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Studies on Methods of Nursery Raising to Combat Cold Injury in *Rabi* Rice

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Abstract

A field study was conducted during *rabi* season 2003-04 at College Farm, Rajendranagar, Hyderabad, India, to evaluate the effect of low temperature and to study the methods of nursery raising and nursery management practices using rice variety JGL 1798. The treatments consisted of two methods of nursery rising- dry and wet nursery, and three nursery protection practices- without protection, protection with poly tunnel, and locally available used fertilizer bags. The experiment was laid out in a Completely Randomized Block Design with four replications. The size of the nursery plot was 2 m x 1.5 m, which was fertilized with uniform dose of 1 kg N, 1.5 kg P_2O_5 and 0.5 kg K_2O for 100 m^2 area. The minimum ambient temperature observed during nursery period in wet and dry nursery without protection was 7-19°C. The ambient temperatures in the poly tunnel protection increased by 4-5°C and with fertilizer bags the increase was 3-4°C in wet and dry nursery over control. At the time of transplanting, the seedlings root length in wet and dry nursery without protection was less than the nursery protected with poly tunnel and fertilizer bag. The root and shoot length was higher in wet nursery protected with poly tunnel and fertilizer bag over that of dry nursery. The grain yield of crop transplanted with wet nursery was significantly superior over that of transplanted with dry nursery. The grain yield of crop transplanted with nursery raised under poly tunnel and fertilizer bags were on par.

1. Introduction

Andhra Pradesh (India) is a surplus rice growing state, which produces about 13% of India's rice from 9% of total rice area. Rice is the staple food for about 70 m people in the state and a major source of livelihood to nearly 70% of rural households. In Andhra Pradesh, out of 43 lakh ha of rice, 28 and 16 lakh ha are cultivated during *kharif* and *rabi* season, respectively. In Telangana region (Andhra Pradesh), rice is cultivated during *kharif* (July-October), *rabi* (November-March) and summer (April-June). Rice nurseries during *Rabi* are raised from second fortnight of November to the end of December in the region. The nurseries sown in December experience low temperature (daily minimum temperature of 8-10°C) which severely restricts seedling growth and sometimes death of the seedlings. Farmers re-sow the nursery to get the required nursery seedling for transplanting the crop. This type of cold injury causes delayed growth of rice plant (Shibata, 1970). Stunted growth of rice seedlings under cold temperature is a sign of low cold tolerance (Chang and Vergara, 1972). 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). 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°C (Shangin et al., 1999). 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.

2. Materials and Methods

A field study was conducted during 2003-04 *rabi* season at College Farm, Rajendranagar, Hyderabad, India to investigate the effect of low temperature and study the methods of nursery raising and nursery management practices. The nursery of rice variety JGL 1798 was sown on December 14, 2004. The

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treatments consisted of two methods of nursery rising - dry and wet nursery, and three nursery protection practices- without protection, and protection with poly tunnel and locally available used fertilizer bags. The study was conducted on a sandy clay loam soil with pH of 8.1, 265 kg ha^{-1} of available N, 22.4 kg ha^{-1} of available P_2O_5 and 245 kg ha^{-1} of available K_2O. The experiment was laid out in a Completely Randomized Block Design with four replications. Each nursery plot was 2 m x 1.5 m and was fertilized with uniform dose of 1 kg N, 1.5 kg P_2O_5 and 0.5 kg K_2O for 100 m^2. Temperatures in the germinating seed lot were recorded with thermocouple. After sowing, daily temperatures of the soil were recorded with soil thermometers inserted at 15 cm depth at 7 a.m. and 2 p.m. during the nursery period.

Minimum temperature at the time of sowing was 9°C on December 14, and temperatures ranged between 7 to 19°C during the nursery period (from December 14 to January 19). During the first 10 days, the temperature was 10.8°C for most of the days, and only for 2 days temperatures were 16°C and 18°C on 24th and 16th December, respectively. During next 10 days (from 25th December to 4th January) the mean temperature was 13.9°C, and it was 11°C and 12°C from 31st December to 4th January. During next 15 days of nursery period, i.e. from 5th to 19th January, the mean temperature was 10.6°C which inhibited the nursery growth. The minimum temperatures in nursery protected with poly tunnel ranged between 10°C to 23°C with fertilizer bag ranged between 10°C to 20°C. The soil and water temperatures were comparatively less than ambient temperatures. The ambient temperature increased by 4-5°C in wet and dry nursery with poly tunnel protection over control, and it ranged between 11°C to 23°C. The soil and water temperatures in wet and dry nursery protected with fertilizers bag increased by 3-4°C over unprotected but less than the nursery protected with poly tunnel.

3. Results and Discussion

3.1. Seedling growth

Wet nursery protected with poly tunnel and fertilizer bag resulted in significantly higher seedling dry weight than dry nursery protected with poly tunnel and fertilizer bag (Table 1).

In the protected nursery, the uptake of P was high and it has been reported that application of P at 18.9 kg ha^{-1} was found to increase seedling dry weight (Anwarullah et al., 1995). It was noted that the low tunnel polythene protected nursery maintained higher soil, water and air temperature than that raised conventionally (Figure 1).

This higher temperature has proved beneficial for producing heavier seedlings in the protected nurseries (Shah et al., 2000). Tang and Zhang (1993) also reported suitability of growing rice seedlings under greenhouse condition as temperature, humidity, light intensity and CO_2 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°C decreased photosynthetic activity (Takahashi et al., 1955).

At the time of transplanting, the root length in wet and dry nursery without protection was less than the wet and dry nursery protected with poly tunnel and fertilizer bag (Table 1) due to inhibition of vegetative growth at low temperature (Kaneda and Beachell, 1974). Wet nursery protected with poly tunnel and fertilizer bag resulted in higher root length and shoot length than dry nursery protected with poly tunnel and fertilizer bag. The P uptake by the dry nursery seedlings was less than that of wet nursery seedlings, and the P uptake helps in development of root growth. Protected seedlings resulted in higher root

Table 1: Effect of methods of nursery raising and nursery protection on growth of seedlings

Treatment	Root length (cm)			Shoot length (cm)			Dry weight (mg $seedling^{-1}$)			P uptake (mg 5 $seedlings^{-1}$)		
	DAS			DAS			DAS			DAS		
	10	20	35	10	20	35	10	20	35	10	20	35
Wet nursery without protection	1.2	2.8	4.8	2.6	8.3	9.5	1.2	11.6	30.1	0.24	5.81	23.17
Wet nursery protection with poly tunnel	1.5	5.3	9.0	4.7	12.0	15.2	5.0	28.3	54.2	1.47	16.98	45.36
Wet nursery protection with fertilizer bag	1.5	4.8	8.5	4.5	11.6	14.8	4.2	27.6	52.6	1.17	14.83	43.22
Dry nursery without protection	0	1.2	3.7	0	8.1	7.6	0	8.8	19.8	0	4.25	14.28
Dry nursery protection with poly tunnel	0	3.4	7.0	0	10.7	11.6	0	16.5	40.2	0	9.45	29.10
Dry nursery protection with fertilizer bag	0	3.0	6.6	0	9.4	11.2	0	15.2	39.2	0	8.28	28.64
SEm±	-	0.3	0.2	-	1.0	0.2	-	1.1	2.1	-	1.10	2.56
LSD (*p*=0.05)	-	1.0	0.7	-	NS	0.6	-	3.3	6.3	-	3.33	7.72
DAS=Days after sowing												

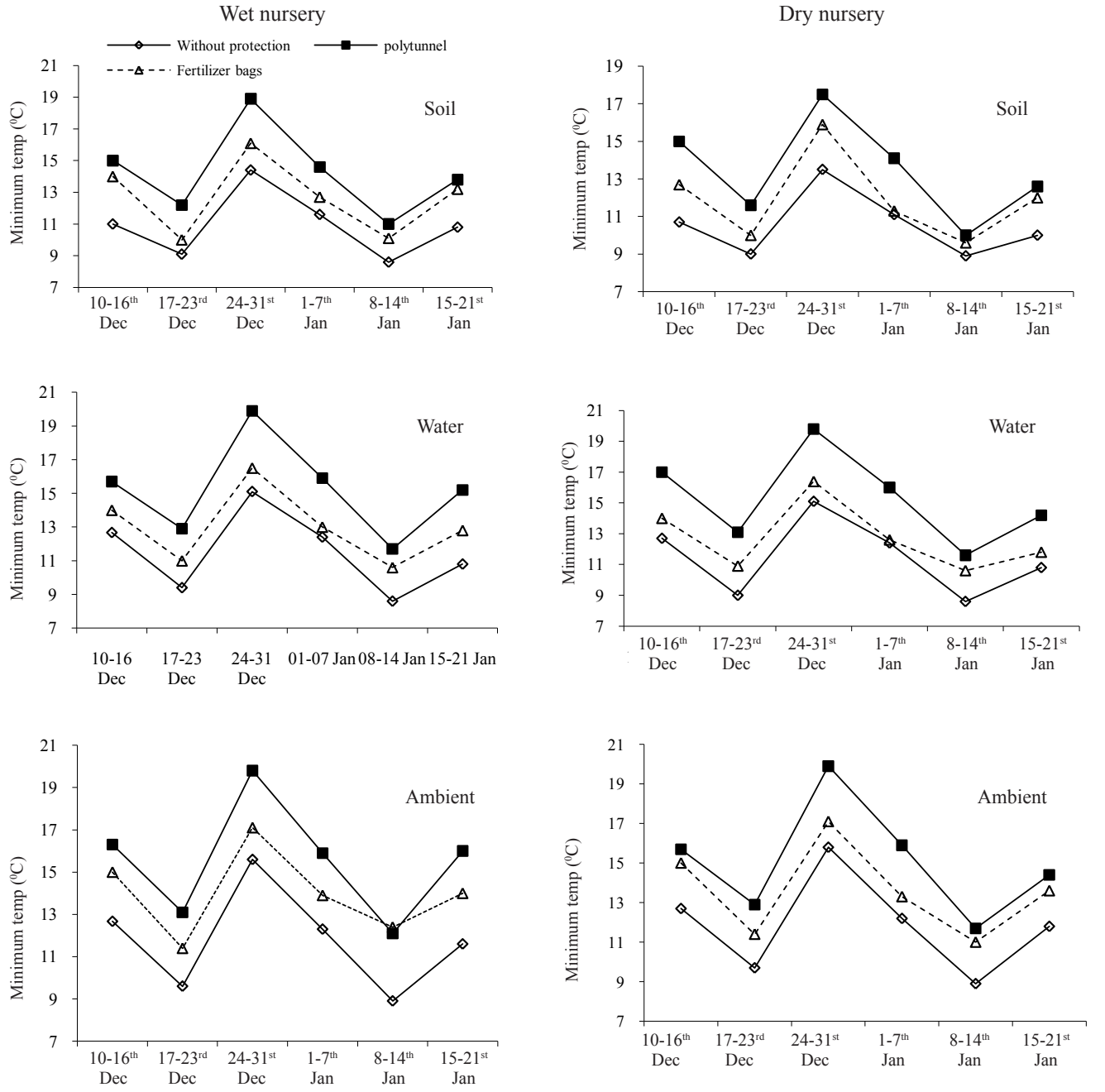

Figure 1: Weekly temperatures (^{0}C) in different treatments during rice nursery growing period

length, dry weight and shoot length than unprotected seedlings where low temperature resulted in slower vegetative growth (Kaneda and Beachell, 1974). This is possibly due to reduced mitotic activity in the cells of the vegetative shoot apex on account of low temperature (Shimizu, 1958). At 20 DAS, the shoot length was non-significant as the temperature at that time was above 15^{o}C. The shoot and root length and dry weight in seedlings of dry nursery without protection were less than that of wet nursery without protection. These parameters in dry nursery with poly tunnel and fertilizer bag protection were less than that of wet nursery protected treatments. In wet nursery treatments, the seeds were soaked and pre-germinated seeds were sown, whereas in dry nursery treatments where non-incubated seeds were sown took 5 days for sprouting. As a result, in dry nursery without protection the 4th leaf did not emerge as more number of days was required for emergence of 1st, 2nd and 3rd 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 dry nursery treatments required more number of days for emergence of 4th leaf (29 days) than that of wet nursery without protection (27 days) as against the days required for 4th leaf emergence in wet nursery with protection (22 days). In protected nursery, the uptake of P was high which might have increased the seedling dry weight (Anwarullah et al., 1995). Hence, there was 50% higher dry matter production in protected nursery than unprotected nursery. The higher temperature has proved beneficial for producing heavier seedlings in the protected nurseries (Shah et al., 2000).

More number of days was required for germination in unprotected than in protected nursery. It has been reported that under low temperature seed requires more days for germination due to adverse effect on activation stage (Matsubaysahi, 1963). Further, the post germination growth is also adversely affected as the water absorption speed of rice seeds will be less under low temperature.

3.2. Grain yield

The grain yield of crop transplanted with wet nursery protected with poly tunnel and fertilizer bag was significantly superior over all other treatments (Table 2).

The per cent increase in yield over wet nursery without protection was 26% and dry nursery without protection was 52%. The dry matter production, tiller number and thereby number of panicles of the crop transplanted with the nursery raised in these treatments was higher than that in latter treatments (Table 2). Further, there was significantly higher number of grains panicle^{-1} in the crop transplanted with the seedlings of protected wet nursery. The increase in dry matter production, tiller number and grain number panicle^{-1} in the protected nursery planted crop resulted in increased grain yield as compared to other treatments. These parameters had positive correlation with grain yield.

The crop transplanted with protected dry nursery resulted in similar grain yield as that of wet nursery without protection. Though the seedling dry weight in wet nursery without protection was significantly lower than the protected dry nursery treatments, the crop transplanted with wet nursery without protection was established well and produced similar dry weight as that of crop transplanted with protected dry nursery treatments (Table 2). Higher dry matter production at harvest noticed in wet nursery without protection might be due to more plant height and more number of tillers m^{-2}. The panicles m^{-2} in protected dry nursery was significantly lower than that of wet nursery with protection due to higher sterility in the crop transplanted with wet nursery without protection compensated the loss in panicle number m^{-2} resulting in similar grain yield as that of dry nursery protected with poly tunnel and fertilizer bag.

The grain yield obtained with crop transplanted with wet nursery without protection was at par with dry nursery protected with fertilizer bag poly tunnel. Lower sterility in dry nursery without protection was observed as compared to wet nursery without protection inspite of more number of panicles in wet nursery without protection. It was because seedling mortality in the crop transplanted with seedlings from unprotected dry nursery resulting in gaps in the field. However, because of gaps there was robust growth of plants as a result of border effect (wider spacing) producing more number of tillers and finally made the grain yield comparable in the crop transplanted with dry nursery protected with fertilizer bag and poly tunnel.

3.3. Economics

The cost of cultivation and gross returns were highest in the crop raised with wet nursery protected with poly tunnel and net returns were more in the crop transplanted with wet nursery protected with fertilizer bags (Table 3). The gross returns, net returns and B: C ratio was highest in the crop transplanted with wet nursery compared to dry nursery. B: C ratio was highest in crop raised with wet nursery protected with fertilizer bag.

Table 2: Effect of methods of nursery raising and nursery protection on crop growth and yield

Treatment	Number of panicles m^{-2}	Spikelet sterility (%)	Grains panicle^{-1}	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Wet nursery without protection	337	23.5	201	4.54	7.34
Wet nursery protection with poly tunnel	403	22.0	225	5.74	8.08
Wet nursery protection with fertilizer bag	392	16.4	219	5.60	7.98
Dry nursery without protection	303	7.1	164	3.78	7.05
Dry nursery protection with poly tunnel	321	12.4	189	4.77	7.60
Dry nursery protection with fertilizer bag	321	16.3	179	4.56	7.64
SEm±	4	0.4	3	0.31	0.14
LSD (p=0.05)	12	1.3	10	0.99	0.42

Table 3: Effect of methods of nursery raising and nursery protection on crop growth and yield

Treatment	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio (net return ₹ $invested^{-1}$)
Wet nursery without protection	12555	29977	17422	1.39
Wet nursery protection with poly tunnel	17555	37298	19743	1.12
Wet nursery protection with fertilizer bag	15555	36446	20891	1.34
Dry nursery without protection	12555	25499	12944	1.03
Dry nursery protection with poly tunnel	17555	31443	13888	0.79
Dry nursery protection with fertilizer bag	15555	30245	14690	0.94

Lowest B: C ratio was observed in crop transplanted with dry nursery protected treatment.

4. Conclusion

It can be concluded that in Telangana region of Andhra Pradesh, the wet nursery protected with poly tunnel or locally available and low cost fertilizer bags resulted in higher seedling vigor and growth of nursery and the crop transplanted with this nursery produced higher grain yield.

5. References

Anwarullah, M.S., Shadakshri, Y.G., Vasudev, H.S., Poonacha, N.M., 1995. Managing rice nurseries during winter season in the hill zone, Karnataka, India. International rice Research Newsletter 20(1), 23-24.

Chang, T., Vergara, B.S., 1972. Ecological and genetic aspects of photo period sensitivity and thermo sensitivity interaction to region adaptabilities of rice varieties. International Rice Research Institute, Los Banos, Phillippines, 431-453.

Kaneda, C., Beachell, H.M., 1974. Response of indica-japonica rice hybrids to low temperatures, SABRAO Journal 6, 17-32.

Matsubayashi, S., 1963. Theory and practice of growing rice. Fuji publishing company Ltd., p.346

Matshushima, S., 1957. Analysis of development factors determining yield and yield prediction in lowland rice. Bulletin of National Institute of Agricultural Science, Japan A5, 1-27.

Shangin.S, Jiang L., Dong D.F., 1999. Studies on cold tolerance mechanism of rice seedlings raised by different methods. Oryza 36(1), 78-79.

Shah, M.H., Amarjit, S.B., Bali, A.S., Singh, K.N., 2000. Studies on sowing dates and systems of rice nursery raising to combat cold injury in temperate Kashmir. Oryza 37(1), 96-99.

Shibata, M., 1970. Present conditions and subjects of rice breeding for cold tolerance in Japan. Japan Agricultural Research Quaterly 5(2), 1-4.

Shimizu, M., 1958. Effects of temperature on structure and physiology of the vegetative shoot apex in the rice plant. Japan Journal of Breeding 8, 195.

Takahashi, J., Yanajiswa, M.S., Kona, M., Yazawa, F., Yoshisa, T., 1955. Studies on nutrient absorption by crops. Bulletin of National Institute of Agricultural Science, Japan B14, 1-83.

Tang, G.H., Zhang, S.D., 1993. The effects of bio-energetic greenhouse on the growth and development of rice. Transactions of Chinese Society of Agricultural Engineering 9(3), 85-89.