Effect of planting date on grain yield of selected rice cultivars grown in the Ord

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Key messages

Correct planting time is crucial to achieve high yields and the best grain quality for selected rice varieties in the Ord River Irrigation Area.

To maximise yield, it is essential to ensure that most of the crop's growth cycle occurs after 21 June, when day length is increasing.

Late planting during May – June may help to achieve this, but if the crop matures under harsh, hot weather during October - November, it may reduce the quality of the harvested grain.

Aims

The purpose of the trial was to evaluate the yield potential and the grain quality parameters of selected temperate and tropical rice varieties grown under raised-bed and flooded conditions with three planting dates during the 2013 dry season at Frank Wise Institute of Tropical Agriculture in Kununurra.

Method

Three varieties (Langi, Viet 5 and Yunlu 29) were tested in aerobic (raised bed) conditions and five varieties (Doongara, Pandan Wangi 7, Viet 1, NTR 426 and NTR 587) were tested under a flooded (paddy) production system. Three planting dates, a fortnight apart, on 22 April 2013, 8 May 2013 and 21 May 2013 were used for both systems. Three replicates were used for each planting date. The raised-bed system and the flooded system were treated as separate experiments.

However, in each case, a split-plot design was used with blocks representing 3 planting dates, whole plots representing 3 replicates and subplots representing 3-5 varieties. A plot size of 100 m × 0.9 m was used for all plantings in the aerobic system and for the third planting in the flooded system. A plot size of 200 m × 0.9 m was used for the first and second plantings in the flooded system. A seeding rate of 152 kg/ha was used. A basal fertiliser consisting DAP 100 kg/ha, Sulphate of Potash 25 kg/ha, Single Super Phosphate 20 kg/ha, Zinc Sulphate 15 kg/ha and Urea 150 kg/ha was applied prior to planting. A top dressing of Urea at the rate of 150 kg/ha was applied closer to panicle initiation stage.

The aerobic system was furrow irrigated once every 12-17 days (average 14.3 days). A fixed irrigation scheduling adjusted according to water availability was used to determine whether the rice plants can utilise the subsoil moisture. An EnviroScan system was installed to monitor soil moisture status of the aerobic system from 21 May 2013 to 29 October 2013. Flooded system was flushed twice before applying the permanent water after 28 days, and the ponded water was maintained until the paddy was drained to prepare for harvest. Two herbicides, Stomp just after sowing, and MCPA 4-5 weeks after sowing, were used to control weeds. Temperature loggers were installed to monitor air and water temperatures at 30 minute intervals. Aerobic trials were hand harvested (3 m samples from each replicate) and the flooded system trials were machine harvested (whole of plot). Yield (t/ha at 14% moisture) of each variety and quality parameters (millout, chalk, amylose and protein) of selected varieties were determined. Results were subjected to analysis of variance (ANOVA) and mean results are reported here.

Results

The seeding equipment was calibrated using variety Quest (medium grain, seed weight 25.7 mg) to sow seed at the rate of 152 kg/ha, aiming at a total plant density of 200-300 plants/m^2. However, the grain characteristics were different for the varieties used and calibrating the seeder using the Quest variety resulted in applying varying amounts of seed for the other varieties (Table 1). However, correlation analysis between sowing rate and grain yield resulted in a coefficient of 0.063 which indicated that the different sowing rates did not impact on the grain yield of these varieties. It is well known that the rice plant has remarkable ability to compensate for less plant density by producing more tillers and *vice versa*. Therefore varying plant densities resulting from different sowing rates have no effect on grain yield. This phenomenon has been observed in previous trials at Kununurra and by other workers in NSW.

Table 1 Varietal characteristics and their resulting sowing rate

Varieties	Grain size	Seed weight (mg)	Sowing rate (kg/ha)
Doongara	Long	21.9	152
NTR 426	Long	24.2	163
NTR 587	Long	28.4	181
Pandan Wangi 7	Long	27.0	171
Viet 1	Medium	24.3	182

Aerobic rice

The Langi and Viet 5 plot plantings failed to produce any significant yields in the aerobic system for all three planting dates. Therefore it was decided not to harvest these varieties from this aerobic trial. However variety Yunlu 29 was hand harvested and it produced low yields which were not significantly different ($P > 0.23$) between the three planting dates. It should be noted that this variety in the 2011 and 2012 trials yielded 11.7 and 9.9 t/ha, respectively. Cold stress did not seriously affect the yields from the 2013 aerobic trials. The number of days when the minimum air temperature dropped below 15ºC was 74 days in 2013 whereas it was 115 and 118 days in 2011 and 2012, respectively. Water stress was the main factor which contributed to the failure of the aerobic trials in 2013.

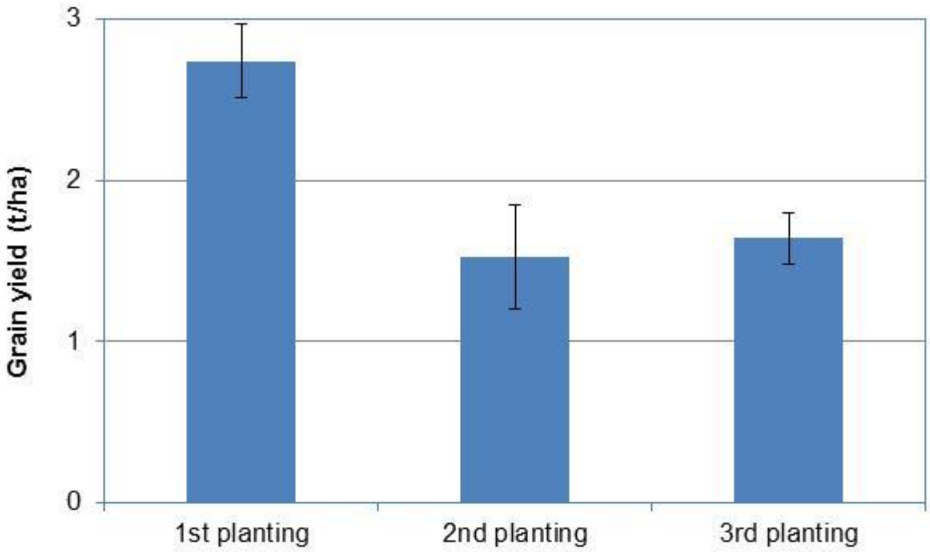

Figure 1 Mean yield of Yunlu 29 under three planting dates (error bars indicate standard error)

Data from the EnviroScan system showed that the soil moisture dropped below the desired critical soil moisture level (i.e. the refill point at 50% depletion of plant available water) at 10 and 20 cm depths (Figure 2). While the root system has down to 40 cm, 70% of the absorbed water is extracted from the top 20 cm of the root zone. This means that the soil moisture data at both the 10 cm and the 20 cm depths are important for irrigation scheduling purposes. Rice is a semi-aquatic plant and considered as heavy user of water. Soil moisture levels closer to the drained upper limit are necessary to avoid water stress leading to reduced yields. The data on Figure 2 suggests that the soil moisture at 10 cm depth reached the refill point in approximately 7 days.

A delay in commencing the next irrigation will subject the crop to water stress, especially in the root zone within the first 10 cm which absorbs 40% of total water uptake. The irrigation intervals for the 2013 trials varied from 12 to 17 days (average 14.3 days) and this caused severe water stress to plants. The ideal irrigation interval for rice in Kununurra soil has been estimated to be 7 days. This is supported by the trials in 2011 when a yield of 11.7 t/ha was achieved with an average irrigation interval of 7.0 days. Similarly in 2012, a yield of 9.9 t/ha was achieved with an average irrigation interval of 7.7 days.

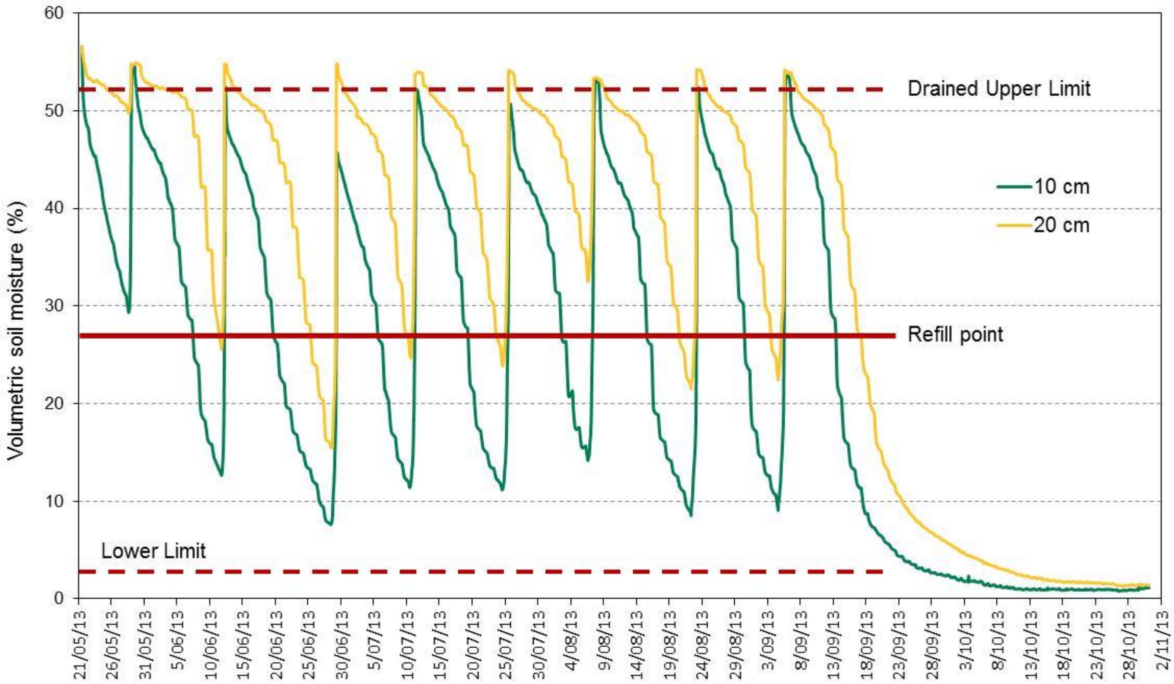

Figure 2 Fluctuation of soil moisture at 10 and 20 cm depths in the aerobic trial

Flooded rice

The ANOVA of grain yields of 5 flooded rice varieties over 3 planting dates indicated significant differences ($P < 0.001$) between the varieties and between the planting dates (Table 2). The interaction between the varieties and the planting dates is also significant ($P = 0.00105$) which means that certain varieties preferred certain planting dates. Average yields of 5 varieties for the first, second and third plantings were 3.9, 9.7 and 5.6 t/ha, respectively. This indicates that the second planting date (8 May) is the preferred time for sowing the tested varieties. Average yields over 3 planting dates for each variety varied from 4.4 t/ha (Doongara) to 8.3 t/ha (NTR 587).

Table 2 Results of analysis of variance of grain yields of 5 varieties tested with 3 planting dates

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Planting dates	272.7504058	2	136.3752029	102.7583319	3.77133E-14
Varieties	84.0795347	4	21.0198836	15.8384232	4.50063E-07
Interaction	48.2464811	8	6.0308101	4.5441984	0.00105
Within	39.8143489	30	1.3271449		
Total	444.8907707	44			

Mean grain yields of each variety for each planting date are shown in Figure 3. Significantly higher yields were achieved with the second planting date (8 May) compared with first planting (22 April) and third planting (21 May). Crop planted on 8 May might have been more exposed to increasing daylight hours after 21 June compared to that planted on 22 April. Greater exposure to sunlight enables more photosynthesis and hence higher grain yields. This trend was not observed with the third planting date (21 May) and this may be due to severe crop damage caused by Brolgas during establishment time. Note, that NTR 587 was the highest yielding variety in both first and third plantings and equal highest at the second planting. Viet 1 produced new record yields of 11.4, 12.3 and 14.3 t/ha for the 3 replicates. Based on grain maturity, Viet 1 took about 2-4 weeks longer than the other varieties and this phenomenon might be a disadvantage for this variety when the additional costs of extended bird damage control and extra water and nutritional requirements for Viet 1 are considered. Alternatively, the equal highest yielding variety NTR 587 looks promising for the Ord River Irrigation Area.

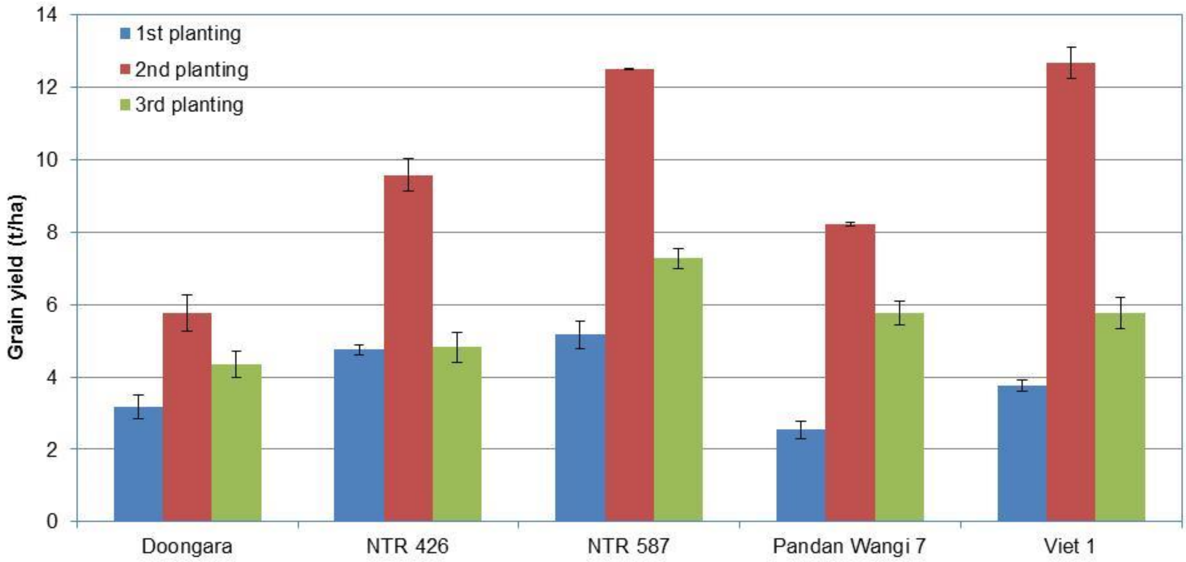

Figure 3 Mean yields of 5 varieties tested under 3 planting dates in a flooded system (error bars indicate standard error)

The three replicates for NTR 587 with the second planting date yielded close to each other (12.4, 12.6 and 12.4 t/ha) indicating less variability under high yields. In 2012 it achieved the highest yield of 11.5 t/ha for a planting date of 2 May. Based on previous studies at Kununurra, NTR 587 is very sensitive to cold temperatures. However ponding water within the anaerobic production system helped to minimise the cold damage by maintaining a water temperature above 15ºC while the air temperature dropped below 15ºC on 74 days.

Quality analysis of selected varieties (data not shown) indicated low millout percentages and high chalk for the harvested grain. The crop experienced high temperatures before harvest and this is likely to have caused the high amount of chalk in grains. The harvesting was delayed to enable the grain moisture to drop to lower levels (15-18%). This practice was adopted to reduce drying costs and keep the seed for planting next year. The recommended grain moisture for harvesting commercial crops is 22-24% which is then milled at 18% moisture. The harvested grain in these trials was milled at 10-11% moisture. Therefore the low grain moistures at harvest and milling contributed to lower millout percentages. The preferred rice quality parameters, high millout percentage and low chalk, can be achieved by harvesting early at the recommended grain moisture level. These aspects will be tested in trials in 2014.

Conclusion

Aerobic trials in 2013 suffered severe water stress and the results indicated an irrigation interval of 7 days is required for rice in Cununurra soil in the Ord region. For the flooded system, it appears that a planting date of 8 May might enable to achieve very high yields. Among the tested varieties, Yunlu 29 and NTR 587 are recommended for the aerobic and flooded systems, respectively. Quality of harvested grain can be improved by harvesting the crop early at higher moisture levels. These results provide valuable information for future development of the rice industry on the Ord.

Key words

Aerobic rice, flooded rice, planting date, grain yield.

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