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# Screening of Rice Cultivars Resistance to Water Scarcity (Aerobic Condition) during Summer under Drip Fertigation System

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**ABSTRACT: A field experiment was conducted at AICRP on Water management research block, Agricultural College and Research Institute, Madu raito screen the suitable rice cultivar for aerobic cultivation under drip fertigation system. 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. Among the different rice cultivars tested under drip fertigation system, APO 1 recorded the highest SPAD value (37.1, 40.9 and 42.4 at active tillering, panicle initiation and at flowering stage, respectively), root volume (19.3, 40.7 and 42.1 cc at active tillering, panicle initiation and at harvest stage, respectively), maximum number of tillers m$^{-2}$ (328 tillers m$^{-2}$), number of productive tillers (302 productive tillers m$^{-2}$), dry matter production (11904 kg ha$^{-1}$), grain (4459 kg ha$^{-1}$) and straw yield (6581 kg ha$^{-1}$) in aerobic condition under drip fertigation.**

**Keywords:** Screening, aerobic condition, growth, productivity, drip fertigation.

## INTRODUCTION

India is projected to have 25 per cent of water supply demand gap. More amount of groundwater is used for rice cultivation; hence the groundwater table is decreasing in all rice-growing states in India (Sharma *et al*., 2018). It was estimated that 17 million ha of Asia's irrigated rice may experience physical water scarcity and 22 million ha may experience economic water scarcity by 2025 (Bouman and Tuong 2003). Rice is cultivated in the four different ecosystems namely, Irrigated, rainfed upland, rainfed lowland and flood prone deep water. Water and labour availability is low and also increasing input costs and climatic change will ultimately reduce the transplanted rice cultivation under puddled condition (Mahajan *et al.,* 2011). Future predications on water scarcity limiting agricultural production have estimated that by 2025 about 2 million ha of Asia's irrigated rice fields will suffer from water shortage (Prakash *et al*., 2019). Developing an alternate method of rice cultivation without compromising crop productivity and to achieve economic security is indeed a great challenge. Water related problems mitigated gradually by shifting lowland rice to aerobic rice cultivation. Aerobic rice can save up to 50 per cent of irrigation water, labour, nutrients and other inputs compared to irrigated lowland rice (Mahalakshmi *et al*., 2020)

Aerobic rice is a system of production with unpuddled cultivation using less amount of water. Aerobic method of rice cultivation is a novel idea which contrasts to the practices such as nursery raising, puddling, transplanting and submergence mainly focuses on direct seeding and intermittent irrigation (Jadeyegowda *et al*., 2019). Furthermore, aerobic rice cultivation had another merit, which reduced the greenhouse gas emission from rice field (Mandal *et al.* 2010).

Lack of suitable variety for aerobic condition resulted in lesser productivity. Shifting from traditional method to water saving management strategies desires the introduction of aerobic rice cultivars (Lin *et al.*, 2005). Hence, screening of suitable varieties for aerobic cultivation is essential to increase the productivity.Drip irrigation can be recommended for aerobic rice to increase the productivity besides saving water (Sharda *et al.*, 2017).

Drip irrigated rice is a new innovative production system in which seeds are directly sown in well drained and un puddled soil and the crop is grown in unsaturated soil moisture conditions for the entire crop duration. It involves using high yielding varieties well adapted to aerobic conditions and responsive to irrigation and fertigation, attaining high yields.Furrow irrigated raised bed system with drip irrigation system maintains adequate amount of soil moisture which increase the availability of water to the crops (Sharma *et al.,* 2018). With this background, the present investigation was conducted to screen the suitable rice cultivar resistance to water scarcity for aerobic cultivation under drip fertigation.

## MATERIALS AND METHODS

*A. Experimental site*

The field investigation was made at AICRP on irrigation water management research block of Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai during *summer* season 2020.

*B. Experimental site characteristics*

The experimental site is geographically located at 9° 54' N latitude and 78° 80' E longitude at an altitude of 147 m above mean sea level. The meteorological parameters averaged over 25 years revealed that a mean annual rainfall of 850 mm was received in 46 rainy days. Out of which, 39.8 per cent was distributed during South West Monsoon (SWM), 42.0 per cent during North East Monsoon (NEM), 2.1 per cent during winter and 16.1 per cent during summer. The daily mean maximum and minimum temperatures were 33.7 and 23.8°C, respectively. The mean daily pan evaporation was 6.2 mm with a mean relative humidity of 81 per cent.

*C. Physico-chemical properties of the experimental field*

The experimental field soil is sandy clay loam in texture. The initial soil samples were collected randomly in five different places of field at the depth of 0-15 cm using auger and were processed through 2 mm sieve and used for physicochemical analysis in the laboratory. Physico-chemical properties of the experimental field were depicted in Table 1.

*D. Methodology*

The experiment was laid out in randomized bock design with six treatments and four replications. The rice cultivars namely, $V_1$ - Anna (R) 4, $V_2$ - CO 51, $V_3$ - APO 1, $V_4$ - MDU 6, $V_5$ - TKM 13 and $V_6$ - ADT (R) 45 were tested, sown on furrow irrigated raised bed (FIRB) and cultivated under aerobic environment under drip fertigation system.

**Table 1: Physico-chemical characteristics of the experimental field during *summer* 2020.**

| **A.** | **Textural composition (% on moisture free basis)** | **Data (Field No. 30)** |
|---|---|---|
| | Clay | 29.5 |
| | Silt | 18.2 |
| | Fine sand | 24.4 |
| | Coarse sand | 27.8 |
| | Textural class | Sandy clay loam |
| **B.** | **Physical properties** | **Depth (cm)** |
| | Bulk density (g $cc^{-1}$) | 1.38 |
| | Field capacity (%) | 26.0 |
| | Permanent wilting point (%) | 12.1 |
| **C.** | **Chemical properties** | |
| | Organic carbon (%) | 0.56 |
| | Available N (kg $ha^{-1}$) | 264 |
| | Available P (kg $ha^{-1}$) | 19.0 |
| | Available K (kg $ha^{-1}$) | 296 |
| | pH (1:2 soil and water extraction) | 7.2 |
| | EC ($dSm^{-1}$) (1:2 soil and water extraction) | 1.52 |

*E. Statistical Analysis*

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). The IRRI – Star R Software was used for analysis which was introduced from IRRI, Phillipines. SPAD values of rice cultivars at different growth stages were analyzed using IRRI – Star software.

## RESULT AND DISCUSSION

*A. Growth parameters*

The growth parameters *viz.,* SPAD value, root length, root volume, number of tillers, productive tillers per square meter and dry matter production were significantly differed for all the rice cultivars in aerobic condition under drip fertigation system.

**SPAD value.** The Soil Plant Analysis Development (SPAD) chlorophyll meter is a tool used to diagnostic tools to measure crop nitrogen status. The data were analysed in IRRI R software and graphically presented in Boxplot for different growth stages of rice cultivars (Fig. 1, 2 and 3). At active tillering and panicle initiation stage, the highest SPAD value of 37.1 and 40.9 respectively was recorded in APO 1 followed by MDU 6 (35.4 at active tillering and 38.8 at panicle initiation stage) (Fig. 1).

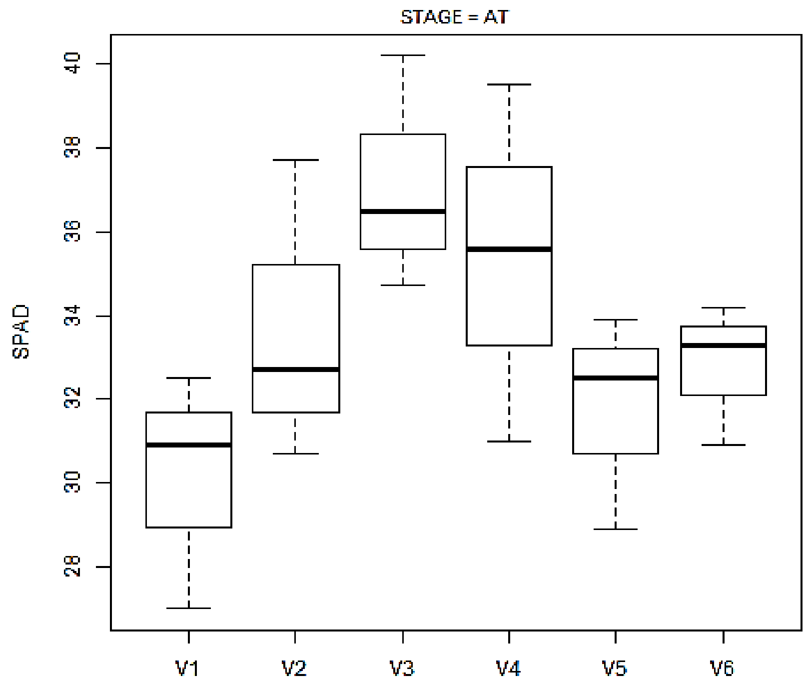


**Fig. 1.** SPAD value of different rice cultivars at active tillering stage in aerobic condition under drip fertigation system.

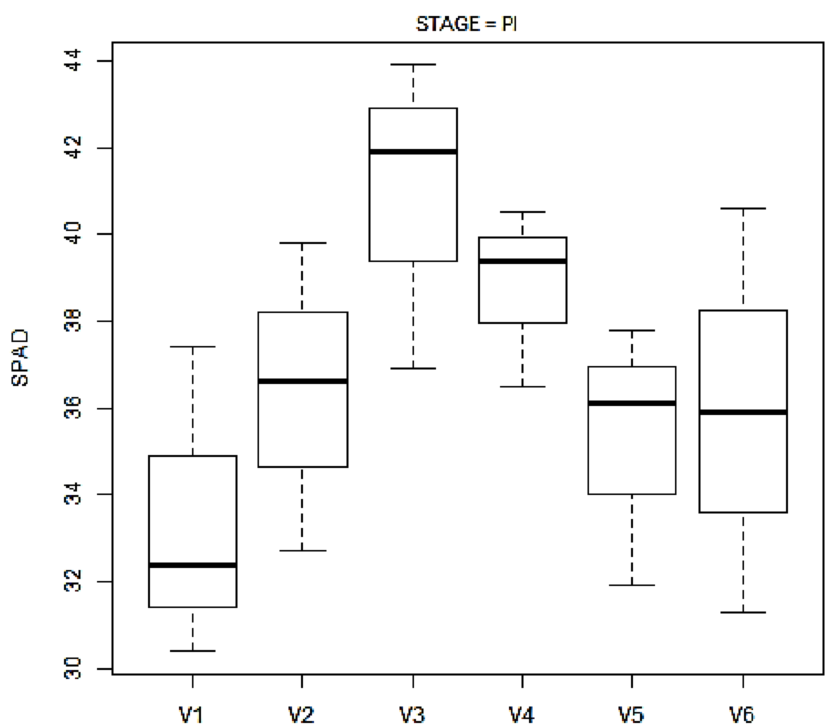


**Fig. 2.** SPAD value of different rice cultivars at panicle initiation stage in aerobic condition under drip fertigation system.

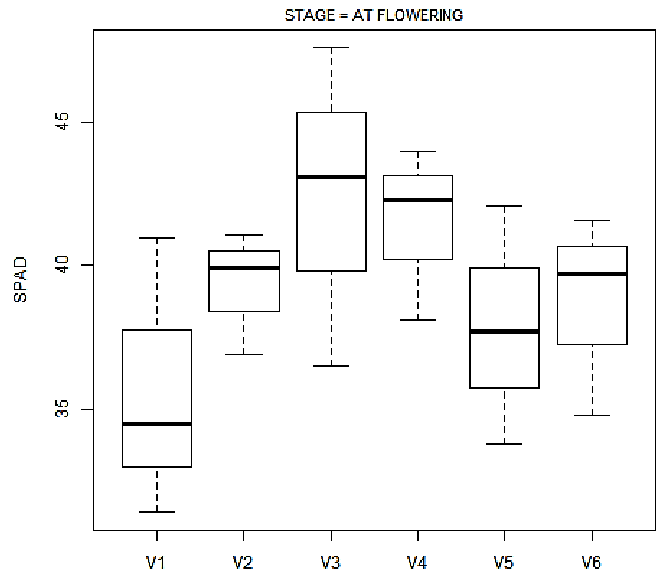


**Fig. 3.** SPAD value of different rice cultivars at flowering stage in aerobic condition under drip fertigation system.

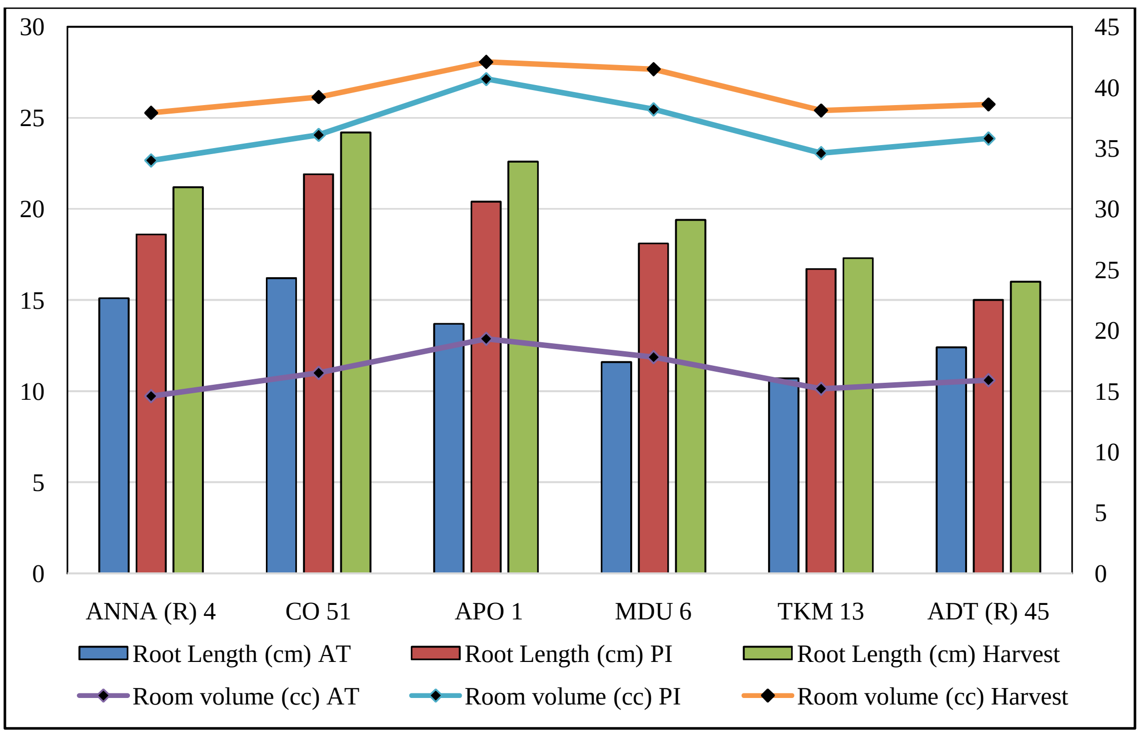


**Fig. 4.** Root length and root volume of rice cultivars at active tillering, panicle initiation and at harvest stage in aerobic condition under drip fertigation system.

In boxplot the values were distributed evenly. At active tillering stage mostly the median was comes in right side corner of the boxplot which indicates that data were present in the upper quartile except APO 1 and Co 51 where SPAD values present in lower quartile with the values ranging from 30 to 37.1. At panicle initiation stage, the SPAD values were gradually increased up to 40.9 in APO 1 where the median is presented in the upper quartile. The lower SPAD value of 30.1 and 33.4 was recorded in Anna (R) 4 at active tillering and panicle initiation stage respectively.

At flowering stage, among the different cultivars, APO 1 exhibited higher SPAD value of 42.4 and it is comparable with MDU 6 (41.5) where the median was presented in the center of the box plot denoted that data equally distributed. The higher root volume of APO 1 and MDU 6 facilitated absorption of more soil moisture and nitrogen from the soil resulted in higher chlorophyll content in the leaves which indicated higher SPAD values. The chlorophyll meter - SPAD values were positively correlated with leaf N concentration of rice (Das *et al.,* 2016; Preethi *et al*., 2020). The lower SPAD value of 32.3 was recorded in Anna (R) 4.

**Root length.** Among the different varieties, at active tillering stage CO 51 (16.2 cm) recorded the highest root length which was followed by ANNA (R) 4 (15.1 cm) and the lowest root length was recorded in TKM 13(10.7 cm) (Fig 4).After that, at panicle initiation and harvest stage the higher root length was recorded in CO 51 (21.9 cm) followed by APO 1. ADT (R) 45 recorded the lowest root length of 15.0, 16.0 cm at panicle initiation and harvest stages, respectively.

**Root volume.** APO 1 recorded significantly higher root volume at active tillering(19.3 cc), panicle initiation (40.7 cc) and harvest stages (42.1 cc) and followed by MDU 6 (17.8, 38.2 and 41.5 ccat active tillering, panicle initiation and harvest stage, respectively) (Fig. 4). The root volume was declined in ANNA (R) 4 at all the stages under drip fertigation.

**Number of tillers $m^{-2}$.** Tillering is an important agronomic trait which determines the number of panicles and grain yield per unit area. The number of tillers per unit area was significantly varied with the different varieties in aerobic condition under drip fertigation. Among the different rice cultivars, APO 1 significantly produced maximum number of tillers $m^{-2}$ (328 tillers $m^{-2}$) and next to this cultivar MDU 6 produced 311 tillers $m^{-2}$ (Table 2). The lesser number of tillers were observed under Anna (R) 4 (215 tillers $m^{-2}$). Maximum percentage of seedling vigour and increased root volume which helped in extracting the available nutrients and moisture efficiently from the soil which ultimately increased the tiller production (Li *et al.*, 2003).

**Number of productive tillers $m^{-2}$.** Higher number of productive tillers $m^{-2}$ were registered by APO 1 (302 productive tillers $m^{-2}$) followed by MDU 6 (267 productive tillers $m^{-2}$) (Table 2). Anna (R) 4 produced the lowest number of productive tillers $m^{-2}$(173 productive tillers $m^{-2}$).

**Table 2: Growth and yield of different rice cultivars in aerobic condition under drip fertigation system.**

| Treatment | Number of tillers $m^{-2}$ | Number of productive tillers $m^{-2}$ | DMP (kg $ha^{-1}$) | Grain yield (kg $ha^{-1}$) | Straw yield (kg $ha^{-1}$) |
|---|---|---|---|---|---|
| **$V_1$ - ANNA (R) 4** | 215 | 173 | 8741 | 2983 | 4756 |
| **$V_2$ - CO 51** | 294 | 241 | 10652 | 3935 | 5902 |
| **$V_3$ - APO 1** | 328 | 302 | 11904 | 4459 | 6581 |
| **$V_4$ - MDU 6** | 311 | 267 | 11276 | 4206 | 6214 |
| **$V_5$ - TKM 13** | 258 | 204 | 9395 | 3418 | 5133 |
| **$V_6$ - ADT (R) 45** | 215 | 226 | 10029 | 3672 | 5587 |
| **S.Ed** | 6.32 | 4.7 | 308.2 | 125.3 | 148.5 |
| **CD (p=0.05)** | 12.9 | 10.8 | 615 | 248 | 299 |

**Dry matter production.** The dry matter production directly proportional to the rate of photosynthesis and efficient assimilating area. It is gradually increased with initial growth stages and reached the maximum at maturity stage. The highest dry matter production was recorded under APO 1 (11,904 kg $ha^{-1}$) and which was followed by MDU 6(11,276 kg $ha^{-1}$) in aerobic condition under drip fertigation (Table 2).

The higher values ofgrowth parameters namely plant height and LAI of APO 1resultedin productionand accumulation of more photosyntheates which eventually increased the dry matter production. Production of maximum number of tillers and productive tillers $m^{-2}$ leads to more leaf area with thick and erect leaves which increased the net photosynthetic leaf area as well as net photosynthetic rate and also ultimately resulted in the production of increased dry matter production. This result was in conformity with the findings of Prakash *et al*., (2019) and Memon *et al.,* (2007).The lowest dry matter production was recorded by Anna (R) 4 (8741kg $ha^{-1}$).

*B. Grain and straw yield*

Grain and straw yield are the key parameters which highly determine the performance of any cultivar. Among the different rice cultivars APO 1 registered significantly higher grain and straw yield (4459 kg $ha^{-1}$ and 6581kg $ha^{-1}$, respectively) and it was followed by MDU 6 (4206 kg $ha^{-1}$ and 6214kg $ha^{-1}$, respectively)in aerobic condition under drip fertigation (Table 2). The mobilization of assimilates stored from source to the grains (sink), vigorous and healthy growth during initial phase and efficient utilization of resources lead to production of more leaf area index and productive tillers which ultimately resulted in higher grain and straw yield of rice cultivar.The similar results were reported by the scientists Preethi *et al*., (2020;) Pramanik and Bera (2013); Shekara and Sharanappa, (2010). The lowest grain and straw yield was recorded by Anna (R) 4 (2983 kg $ha^{-1}$and 4756kg $ha^{-1}$grain and straw yield, respectively).

## CONCLUSION

From the above results, 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 due to its higher growth and yield.

## FUTURE SCOPE

Irrigation management and drip fertigation at different levels for aerobic rice cultivars will be studied to optimize the use of irrigation water and reduce the loss of applied fertilizers in aerobic rice.

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**Conflict of Interest.** All the authors are declared that there is no conflict of interest.

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