kg ha^{-1}), available phosphorus (14.14 kg ha^{-1}) and available potassium (249.76 kg ha^{-1}). The other cultivation practices were recommended for raising the crop.

Intercepted PAR (Photosynthetically Active Radiation)

Sun Scan Plant Canopy Analyser was used to measure the incident and transmitted PAR through canopies during the crop growth period at panicle initiation, heading and physiological maturity stages. The intercepted PAR and transmitted PAR were expressed in percentage.

Radiation Use Efficiency (RUE)

The radiation use efficiency was calculated as the ratio of dry matter to radiant energy intercepted (Intercepted photosynthetically active radiation) by the crop (Gallagher and Biscoe, 1978).

$$RUE = \frac{\text{Amount of dry matter produced (g m}^{-2}\text{)}}{\text{Amount of cumulative intercepted PAR (MJ m}^{-2}\text{)}}$$

Results and Discussion

Intercepted PAR (Photosynthetically Active Radiation) (%)

Experimental results revealed that, light interception increased consistently up to heading and reached maximum at heading stage, thereafter it declined towards physiological maturity (Fig.1). This was due to senescence of leaves and tiller mortality. percent light interception was increased from 1 seedling hill^{-1} to 5 seedlings hill^{-1}. The highest interception was recorded with 5 seedlings hill^{-1} (54.6, 66.3 an 63.3) at panicle initiation, heading and physiological maturity respectively and was significantly superior to 3 seedlings hill^{-1} and 1 seedling hill^{-1}, in turn the lowest values were observed with 1 seedling hill^{-1} at panicle initiation (41.7), heading (50.8) and physiological maturity stages (48.5). The increased light interception might be due to increased leaf area index at higher plant densities over low plant densities (Baloch *et al*., 2006).

In similar way percent light interception was increased with different age of seedlings during crop growth (Fig.2). Significantly the highest radiation interception was observed with 25 days old seedlings (61.7, 71.8 and 68.5) over 15 (48.6, 63.0 and 60.8), 35 (42.8, 53.7 and 50.2) and 45 days old seedlings (37.0, 47.1 and 44.4) at panicle initiation, heading and physiological maturity stages respectively. This might be due to the lower leaf area index with old age seedlings, which reduced the intercepted light (Salem *et al*., 2011).

Radiation Use Efficiency (g MJ^{-1})

The radiation use efficiency was increased with progress of the crop growth (Table.1). The highest radiation use efficiency was observed with 1 seedling hill^{-1} at at panicle initiation, heading and physiological maturity stage and was followed by 3 and 5 seedlings hill^{-1}. With advancement of crop age the radiation use efficiency was increased up to physiological maturity stage. The lowest radiation use efficiency was recorded with 45 days old seedlings. This might be due to early harvesting of 45 days old seedlings, lead to less radiation accumulation compared to younger seedlings, where younger seedlings retained for the longer period under field condition.

A linear relationship was observed between biomass and intercepted PAR. Overall the RUE of rice for Southern Telangana zone was estimated to be 1.12 g MJ^{-1} (Fig. 3). In similar way Kiniry *et al*., (1989) noticed the RUE of 2.2 g MJ^{-1} of intercepted PAR from a non-stressed rice crop. The estimated RUE of *kharif* transplanted rice under Southern Telangana zone was 1.12gMJ^{-1}.

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Table 1. Radiation use efficiency (g MJ^{-1}) of rice at different growth stages under varied plant densities and age of seedlings

Treatments	Panicle initiation	Heading	Physiological maturity
Plant densities			
1 seedling $hill^{-1}$	1.05	1.28	1.54
3 seedlings $hill^{-1}$	1.15	1.20	1.41
5 seedlings $hill^{-1}$	1.04	1.13	1.31
Age of seedlings			
15 days	0.82	0.98	1.24
25 days	0.81	0.97	1.26
35 days	1.18	1.43	1.63
45 days	1.51	1.43	1.56

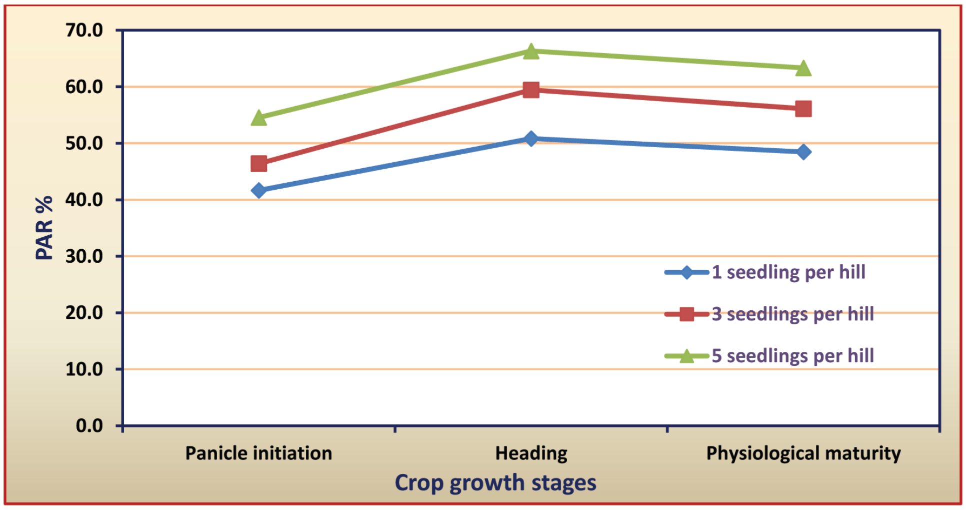

Fig. 1. Per cent intercepted PAR at different phenophases of rice under variable plant densities

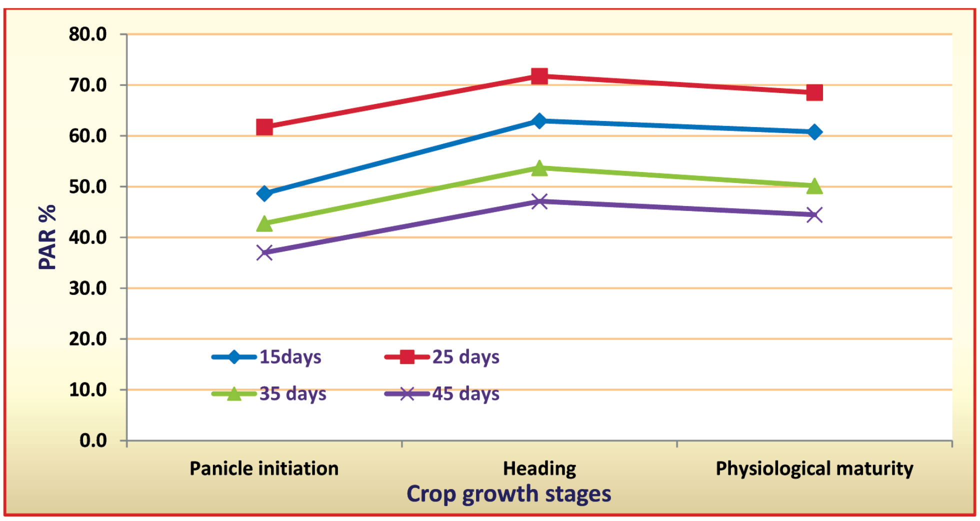

Fig. 2. Per cent intercepted PAR at different phenophases of rice under variable age of seedlings

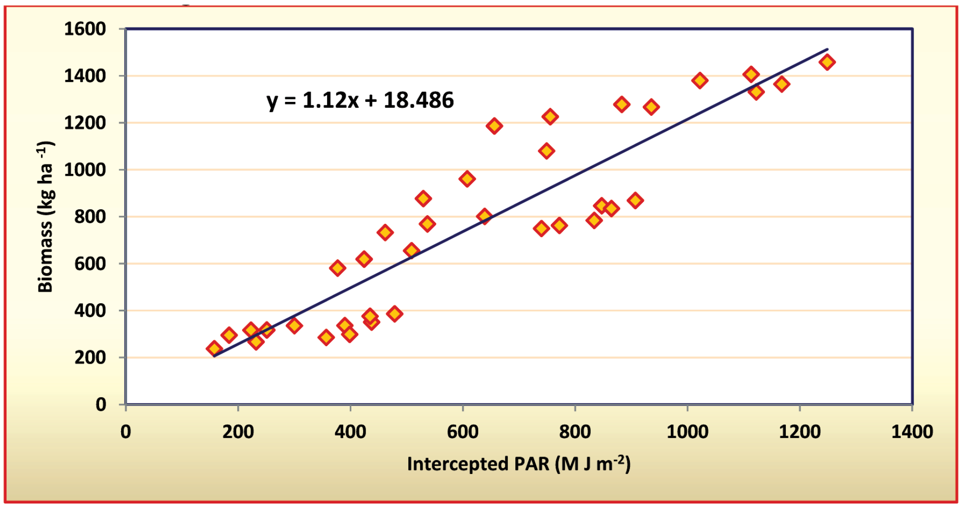

Fig. 3. Relationship between intercepted PAR and biomass of rice under variable plant densities and age of seedlings