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Standardization of lateral spacing and pestigation for drip irrigated rice

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Abstract
Rice is the most stable food crop in the world and in Asiamore than two billion people are getting 60-70% of their food energy from rice and its derived products. Tamil Nadu is one of the biggest producer's of rice. The Cauvery Delta Zone (CDZ) of the composite Thanjavur district is known as the Rice Bowl of South India. In Cauvery Delta Zone, rice is grown in three seasons *viz., Kuruvai* (June- September), *Samba* (August – January) and *Thaladi* (October-February). Rice is the principal crop of CDZ. Owing to increasing water scarcity, it is highly essential to find out alternate methods of rice cultivation which require less water. One of the approaches that lead to a considerable amount of water saving in rice production is drip irrigation. With this view, research experiment was conducted to standardize the lateral spacing and pestigation techniques for higher productivity of drip irrigated rice at Soil and Water Management Research Institute, Thanjavur. Two lateral spacings *viz.,* 80 cm and 110 cm of 12 mm diameter lateral with 4 lph drippers spaced at 30 cm apart with four pestigation treatments to control nematode namely soil application of carbofuran (33 $kgha^{-1}$), pestigation with carbofuran (33 $kgha^{-1}$) and cartaphydrochloride (10 $kgha^{-1}$) and control were tested in two rice varieties *viz.,* CORH 3 and ADT 45 during *Kharif* 2013 and Summer 2014. Irrigation was given at 150 % PE throughout the crop period in every alternate day. Pestigation with equal splits was given on 10 and 30 DAS. The quantity of water consumed through drip upto 10 days prior to harvest was 977.4 mm (*Kharif* 2013) and 1104.8 mm (Summer 2014). Among the rice varieties, CORH 3 performed better with higher grain yield of 4932 kg ha^{-1} which was found superior over ADT 45 with a grain yield of 4698 kg ha^{-1}. Within the lateral spacings, the 80 cm lateral spacing recorded higher yield of 4935 kg ha^{-1} than 110cm lateral spacing (4695 kg ha^{-1}). Pestigation with carbofuran @ 33kg ha^{-1} was found to be effective in managing the rice root nematode. Drip layout of 80 cm lateral spacing with 4 lph drippers spaced at 30 cm apart for CORH 3 hybrid rice along with the pestigation of carbofuran @ 33kg ha^{-1} in equal splits on 10 and 30 DAS found to be the best suitable combination for drip irrigated rice in the CDZ.

Keywords: drip irrigated rice, lateral spacing, pestigation, CDZ

1. Introduction

Rice is the dominant cereal crop in many developing countries and is the staple food for more than half of the world's population. The present and future food security of Asia depends upon the irrigated rice production system. In Asia, more than 50 per cent of water available for irrigation is used for irrigated rice (Barker *et al.*, 1999) [1]. Water use in irrigated rice is high because the crop is grown under low land condition, the soil is puddle and the field is kept flooded with 3 to 5 cm depth of water after transplanting until 10 days before harvest. Because of continuous presence of ponded water, there is a huge loss of water by evaporation, seepage and percolation out of the root zone (Castaneda *et al.*, 2002) [5]. Thus, Indian farmers are using as much as 15,000 liters of water to produce one kg of rice when the maximum requirement is only 4,000 liters (Cyril Kanmony, 2001) [6]. On the other hand, with rapid industrial and urban development, more water will be required to meet non-agricultural consumption needs. Thus, both total agricultural water consumption and the proportion of water used for agriculture have been decreasing.

Rice production will have to sustain itself with lesser water supply. To safeguard food security and preserve precious water resources, ways must be explored to grow rice using less water (Belder *et al.*, 2002) [2]. Even though there are many water saving methods, drip irrigation was found to save considerable amount of water. In drip irrigation, the crop yield depends on the lateral spacing which in turn affects the moisture wetting pattern and water movement in the soil.

Soil-borne pests and diseases find different living conditions in aerobic soils and especially root knot nematodes (RKN) have been reported to become problematic when the production system becomes partially or fully aerobic. Hence, the present study was undertaken with the objectives (i) Standardization of lateral spacing for higher productivity of drip irrigated rice and (ii) Efficiency of pestigation for the control of nematode in drip irrigated rice on the growth and yield of rice varieties (*Oryza sativa* L.).

2. Materials and methods

The present study on the standardization of lateral spacing and the efficiency of pestigation to control nematode on the growth and yield of rice varieties (*Oryza sativa* L.) were carried out during *kharif 2013 and summer 2014* at Soil and Water Management Research Institute, Thanjavur located in the Cauvery delta agro climatic zone of Tamil Nadu, at 10°45' N latitude 79° E longitude and at an elevation of 50 m above mean sea level. The daily mean maximum and minimum temperatures during *kharif* 2013 season were 32.9 and 19 °C, respectively. The daily mean pan evaporation per day was 4.1 mm with relative humidity of 81.2 per cent during the season. The daily mean maximum and minimum temperatures during *summer* 2014 season were 36.9 and 21.9 °C, respectively. The daily mean pan evaporation per day was 5.3 mm with relative humidity of 79.8 per cent during the season. During the *kharif* 2013 season, the crop received a total of 326.7 mm of rainfall and in the *summer* 2014 season 127.4 mm of rainfall. The soil of the study area was sandy loam clayey with a pH of 7.2, available N, P, K status of 176, 60 and 264 N P K kg ha^{-1} respectively. The organic carbon content was 1.2 g kg^{-1} and EC 0.14 dSm^{-1}.

Design and layout of the experiment

The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. The treat mental structure comprised of two factors *viz.* two lateral spacing and four pestigation treatments for each variety separately *viz.*, ADT 45 and CORH 3.

Lateral spacing

L_1 - 110 cm
L_2 - 80 cm

Pestigation

P_1- Control
P_2- Soil application (Carbofuran) - 33 kg/ha
***P_3**- Pestigation (Carbofuran) - 33 kg/ha (each)
***P_4**- Pestigation (Cartap Hydrochloride) – 10 kg/ha (each)

Treatments were given 10^{th} and 30^{th} days after sowing

The experimental field was made to good tilth condition by ploughing with tractor drawn disc plough followed by ploughing with cultivator twice. The clods were broken with rotavator and the field was well leveled. Raised beds were formed with a top bed width of 80 cm for 110 cm lateral spacing and 60 cm for 80 cm lateral spacing and furrows were formed to a width of 30 cm and good tilth condition was made in the bed for easy sowing of seeds for early germination.
Seeds were soaked in water for 12 hrs and shade dried for 12 hrs. The seeds were sown direct spot seeding and covered in line over the raised bed. The planting pattern of 110 cm lateral spacing was 10x15x60x15x10 cm and of 80 cm lateral spacing was 10x15x30x15x10 cm between the rows and 10 cm between the plants in both the cases.

Drip irrigation schedule

First irrigation was given immediately after sowing and subsequent irrigations were scheduled for every alternate days based on the daily pan evaporation. The irrigation was given at 150% PE. The quantity of water was calculated as follows.
Volume (lit ha^{-1}) = PE × Kp × Area (m^2)

Where, PE = pan evaporation
Kp= Pan Factor (0.80)
Time of operation of drip system was computed based on the formula

$$Time\ of\ application = \frac{Volume\ of\ water\ required\ (l)}{Emitter\ discharge\ \left(\frac{lit}{ha}\right)\ x\ No.of\ emitters/plot}$$

Soil sample was taken after 10 days of application of pestigation treatments and was analyzed for nematode population.

3. Results and Discussion

Water management embraces the control of water for optimum rice yield and the best use of a limited supply of water. Water required to produce optimum yield *i.e.* irrigated water must satisfy the evapotranspiration needs of the paddy rice and losses through percolation and seepage. In this study, irrigated water is the amount of water given during paddy rice cultivation started from transplanting up to ripening stage excluding water needed for land preparation. The irrigated water is purely for rice growing since the seepage or percolation from the experiments was negligible.

Table 1: Effect of lateral spacing and varieties on the yield of drip pestigated rice

Treatments	Grain yield (kg ha^{-1})			
	Kharif 2013		Summer 2014	
	ADT 45	CORH 3	ADT 45	CORH 3
L_1T_1	4670	4708	4070	4306
L_1T_2	4763	4820	4916	5272
L_1T_3	4785	4805	4236	4845
L_1T_4	4800	4831	4509	4782
L_2T_1	4698	4801	4434	4845
L_2T_2	4795	4875	5139	5320
L_2T_3	4865	4975	4845	5636
L_2T_4	4778	4902	4863	5187

Effect of micro irrigation treatments on yield of rice showed significant differences among the treatments (Table 1). Among the lateral spacing, 80 cm lateral spacing gives more yield (4935 kg ha^{-1}) when compared to 110 cm lateral spacing (4695 kg ha^{-1}) and between the varieties CORH 3 (4932 kg ha^{-1}) performed better than ADT 45 (4698 kg ha^{-1}) in term of produce.

Table 2: Total water and water saving in the drip irrigated rice

Seasons	Irrigation water (mm)	Rainfall (mm)	Total water (mm)	Total water consumption (conventional method) in mm	Water saving (mm)	% Water saving
Kharif 2013	650.7	326.7	977.4	1250	272.6	21.81
Summer 2014	861.9	127.4	1104.8	1250	145.2	11.62

Drip irrigation is an efficient method to deliver water and nutrients to the plants because water is directly applied to the effective root zone of crop plants. The loss of water was minimum and that results in the lower water requirement in the drip irrigation system. In this experiment, the total water used by the crop at 150 per cent PE was 21.81 per cent lower than the conventional method of irrigation during Kharif 2013 and 11.62 per cent lower than the conventional method of irrigation during summer 2014 (Table 2). The percentage of water saving is less in the summer season when compared to the Kharif season due to the increased rate of evapotranspiration during the summer.

Water savings in the drip irrigated rice system when compared to the conventionally irrigated rice results mainly from (1) no water losses during land preparation (2) less percolation and seepage due to the elimination of the pressure head of the ponded water layer normally maintained in an irrigated field, and (3) less evaporation (Govindan and Myrtle Grace, 2012) [7].

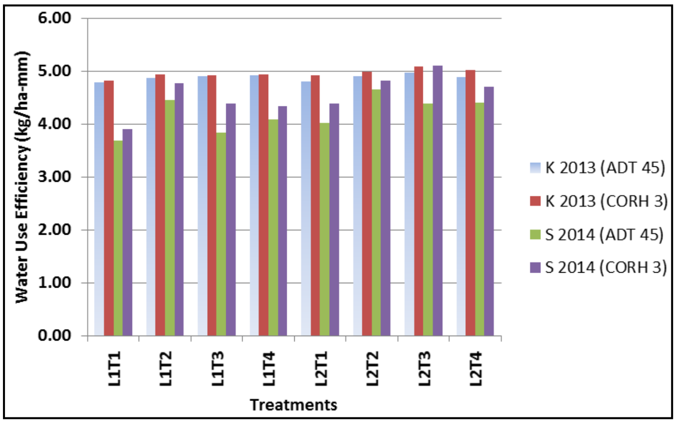

Fig 1: Water use efficiency for different treatments

The water use efficiency for various treatments were calculated and depicted in Figure 1 for both the varieties and seasons. High water use efficiency was achieved in the 80 cm lateral spacing when compared to 110 cm lateral spacing. This is due to the fact that more uniform was achieved in 80 cm lateral spacing which in turns affects the yield. Yunbo Zhang *et al.*, (2012) [13] reported that the yield and WUE of the rice crop depends on the available moisture content in the effective root zone.

Table 3: Soil nematode population in the soil

Treatments	Soil nematode Population (*Meloidogyne spp + Hirschmanniella spp 250 gm of soil*)							
	Kharif 2013				Summer 2014			
	10 DAS		30 DAS		10 DAS		30 DAS	
	ADT 45	CORH 3	ADT 45	CORH 3	ADT 45	CORH 3	ADT 45	CORH 3
L_1T_1	55	51	71	72	311	289	320	299
L_1T_2	52	52	76	61	244	238	251	245
L_1T_3	37	41	48	44	204	196	216	203
L_1T_4	45	42	51	45	190	173	197	188
L_2T_1	63	69	69	91	273	266	290	272
L_2T_2	52	43	54	68	215	202	228	209
L_2T_3	26	25	42	49	197	165	219	195
L_2T_4	41	54	52	47	167	142	173	161

The nematode population in the soil for different treatments at 10 and 30 DAS pestigation were tabulated in the Table 2. Among the four pestigation treatments, carbofuran @ 33 kg ha^{-1} at 10 and 30 DAS each gives better control over nematodes than other treatments. The yield of rice was also increased by 11.2 and 26.7 per cent in the carbofuran @ 33 kg ha^{-1} pestigation treatment when compared to the control. Similar results of upland or only temporarily submerged conditions, yield increased by 12–80% when control measures against root knot nematode were applied (Prot and Matias, 1995, Soriano and Reversat, 2003, Bridge, 2005, Kreye *et al.* (2009) [9, 11, 4, 8].

4. Conclusions

From the above study, it can be concluded that variety CORH 3 responded well to the drip irrigation at 150 per cent PE and maximized the yield, in addition to better crop growth, higher yield attributes, yield and substantial quantity of water saving. In case of lateral spacing, 80 cm gives higher yield than 110 cm and pestigation with carbofuran @ 33kg ha^{-1} was found to be effective in managing the rice root nematode. Thus, it clearly indicated the feasibility of introducing drip layout of 80 cm lateral spacing with 4 lph drippers spaced at 30 cm apart for CORH 3 hybrid rice along with the pestigation of carbofuran @ 33 kg ha^{-1} in equal splits on 10 and 30 DAS found to be the best suitable combination for drip irrigated rice in the CDZ.

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