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Management practices on cold injury in rice nurseries

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Abstract
A field experiment was conducted during *rabi* 2014-15 and 2015-16 at Regional Sugarcane and Rice research Station, Rudrur to identify suitable management practices to overcome cold injury in rice nurseries using rice varieties, JGL 1798 and WGL 283. The experiment was conducted on a sandy clay loam soil of medium fertility with twelve treatmental combinations using fertilisers, organic manures, water management practices and covering with polythene sheet. The minimum ambient air temperature observed during nursery period was 9-18 ^{o}C. The results revealed that, the treatments which were covering with polythene sheet (T_9, T_{10} and T_{11}) and double the dose of P_2O_5 recorded highest root length, shoot length and seedling height at 15 and 30 days after sowing (DAS) in both the varieties. The seedling height of nursery without protection was less than the nursery protected with polythene sheet. With respect to organic manure applied treatments (T_3, T_4, T_5 and T_6), all the treatments were on par with each other and significantly higher over control. Among all the treatments, the treatment T_{11} (Double the dose of P_2O_5 + Cover the nursery beds with polythene sheet during night and remove in the morning, irrigate the nursery bed every day in the evening and let out the water in the morning) recorded highest root length, shoot length and seedling height at 15 and 30 DAS in both the varieties. At the time of transplanting, the seedling height of JGL 1798 variety was less than the Var: WGL 28.

Keywords: Cold injury, rice nursery, rice varieties, management practices

Introduction
Rice (*Oryza sativa* L.) is an important food crop in India grown in an area of 43.1 million hectares with a production of 110.2 million tonnes and productivity of 2550 kg ha^{-1} (Annual Report, 2017-18) [2]. In Telangana region, out of 19.7 lakh ha of total area under the crop about 3.8 lakh ha are grown in *rabi* (Directorate of Economics and statistics, 2017-18) [5]. Rice is the Principal food crop cultivated throughout the Telangana state providing food for its growing population, fodder to the cattle and employment to the rural masses. Any decline in its hectarage and production will have a perceivable impact on the state's economy and food security.
In Telangana, cold injury has been identified as one of the major abiotic constraint limiting the yield potential of rabi rice. Rice nurseries during *Rabi* are raised from second fortnight of November to the end of December. The nurseries sown in December experience low temperature (daily minimum temperature of 9-18 ^{o}C) which severely restricts seedling growth and sometimes death of the seedlings. The common effects of cold injury during nursery will be low germination, slow growth of seedlings, leaf yellowing, stunted growth characterized by reduced height. Consequently, more time is required for seedlings to attain four leaf stages for transplantation compared to normal wet season. This type of cold injury is of delayed type and causes delayed growth of rice plant (Shibata, 1970) [11]. The stunted growth of rice seedling under cool temperature is a sign of low cold tolerance (Chang and Vergara, 1972) [4]. Further, the seedling height could be the criterion for adjudication of cold tolerance in rice and there are differences in seedling height among rice varieties (Adair, 1968) [1].
The low air and water temperatures during cool season are the major causes of mortality, and to overcome this, suitable nursery management techniques need to be developed to obtain stable rice production. To increase the soil and air temperature in the nursery beds, the beds can be covered with transparent polythene sheet at 45 cm above the ground level (Anwarullah *et al*., 1995) [3]. Further, the dry land and plastic plate raised seedlings maintain increased green leaf length and less reduction in chlorophyll content at low temperature stress of 10-12 ^{0}C

(Shangin *et al.,* 1999) [10]. Since no perfect information is available on right method by which nursery can be protected so that seedlings will be healthy, an experiment was initiated in this direction.

Materials and Methods

A field experiment was conducted at Regional Sugarcane and Rice research Station, Rudrur during *rabi* 2014-15 and 2015-16 using two rice varieties, JGL 1798 and WGL 283. The experiment was conducted on a sandy clay loam soil with twelve treatments (T_1: Control, T_2: RDN & K + Double the dose of P_2O_5 (RDF), T_3: T_2 + FYM, T_4: T_2 + Vermicompost, T_5: T_2 + Press mud, T_6: T_2 + Poultry manure, T_7: T_2 + Gypsum, T_8: T_2 + Irrigating the nursery bed in the evening and let out the water in the morning, T_9: T_2 + Irrigating the nursery bed in the morning and let out the water in the evening, T_{10}: T_2 + Covering with polythene sheet, T_{11}: T_2 + Covering with polythene sheet + Irrigating the nursery bed in the evening and let out the water in the morning, T_{12}: T_2 + Covering with polythene sheet + Irrigating the nursery bed in the morning and let out the water in the evening) in randomized block design with three replications.

The size of the nursery plot was 1.5 m x 1.5 m. The field was demarcated into 12 plots in each replication and individual plots were separated by bunds and irrigation channels. The nursery was fertilized with a uniform dose of N and K before final levelling in all the plots. N was applied in 2 splits, half at final levelling and other half at 10 DAS. Double the dose of phosphorus was applied as per the treatments. The recommended dose of N, P_2O_5 and K_2O for 100 m^2 nursery area is 1 kg, 0.5 kg and 0.5 kg, respectively. The minimum ambient temperature observed during nursery period in nursery without protection was 9-18 ^oC. The experimental soil was clay loam in texture, neutral (pH 7.2) in reaction, non saline (0.18 dSm^{-1}), low in organic carbon (0.43 percent) and available N (196.5 kg ha^{-1}), medium in available P_2O_5 (29.21 kg ha^{-1}) and K_2O (293.5 kg ha^{-1}).

Results and Discussion

Temperature during nursery period

The minimum temperature at the time of sowing was 11 ^oC on 13^{th} December and the temperatures ranged between 9 ^oC to 18 ^oC during the nursery period (from 13^{th} December to 20^{th} January). During first 10 days (from 13^{th} December to 23^{th} January), the mean temperature was 13.8 ^oC. During next 10 days (from 24^{th} December to 4^{th} January) the mean temperature was 14 ^oC for most of the days but 9 ^oC temperatures was seen on 24^{th} December. During next 15 days of nursery period i.e., from 5^{th} January to 20^{th} January, the mean temperatures were 15 ^oC and these temperatures inhibited the nursery growth.

Growth parameters of rice seedlings

All the treatments recorded significantly higher root growth of rice at 15 DAS and 30 DAS over control (Table 1). The results revealed that, the treatments which were covering with polythene sheet (T_9, T_{10} and T_{11}) and double the dose of P_2O_5 recoded highest root length, shoot length and seedling height at 15 and 30 DAS in both the varieties. The seedling height of nursery without protection was less than the nursery protected with polythene sheet due to inhibition of vegetative growth at low temperature. As a result, nursery without protection the 4th leaf did not emerge and required more number of days for emergence of 1^{st}, 2^{nd} and 3^{rd} leaves. This also might have influenced the reduction in root length and seedling dry weight than other treatments. On the other hand, the seedlings of protected treatments required less number of days for emergence of 4th leaf (22 days) than that of without protection (34 days). Among the three polythene sheet covered treatments (T_9, T_{10} and T_{11}), the treatment T_{11} (Double the dose of P_2O_5 + Cover the nursery beds with polythene sheet during night and remove in the morning, irrigate the nursery bed every day in the evening and let out the water in the morning) recoded highest root length, shoot length and seedling height at 15 and 30 DAS.

Studies in Kashmir valley indicated that the low tunnel polythene protected nursery maintained higher soil, water and air temperatures than that raised conventionally. This higher temperature has proved beneficial for producing heavier seedlings in the protected nurseries (Shah *et al*., 2000) [9]. Tang and Zhang (1993) [15] also reported suitability of growing rice seedlings under greenhouse condition as temperature, humidity, light intensity and CO2 levels within the cover were beneficial than outside atmosphere. The low temperature adversely affected the ability of the plant to produce dry matter since temperature below 15^0C decreased photosynthetic activity (Takahashi *et al*., 1955) [14]. According to Wang Yisou *et al*. (1986) [16], chlorophyll content decreased under condition of low temperature. This is possibly due to reduced mitotic activity in the cells of the vegetative shoot apex on the account of low temperature (Shimizu, 1958) [12]. It has been reported that under low temperatures, the seed requires more days for germination due to adverse effect on activation stage (Matsubaysahi, 1963) [7].

With respect to organic manure applied treatments (T_3, T_4, T_5 and T_6), all the treatments were on par with each other and significantly higher over control. However, The root and shoot lengths were numerically higher in FYM (T_3) and press mud (T_5) applied treatments as compared to vermicompost (T_4) and poultry manure (T_6) applied treatments. This is possibly due to bulky nature of FYM and press mud improves the soil temperatures over fine organic manures like vermicompost and poultry manure.

With respect to irrigation management practices in the nursery bed (T_8 and T_9), irrigating the nursery bed every day in the evening and let out the water in the morning recorded higher root length, shoot length and seedling height at 15 and 30 DAS in both the varieties as compared to irrigating the nursery bed every day in the morning and let out the water in the evening.

Nutrient management in rice nursery indicated that, double dose of P recorded higher root length, shoot length and seedling height at 15 and 30 DAS in both the varieties over control. The P uptake helps in development of root growth. Absorption of P was most strongly inhibited by low temperature (16 ^oC) (Takahashi *et al*., 1954) [13]. The concentration of soil solution P was about 2.5 times more in *kharif* (June to November) than in *rabi* (December – May) which might be due to the higher temperature of 10^0C in the first two months of the *kharif* as compared to corresponding period in *rabi*. This low concentration of soil solution P necessitated the application of higher doses of P fertilizer during the cooler months of *rabi* season (Katyal and Venkatramaya, 1983) [6].

The two rice varieties under the study (JGL 1798 and WGL 283), the higher root length, shoot length and seedling height at 15 and 30 DAS was recorded in rice variety WGL 283 over JGL 1798. At the time of transplanting, the seedlings height of JGL 1798 Variety was less than the Var: WGL 283 (Table 1). The variety, WGL 283 was identified as cold tolerant and recommended for general cultivation in *rabi* season of Telangana region. Uptake and translocation of P was higher in cold tolerant variety than in susceptible (indica) variety (Reddy and Madhusudhan Rao, 1976) [8].

Fig 1: Overall view of the experimental site

Conclusion

Table 1: Effect of Management Practices on Cold Injury in Rice Nurseries (values are pooled data of 2014-15 and 2015-16)

Treatments	Var: JGL 1798						Var: WGL 283					
	15 DAS			30 DAS			15 DAS			30 DAS		
	Root length	Shoot length	Seedling height	Root length	Shoot length	Seedling height	Root length	Shoot length	Seedling height	Root length	Shoot length	Seedling height
	(cm)			(cm)			(cm)			(cm)		
T1	1.31	3.95	5.26	2.66	5.63	8.29	2.71	5.34	8.04	5.35	8.87	15.72
T2	3.32	6.57	9.89	4.87	11.96	16.83	4.45	7.21	11.65	7.82	14.70	22.51
T3	3.66	7.14	10.80	5.15	12.96	18.11	4.93	7.81	12.74	8.03	15.53	23.56
T4	3.28	6.70	9.98	4.54	12.38	16.92	4.38	7.67	12.05	7.65	15.12	22.77
T5	3.68	7.21	10.89	4.83	12.27	17.10	4.95	7.93	12.88	7.70	15.01	22.70
T6	3.28	6.69	9.96	4.77	11.95	16.72	4.55	7.41	11.95	7.75	14.69	22.44
T7	3.32	6.64	9.95	4.63	11.55	16.18	4.62	7.44	12.06	7.51	14.57	22.08
T8	3.91	7.67	11.58	6.50	12.67	19.16	5.03	8.97	14.00	9.04	15.41	24.45
T9	3.86	7.52	11.38	6.04	12.42	18.46	5.28	8.85	14.13	8.80	15.49	24.29
T10	5.34	8.86	14.20	7.15	13.54	20.68	5.98	10.09	16.07	9.34	16.74	26.08
T11	5.77	9.71	15.48	8.04	14.14	22.17	6.46	10.61	17.07	10.48	17.76	28.24
T12	5.35	9.24	14.59	7.11	13.86	20.97	6.19	11.37	17.56	9.86	17.30	27.16
SE (m)	0.21	0.38	0.43	0.42	0.52	0.61	0.30	0.39	0.55	0.48	0.61	0.88
CD	0.50	0.90	1.04	1.02	3.32	1.48	0.67	0.93	1.26	1.16	1.44	2.04

Treatments: T_1: Control, T_2: RDN & K + Double the dose of P_2O_5 (RDF), T_3: T_2 + FYM, T_4: T_2 + Vermicompost, T_5: T_2 + Press mud, T_6: T_2 + Poultry manure, T_7: T_2 + Gypsum, T_8: T_2 + Irrigating the nursery bed in the evening and let out the water in the morning, T_9: T_2 + Irrigating the nursery bed in the morning and let out the water in the evening, T_{10}: T_2 + Covering with polythene sheet, T_{11}: T_2 + Covering with polythene sheet + Irrigating the nursery bed in the evening and let out the water in the morning, T_{12}: T_2 + Covering with polythene sheet + Irrigating the nursery bed in the morning and let out the water in the evening.

Application of double the recommended rate of P_2O_5 (5 kg P_2O_5 for 500 m^2 nursery area sufficient for 1 ha main field) and cover the nursery beds with polythene sheet or locally available and low cost fertiliser bags at 45 cm above the ground level during night and remove in the morning, irrigate the nursery bed every day in the evening and let out the water in the morning resulted in highest root lenth, shoot length and seedling height at 15 and 30 days after sowing. Nursery bed covering with ploythene sheet reduces the time required for seedling to attain four leaf stages for transplantation than that required under without protection.

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