Original Research Article

Evaluation of tillering behavior and yielding ability ofdifferent rice varieties under unpuddled condition

Abstract

A field trial was conducted at Central Farm of Agricultural College and Research Institute, Madurai during *Kharif*, 2017 on sandy clay loam soilsto evaluate the effect of various sowing window on tillering performance and yielding ability of three different varieties under unpuddled condition. The study was evaluated in Split plot design with three replications and treatment consisting of two dates of sowing (July first and second fortnight) assigned in main plots and three varieties *viz.*, ADT 48, MDU 5 and CO 51 in two method of planting (Direct seeded Rice (DSR) and UnPuddled Transplanted rice (UPTR)) in sub plots. The treatments were compared with conventional planting of short duration variety (CO 51) under late release of water from July first and second fortnight (absolute control 1 & 2).The results revealed that, tiller production was not significantly influenced by sowing dates but effective tillers and yield was more in early sowing than late sowing.Among the method of planting with different varieties, direct sowing of CO 51 produced more tillers like primary, secondary tillers m^{-2} at various growth stages. The tertiary tiller production was more in UPTR method than direct sowing. As a result of more number of panicles, higher yield was achieved in direct sowing of CO 51 which produced a grain yield of 5987 kg ha^{-1} and straw yield of 8130 kg ha^{-1}over early and very early duration varieties *viz.*, MDU 5 and ADT 48 under both method of planting. Therefore, direct sowing of CO 51 was economically viable for late receipt of water from the canal up to July second fortnight.

Key words: Direct sowing, UPTR, varieties, sowing window, tillering performance.

Introduction

Rice (*Oryza sativa* L.) is a prime member of graminae family and predominant survival food crop for majority of the world population. Rice cultivation and its productivity is being a challenge in the upcoming decades due to potential climate change.Recently, rice production in India is limited due to water scarcity and monsoon failure (Shetty *et al*., 2013). Water is becoming increasingly scarce in the traditional river valley command area because of many reasons like erratic monsoon behavior, deterioratinghydrological balance and increasing demand for non-agricultural purpose (Natarajan, 1993 and Renuka, 2017).

The traditional practice is raising short duration variety in the first season followed by medium duration variety in the second season, and there are benefited by South West Monsoon and North East Monsoon rains respectively.Changes in on set of South West Monsoon and inadequate level of water in the dam, makes cropping difficult. In some years, the water released for first crop is delayed even up to August consequently, the transplanting of first crop get delayed which results in delayed transplanting of second crop (medium duration). This situation makes the second rice crop to suffer for the want of sufficient water chiefly at flowering and grain filling stages. This shows that some of the *kharif* area (double crop) has been shifted to *rabi*(single crop)mainly consequent of late withdrawal of water from the reservoir. If this situation continues, it is feared that *kharif* crop would completely vanish.

Direct sowing of rice seeds in unpuddled land offers an useful option to reduce the limitations of transplanted paddy and also offers one such water saving, less labour usage technology. This concept is mainly suited for irrigated lowlands, where supplemental irrigation is available for crop cultivation (Belder*et al*., 2005). Likewise the UnPuddled Transplanted Rice (UPTR) is gaining momentum, wherein 30 per cent of water, which is utilized for field preparation, has been reduced and the turnaround period between crops also get reduced.However at the same time, availability of short, early and very early duration, photo-insensitive, semi-dwarf and high yielding rice varieties are a boon for direct seeded technique. Direct seeded rice matures seven to ten days earlier than transplanted rice, which gives more importance in intensive cropping (Gill *et al*., 2006). In this context, very early, early and short duration rice varieties *viz.,* ADT 48, MDU 5 and CO 51 have the duration of95, 100-105 and 110 days respectively may suit for the delayed sowing especially at first season due to late receipt of canal water. Further, it makes the second season rice without any delay in yield penalty. Under these circumstances, the study was carried out to evaluate the promising variety for late receipt of canal water in *Kharif* season to enhance the rice productivity.

Materials and Methods

A field experiment was carried out in *Kharif,* 2017 at Agricultural College and Research Institute, Madurai, Tamil Nadu situated at 9°54' N latitude and 78°54' E longitude with an altitude of 147 m above mean sea level. The tract is located in the southern agro climatic zone of Tamil Nadu. The soil of the experiment field was sandy clay loam in texture. The trial was laid out in split plot design and replicated thrice. The treatments combination comprised 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. The seeds were soaked in water for 12 hours and incubated for 10 hours. Sprouted seeds were line sown with a spacing of 20 x10 cm and (seedlings were already raised in community nursery) eighteen days old seedlings were transplanted with same spacing in a saturated soil on the same day (July first and second fortnight). Irrigation was provided immediately after sowing to hasten the germination and establishment. Subsequent irrigations were given to maintain moist condition and need based plant protection was given. Thetillers production recorded for each treatment by counting the uprooted plant tillers at active tillering stage, panicle initiation stage, flowering stage and at harvest. Primary, secondary and tertiary tillers hill^{-1} were also recorded. The yield attributes and yield were recorded and statistically analyzed at 5 % level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Tiller production m^{-2}

The data on primary, secondary, tertiary and total tillers per unit area recorded at different growth stages are presented in Tables1 & 2.The trend in variation of tiller production per unit area was not significantly differed with respect to date of sowing only. Method of planting with different varieties produced significant variation at all growth stages of crop.The number of tillers m^{-2} is one of the most important growth parameters which influence the grain yield directly. It is apparent from the data indicated that tiller production $m^{-2}$was increased very fast up to panicle initiation stage, thereafter it became very slow and follow the Mitscherlich concept of increases with decreasing trend.

With regard to method of planting with different varieties, significant variation was noticed in primary, secondary, tertiary and total tillers m^{-2}. During active tillering stage, Direct sowing of CO 51 resulted in significantly higher primary (283.9) and secondary tillers m^{-2}(199.4)and this was on par with direct sowing of MDU 5 and UPTR of CO 51 rice variety. The significantly lower number of primary and secondary tillers m^{-2}(199.2 and 148.1) was recorded in case of ADT 48 under UPTR. At panicle initiation stage, primary tiller production was more in direct sowing than the unpuddled transplanting. Direct sowing of CO 51 produced more primary tillers (367.9) and lower number of primary tillers (247.4) was observed under UPTR of ADT 48, which was on par with UPTR of MDU 5. With respect to secondary tillers m^{-2} was more in CO 51 under direct sowing (375.2) and less in ADT 48 under direct sowing and UPTR method (310.3 and 297.2, respectively). Transplanted rice produced more tertiary tillers than direct sowing method. Higher tertiary tillers m^{-2} (75.6) was recorded in UPTR of CO 51 and direct sowing of ADT 48 produced significantly lower number of tertiary tillers m^{-2} (46.7).

During flowering stage, direct sowing of CO 51produced more primary tillers m^{-2} (364.6). The lower number of primary tillers was recorded in ADT 48 under direct sowing and UPTR. Higher number of secondary tillers $m^{-2}$was noticed under direct sowing of CO 51 (441.2). The less number of secondary tillers (347.4) was observed under ADT 48 in UPTR. With respect to tertiary tillers m^{-2}, the rice variety CO 51 produced more tertiary tillers m^{-2}followed by MDU 5.

At harvest stage, primary tillers production was more in direct sowing than unpuddled transplanted rice. Higher number of primary tillers m^{-2}(384.9) were recorded from direct sowing of CO 51 andlower number of primary tillers of 296.9 was observed in UPTR of ADT 48. More secondary tillers (458.7) were observed under direct sowing of CO 51 and it was on par with UPTR of CO 51. Lesser secondary tillers $m^{-2}$was recorded from ADT 48 under both method of planting. With regards to tertiary tillers m^{-2}, UPTR of CO 51 produced higher tertiary tillers (125.5) and ADT 48 under direct sowing produced lower tertiary tillers m^{-2}(90.6).

Regarding total tillers m^{-2}, more number of tillers per unit area was recorded in short duration variety CO 51 at both methods (T_1- Direct sowing and T_4- Unpuddled transplanting). However, comparable tiller production per unit area was observed in early duration rice variety MDU 5 under direct sowing method. But very early duration rice variety ADT 48 under both method of planting produced significantly lower number of tillers per unit area at all the growth stages. The difference in number of tillers m^{-2} among the varieties grown under unpuddled condition was also reported by Reddy *et al*. (2012). More number of tillers per unit area in CO 51 rice might be attributed to the exposure of optimum solar radiation and occurrence of uniform distribution of rainfall during crop growth period, which positively increase the tiller production. The association of increased temperature with low light intensity cause some tillers bud to dormant due to the non-availability of adequate carbohydrate required for growth (Yoshida 1981; BalajiNaik*et al*., 2016), which restricted the primary, secondary and tertiary production of rice plants. The treatment interaction effect also showed a non significant result at all the stages of observation.

Effective tillers hill^{-1}

The data on number of effective tillers hill^{-1} (primary, secondary, tertiary panicles hill^{-1}) were recorded at harvest stage is given in Table 3.The perusal of data indicates that sowing dates did not exert significant impact upon primary and tertiary panicles hill^{-1}. Interestingly significant response where observed in secondary panicle production. However, the method of planting with different varieties brought about significant variation on panicles hill^{-1}. Primary panicles were more in direct sowing and tertiary tillers was more in UPTR method.

Among the treatments, direct sowing of CO 51 (T_1) produced more primary panicles (6.51) and it was on par with direct sowing of MDU 5 (T_2) and UPTR of CO 51 (T_4). The rice variety ADT 48 under direct sowing and UPTR (T_3 and T_6) recorded 5.92 and 5.51 primary panicles hill^{-1}. The same sequence was noticed on secondary panicles hill^{-1}. With respect to tertiary panicles, CO 51 under UPTR condition (T_4) recorded higher value of 0.18 tertiary panicles hill^{-1} which was on par with direct sowing of CO 51 (T_1) and the lesser tertiary panicles (0.11) was found under UPTR of ADT 48 (T_6).These results clearly indicated that direct sowing favoured the production of primary and secondary panicles. Whereas, transplanting favours the production of tertiary panicles because of higher field duration. Moreover, the tertiary panicles remain green and unfilled even the crop attains maturity. Gill *et al*. (2006) also stated similar such research findings.

The number of panicles hill^{-1} and per unit area was significantly influenced by date of sowing. Among the sowing dates, the crop sown at July first fortnight (D_1) produced maximum number of panicles hill^{-1} and per unit area (11.6 and 402.8) than July second fortnight sowing (D_2).Regarding method of planting with different varieties, higher panicles hill^{-1} (12.3) was recorded under direct sowing of CO 51 (T_1) and it was comparable with UPTR of CO 51 (T_4) (11.6). ADT 48 under direct sowing and UPTR (T_3 and T_6) registered less number of panicles hill^{-1} (10.8 and 10.3 respectively). Total number of panicles per unit area was also higher in direct sowing of CO 51 (T_1) (467). While, less number of panicles per unit area was obtained in UPTR of ADT 48 (T_6) and this was on par with direct sowing of ADT 48 (T_3). The interaction effect was not significant with respect to primary, secondary and tertiary panicles hill^{-1} andnumber of panicles m^{-2}.

Grain yield and Straw yield (kg ha^{-1})

The results on grain yield and straw yield are given in Table 4. The sowing dates as well as method of planting with different varieties brought about significant impact upon the production of grain yield kg ha^{-1}. Among the sowing dates, July first fortnight sowing (D_1) produced a grain yield of 5136 kg ha^{-1}, being superior to July second fortnight sowing (D_2), which recorded the grain yield of 4891 kg ha^{-1}. These results were in conformity with the results of Rai and Kushwaha (2008) who reported that early sowing crop produced more yield than late sowing, which might be due to optimum period available for growth and development resulted in more storage of photosyntheates in the grain in early sown crop. With regards to method of planting with different varieties, direct sowing ofCO 51 (T_1) produced significantly higher grain yield of 5987 kg ha^{-1} than other varieties which was followed by UPTR of CO 51 (T_4) and direct sowing of MDU 5 (T_2) produced a grain yield of 5413 and 5228 kg ha^{-1}, respectively. The UPTR of ADT 48 (T_6) found to be the lowest yielder (4083 kg ha^{-1}) among the treatments.

The results from the Table 4 indicated that, date of sowing and varieties showed a significant effect on this parameter. With respect to sowing dates, the crop sown at July first fortnight (D_1) recorded maximum straw yield of 8130 kg ha^{-1} and this was significantly higher with sowing at second fortnight of July (D_2). Among the treatments, direct sowing of CO 51 (T_1)

produced significantly higher straw yield of 9138 kg ha^{-1} followed by UPTR of CO 51 (T_4) produced 8784 kg ha^{-1} straw yield it was comparable with direct sowing of MDU 5 (8215 kg ha^{-1}). The lower straw yield of 6953 and 6322 kg ha^{-1} was obtained from ADT 48 under direct sowing and UPTR method (T_3 and T_6), respectively.The rate of increase in straw yield proceeded at a higher magnitude in direct sowing of CO 51 rice than the other treatments. Production of more tillers and high accumulation of dry matter would have favoured for increased straw yield in CO 51 rice variety than MDU 5 and ADT 48 rice variety. This is in accordance with the findings of Manjunatha (2010). Direct sown crops produced higher straw yield than UPTR crop and this may be due to more number of tillers per unit area which confirms the findings of Akbar *et al.* (2010) and Praveen *et al*. (2014).

Conclusion

Based on the results, the study was concluded thatthe CO 51 rice proved its supremacy under unpuddled condition by registering higher growth and yield parameters and yield followed by MDU 5 rice variety.Transplanting under unpuddled condition is found to be comparable with direct sowing condition and it may be recommended for heavy weed infested area. Regarding to the sowing window, the water releases from the reservoir up to second fortnight of July month, direct sowing of short and early duration rice varieties like CO 51 and MDU 5 under unpuddled condition is an ideal for getting higher yield.

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Table 1: Date of sowing and method of planting on primary, secondary, tertiary and total tillers m^{-2} at AT and PI stages ofrice

Treatment	Active tillering stage			Panicle initiation stage			
	Primary	Secondary	Total	Primary	Secondary	Tertiary	Total
Main plot : Date of sowing							
D_1	243.7	174.3	418.1	311.8	348.8	63.3	725.6
D_2	231.8	166.8	399.5	289.3	310.9	54.3	655.0
Mean	237.8	170.5	408.8	300.5	329.9	58.8	690.3
SEd	**7.86**	**3.18**	**7.11**	**5.29**	**10.1**	**2.76**	**17.3**
CD (p=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Sub plot : Method of planting/sowing with different varieties							
T_1	283.9	199.4	483.2	367.9	375.2	65.5	808.6
T_2	242.2	171.0	416.6	316.7	317.1	51.8	685.5
T_3	220.6	159.5	375.8	290.6	310.3	46.7	647.6
T_4	251.7	178.3	431.0	315.7	357.7	75.6	749.0
T_5	228.8	166.9	398.9	264.9	321.6	59.1	653.9
T_6	199.2	148.1	347.3	247.4	297.2	50.8	597.0
Mean	237.8	170.5	408.8	300.5	329.9	58.2	690.3
SEd	**7.04**	**6.67**	**11.5**	**10.5**	**11.6**	**4.54**	**17.9**
CD (p=0.05)	**14.2**	**13.4**	**23.2**	**21.1**	**23.3**	**9.16**	**36.2**

Table 2: Date of sowing and method of planting on primary, secondary, tertiary and total tillers m^{-2} at flowering andharveststages of rice

Treatment	Flowering stage				Harvest stage			
	Primary	Secondary	Tertiary	Total	Primary	Secondary	Tertiary	Total
Main plot : Date of sowing								
D_1	323.4	390.8	94.8	813.6	335.3	412.0	114.8	879.7
D_2	309.7	381.1	89.0	778.3	322.1	391.4	99.6	797.8
Mean	316.6	386.0	91.9	795.9	328.6	402.0	107.2	838.7
SEd	**6.56**	**15.8**	**2.71**	**14.9**	**7.23**	**6.99**	**5.00**	**17.1**
CD (p=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Sub plot : Method of planting/sowing with different varieties								
T_1	364.6	441.2	113.9	927.7	384.9	458.7	122.5	966.2
T_2	313.4	390.8	90.6	798.1	321.8	394.6	101.1	804.9
T_3	302.8	364.3	87.5	737.8	305.4	379.1	90.6	787.3
T_4	324.8	397.1	93.8	824.6	344.7	428.6	125.5	890.3
T_5	312.1	375.1	87.8	781.6	319.6	384.6	109.9	834.5
T_6	281.7	347.4	77.9	705.8	296.9	366.5	96.7	749.4
Mean	316.6	386.0	91.9	795.9	328.6	402.0	107.2	838.7
SEd	**15.6**	**17.7**	**4.76**	**35.7**	**12.6**	**15.1**	**8.74**	**29.1**
CD (p=0.05)	**31.4**	**35.6**	**9.60**	**72.0**	**25.4**	**30.5**	**17.6**	**58.7**

Table 3: Date of sowing and method of planting on panicle production hill^{-1}at harveststages of rice

Treatments	Panicles hill^{-1}				Panicles m^{-2}
	Primary panicle	Secondary panicle	Tertiary panicle	Total	
Main plot : Date of sowing					
D_1	6.21	5.26	0.18	11.6	402.8
D_2	5.80	4.98	0.15	10.9	357.9
Mean	6.00	5.12	0.17	11.0	380.4
SEd	**0.13**	**0.09**	**0.01**	**0.13**	**8.06**
CD (p=0.05)	**NS**	**0.25**	**NS**	**0.56**	**34.7**
Sub plot : Method of planting/sowing with different varieties					
T_1	6.51	5.63	0.17	12.3	467.0
T_2	6.20	5.26	0.15	11.4	392.2
T_3	5.92	4.77	0.11	10.8	323.9
T_4	6.06	5.31	0.18	11.6	430.5
T_5	5.98	5.07	0.16	11.2	340.0
T_6	5.51	4.67	0.15	10.3	298.5
Mean	6.06	5.12	0.17	11.0	380.4
SEd	**0.29**	**0.35**	**0.01**	**0.35**	**19.8**
CD (p=0.05)	**0.58**	**0.72**	**0.02**	**0.71**	**39.9**

Fig 1. Planting methods with different varieties on panicles m^{-2} and grain yield (kg ha^{-1})

Table 4: Date of sowing and method of planting with varieties on grain and straw yield

Treatment	Grain yield (kg ha^{-1})							Straw yield (kg ha^{-1})						
	T_1	T_2	T_3	T_4	T_5	T_6	Mean	T_1	T_2	T_3	T_4	T_5	T_6	Mean
D_1	6291	5323	4537	5458	5021	4183	**5136**	9680	8571	7125	8967	7954	6477	**8129**
D_2	5683	5133	4350	5366	4829	3983	**4891**	8596	7859	6782	8601	7610	6167	**7602**
Mean	**5987**	**5228**	**4443**	**5413**	**4925**	**4083**	**5013**	**9869**	**8946**	**7684**	**9515**	**8513**	**7053**	**8597**

	D	T	DxT	TxD	D	T	DxT	TxD
SEd	54.7	173.8	231	198	104.6	274.8	415.9	465.8
CD (p=0.05)	235.6	350.4	NS	NS	449.8	553.9	NS	NS