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RESEARCH PAPER

Performance of rice varieties, irrigation methods and foliar spray on growth attributes of aerobic rice

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Abstract : A field investigation was carried out at east farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during winter (*Navarai*), 2017. Two rice varieties *viz*., V_1 - ADT 46 and V_2 - KMP 175 were evaluated under two irrigation methods *viz*., I_1 - Surface irrigation as flooding and I_2 - Drip irrigation at 1.2 CP Eeach with six foliar spray treatments on 55 and 75 DAS *viz*., F_1 – Water spray, F_2 – Silica @ 500 ppm, F_3 – KCl @ 10000 ppm, F_4 – Boric acid @ 0.4 ppm, F_5 – Triacontanol @ 2 ppm, F_6 – Brassinosteroids @ 1 ppm along with F_0 - control. The aerobic rice experiment was laid in Split split plot design. Surface irrigation as flooding (I_1) and the variety KMP 175 (V_2) have proved superior by registering taller plants when compared to their respective other treatments. However, the number of tillers produced per hill and LAI of the variety ADT 46 were significantly higher when compared to KMP 175 and surface irrigation again had favoured significantly higher number of tillers and LAI. At the same time, the response of ADT 46 in producing higher number of tillers and LAI was significantly higher under surface irrigation method while the response of the variety KMP 175 under both the irrigation methods was similar. Averaged across irrigation methods and foliar treatments, the variety KMP 175 had significantly and consistently registered higher DMP. Similarly, averaged across varieties and irrigation methods, application of brassinosteroids had consistently registered significantly higher DMP at all the growth stages of rice. Among the two varieties tested, KMP 175 had significantly registered lengthier roots than ADT 46. On the other hand, the root volume and root DMP of the variety ADT 46 was significantly higher than the variety KMP 175. Similarly, foliar spraying of KCl, water spray and Brassinosteroids had significantly registered statistically at par and higher root volume than the other foliar treatments.Therefore, it could be concluded from the experiment that surface irrigation had favoured most of the growth parameters of aerobic rice. The growth performance of the variety KMP 175 under aerobic soil was significantly higher in terms of plant height, DMP and root length whereas ADT 46 had produced more number of tillers, LAI and root volume. Among the foliar treatments, brassinosteriods had registered higher DMP and root volume.

Key Words : Aerobic rice, Irrigation methods, Foliar spray, Varieties, Growth attributes

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INTRODUCTION

Rice is consumed by about three billion people and is a staple food for a large people on the earth (Wassman *et al.*, 2009). It is cultivated in an area of 18.45 and 0.21

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lakh hectares, in Tamil Nadu and Union Territory of Puducherry with an average production of 56.63 and 0.52 lakh tonnes and productivity of 3070 and 2507 kg ha^{-1}, respectively (DRD, 2011). Karaikal, a separate enclave of Union Territory of Puducherry in the east coast of Tamil Nadu is considered as the rice bowl of Puducherry and rice is grown in an area of 6,011 ha with an average productivity of 2,400 kg ha^{-1} (DES, 2012).

Rice cultivation which is pre-dominant in the Cauvery river command area is now under a serious threat of water availability owing to distinct reasons. Irrigated lowland rice is one of the major consumers of fresh water as it utilizes 24–30 per cent of the world's accessible freshwater resources (IWMI, 2007 and Singh, 2013). Tuong and Bouman (2002) have predicted that by the year 2025, about 17 m. ha of irrigated rice area in Asia may experience *'physical water scarcity'* and 22 m ha may face '*economic water scarcity*'. The average overall efficiency of canal irrigation projects in rice growing areas of the world is estimated at a miserably low of 23 per cent (Walters and Bos, 1999) while on the contrary, efficiency of trickle (drip) irrigation can approach 90-96 per cent (Bucks *et al.*, 1982). Hence, there is an urgency to adopt rice cultivation to consume less water while sustaining the productivity.

Aerobic rice is a new technique of rice cultivation that saves water to a tune of 73 per cent in land preparation and 56 per cent during crop growth compared to conventional method. Similarly, the water required for pipe conveyance was 152 mm as against 240 mm under open channel irrigation resulting in a saving of 36.6 per cent water with the same or a slightly higher yield of rice (Srivastava, 2009). On the other hand, as rice from time immemorial adopted to puddled soil condition, aerobic rice cultivation results in water stress to the plants which could be mitigated by applications of foliar chemicals and leaves a better scope to enhance the growth of aerobic rice. Therefore, an investigation on aerobic rice under both surface and drip irrigation with six different foliar chemicals was carried out on two varieties to study its performance.

MATERIAL AND METHODS

The field experiment was conducted at East farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA and RI), Karaikal during winter (*Navarai*) season (2016-17). The farm is situated at 10° 55'N latitude and 79°49'E longitude at an altitude of four meters above MSL with relatively flat and uniform gentle slope. Karaikal region comprises within the eleventh agro ecological zone of India and it is classified as PC_2 -Coastal deltaic alluvial plain. The region enjoys tropical climate and receives an annual average rainfall of 1368.4 mm in 55.8 rainy days. The beneficial monsoon is north- east monsoon (October – December) which accounts for nearly 75 per cent of total rainfall while the south- west monsoon (June – September) contributes nearly 16 per cent and the rest of the rainfall occurs during summer (March to May) and winter (January – February) seasons. The soil of the experimental field is sandy clay in texture as per the USDA classification and is near neutral, non – saline. The fertility status (Organic C) of the experimental field soil was medium (0.5), low in available nitrogen, high in phosphorus and medium in potassium availability. The field experiment was conducted in Split-split plot design and replicated thrice with irrigation methods as main plot (I_1- Surface irrigation as flooding and I_2 - Drip irrigation at 1.2 CPE), two varieties (V_1- ADT 46 and V_2 - KMP 175) as sub plot and six foliar spray treatments on 55 and 75 DAS as sub-sub plot (F_1- Water spray, F_2 – Silica @ 500 ppm, F_3 – KCl @ 10000 ppm, F_4 – Boric acid @ 0.4 ppm, F_5- Triacontanol @ 2 ppm, F_6 – Brassinosteroids @ 1 ppm along with F_0 – control). The net plot area was 4.8m x 1.8m (8.64 m^2) and the seeds were dibbled manually in the dry soil at 20 cm inter and 20 cm intra row spacing.

Irrigation scheduling:

The first irrigation and the life saving irrigation were given as common to all the treatments. Subsequently, for the I_1 – Surface flood irrigation treatments, irrigation was scheduled as per the climatological approach (IW/CPE) with the "r" value of 1.0 at all the growth stages. A depth of 5 cm irrigation water was provided each time in the surface flooding irrigation method. The interval of irrigation for was calculated as per the formula given below:

$$\textbf{Irrigation interval (days)} = \frac{\textbf{Cumulative pan evaporation (CPE)}}{\textbf{Average daily pan evaporation (mm)}}$$

where,

$$\textbf{(CPE)} = \frac{\textbf{Irrigation water depth (mm)}}{\textbf{r}}$$

However, in I_2 - drip irrigation treatments, irrigation water quantity of 1.2 times the open pan evaporation (mm) was provided through the laterals once in alternate days. The time of operation of drip system in the drip irrigation plots was calculated as below:

$$\textbf{Time of operation (hours)} = \frac{\textbf{Volume of water (V) in litres required per plot}}{\textbf{Emitter rate (LPH) x No. of emitters in the plot}}$$

where, Volume of water (V) in liters required per plot is calculated based on the following formula:

V = Eo x 1.2 x A

where,

Eo = Daily USWA open pan evaporation data (mm/ day)

A = Area of the plot (m^2).

RESULTS AND DISCUSSION

The variety KMP 175 which is specifically developed for aerobic condition, due to its inherent varietal characteristics had registered significantly taller plants (Table 1) at all the growth stages. As the soil was constantly maintained at below field capacity condition in the drip irrigation treatment, it registered shorter plants than high water supply treatment, surface irrigation where the soil was brought to above saturation condition during the days of irrigation and had been allowed to dry until the next irrigation.

In contrast to the plant height, ADT 46, a semi dwarf variety that had produced shorter plants had registered significantly higher tiller numbers at all growth stages under aerobic soil condition (Fig. 1). The intrinsic stress tolerating mechanism of KMP 175 might have restricted the production of tillers instead spend its energy on stress tolerance. The surface flooding treatment (I_1) provided analogous condition to alternate wetting and drying with favourable redox value and high nutrient availability (Ponnamperuma, 1981) that led to production of more number of tillers at all the growth stages. The interaction response on the production of tillers by foliar spray chemicals with varieties was found to be significant during the peak growth phase (flowering) of rice. The rice variety (ADT 46) which is intendedly developed for lowland flooded ecosystem having chosen to grow under aerobic soil have respond well to KCl that is intended to induce stress tolerance. On the other hand, the variety

Table 1 : Plant height (cms) of aerobic rice at 90 DAS and at harvest stage as influenced by varieties, irrigation methods and foliar treatments

Treatments		90 DAS							Mean	At harvest							Mean
		F_0	F_1	F_2	F_3	F_4	F_5	F_6		F_0	F_1	F_2	F_3	F_4	F_5	F_6	
I_1 – Surface irrigation	V_1-ADT 46	81.9	90.5	84.6	79.9	81.2	83.7	79.7	83.1	91.2	94.2	93.5	87.1	92.2	93.0	84.4	90.8
	V_2-KMP 175	137.9	134.5	127.9	123.1	133.6	136.1	141.5	133.5	133.0	134.3	128.9	124.7	130.9	135.1	136.8	132.0
	Mean	109.9	112.5	106.3	101.5	107.4	109.9	110.6	108.3	112.1	114.2	111.2	105.9	111.5	114.1	110.6	111.4
I_2 – Drip irrigation	V_1-ADT 46	74.3	69.1	64.7	57.3	62.3	64.5	72.9	66.5	91.60	83.4	84.3	73.3	79.7	78.3	81.7	81.7
	V_2-KMP 175	106.3	109.8	117.7	98.4	121.3	86.5	117.7	108.2	111.8	117.1	120.3	109.0	122.8	104.7	118.5	114.9
	Mean	90.3	89.5	91.2	77.9	91.8	75.5	95.3	87.4	101.7	100.2	102.3	91.9	101.2	91.5	100.1	98.3
V_1 – ADT 46		78.1	79.8	74.6	68.6	71.8	74.1	76.3	74.8	91.4	88.8	88.9	80.2	85.9	85.7	83.0	86.3
V_2 – KMP 175		122.1	122.2	122.8	110.8	127.5	111.3	129.6	120.8	122.4	125.7	124.6	116.9	126.8	120.0	127.7	123.4
Foliar mean		100.1	101.0	98.7	89.7	99.6	92.7	102.9	-	106.9	107.2	106.8	98.5	106.4	102.8	105.4	-

Sources	S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)
Irrigation (I)	3.25	9.5	1.11	3.2
Varieties (V)	10.47	22.3	6.53	13.9
V x I	14.81	NS	9.23	NS
Foliar (F)	52.66	NS	56.56	NS
V x F	74.47	NS	79.99	NS
I x F	74.47	NS	79.99	NS
V at IF	98.63	NS	105.13	NS
I at VF	55.73	NS	57.88	NS

F_0 – Control (No foliar spray), F_1 – Water spray on 55 and 75 DAS, F_2 – Silica @ 500 ppm on 55 and 75 DAS,
F_3 – KCl @ 10000 ppm on 55 and 75 DAS, F_4 – Boric acid @ 0.4 ppm on 55 and 75 DAS, F_5 – Triacontanol @ 2 ppm on 55 and 75 DAS,
F_6 – Brassinosteroids @ 1 ppm on 55 and 75 DAS

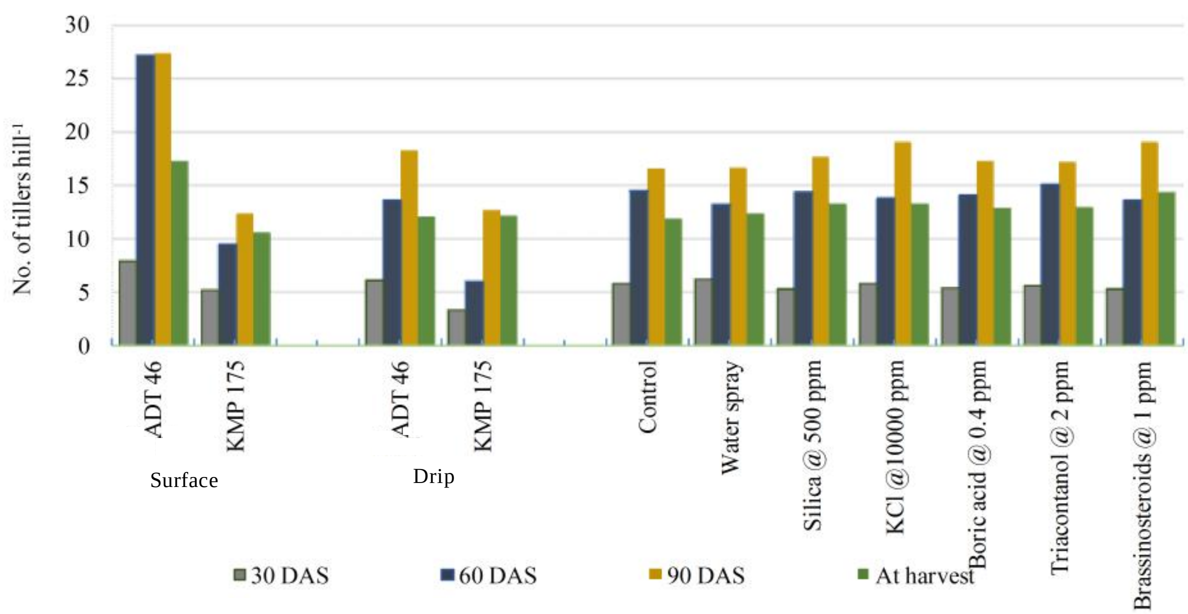

Fig. 1 : No. of tillers hill-1 of aerobic rice as influenced by the varieties, irrigation methods and foliar spray treatments at different growth stages

(KMP 175), which is intendedly developed for aerobic soil have responded to Brassinosteroids, Silica and Boric acid that are intended to have growth regulating mechanism. The response of foliar spray chemicals was greatly observed in drip irrigation where a persistent moisture stress was maintained whereas the magnitude of influence of foliar chemicals did not vary in surface irrigation method since saturated soil moisture was maintained alternatively.

Owing to greater tiller production during tillering and

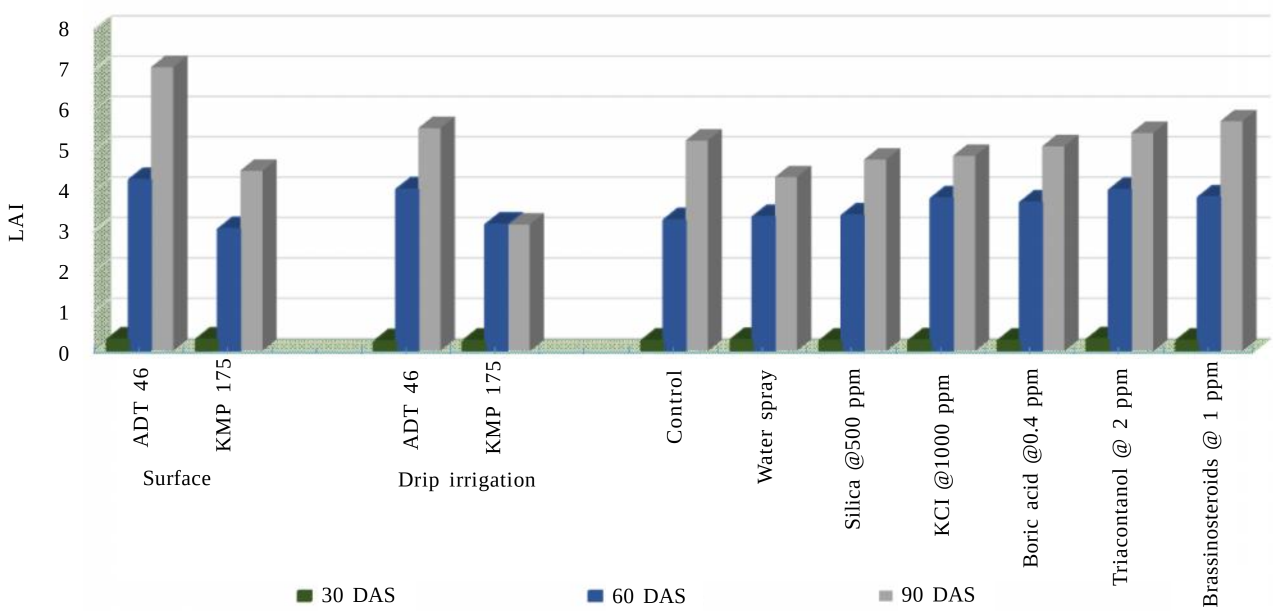

Fig. 2 : Leaf area index (LAI) of aerobic rice as influenced by the varieties, irrigation methods and foliar spray treatments at different growth stages

flowering stages, the LAI of ADT 46 was significantly higher than KMP 175 (Fig. 2). Similarly, the response of the variety KMP 175 was similar under both the methods of irrigation whereas ADT 46 had produced significantly higher LAI under surface irrigation than at drip irrigation. Among the foliar spray chemicals, Brassinosteroids by providing drought tolerance had registered significantly higher LAI. The Triacontanol which is a potent plant growth regulator identified for enhancing shoot growth (Chen *et al.*, 2003) and stress resistance (Naeem *et al.*, 2012) had also registered higher LAI during flowering stage. Similarly, the response of Brassinosteroids was significantly and greatly pronounced under drip irrigation system where a persistent water stress throughout the crop growth was maintained.

The variety KMP 175 with its inherent stress tolerating ability had advanced its growth to register significantly higher DMP (Fig. 3) over the variety ADT 46 at all the growth stages. Even though irrigation methods hadn't produced any significant variations at any of the growth phase, the varietal response to irrigation methods was significant at all the growth phases. The response of variety ADT 46 to produce significantly higher DMP under surface irrigation methodswas mainly attributed by production of more number of tillers with higher LAI. Contrastingly, the variety KMP 175 had registered significantly higher DMP under drip irrigation system. Among the various foliar chemicals, Brassinosteroids followed by KCl and water spray had produced significantly higher DMP than other chemicals at all the growth stages.

The variety KMP 175 possessed mechanism of drought tolerance by producing significantly deeper roots instead to produce more number of shallow fibrous roots that was evident from lower root volume and root dry weight. On the other hand, the variety ADT 46 had produced significantly more root volume and root dry weight (Fig. 4) when compared to KMP 175. Brassinosteroids had concurrently increased both root volume and root dry weight while KCl had specifically increased the root volume and triacontanol had specifically increased root dry weight.

Conclusion:

Surface irrigation method when compared to drip irrigation had favored most of the growth parameters of aerobic rice. The growth performance of the variety KMP 175 in terms of plant height, DMP and root length under aerobic soil was significantly higher whereas ADT 46 had produced more number of tillers, LAI and root volume. Among the foliar treatments, brassinosteriods had registered higher DMP and root volume.

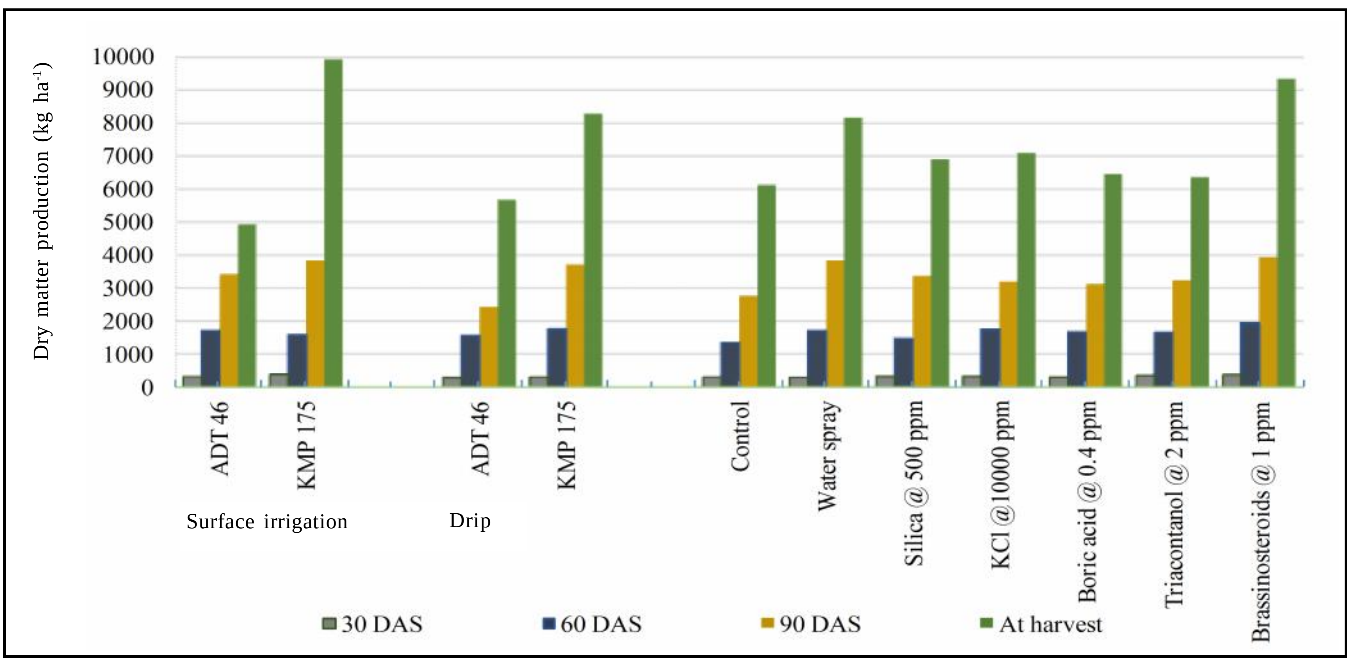

Fig. 3 : Dry matter production (DMP) (kg ha^{-1}) of aerobic rice as influenced by the varieties, irrigation methods and foliar spray treatments at different growth stages

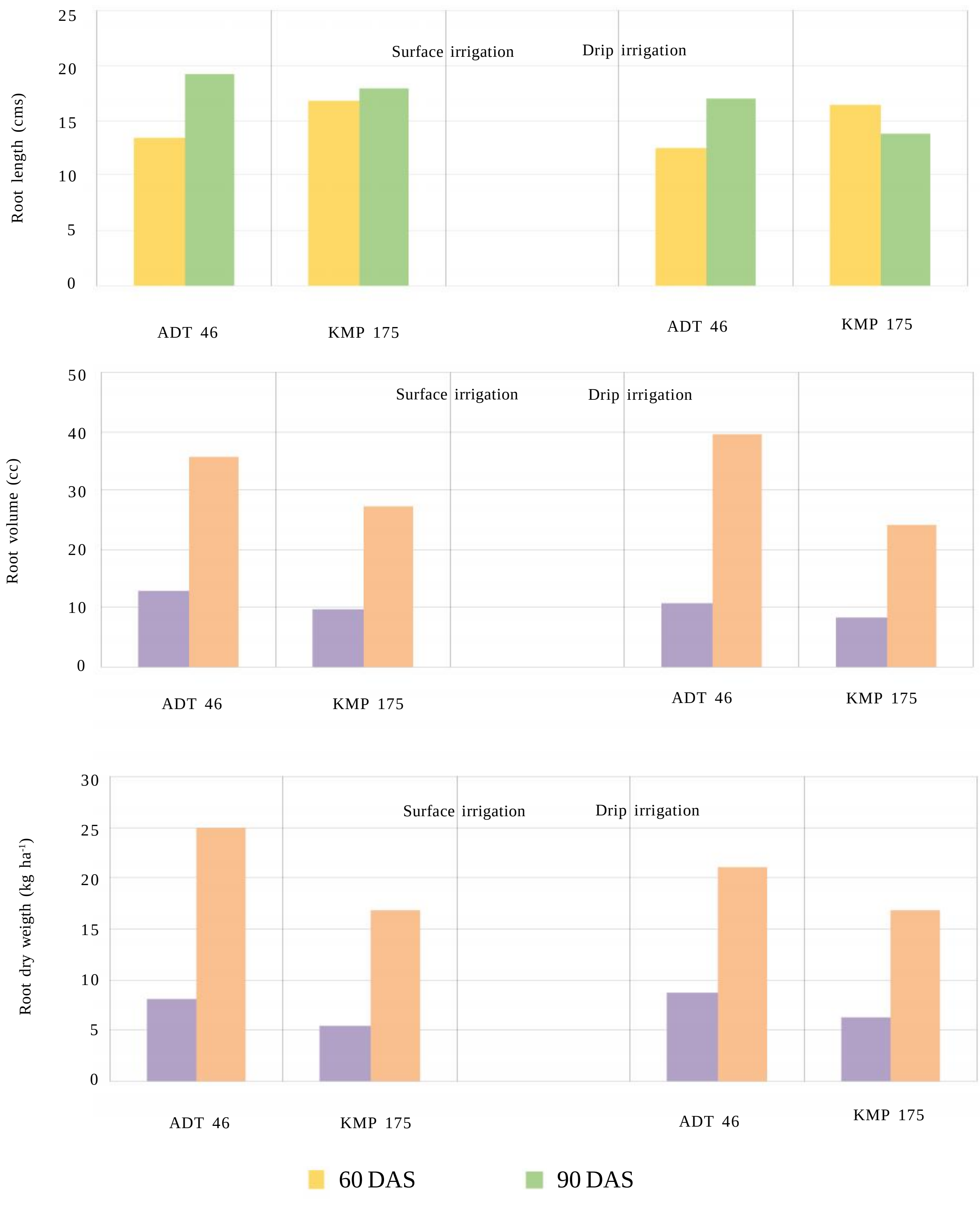

Fig. 4 : Root characteristics of aerobic rise as influenced by the varieites and irrigation methods at 60 and 90 DAS

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