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Growth dynamics and yield potential of different rice cultivars

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Abstract
The study employed a split-plot design with four replications to analyze the impact of transplanting date and variety on rice yield. Main plots consisted of three transplanting dates, and subplots consisted of three varieties. The three transplanting of dated 15 July, 25 July, and 5 August of year 2015, were kept in main plot and three varieties of Sarju 52 NDR-359 and Swarna were kept in sub plots. The fourteen kilo-grams weighted seeds were used for nursery raising. Crop was fertilized with recommended dose of fertilizer of 120 kg N, 60 kg P2O5 and 60 kg K2O. Results indicated that Swarna yielded significantly higher with recommended fertilizer application.

Keywords: Transplanting, fertilizer-dose, split-plot

Introduction
Rice (*Oryza sativa* L.) is one of the most important food grain crops of more than 60 percent of the world's population. About 90 percent of all rice grown in the world is produced and consumed in the Asian region. It is the world's leading food crop in terms of area and production. Among the rice growing countries, India has the largest area followed by China and Indonesia. India ranks second in production after China. Andhra Pradesh, Bihar, Uttar Pradesh, Madhya Pradesh and West Bengal are leading states in the area of rice. In India, it is grown over an area of 43.79 million hectares having production of 112.91 million tonnes with average productivity of 2578 kg ha^{-1}. In Uttar Pradesh, it is grown on 5.95 million hectares area with production of 13.27 million tonnes and productivity of 2230 kg ha^{-1} (Ivanov *et al.* 2018) [3].

Materials and Methods
The experiment was conducted during *Kharif* season of year 2015 at Aerometry Research Farm of Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad, Uttar Pradesh India. The field was well levelled having good soil condition. Geographically, Faizabad (Kumarganj) falls in subtropical climate and is situated at 26^{0}.47' North latitude, 82^{0}12' East longitude with an altitude of 113 meters above mean sea level. The experimental site is situated in main campus of University on Faizabad- Raibarelli road at the distance of 42 km from Faizabad district headquarter. The details of the adopted method for conducting the research have been depicted below:

1. Experimental Design: Split-Plot Design
- **Rationale**
- A split-plot design is used when one factor (in this case, transplanting date) is more difficult or costly to apply than the other (rice variety).
- Transplanting dates require larger plots and field-wide adjustments, making them suitable for main plots. Varieties, on the other hand, can be easily randomized within the main plots.
- This design allows for the analysis of both main effects (transplanting date and variety) and their interaction (how variety performance changes across different transplanting dates).

2. Replication: Four Replications
Rationale

- Replication is crucial for reducing experimental error and increasing the precision of results.
- Four replications provide a reasonable balance between statistical power and resource constraints.
- Replication helps to account for field variability and ensures that the observed effects are not due to random chance.

3. Objective: Analysing the Impact on Rice Yield
Rationale

- Rice yield is a critical agronomic trait and a primary indicator of crop performance.
- Understanding how transplanting date and variety affect yield is essential for optimizing rice production.

4. Main Plot Factor: Transplanting Date
Rationale

- Transplanting date significantly influences rice growth and development, as it affects the crop's exposure to temperature, sunlight, and rainfall.
- Different transplanting dates can lead to variations in vegetative growth, flowering, and grain filling.

5. Main Plot Levels: July 15, July 25, August 5 (2015)
Rationale

- These dates were likely chosen based on local knowledge and experience, as they represent a range of typical transplanting times for the region.
- The choice of 2015 is a specific year, therefore the weather patterns of that year would had an effect on the outcome of the experiment.

6. Subplot Factor: Rice Variety
Rationale

- Rice varieties differ in their genetic potential for yield, growth duration, and adaptation to environmental conditions.
- Selecting the right variety is crucial for maximizing rice production.

7. Subplot Levels: Sarju 52, NDR-359, Swarna
Rationale

- These varieties were likely chosen based on their popularity, availability, or specific traits of interest.
- Each of these varieties has differing growth duration, and other characteristics.

8. Nursery Preparation: 14 kg Seeds
Rationale

The seed rate is a critical factor in nursery management, as it affects seedling density and quality. The 14 kg weighted seed were used for the nursery raising.

9. Fertilization: 120-60-60 kg N-P2O5-K2O
Rationale

- This represents a recommended fertilizer dose for rice production in the region.
- Adequate nutrient supply is essential for optimal crop growth and yield.

Results and Discussion

Rice variety significantly impacted plant growth, yield components, and yield (Cruz *et al*. 1984; Dawadi *et al*. 2013) [1, 2]. NDR-359 and Sarju-52 resulted in taller plants, while NDR-359 and Swarna exhibited higher tiller numbers and leaf area index. Swarna and NDR-359 accumulated more dry matter and produced higher grain and straw yields, likely due to their longer growth duration and enhanced yield attributes. Sarju-52 consistently showed the lowest performance across most measured parameters. The complete findings for impact of transplanting date and variety on rice yield, dry matter production, biomass accumulation, rice tiller density and rice leaf area index, have been tabulated from Table 1 to Table 4.

Table 1: Variations in rice yield attributes and yield in response to transplanting date and cultivar

Treatment	No. of effective tillers/m^2	Length of panicle (cm)	No. of grains/ panicle	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
Date of transplanting							
15 July	436.5	10.4	167.3	26.6	48.7	72.7	40.1
25 July	410.4	9.8	155.6	25.2	46.1	69.2	40.0
5 August	368.0	9.5	141.9	24.9	40.4	63.8	39.9
S.Em±	12.08	0.23	4.47	0.04	1.35	1.75	
C.D. at 5%	38.08	0.72	14.09	NS	4.28	5.53	
Varieties							
Sarju-52	376.36	7.25	147.6	24.47	43.7	64.28	39.98
NDR-359	409.90	9.93	154.3	25.17	44.9	67.02	39.99
Swarna	418.74	10.63	163.9	26.10	48.5	74.45	40.01
S.Em±	8.45	0.19	3.07	0.09	0.90	1.47	
C.D. at 5%	24.68	0.56	8.98	NS	2.64	4.31	

Table 2: Effects of transplanting date and varietal selection on dry matter accumulation (gm-2) in rice

Treatment	Dry matter accumulation (g m^{-2})			
	30 DAT	60 DAT	90 DAT	At harvest
Date of transplanting				
15 July	147.7	501.9	887.8	1009.8
25 July	138.8	466.9	832.3	1040.3
5 August	124.4	425.8	768.1	960.1
S.Em±	3.52	13.42	21.91	30.89
C.D. at 5%	11.11	42.28	69.06	97.33
Varieties				
Sarju-52	127.2	442.7	784.0	980.0
NDR-359	144.9	488.8	885.7	1007.1
Swarna	138.6	463.0	818.4	1023.0
S.Em±	2.75	9.23	16.09	20.93
C.D. at 5%	8.03	26.93	46.97	61.10

Table 3: Variations in rice tiller density (m-2) in response to transplanting date and cultivar

Treatment	Number of tillers (m^{-2})			
	30 DAT	60 DAT	90 DAT	At harvest
Date of transplanting				
15 July	226.3	610.1	626.2	613.7
25 July	212.8	570.4	587.0	575.3
5 August	190.8	567.5	541.8	530.9
S.Em±	5.08	11.07	15.45	14.72
C.D. at 5%	17.59	38.31	53.49	50.96
Varieties				
Sarju-52	205.2	538.1	553.0	541.9
NDR-359	212.5	562.8	577.3	565.7
Swarna	222.3	594.1	624.7	612.3
S.Em±	4.21	10.54	11.35	11.13
C.D. at 5%	12.52	31.34	33.72	33.08

Table 4: Effects of transplanting date and varietal selection on the leaf area index of rice

Treatment	Days after transplanting		
	30 DAT	60 DAT	90 DAT
Date of transplanting			
15 July	2.13	4.53	4.92
25 July	2.01	4.22	4.62
5 August	1.80	3.85	4.26
S.Em±	0.04	0.12	0.12
C.D. at 5%	0.15	0.38	0.38
Varieties			
Sarju-52	1.84	4.00	4.35
NDR-359	2.00	4.18	4.54
Swarna	2.10	4.42	4.91
S.Em±	0.04	0.08	0.08
C.D. at 5%	0.11	0.24	0.26

The complete results and discussion for the research can be summarized as below:

1. **Plant Height**

- Varietal differences significantly affected plant height throughout the crop's growth (Kalita *et al*. 1981; Dawadi *et al*. 2013) [4, 2]. NDR-359 produced the tallest plants, statistically similar to Sarju-52. Swarna exhibited the shortest plants.

2. **Tillering and Leaf Area Index (LAI)**

- Varieties significantly influenced tiller number per hill and LAI (Kumar *et al*. 2013) [6]. NDR-359 and Swarna had the highest tiller counts and LAI, indicating a prolonged vegetative and reproductive phase. Sarju-52 had the lowest values.

3. **Dry Matter Accumulation**

- Dry matter accumulation varied significantly among varieties at all growth stages. Swarna and NDR-359 showed the highest accumulation, likely due to their longer growth duration, which facilitated increased plant height, shoot production, and LAI. Sarju-52 had the lowest accumulation.

4. **Yield Attributes and Yield**

- Yield attributes (effective tillers, panicle length, grains per panicle) were significantly influenced by variety (Singh *et al*. 2013; Khan *et al*. 1990) [8, 5]. Swarna and NDR-359 exhibited the highest values for these attributes. Consequently, Swarna and NDR-359 produced significantly higher grain and straw yields, attributed to enhanced yield components and dry matter production. Sarju-52 yielded the lowest.

5. **Key Finding**

- The superior performance of Swarna and NDR-359 is attributed to their longer growth duration, which allowed for greater vegetative and reproductive development, ultimately leading to higher yields.

Conclusion

In this study, rice variety significantly influenced growth, yield attributes, and overall yield *(Mandal et al. 1968)* [7]. Long-duration varieties, specifically Swarna and NDR-359, consistently outperformed Sarju-52. Swarna and NDR-359 exhibited higher dry matter accumulation, increased tiller numbers, larger leaf area indices, and superior yield component values, leading to significantly higher grain and straw yields. Sarju-52 consistently displayed the lowest performance across all measured parameters. Therefore, for optimal rice production under the conditions of this experiment, the selection of long-duration varieties, such as Swarna or NDR-359, is recommended. These varieties demonstrate a greater capacity for vegetative and reproductive growth, resulting in significantly enhanced yields.

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