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RESEARCH ARTICLE :

Studies on agronomic practices to mitigate crop stress in aerobic rice (*Oryza sativa*) at coastal deltaic areas of Karaikal

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SUMMARY : A field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA and RI), Karaikal to investigate the performance of seed hardening in aerobic rice at various dates of sowing during *Rabi* season in the coastal deltaic areas of Karaikal. The treatment combination comprised of four dates of sowing at weekly interval [September 12th (D_1), September 20th (D_2), September 27th (D_3) and October 4th (D_4)] and three seed hardening techniques [one % KCl (H_1), water (H_2) and control (H_3)]. The treatments were evaluated in factorial concept of RBD and replicated thrice. It was found from the present investigation that growth and yield attributes were higher in early sown crop (September 12th) (D_1) coupled with water hardening (H_2) technique. Phenophase studies were also conducted for all the treatments. Direct and derived weather parameters were correlated and regressed between grain yield and DMP of aerobic rice during the crop period.

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KEY WORDS :
Aerobic rice, Dates of sowing, Seed hardening, Direct, Derived weather parameters

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BACKGROUND AND OBJECTIVES

Climatic factors (temperature, solar radiation and rainfall) affect the major processes involved in rice production such as vegetative growth, phenological development and the formation of storage organs and grain filling (Wassmann *et al.*, 2009). Concerns about global warming have encouraged the scientific community to focus on food production constraints that may occur under conditions of global climate change and the corresponding adaptation strategies to support food security (Tubiello and Fischer, 2007). Rice plays an important role as staple food throughout Asia and parts of Africa and any negative consequences of climate change on rice production would put at risk the fragile food supply stability of these regions. Rice cultivation is a water intensive enterprise. However, lowland rice fields have relatively high water requirements and their sustainability is threatened by increasing water shortages (Bouman and Tuong, 2001). Aerobic rice system is a new way of growing rice that

needs less water than low land rice. It is grown like an upland crop in soil that is not puddled,non-flooded or saturated. It is a sustainable rice production methodology for immediate future to address water scarcity and environmental safety arising due to global warming. Hence, this study is oriented towards establishing the crop weather relationship of aerobic rice with regard to crop stress along with ways and means to mitigate the climate stress.

– To identify the optimum sowing window for aerobic rice.

– To evaluate the agronomic management practices *viz;* seed hardening to overcome the crop stress in aerobic rice.

– To study the crop weather relationship of aerobic rice with regard to crop stress during *Rabi* season.

RESOURCES AND METHODS

The experiment on aerobic rice was conducted at Karaikal during *Rabi* season (September 2014 – February 2015) with different sowing window. Karaikal is situated at 10°55' N latitude and 79°49' E longitude with an altitude of 4 meters above Mean Sea Level (MSL). The region comes under Eleventh Agro Climatic Zones of India and is classified as "PC_2 Coastal Deltaic Alluvial Plains Zone" under fifteen All India Agroclimatic Zonal Classification. Karaikal enjoys a tropical climate and receives a normal rainfall of 1397 mm in a year with mean maximum and minimum temperature of 35.4°C and 25.6°C, respectively. The field was loamy sand in texture, taxonomically known as "*Fluventic ustropept*". The treatment combination comprised of four dates of sowing at weekly interval [September 12th (D_1), September 20th (D_2), September 27th (D_3) and October 4th (D_4) and three seed hardening techniques [one % KCl(H_1), water (H_2) and control (H_3)]. The treatments were evaluated in factorial concept of RBD and replicated thrice. Rice variety chosen for the study was ADT (R) 46. As per the recommendation, viable seeds of rice @ 80 kg ha^{-1} were used for sowing. Initially, the seeds were soaked in one per cent KCl or water as pretreatment for 12 hours and then allowed to shade dry for 24 hours to attain its original weight. The treated seeds were sown in line in the respective plots with an inter row spacing of 20 cm and intra row spacing of 10 cm, respectively. Irrigation was given immediately after sowing and life irrigation was given on third day after sowing. Dimension of the plot is 5.0 m x 4.0 m. The biometric observation on growth attributes was recorded on 30, 60 and 90 DAS and the yield attributes were recorded at the time of harvest. The crop was harvested at its physiological maturity. The major phenological stages of rice *viz.*, Seedling, Vegetative, Reproductive and Maturity stages were identified from the treatment when 50 per cent of the population exhibited the condition. The direct weather parameters like maximum temperature, minimum temperature, evaporation, soil temperature, rainfall and sunshine hours were recorded at various phenological stages of the respective treatments, to study their influence on rice yield.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Effect of weather parameters on growth attributes of aerobic rice :

The findings from the present investigation revealed that early sown crops treated with one per cent KCl grew taller throughout the crop growth phase (Fig. 1). Similarly the LAI was also higher for the crops sown earlier especially on 12th September treated with one per cent KCl or plain water throughout the phenophases. It was also observed that late sown crop especially D_3 (27th September) and D_4 (4th October) without seed hardening did not result with higher dry matter production (DMP) almost in all the phases of investigation. The better performance of early sown crop especially September 12th and September 20th was possible because of the prevalence of favourable weather parameters such as

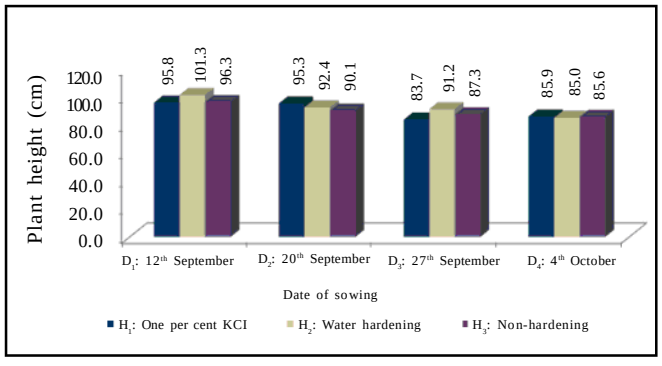

Fig. 1 : Effect of date of sowing and seed hardening on plant height (cm) at flowering phase

relatively higher maximum and minimum temperature, solar radiation, total rainfall and lower morning and evening relative humidity as compared to other dates of sowing. Similar results of higher DMP with relatively higher maximum and minimum temperature was reported by Singh and Singh (2000). Also Goswami *et al.* (2003) narrated that the performance of relatively low temperature results in retarded growth in rice and thereby reduced the DMP.

Yield attributes and yield :

Effect of weather parameters on yield of aerobic rice :

The production of grain yield in aerobic rice is controlled by various physiological and biochemical process that are involved in growth and development of crop. The potential yield of the crop is decided by appropriate sowing window as opined by Pillai (1958) and Singh *et al*. (1990). It was observed that crop raised on 12th September resulted in increased grain yield (Table 1) of 58 per cent higher over the crop raised on October 4th. Therefore, a mere shifting of sowing window results in greater realization of higher remuneration by the farming community. It was also found that 20 per cent yield reduction was faced by the crop raised on 20th September just a week behind 12th September. This yield variation occurred mainly due

Table 1: Effect of date of sowing and seed hardening on mean grain yield (kg ha^{-1}) and harvest index (%) of aerobic rice

Treatments	Grain yield (kg ha^{-1})	Harvest index (%)
Date of sowing (D)		
D_1 :12th September	3972	28
D_2 : 20th September	3190	29
D_3 : 27th September	2010	26
D_4 : 4th October	1685	27
S.E.±	152.4	2.3
C.D. (P = 0.05)	316.1	4.8
Seed hardening (H)		
H_1 : Hardening with one per cent KCl	2821	29
H_2 : Hardening with Water	2898	26
H_3 : Without hardening	2423	27
S.E.±	132.0	2.0
C.D. (P = 0.05)	273.8	NS
Interaction (D x H)		
S.E.±	264.0	4.0
C.D. (P = 0.05)	NS	NS

NS= Non-significant

Table 2: Mean diurnal variation temperature (DVT) (degrees) prevailed at different phases of aerobic rice

Seed hardening and phenophases	Date of sowing (D)				
	D_1	D_2	D_3	D_4	Mean
Hardening with one per cent KCl (H_1)					
Seedling phase	9.25	8.43	7.80	7.43	8.23
Vegetative phase	6.69	5.84	5.98	5.90	6.10
Reproductive phase	5.24	5.56	5.76	5.67	5.56
Maturity phase	7.40	7.89	8.32	8.24	7.96
Full life span	7.09	6.69	6.87	6.81	6.87
Hardening with water (H_2)					
Seedling phase	9.25	8.43	7.80	7.43	8.23
Vegetative phase	6.23	5.94	5.98	5.89	6.01
Reproductive phase	5.48	5.55	5.76	5.98	5.70
Maturity phase	7.93	8.06	8.32	8.26	8.14
Full life span	7.10	6.85	6.87	6.86	6.92
Control (H_3)					
Seedling phase	9.25	8.43	7.80	7.43	8.23
Vegetative phase	6.45	5.94	5.84	5.94	6.04
Reproductive phase	5.45	5.45	5.38	5.62	5.48
Maturity phase	7.20	7.85	7.85	8.09	7.75
Full life span	7.08	6.91	6.76	6.80	6.89

(Data statistically not analyzed)

to the fluctuation of weather parameters that prevailed during various crop growth stages. The crops that were raised on 4th October was exposed to higher RH (93.78%) coupled with low temperature of 28.12°C which induces the spikelet sterility and increased the number of ill-filled grains Abeysiriwardena *et al.* (2002), Narayanan (2004). Similarly heavy rain that occurred at the time of anthesis had washed away the pollen grains which leads to yield reduction Pradhan and Dixit (1981). Harvest index could be attributed as one of the reasons for higher grain yield for the crop raised on September 12th which showed that source to sink movement was exhaustive and commendable. It was noted that on an average 15 kg ha^{-1} of grain yield decreased per day due to delay in sowing from September 12th to October 4th. The derived weather parameters *viz.*,GDD, RTD, RHD, HTU, PTU and HUE also contributed significantly in a positive manner to the rice grain yield. A dip in diurnal variation, DVT (Table 2) during maturity phase could be attributed as one of the reasons for better source to sink movement and thereby resulted in higher rice grain yield. Similar findings as that of the influence of weather parameters on rice grain yield was also reported by Tamilselvan (2008).

Effect of weather parameters on phenophases of aerobic rice :

The phenophase results revealed that though much variation could not be observed, a slight increase in duration of early raised crop to an extent of 3 days was visualized for September 12th sowing compared to late sowing on October 4th, that to this slight increase in the duration was reflected in the maturity phase which evidenced in the production of higher yield due to availability of longer period for transformation of photosynthates from source to sink (Fig 2). The total duration of the crop especially reproductive and maturity phase got shortened with respect to delayed sowing which may be one of the reasons for yield reduction. Similar reports of production of higher yield of rice was also reported by Narayanan (2004); Haridasan (2006) and Kannediraju (2014).

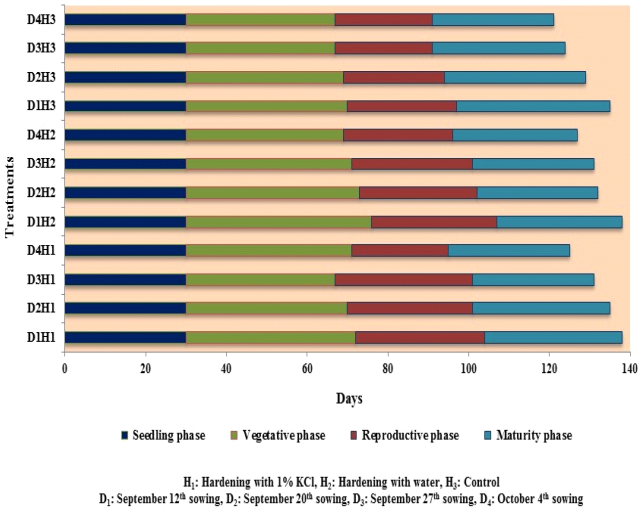

Fig 2: Duration of major phenophases of aerobic rice

Conclusion :

Finally it was proved that the early crop of rice achieved the nearly potential yield and the sowing window optimized for aerobic rice during *Rabi* season was September 12th for hardened seeds. Since temporal and spatial variation of rainfall was observed during the crop period hence, water hardening technique provides an opportunity to mitigate the untoward incidence of drought in the coastal belt of Karaikal.

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