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Performance of different rice cultivars in aerobic condition under drip fertigation

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Abstract
A field experiment was conducted at AICRP on Water management research block, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, India during *rabi*, 2019 to screen the suitable rice cultivar for aerobic cultivation under drip fertigation system. The experiment was laid out in randomized bock design with four replications. The rice cultivars namely, Anna (R) 4, CO 51, APO 1, MDU 6, TKM 13 and ADT (R) 45 were tested under drip fertigation system. Growth parameters *viz*., plant height, LAI, tiller production m^{-2} and dry matter production; number of productive tillers m^{-2} and yield were recorded. Total crop water use and water use efficiency were also computed. Among the rice cultivars APO 1 recorded the highest plant height (136.1 cm), LAI (5.61), tiller production (365 tillers m^{-2}), dry matter production (12416 kg ha^{-1}), number of productive tillers (326 m^{-2}) grain (5104 kg ha^{-1}) and straw yield (6928 kg ha^{-1}). Highest water use efficiency (1.05 kg m^{-3}) was amounted with APO 1 compared to other cultivars under drip fertigation system.

Keywords: Rice cultivars, aerobic system, yield, water use efficiency

Introduction
Food and water are the most important necessities for survival in this world. With the growing population, water is now becoming a most precious product which highly used for household, industry, and agriculture purposes. The increased demand for food as well as water leads to shortage of both in future unless the novel technologies are developed. At present, agricultural scientists are giving more focus on developing rice production systems that can survive under water scarcity. In India the rice is being cultivated in 44.2 M ha with the production of 116.5 m.t and the average productivity is 2.63 t ha^{-1}. Among the states, Tamil Nadu ranks fifth place in rice production with an area of 1.72 M ha, production of 6.13 m t and the average productivity of 3.56 t ha^{-1} (India stat, 2017-18) [5].
With predictions that many Asian countries will have severe water problems by 2025, rice farmers will not be able to acquire enough water to keep their fields flooded. Aerobic rice is a production system where rice is grown in well-drained, non-puddled, and non-saturated soils gives hope to farmers who do not have access to enough water to grow flooded lowland rice. Water requirements can be lowered by reducing water losses due to seepage, percolation, and evaporation. Transplanted Low land rice consumes 3000–5000 litres of water to produce 1 kg of rice. Hence the water-use efficiency is also very low (Humphreys *et al*., 2010) [4]. Drip irrigation is promising technologies have been proved to increase water and nutrient use efficiency of crops. Suitable stress tolerant rice cultivar needs to be identified for adaptability, sustainability and to increase productivity under aerobic condition.

Materials and methods
The field investigation was made at AICRP on irrigation water management research block of Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, India during *rabi* season 2019. The experimental site is geographically located at 9º 54' N latitude and 78º 80' E longitude at an altitude of 147 m above mean sea level. The mean annual rainfall is 850 mm distributed in 46 rainy days. The experiment was laid out in randomized bock design with six treatments and four replications. The field soil is sandy clay loam in texture with low N, medium P and high K nutrient status. The rice cultivars namely, Anna (R) 4, CO 51, APO 1, MDU 6, TKM 13 and ADT (R) 45 were sown on furrow irrigated raised bed (FIRB) and cultivated under aerobic environment under drip fertigation system. Field water use efficiency (WUE) was calculated by using the following formula given by Viets (1962) [13].

WUE = Y/W (kg m^{-3})

Where,
Y = Grain yield (kg ha^{-1})
W = Total water used (I + Re) to produce the yield (m^{-3})

Where,
I = Irrigation water applied (mm)
Re = Effective rainfall (mm)
The field data of different growth and yield parameters were recorded during the course of investigation was statistically analyzed by using the procedures given by Gomez and Gomez (2010) [2].

Result and Discussion

Growth parameters

Significant difference was observed among the cultivars on growth parameters like plant height, LAI, dry matter production, number of tillers m^{-2} and total tiller production (Table 1).

Table 1: Growth performance of rice cultivars in aerobic condition under drip fertigation system

Treatment	Plant height (cm)	LAI	DMP (kg ha^{-1})	Number of tillers m^{-2}	Number of productive tillers m^{-2}
V_1 - Anna (R) 4	82.4	4.22	9142	246	198
V_2 - CO 51	110.3	5.13	11068	320	287
V_3 - APO 1	136.1	5.61	12416	365	326
V_4 - MDU 6	121.9	5.48	11725	342	305
V_5 - TKM 13	90.7	4.53	9785	274	241
V_6 - ADT (R) 45	99.5	4.82	10423	297	269
S.Ed	2.97	0.15	318	8.51	6.9
CD (p=0.05)	6.25	0.28	632	17.2	14.1

The plant height was ranged from 136.1 to 82.4 cm. Among the rice cultivars, APO 1 recorded significantly highest plant height of 136. 1 cm which was followed by MDU 6; and APO 1 had about 40 per cent increased plant height over Anna (R) 4 (82.4 cm). Maximum number of 365 tillers m^{-2} were produced by APO 1 than the other rice cultivars and followed by MDU 6 (342 tillers m^{-2}). The lowest number of tillers m^{-2} was produced under Anna (R) 4 (246 tillers m^{-2}). The LAI (Leaf area index) also significantly higher under APO 1 (5.61) which was followed by MDU 6. This might be due to the increased plant height and number of tillers produced by APO 1 resulted in higher LAI in aerobic rice cultivation under drip fertigation. These results were conformity with the findings of Nguyen *et al*., (2009) [9]. The lowest LAI was recorded with Anna (R) 4 (4.22).

With regards to dry matter production, APO 1 produced significantly more dry matter (12,416 kg ha^{-1}) while compare to other cultivars. The lowest dry matter production was recorded by Anna (R) 4 (9142 kg ha^{-1}). The increased cell division, cell elongation and photosynthetic activity might have led to increased plant height, LAI and more number of tillers which ultimately resulted in production of higher dry matter production in APO1 variety at harvest stage (Ockerby and Fukai, 2001; Sathyamoorthy *et al*., 2018) [10, 11].

Number of productive tillers m^{-2}

Results revealed that APO 1 registered significantly (p =0.05) higher of productive tillers m^{-2} compared to CO 51, MDU 6, ADT (R) 45, TKM 13 and Anna (R) 4 in aerobic rice cultivated under drip fertigation (Table 1). Higher number of productive tillers m^{-2} were registered by APO 1 (326 productive tillers m^{-2}) and the lowest numbers were recorded under Anna (R) 4 cultivar (198 productive tillers m^{-2}) which was 29 percent higher than the Anna (R) 4.

Grain and straw yield

The highest grain yield of 5104 kg ha^{-1} was recorded with APO 1 and it was followed by MDU 6 (4791 kg ha^{-1}) (Table 2). Being a bold grain variety and production of higher number of productive tillers m^{-2} by APO 1 the grain yield was ultimately increased compare to other rice cultivars under aerobic rice cultivation (Shekara and Sharanappa, 2010) [12]. With regards to straw yield, APO 1 recorded the highest value of 6928 kg ha^{-1} followed by MDU 6 (6583 kg ha^{-1}). The increase in the grain and straw yield of APO 1 is related to higher LAI and dry matter production which are contributed for assimilation of more photosynthates and resulted in superior yield attributes and yield (Fig 1). This result is in similarity with the findings of; Latif (2001) [8]; Ali *et al*. (2005) [1] and Gururaj Kombali *et al*. (2016) [3].

Anna (R) 4 recorded the lowest grain and straw yield of 3557 kg ha^{-1} and 5174 kg ha^{-1} respectively. Production of less number of productive tillers $plant^{-1}$ subsequently reduces the both source and sinks capacity which in turn reduced the grain and straw yield of Anna (R) 4. These results were in accordance with the findings of Kamoshita and Abe, (2007) [6].

Table 2: Yield and water use of rice cultivars in aerobic condition under drip fertigation system

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	WUE (kg m^{-3})
V_1 - Anna (R) 4	3557	5174	0.76
V_2 - CO 51	4483	6249	0.98
V_3 - APO 1	5104	6928	1.05
V_4 - MDU 6	4791	6583	0.99
V_5 - TKM 13	3862	5527	0.78
V_6 - ADT (R) 45	4165	5891	0.90
S.Ed	147.5	162.4	-
CD (p=0.05)	296	321	-

Water use efficiency

The results revealed that the significantly higher water use efficiency was recorded in APO 1 (1.05 kg m^{-3}) and the next best rice cultivar was MDU 6 (0.99 kg m^{-3}) (Table 2). This might be due to the effective utilisation of available soil moisture near the root zone depth and also reduced loss of water through evapotranspiration, percolation and seepage in the drip irrigation system. Highest WUE was recorded under APO 1 over Anna (R) 4 because of drastic increase in the yield against total water used in APO 1 (Kumar *et al*., 2019) [7]. The lower water use efficiency was recorded in ANNA (R) 4 (0.76 kg m^{-3}) under drip fertigation might be due to the lower grain yield to the total water use.

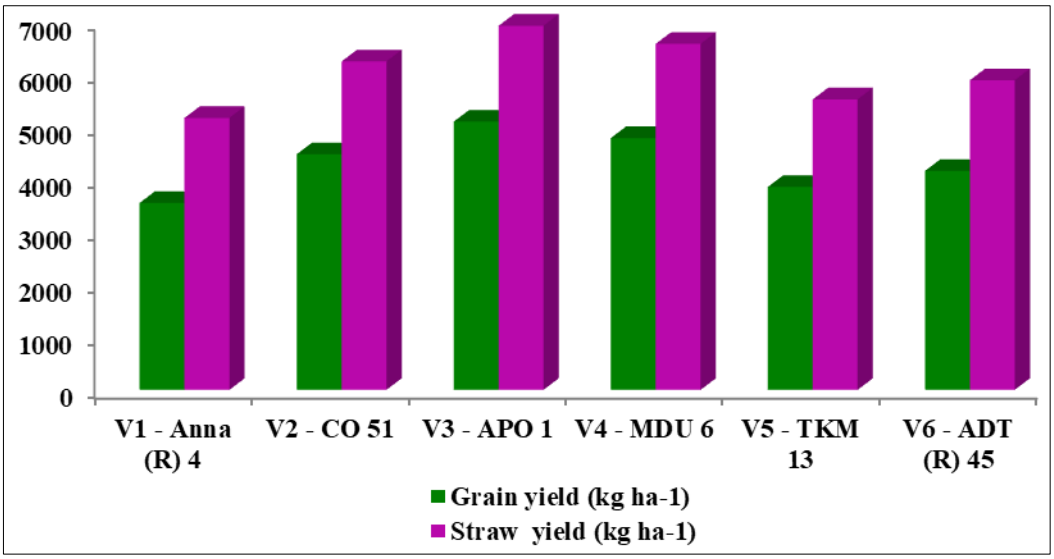

Fig 1: Performance of rice cultivars with reference to Grain and straw yield (kg ha^{-1}) in aerobic condition under drip fertigation system

Conclusion

From the above results, it could be concluded that among the different rice cultivars APO 1 recorded the taller plants, higher LAI, higher number of tillers, increased dry matter production, more number of productive tillers m^{-2}, grain and straw yield with high water use efficiency. Hence, APO 1 cultivar can be recommended to the farmers for aerobic rice cultivation with drip fertigation system to overcome the problem of water scarcity and to get sustainable yield.

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