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Influence of chemigation on root knot nematodes in drip irrigated rice

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Abstract
Rice is the most stable food crop in the world and in Asia more 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. But major problem in cultivating rice under aerobic condition is root knot nematode (RKN). To study the efficiency of chemigation for RKN, research experiment was conducted at Soil and Water Management Research Institute, Thanjavur. Two lateral spacings *viz.*, 80 cm and 110 cm with four chemigation treatments to control nematode namely soil application of carbofuran (33 kgha^{-1}), chemigation with carbofuran (33 kgha^{-1}) and cartap hydrochloride (10 kgha^{-1}) and control were tested in two rice varieties *viz.*, CORH 3 and ADT 45 during *Kharif* 2013 and Summer 2014. Chemigation with equal splits was given on 10 and 30 DAS. Chemigation with carbofuran @ 33kg ha^{-1} was found to be effective in managing the rice RKN. CORH 3 hybrid rice along with the chemigation of carbofuran @ 33kg ha^{-1} in equal splits on 10 and 30 DAS through drip irrigation was found to be the best suitable combination in the CDZ.

Keywords: Drip irrigated rice; Chemigation; RKN; CDZ

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 majority of Asia's rice is produced in irrigated lowland fields, where irrigation requirements can often be high, while irrigation water is becoming an increasingly limited resource (Bouman *et al*., 2007) [2]. Therefore, water-saving production technologies such as drip irrigation may provide viable adaptation strategies for farmers who want to continue growing rice under water-short conditions. In the drip irrigated production system, the crop is normally direct dry seeded and soils are kept aerobic throughout the growing season. In the tropics, occasional yield failures of aerobic rice have been observed (Vermeulen, 2007 [26]; George *et al*., 2002) [10]. The cause of these yield failures is not fully studied, but the failures could be a combined effect of many factors like nutrient deficiency, soil-borne diseases and pests (Ventura and Watanabe, 1978) [25]. More sustainability issues may emerge in non-flooded condition of rice production. As rice production systems become more often non-flooding conditions, root-knot nematodes (RKN) are a potential constraint to rice production (Prot *et al*., 1994) [19]. Yield increases of 12-80% were reported in experiments in which soil were not fully flooded when various types of control measures were adopted for RKN (Arayarungsarit, 1987 [1]; Padgham *et al*., 2004 [17]; Soriano and Reversat, 2003) [24].
Infestations of the root-knot nematode, Meloidogyne species have been reported in a range of rice production system in South and Southeast Asia, including upland, irrigated, low-land rainfed, and deep water rice (Arayarungsarit, 1987 [1]; Bridge, 1990 [5]; Bridge and Page, 1982 [4]; Cuc and Prot, 1992 [6]; Gaur *et al*., 1993 [8], 1996 [9]; Miah *et al*., 1985 [12]; Mondal *et al*., 1988 [14]; Netscher and Erian, 1993 [16]; Prot and Matias, 1995 [18]; Roy, 1987 [21]; Sharma *et al*., 2001) [23].
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 study was undertaken with the objective of to test the efficiency of chemigation for the control of RKN in drip irrigated rice on the growth and yield of rice varieties (*Oryza sativa* L.).

Materials and Methods

The study on the efficiency of chemigation to control RKN on the growth and yield of rice varieties (*Oryza sativa* L.) was 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 treatmental structure comprised of two factors *viz.* two lateral spacing (110 cm and 80 cm) and four chemigation treatments for each variety separately *viz.,* ADT 45 and CORH 3.

Chemigation

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

**Treatments were given 10th and 30th days after sowing*

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

Results and Discussion

The nematode population in the soil for different chemigation treatments were tabulated in the Table 1. Among the four chemigation treatments, carbofuran @ 33 kg ha^{-1} at 10 and 30 DAS each gives better control over nematodes than other treatments for both the varieties and lateral spacing. The yield of rice was also increased by 11.2 and 26.7 per cent in the carbofuran @ 33 kg ha^{-1} chemigation treatment when compared to the control for ADT 45 and CORH 3 respectively. These results support the findings of Arayarungsarit (1987) [1] who stated that nematicide application resulted in a yield increase of 12 - 33 per cent in *M. graminicola* infested upland rice fields.

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 [18], Bridge, 2005 [3], Kreye *et al.* (2009) [11]. *M. graminicola* caused an almost 30 per cent reduction in yield under aerobic soil conditions (De Waele *et al*., 2013) [7]. Other researchers have reported the effectiveness of carbofuran against rice root knot nematode (Rahman 1991 [20]; Mohanty *et al.*, 2000 [13]; Soriano and Reversat, 2003) [24].

Table 1: 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

Conclusion

From the above study, it can be concluded that variety CORH 3 responded well to the chemigation when compared soil application. Thus, it clearly indicated the feasibility of introducing drip irrigation in combination with chemigation of carbofuran @ 33kg ha^{-1} in equal splits on 10 and 30 DAS for CORH 3 hybrid rice found to be the best suitable combination in the CDZ.

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