

Study on Physiological Indices and Profitability of Unpuddled Rice under Late Receipt of Canal Water in Periyar Vaigai Command Area

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The field experiment was conducted at Agricultural College and Research Institute, Madurai, Tamil Nadu, during Kharif, 2017 to study the physiological and economic analysis of rice grown under unpuddled condition. The treatments comprised of two date of sowing (first and second fortnight of July) and two establishment methods with different varieties (Direct sowing and Unpuddled Transplanted Rice (UPTR) of CO 51, MDU 5 and ADT 48 rice varieties). The experiment was laid out in split plot design with three replications. The results revealed that direct sowing of CO 51 had superior physiological indices like LAI, CGR and RGR at panicle initiation, flowering and harvest stages than the other varieties and net return and benefit cost ratio were also achieved highly in this method of cultivation on sowing at first fortnight of July. While, the lower net return was obtained from ADT 48 under UPTR cultivation. This study clearly indicated that delay of water released from the dam up to July second fortnight, CO 51 and MDU 5 rice variety under direct sowing condition gives the better result than other varieties.

Key words: Rice varieties, Direct sowing, Unpuddled Transplanting, Physiological indices.

Rice is the second largest food crop in the world, in terms of area, production and also the most favoured stable food for half of the global population. It grows in a diverse range of climatic and agro-ecological conditions. Recent past, water is becoming scarce due to many reasons like erratic and unpredictable behavior of monsoon and increasing demand of water for other sectors. Rice is a semi-aquatic plant, which requires high water under traditional flooding method, which leads to greater loss through seepage and percolation. Perivar Vaigai Command (PVC) is the major irrigation source for agricultural productivity in Madurai district of Tamil Nadu. In this region, rice is cultivated as double crop during the seasons of Kharif and Rabi. Normally, water is released in first week of June for irrigation to raise Kharif rice followed by Rabi rice in September-October. This is possible only when South West Monsoon (SWM) sets in time and provides an adequate amount of rainfall in the catchment area. Recently, the water release schedule is varied and delayed up to August owing to failure of SWM resulted in poor water storage in the reservoir.

Under such condition, the farmers are not in a position to raise kharif rice hence they are shifted to single season rice (rabi/samba) during August – September. These consequence leads to complete termination of raising kharif rice at the command areas of Tamil Nadu. Alternate crop plan was adopted in this region to cultivate other crops instead of rice crop on kharif season. To meet the food demand of increasing population, rice cultivation in kharif season is very essential for food security.Keeping this in

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view, the study was mainly conducted to practice alternate techniques in rice cultivation with short duration varieties aiming to kharif season instead of alternate crops.

Materials and Methods

Field experiment was carried out in Agricultural College and Research Institute, Madurai, Tamil Nadu during Kharif, 2017. The experiment was laid out in split plot design with two date of sowing, viz., first and second fortnight of July in main plots and two method of planting with three varieties (Direct sowing and Unpuddled Transplanted rice (UPTR) with CO 51, MDU 5 and ADT 48 rice varieties) in sub plots. Totally twelve treatmental combination was used and replicated thrice. The good quality seeds were line sown at 20 x 10 cm spacing and transplanting (community nursery or tray was adopted) were also done on the same day at 20 x 10 cm spacing. Additionally the rice variety CO 51 was sown at nursery during first and second fortnight of July followed by transplanting at 21 days old seedlings under traditional practice based on the late receipt of water from the canal for comparison. The entire quantity of P was applied as basal, K and N were applied in four splits at basal, active tillering, panicle initiation and flowering stages with recommended dose of 150:50:50 kg of N, P2O5 and K2O ha-1. The observations on growth parameters and yield attributes were recorded and LAI, CGR and RGR were worked out. The grain and straw yield was observed and compared with conventional practice. The economic analysis of rice was worked out and

the data was statistically analyzed at 5 per cent level of significance (Gomez and Gomez, 2010).

Results and Discussion

Impact of date of sowing on physiological indices

The data on growth attributes like LAI, CGR and RGR in date of sowing showed non significant response and depicted in Table 1. However, the higher LAI (3.45 and 4.87), CGR (12.8 and 9.59) and RGR (0.011 and 0.005) were observed in rice cultivated on first fortnight of July than second fortnight of July at panicle initiation to flowering and flowering to harvest stage respectively. The growth attributes was mainly depends on the number of leaves, leaves morphology and dry weight of the plant.

Table 1. Date of sowing and method of planting with varieties on LAI, CGR (g m-2 day-1) and RGR (g g-1 day⁻¹) at various stages of rice

| Treatment - | LAI | | CGR (g m ⁻² day ⁻¹) | | RGR (g g ⁻¹ day ⁻¹) | | Grain yield | Straw yield | Harvest |
|--|------|------|--|---------|--|---------|-------------|-------------|---------|
| | PI | FLR | PI – FLR | FLR – H | PI – FLR | FLR - H | (kg ha⁻¹) | (kg ha-1) | index |
| Main plot – Date of sowing | | | | | | | | | |
| D ₁ − July 1 st FN | 3.45 | 4.87 | 12.8 | 9.59 | 0.0108 | 0.0049 | 5136 | 8130 | 0.460 |
| $D_2^{}$ – July 2 nd FN | 3.29 | 4.64 | 11.4 | 8.45 | 0.0100 | 0.0039 | 4891 | 7602 | 0.394 |
| Mean | 3.37 | 4.76 | 12.1 | 9.02 | 0.0104 | 0.0044 | 5013 | 7866 | 0.427 |
| SEd | 0.16 | 0.14 | 0.61 | 0.31 | 0.0003 | 0.0003 | 54.7 | 104.6 | 0.009 |
| CD (p=0.05) | NS | NS | NS | NS | NS | NS | 235.6 | 449.8 | 0.037 |
| Sub plot – Method of sowing/ planting with different varieties | | | | | | | | | |
| $T_1 - DSR$ of CO 51 | 3.88 | 5.43 | 18.7 | 11.9 | 0.0137 | 0.0067 | 5987 | 9138 | 0.451 |
| T_2 – DSR of MDU 5 | 3.55 | 4.85 | 11.2 | 10.1 | 0.0102 | 0.0051 | 5228 | 8215 | 0.433 |
| $T_{_3}$ – DSR of ADT 48 | 3.09 | 4.51 | 8.86 | 7.35 | 0.0090 | 0.0032 | 4443 | 6953 | 0.411 |
| $T_4 - UPTR$ of CO 51 | 3.74 | 5.05 | 14.8 | 10.6 | 0.0117 | 0.0052 | 5413 | 8784 | 0.443 |
| $T_5 - UPTR$ of MDU 5 | 3.21 | 4.61 | 10.9 | 9.32 | 0.0095 | 0.0043 | 4925 | 7782 | 0.425 |
| $T_6^{}$ – UPTR of ADT 48 | 2.75 | 4.05 | 8.10 | 4.89 | 0.0085 | 0.0019 | 4083 | 6322 | 0.398 |
| Mean | 3.37 | 4.76 | 12.1 | 9.02 | 0.0104 | 0.0044 | 5013 | 7866 | 0.427 |
| SEd | 0.26 | 0.25 | 1.20 | 0.66 | 0.0008 | 0.0048 | 173.8 | 274.8 | 0.007 |
| CD (p=0.05) | 0.53 | 0.50 | 2.42 | 1.33 | 0.0016 | 0.0010 | 350.4 | 553.9 | 0.014 |
| Traditional practice -1 | 3.64 | 4.98 | 15.1 | 10.2 | 0.0128 | 0.0054 | 5440 | 9474 | 0.441 |
| Traditional practice -2 | 3.04 | 4.37 | 9.6 | 8.7 | 0.0094 | 0.0042 | 4170 | 8237 | 0.407 |

Interaction effect was non-significant

PI - Panicle Initiation stage, FLR - Flowering stage, H - Harvest stage

FN - Fort Night, DSR - Direct Sowing of rice, UPTR - Unpuddled Transplanted Rice

Effect of method of planting with different varieties on physiological indices

The data on LAI, CGR and RGR are given in Table 1. LAI is the important index to strengthen the source-sink relationship. The results revealed that LAI, CGR and RGR were significantly influenced by method of planting with different varieties. With respect to LAI, the significant difference in LAI was observed at panicle initiation stage. Direct sowing of CO 51 recorded higher LAI (3.88) and it was on par with UPTR of CO 51 (3.74) and direct sowing of MDU 5 (3.55). The same trend was fallen at flowering stage. The lower LAI was observed in UPTR of ADT 48 at panicle initiation and flowering stage (2.75 and 4.05 respectively). More LAI in CO 51 rice variety might be due to higher number of broader leaves than other varieties. However, good crop canopy and genetic potential might also be responsible for more LAI in CO 51 and MDU 5 than ADT 48 rice variety. The similar results were confirmed with Gill et al. (2006) Rajput et al. (2017).

With respect to CGR, during panicle initiation to flowering stage, higher CGR (18.7) was recorded in direct sowing of CO 51 than other varieties. Lower CGR values of 8.10 and 8.86 were found in UPTR and direct sowing of ADT 48. The CGR increased up to flowering then it starts to decline gradually due to age of crop. The CGR values were more in vegetative period due to more tiller production, LAI development and decreased during reproductive stage owing to greater spikelet formation, grain development and high crop productivity. The same trend was occurred in flowering to harvest stage. Similar findings were reported by Wang et al. (2002) and Azarpour et al. (2014).

Regarding RGR, direct sowing of CO 51 registered higher value of 0.014 and 0.0067 at panicle initiation to flowering and flowering to harvest stage respectively. The lower RGR value was noticed under UPTR of ADT 48 at panicle initiation to flowering stage and at flowering to harvest stage. The higher relative growth rate might be due to the enhanced photosynthetic rate and dry matter production. The results were in accordance with the findings of Maheswari et al. (2007) and Sekhar Sing Mura et al. (2017).

| Table 2. Economic analysis of date of sowing and method of planting with different varieties of rice (RS. na | e 2. Economic analysis of date of sowing an | wing and method of planting wi | ith different varieties of rice / | (Rs. ha ⁻¹⁾ |
|--|---|--------------------------------|-----------------------------------|------------------------|
|--|---|--------------------------------|-----------------------------------|------------------------|

| Treatment | Cost of cultivation (Rs. ha ⁻¹) | Gross income (Rs. ha ^{.1}) | Net income (Rs. ha ^{.1}) | B:C ratio | Per day productivity (kg ha ⁻¹) | | | |
|--|---|---|---------------------------------------|-----------|---|--|--|--|
| Main plot – Date of sowing | | | | | | | | |
| D1 – July 1st FN | 50132 | 94364 | 44233 | 1.90 | 48.8 | | | |
| D2 – July 2nd FN | 50132 | 89659 | 39527 | 1.80 | 47.5 | | | |
| Mean | 50132 | 92012 | 41880 | 1.80 | 48.2 | | | |
| SEd | 435.8 | 962 | 565 | 0.016 | 0.56 | | | |
| CD (p=0.05) | NS | 4138 | 2431 | 0.069 | NS | | | |
| Sub plot – Method of sowing/ planting with different varieties | | | | | | | | |
| T1 – DSR of CO 51 | 47436 | 109499 | 62063 | 2.33 | 54.6 | | | |
| T2 – DSR of MDU 5 | 47436 | 95975 | 48539 | 2.03 | 51.0 | | | |
| T3 – DSR of ADT 48 | 47436 | 81523 | 34087 | 1.72 | 47.3 | | | |
| T4 – UPTR of CO 51 | 52827 | 99776 | 46949 | 1.89 | 48.1 | | | |
| T5 – UPTR of MDU 5 | 52827 | 90479 | 37652 | 1.72 | 46.7 | | | |
| T6 – UPTR of ADT 48 | 52827 | 74817 | 21990 | 1.42 | 41.2 | | | |
| Mean | 50132 | 92012 | 41880 | 1.80 | 48.2 | | | |
| SEd | 1019 | 1609 | 949 | 0.032 | 0.62 | | | |
| CD (p=0.05) | 2053 | 3242 | 1914 | 0.065 | 1.23 | | | |
| Traditional practice - 1 | 55070 | 100651 | 45581 | 1.83 | 45.3 | | | |
| Traditional practice - 2 | 55070 | 78699 | 23629 | 1.43 | 44.2 | | | |

Interaction effect was non-significant

FN – Fort Night, DSR – Direct Sowing of rice, UPTR – Unpuddled Transplanted Rice

Effect of date of sowing and method of planting with varieties on yield and harvest index

The data on grain yield, straw yield and harvest index are furnished in Table 1. The higher grain yield (5136 kg ha⁻¹) and straw yield (8130 kg ha⁻¹) were observed under July first fortnight sowing than July second fortnight sowing. Comparatively reduced yield in July second fortnight sowing was observed due to the maturity stage coincide with rainfall and cloudy weather during the cropping period which affects the filling percentage of grains and productive tillers hill⁻¹. With respect to method of planting with varieties, higher yield was achieved in direct sowing of CO 51 which produced a grain yield of 5987 kg ha⁻¹ and it was 10 and 43.6 per cent higher than the normal transplanting method followed in this area (conventional rice raised as per the release of water).

Irrespective of method of establishment, the variety CO 51 produced 13 and 25 per cent higher grain yield when compared with MDU 5 and ADT 48 rice varieties. Likewise, the straw yield was also high in CO 51 under direct sowing method which was comparable with UPTR of CO 51 and followed

by direct sowing of MDU 5. Harvest index also higher was noticed in direct sowing of CO 51 than other treatments due to better growth attributes and grain and straw yield (Fig. 1). The treatmental interaction effect was non significant with respect to grain yield, straw yield and harvest index. Hence, irrespective of the establishment technique and varieties, sowing within July first fortnight (D_1) was the ideal time for getting higher yield and to catch the subsequent crop in the double cropped wetland in the Periyar Vaigai Command area.

Profitability of unpuddled rice

The economic analysis of unpuddled rice differed due to method of planting with different varieties and date of sowing and depicted in Table 2. Cost of cultivation and per day productivity was not significantly influenced by date of sowing. With respect to per day productivity the treatmental interactions were also non significant. Irrespective of varieties, cost of cultivation was higher in transplanted rice than direct sowing due to more labour requirement for transplanting and nursery establishment. In traditional practice the cost of cultivation was higher than UPTR because of preparatory operations of puddling and leveling. The higher gross income of Rs. 1,09,499 net income of Rs. 62, 063 and benefit cost ratio of 2.33 respectively were realized from direct sowing of CO 51 rice variety followed by direct sowing of MDU 5 rice variety (Rs. 95,975, 48,539 and 2.03 respectively) due to more yield. The CO 51 under direct sowing condition was found superior over other varieties. This might be due to more growth and high yielding capacity of rice variety. The lower gross income, net return and benefit cost ratio were observed in UPTR of ADT 48



Fig. 1. Planting methods and varieties on grain yield and straw yield

(Rs. 74, 817, Rs. 21, 990 and 1.42 respectively). Identical finding was given by Ningaraju et al. (2015).

Summary

The present investigation revealed that the water released from the reservoir extend up to July first fortnight, the rice variety CO 51 perform better at both method of planting than the other rice varieties. However, the economic analysis indicated that the direct sown method gives higher returns than UPTR method. Therefore, direct sowing of CO 51 rice variety under unpuddled condition on first fortnight July was given the higher growth analysis characters like LAI, LAD, CGR and RGR than other rice varieties. Similarly, gross and net returns were also achieved higher in CO 51 followed by MDU 5 rice variety under direct sowing method.

Conclusion

The study concluded that direct sowing of short duration variety CO 51 perform better than transplanted rice under the late receipt of water from the reservoir up to July second fortnight in Periyar Vaigai Command (PVC) area.

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