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MODIFIED DOUBLE TRANSPLANTING-AN INNOVATIVE RESILIENT APPROACH TO BOOST THE YIELD OF *KANAKCHUR* IN ADVERSE COASTAL ENVIRONMENTS

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Abstract

Among the various native aromatic rice varieties in West Bengal, *Kanakchur* is prominent, especially in coastal regions, owing to its unique fragrance, high quality, and cultural significance, such as its use in the regional delicacy '*Jaynagar er Moa*.' However, *Kanakchur* cultivation faces challenges from erratic monsoon patterns, delayed rainfall, and frequent flooding, which disrupt conventional transplanting schedules and adversely affect seedling growth along with 'lodging' problem. Modified Double Transplanting (MDT) is a traditional crop establishment system for rice cultivation which involves an initial transplanting of 30-day-old seedlings at wide spacing, followed by a second transplanting 30 days later into the vacant spaces between the initially planted hills by maintaining square planting geometry. This method enhances seedling vigour, improves root development, and increases resilience to stress by reducing transplanting shock, making the plants more capable of withstanding adverse conditions such as heavy rainfall and submergence. The square planting geometry utilized in MDT optimizes resource use, ensuring better light, water, and nutrient availability while reducing disease incidence and weed growth. Although MDT is labour-intensive, it significantly enhances grain quality and yield potential compared to traditional transplanting methods, offsetting the higher labour costs. This approach provides a viable alternative for sustaining the production of *Kanakchur* rice under increasingly unpredictable climatic conditions, thereby supporting the economic stability of farmers in coastal West Bengal.

Key words: Modified Double Transplanting, Submergence, Lodging, Square Planting Geometry.

In recent years, rice production has increased worldwide, therefore, rice grain quality is the critical factor from the consumer and market point of view. Aromatic rice, characterized by its aroma and kernel elongation compared to ordinary rice, has significant demand in different countries. There is a growing trend for consumers to pay more for scented rice varieties relative to ordinary rice types (Louis *et al*., 2005). There are more than a hundred native aromatic rice types grown in West Bengal. On the other hand, aromatic rice is far more valuable than high-quality non-aromatic rice because of its unique flavour, alluring aroma, and increased market value (Yadav *et al*., 2014). Amongst non-basmati scented rice varieties *Kanakchur* occupies a very high place in coastal zone of West Bengal. This crop is one of the most important scented rice varieties grown in this region, earmarked by its unique fragrance and superior quality.

Kanakchur Heritage Rice has native areas of cultivation at parts of 24 Parganas (Joynagar-Mojilpur, Gosaba) in West Bengal (Adhikari *et al*., 2011, Rohilla *et al*., 2000). *Kanakchur* rice is used for making '*Jaynagar er Moa'* which round shaped sweet item made up of puffed paddy (*Khai*) of this rice. '*Jaynagar er Moa'* is famous for its quality and taste among local, all-over West Bengal and International tourist of Sundarbans.

The *Kanakchur* variety rice gives 2-3 times more return to the farmers (Pani *et al*., 2013). As it is an aromatic rice, so mainly it is grown in kharif season to maintain its aroma. The coastal region of our state is more vulnerable to the adverse effects of climate change. Monsoon rainfall in our state is becoming erratic as a result the risk of drought and flood damage to rice crops is increasing. There is a tendency to increase the intensity of rainfall in the month of September-October rather than June-July.

In coastal lowland areas where inundation is a common problem during *kharif* season (up to September), farmers could not transplant during the normal transplanting time and they have to wait until water recedes for transplanting of rice. Further, due to late onset of monsoon or in areas with scarce water availability, farmers are bound to go for late transplanting of rice seedlings. So, this present context of climate change dont allow to transplant at the ideal time from nursery. This makes the seedlings to remain in nursery for long period resulting high competition among each other for different resources, thereby, poor growth and tiller (or sometimes, entire seedling) mortality.

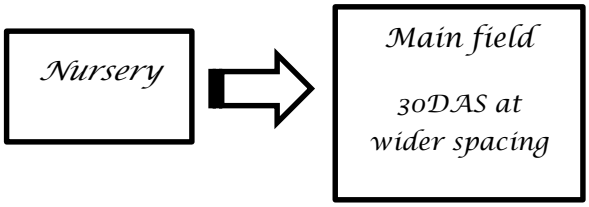
Modified Double transplanting (MDT) is well suited for establishing rice under delayed onset of monsoon as well as flood like situation where usual transplanting is not possible. well as modified Double transplanting can impose transient stress that temporarily slows vertical growth as the plant reallocates energy towards root recovery and tillering. This allows the seedlings to become tall and stout enough. This method is labour and time consuming but comparatively more economic as the yield of rice under MDT is more than the yield of rice from normal transplanting of same aged seedlings.

The double transplanting system permits a flexible late transplanting during the rainy season, which is its prime advantage. During the months of July to mid-September, generally the medium to low lying areas of West Bengal are either submerged in water or face drought due to unpredictable rainfall.

The main challenge to double transplanting of rice cultivation is the high cost of labour needed for the preparation of the main field and two nurseries, uprooting and separating seedlings, transplanting, and management of the crops. This process is labour-intensive and might be a huge concern to the farmers. Therefore, modification in the double transplanting method may give a promising solution.

Crop Management under Modified Double Transplanting

MDT is ideal for long-duration, photosensitive rice varieties. The seed rate recommended is about 20 kg ha^{-1} for MDT specially for *Kanakchur* as it is medium grain aromatic rice. MDT is somewhat different from double transplanting, here only primary seed bed is used no other field is required for secondary seed bed. In this modified method, seedlings are first uprooted at 30DAS from the primary nursery and then transplanted in hills placed 5-6 seedlings into the main field at wider spacing (At 40×20 cm or 30×15 cm). After about 30 days, when the tillers $hill^{-1}$ have increased, seedlings are clipped and half of the seedlings (7-8 seedlings $hill^{-1}$) are then re-transplanted again within the same field into vacant space between two previously transplanted hills at comparatively closer spacings (At 20×20 cm or 15×15 cm).



Process of Modified Double Transplanting

MDT is highly compatible with organic cultivation systems, especially for aromatic varieties like *Kanakchur*. No application of chemical fertilizers is done, and the nursery beds and main field were mixed with green manure crop of *Dhaincha*, to nurture the soil.

Second transplanting is arranged with the weather condition because it may reduce the submergence likelihood of seedlings during peak monsoon periods. It is usually performed when successive days of heavy rainfall are least probable.

Even during heavy rains, the taller and stronger seedlings from the secondary nursery can have the capacity to not be entirely submerged as usually happens with ordinary seedlings. The practice serves to minimize the risk of flood damage to the transplanted seedlings at critical growth stages. MDT requires labour-intensive activities somewhat greater than normal transplanting, mainly due to added operations such as seedling uprooting, separation of the seedlings, and a second transplanting. These extra operations increase the cost of production mainly due to the necessity for more manual labour.

Reason behind the success of MDT

Improved seedling vigour and stress amelioration:

The system of MDT reduces transplanting shock by growing the seedlings in a phased growth environment, firstly, in a primary nursery and then in a well-spaced, nutrient-enriched in main field. In such a two-stage process, the seedlings are allowed to recover their growth and acquire strength before final transplanting.

Due to this reduced stress coupled with an improved recovery time, the development of robust seedlings is allowed to take place, which has an enhanced tillering capacity, increase in root volume, and has stronger stems, especially when overaged seedlings are used.

Resilience to Adverse Environmental Conditions:

MDT enables taller and more resilient seedlings that can better face the extreme weather conditions typical of heavy rainfall, floods, and high-water depths during the *kharif* season. Clipping the aerial parts during the final transplanting reduces lodging risk and diverts the energy of the plant into better establishment of its roots after transplanting.

A Reduction in Seedling Mortality under Adverse Conditions:

In the MDT, seedlings undergo two transplanting shocks, which helps to harden them against harsh conditions. This "hardening" effect is responsible for a drastic reduction in mortality rate when plants undergo adverse weather conditions compared to those from single transplanting.

Healthier seedlings from MDT are better prepared against adverse environmental conditions, such as too-high water depths or sudden weather changes, which may drastically affect a single transplanted seedling.

Optimization of Microclimate and Weed Suppression:

The judicious use of wide spacing in appropriate square geometry in MDT acts to create a favourable microclimate around each plant, thus being conducive to the rice crop. The configuration ensures an ideal light penetrations and aeration for the crops, which promote photosynthesis and minimizes disease-prone micro-environmental conditions. Along with this, the vigorous growth of the MDT seedling naturally suppresses weed growth.

Higher Grain Quality and Yield Potential:

MDT, particularly with wider spacing at 23×23 cm, permits a greater plant-to-plant distance, allowing them to grow far apart from each other without competition and consequently use the available nutrients and water more efficiently.

This favourable spacing effectively supports plants to develop heavier grains panicle^{-1}, improved test weights and better panicle structures, hence contributing to higher overall grain yield and quality. Besides, low plant competition in MDT systems combined with the benefits of square planting ensures that each plant achieves its optimum potential for productivity, yielding high output.

Production economics of this system

The overall cost of cultivation would be more in modified double-transplanted systems on account of additional cost of labour for seedling uprooting and transplanting against conventional transplanting system. However, the higher cost of production under m double transplanting was compensated by the higher yield of the system.

Comparison between CT, DT and MDT

Basis	**Conventional transplanting**	**Double transplanting**	**Modified double transplanting**
No of Seed bed	1	2	1
Water requirement	more	less	less
Labour requirement	less	more than CT	Less than DT but more than CT
Yield	less	More than CT	More than DT
Net return	less	More than CT	More than DT

Production economics of CT and MDT system

CT: Conventional Transplanting, MDT: Modified Double Transplanting

Particulars	**Input**	**Rate (Rs.)**	**Cost (Rs.)**
Fertilizer			
Green manuring with Dhaincha	18kg/ha	45/kg	810
SSP	62.5kg/ha	362/50kg	453
		Total	1263
Plant Protection			
Plant protection	-	-	2690
Nursery preparation			
Ploughing+puddling	2 tractor 45 minutes	1200/hr	900
Main-field preparation			
Ploughing +puddling	7 tractor hours	1200/hr	8400
Labour Requirements			
Including all operation	107-man days	350/man days	37450
Miss			2250
Seed rate	22kg/ha	50/kg	1100
Transplanting (both 1st and 2nd)	50-man days	350/man days	17500
	Total		71553

Common cost of cultivation of *Kanakchur* during *kharif* 2023

Treatment	Grain yield (t ha^{-1})	Total cost of cultivation (Rs ha^{-1})	Gross Return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C Ratio
CT 23×23 cm	2.08	64953	112271	47318	0.73
MDT 20×20 cm	3.31	71553	173856	102303	1.43

Summary & conclusion

MDT is a strategic approach for growing scented rice varieties, particularly *Kanakchur* in coastal zone of west Bengal. This can be extremely useful under adverse climatic conditions, like delayed monsoons and floods. Grown in West Bengal, *Kanakchur* is highly valued for its unique fragrance and superior grain quality, it also contributes to the local economy through its various products, such as *'Jaynagar er Moa*.' However, due to increasing unpredictability in the monsoon pattern, traditional transplanting often falls behind schedule, thus delaying transplanting with compromised seedling growth. MDT is the transplantation of 30-day-old seedlings in wide spacing, and after another 30 days, half of the seedlings are clipped and re-transplanted into the gaps between two hills previously planted.

In this technique, seedlings have better vigour in seedling growth, root development, and resilience to stress, hence, it will be more able to face adverse conditions such as heavy rainfall and submergence. It optimizes resource usage with square planting geometry, allowing for better light, water, and nutrient availability while reducing disease incidence and weed growth. Since MDT is labour-intensive, the resultant higher yield potential and improvement in grain quality makes the cultivar economically viable.

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