Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 606-610
Received: 14-07-2020
Accepted: 16-08-2020

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Weather related yield constraints and optimum date of planting for rainfed rice (*Oryza sativa*) in central zone of Kerala

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Abstract
Weather is the most determining factor in rain fed rice production. A field experiment was carried out during *kharif* season, 2019 at Agricultural research station, Mannuthy. The experiment was laid out in split plot design with five dates of planting *i. e* June 5th, June 20th, July 5th, July 20th and August 5th as main plot treatment. Two rice varieties Jaya and Jyothi was considered as sub plot design. Correlation was done between weather parameters and yield. According to correlation analysis yield was found to be significantly correlated with weather variables like maximum temperature, minimum temperature, rainfall, relative humidity, pan evaporation and bright sunshine hours. Effect of dates of planting on grain yield was found to be significant. Maximum grain yield was recorded during June 5th planting which was on par with June 20th planting. Among the two varieties yield and yield attributes recorded for Jaya was higher compared to Jaya. A higher value of maximum temperature and a lower value rain fall experienced during ripening period was found to be detrimental for yield.

Keywords: Dates of planting, correlation, maximum temperature, minimum temperature, rainfall, relative humidity, pan evaporation and bright sunshine hours

Introduction
Rice has moulded the culture, regime and wealth of millions of people. For more than a half of population around the globe "Rice is life". It is the staple food for more than half of global population. Twenty one per cent of global human per capita energy, and 15% of per capita protein was delivered by rice. In India, rice cultivation is a key component of the national economy. It provides employment and livelihood security to 70 per cent of Indian population. It is the superior crop cultivated in India by contributing 41% of nation's total food grain production. Rice is grown under varying conditions of climate and topography. India ranks first in total rice harvesting area covering 44 million hectares and second in rice production by contributing 22% of global rice production. It is grown in assured irrigated areas and in rain fed areas where assured annual rainfall is received. About 84% of the country's rice crop is grown as *kharif* crop. Area under rain fed rice is 46% of total rice cultivated area. India's rice production should be increased by 3 per cent to achieve food self sufficiency and to satisfy future food demand (Thiyagarajan and Selvaraju, 2001) [5].
Among all the factors that affect rice production, weather plays a crucial role in determining the success of rice production especially in case of rain fed rice cultivation. The onset of rice cultivation completely depends on the onset of monsoon. Adverse and erratic weather conditions may cause considerable production losses especially if experienced during critical stages of crops. Elevated temperature can adversely affect rice yields due to spikelet sterility and reduced accumulation of assimilates (Korres *et al*, 2017) [2]. Reproductive and ripening stages of rice were more sensitive to weather (Sridevi and Chellamuthu, 2015) [4]. With an increase in 1 ℃ temperature, yield decreased was found to be decreased by 156.2 kg ha^{-1} and with increase in 1mm rainfall yield increases by 0.35 kg ha^{-1} (Bhattacharya and Pandey, 2013) [1] Weather influences incidence of pest and disease, crop duration and produce quality. The yield defining weather parameters were investigated under this study.

Materials and Methods
Field experiment was conducted during *kharif* season, 2019 at Agricultural research station, Mannuthy where major soil type was sandy loam. The experiment was laid out in split plot design. Five dates of planting starting from 5th June, 20th June, 5th July, 20th July and 5th August were assigned as main plot treatments. Two rice varieties *i.e*., Jaya (medium duration) and Jyothi (short duration) were assigned as sub plot treatments. The spacing adopted for Jaya was 20 cm*15 cm and for Jyothi it was 15 cm*10 cm.

Yield and yield attributes were recorded at harvest. Weather experienced on daily basis during the experimental period was collected from principal agrometeorological observatory, Vellanikkara.

Statistical analysis

By carrying out the correlation analysis between weather observed during each phenophases and yield and yield attributes data collected from experimental plot, the influence of weather on yield was understood using SPSS software. Correlation was done between yield and yield attributes.

The influence of dates of planting, variety and their interaction on yield and yield attributes were understood by carrying out analysis of variance using R-statistical software. When significant difference was found between the treatments and interaction, critical difference values were calculated and pair wise comparisons were carried out.

Results and Discussion

Influence of weather on grain yield

As per the correlation done between weather variables experienced during transplanting to active tillering stage and yield in both Jaya and Jyothi, yield was found to be increasing with increase in maximum temperature, minimum temperature and bright sunshine hours experienced during transplanting to active tillering stage in case of both the varieties. Yield was found to be increasing with increase in pan evaporation in the variety Jyothi. Yield was found to be decreased with increase in forenoon relative humidity, after noon relative humidity and rainfall in both varieties. Yield was found to be increasing with increase in minimum temperature, forenoon relative humidity and wind speed experienced during active tillering to panicle initiation stage in both varieties. In Jyothi an increase in pan evaporation and bright sunshine hours influenced yield positively. As per the results suggested by the correlation between weather variables experienced between panicle initiation and booting stage, yield was found to be increasing with minimum temperature and wind speed in both the varieties. In Jyothi yield was found to be increasing with rain fall and decreasing with maximum temperature.

Correlation carried out between weather experienced during booting to heading suggest that yield was found to be increasing with fore noon relative humidity and rainfall in Jaya. And it was found to be decreasing with pan evaporation. In case of Jaya yield was found to be decreasing with increase in maximum temperature.

As per the correlation analysis carried out between weather experienced during heading to 50% flowering, yield was found to be increasing with increase in rain fall, forenoon relative humidity and after noon relative humidity in case of both the varieties. In Jyothi with an increase in wind speed yield was also found to be increasing. Maximum temperature, bright sunshine hours, and pan evaporation decreases grain yield in case of both Jaya and Jyothi.

As per the correlation analysis done between 50% flowering to physiological maturity, yield was found to be increasing with increase in forenoon relative humidity, afternoon relative humidity, rain fall and rainy days.

It was found to be decreasing with increase in maximum temperature, bright sunshine hours and pan evaporation in case of both varieties. In Jaya increase in wind speed also reduces yield. The above mentioned correlation results were explained in Table 1.

Table 1: Correlation between weather variables and grain yield in both Jaya and Jyothi

Stages	Tmax	Tmin	RH1	RH2	WS	BSS	RF	RD	Epan
Jaya									
T-AT	0.845**.	0.736**	-0.887**	-0.580**	0.495	0.711**	-0.802**	-0.50	0.855.
AT-PI	0-.255	0.463*	0.464*	0.370	0.593**	0.182	0.156	0.057	0.073
PI-B	-0.333	0.761**	0.310	0.322	0.648**	-0.303	0.108	-0.041	-0.262
B-H	-0.562**	0.271	0.325	0.639**	0.231	0.019	0.656**	0.646**	-0.725**
H-F	-0.596**	-0.209	0.456*	0.782**	-0.326	-0.570**	0.497*	0.045	-0.793**
F-PM	-0.840**	0.397	0.595**	0.617**	-0.505*	-0.784**	0.817**	0.802**	-0.780**
Jyothi									
T-AT	0.679**	0.669**	-0.670**	-0.584**	0.272	0.564**	-0.721**	-0.269	0.749**
AT-PI	-0.412	0.549*	0.416	-0.175	0.912**	0.814**	0.115	-0.234	0.512*
PI-B	-0.445*	0.675**	-0.164	0.085	0.629**	-0.065	0.594**	-0.264	-0.420
B-H	0.135	0.256	0.217	-0.295	0.340	0.181	-0.333	-0.034	-0.450*
H-F	-0.640**	0.169	0.488*	0.672**	0.533*	-0.626**	0.520*	-0.071	-0.686**
F-PM	-0.793**	0.081	0.637**	0.602**	-0.161	-0.820**	0.635**	0.861**	-0.694**

Tmax- Maximum temperature, Tmin – Minimum temperature, RH1- Forenoon relative humidity, RH2- Afternoon relative humidity, WS- Wind speed, BSS- Bright sunshine hours, RF- Rainfall, RD- Rainy days, Epan – pan evaporation, T-Transplanting, AT –Active tillering, PI- Panicle initiation, B-Booting, H- Heading, F- 50% floweing, PM-Physiological maturity

Correlation was also done between yield and yield attributes like number of panicle, thousand grain weight and number of filled grains (Table 2). Correlation study suggest that a significant positive correlation was observed between yield and thousand grain weight at 0.01 level of significance. Yield and number of filled grains were found to be positively correlated at 0.05 level of significance.

Table 2: Correlation between yield and yield attributes

Yield attribute	1000 grain weight	Filled grains	Number of panicle
Correlation coefficient	0.657**	0.345*	0.136

Influence of date of planting on yield and yield attributes

Effect of date of planting on grain yield was found to be significant. Influence of date of planting on yield and yield attributes were described in Table 3.

Pairwise comparison was done and the results are represented in Figures 1 to 4 which was drawn using R-statistical software. Grain yield recorded during 5th June planting (4418.4 kg ha^{-1}) was on par with 20th June planting (4029.4 kg ha^{-1}), 5th July planting (2836.2 kg ha^{-1}) was on par with 5th August planting (2846.2 kg ha^{-1}). Grain yield recorded July 20th (1249.2 kg ha^{-1}) planting was minimum among other plantings. Number of tillers recorded during August 5th planting was on par with June 5th planting. Number of spikelet recorded during third planting was higher (136). Number of filled grains was more (89) during July 5th planting. Thousand grain weight recorded during June 5th planting, June 20th and July 5th planting were found to be on par. Effect of date of planting was found to be non significant in case of number of panicles per meter square and straw yield.

Table 3: Effect of dates of planting on grain yield

Date of planting	Tillers per unit area	Panicles per unit area	Spikelets per panicle	Filled grains per panicle	1000 grain weight(g)	Straw yield (kg ha^{-1})	Grain yield (kg ha^{-1})
5th June	334.5^{ab}	284.5	79.8^{c}	72.2^{b}	29.6^{a}	3503	4418.4^{a}
20th June	292.5^{b}	295	99^{b}	75.2^{b}	28.9^{a}	3613	4029.4^{a}
5th July	260^{b}	259	136^{a}	89.7^{a}	28.5^{a}	4374	2836.2^{b}
20th July	310.5^{b}	294	117^{b}	57.6^{b}	23.9^{b}	3453	1249.2^{c}
5th August	362^{a}	286	145^{a}	69.9^{b}	24.2^{b}	4006	2846.2^{b}
CD	50.6	NS	18.96	14.54	2.45	NS	300.67

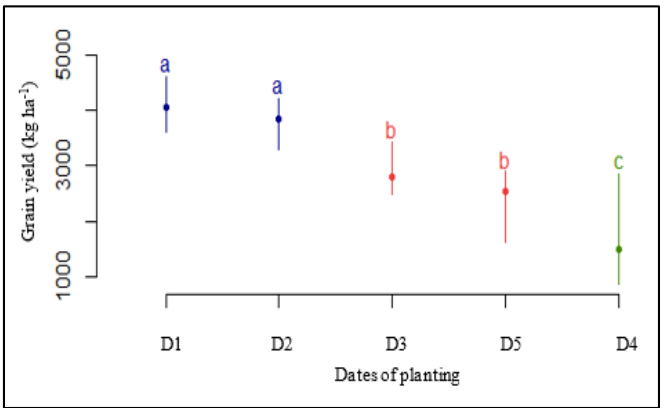

Fig 1: Effect of dates of planting on grain yield

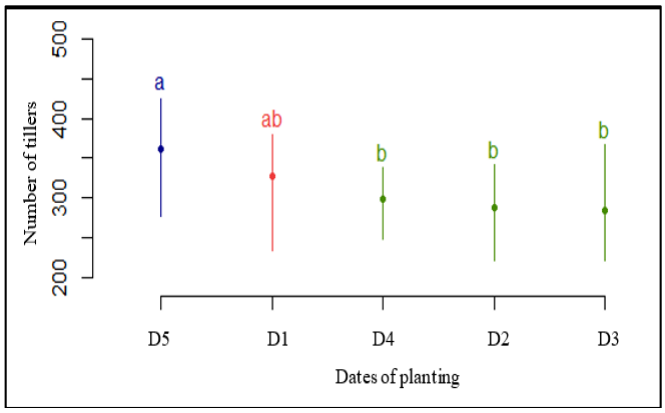

Fig 2: Effect of dates of planting on number of tillers

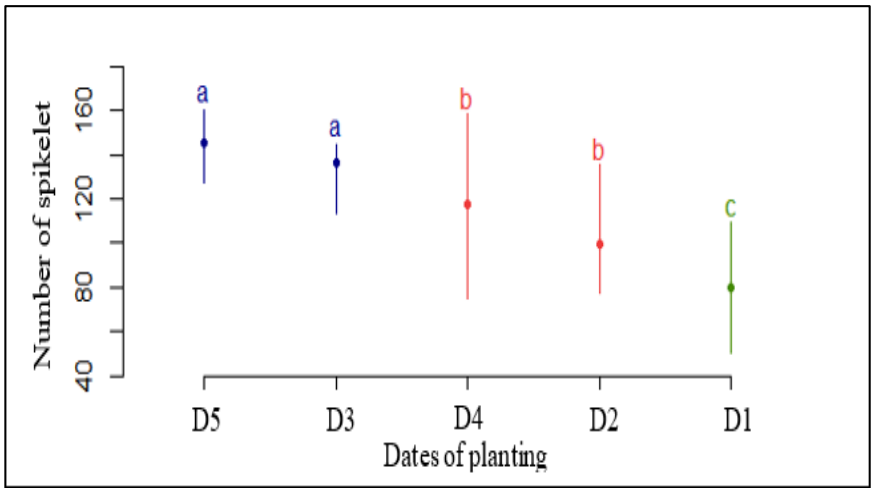

Fig 3: Effect of dates of planting on number of spikelet

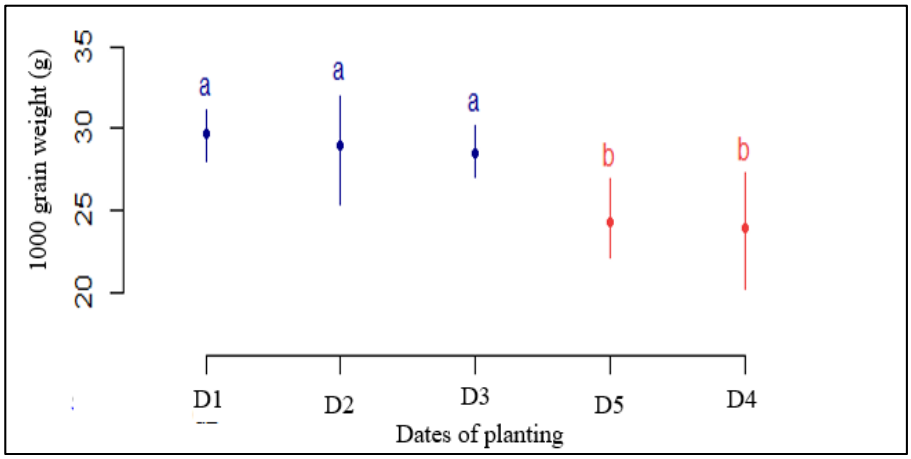

Fig 4: Effect of dates of planting on 1000 grain weight

Influence of variety on yield and yield attributes

Effect of variety on yield and yield attributes were found to be significant in all attributes except for straw yield (Table 4). Yield and yield attributes recorded on Jaya was higher than Jyothi.

Table 4: Comparison between varieties with respect to yield and yield attributes

Variety	Tillers per m^2	Panicles per m^2	Spikelets per panicle	Filled grains per panicle	1000 grain weight (g)	Straw yield (kg ha^{-1})	Grain yield (kg ha^{-1})
Jaya	320.2	294 ^{a}	123 ^{a}	83.3 ^{a}	27.3 ^{a}	3876	3052^{a}
Jyothi	303.4	266 ^{b}	102 ^{b}	62.7 ^{b}	26.7 ^{b}	3703	2712^{b}
CD	NS	20.08	8.59	7.24	0.786	NS	179.2

Interaction between dates of planting and variety

Interaction effect was found to be significant on grain yield, number of tillers, number of spikelets and thousand grains (Table 5).

In Jaya grain yield obtained during June 5th planting was on par with June 20th planting. The Same trend was seen in Jyothi. Number of tillers recorded during June 5th planting was on par with June 20th planting in case of Jaya. In case of Jyothi maximum number of tillers recorded during June 5th planting was higher among five dates of planting.

Number of spikelets recorded during July 5th planting was higher than the other dates of planting. Thousand grain weight recorded during June 5th planting was on par with June 20th and July 5th planting in both Jaya and Jyothi.

Table 5: Interaction of date of planting and variety with yield and yield attributes

Date of planting	Number of tillers per unit area		Number of spikelets per panicle		1000 grain weight (g)		Grain yield (kg ha^{-1})	
	Jaya	Jyothi	Jaya	Jyothi	Jaya	Jyothi	Jaya	Jyothi
5th June	338^{ab}	331^{a}	97 ^{b}	62.7 ^{b}	30.2 ^{a}	29 ^{a}	4487 ^{a}	3655^{a}
20th June	322^{ab}	263^{bc}	117.7 ^{b}	80.8 ^{b}	29.6 ^{a}	28.2 ^{ab}	4111 ^{a}	3609^{a}
5th July	282^{b}	238^{c}	142.8 ^{a}	129.6 ^{a}	27.8 ^{ab}	29.1 ^{a}	2932 ^{b}	2775^{b}
20th July	306a^{b}	315 ^{bc}	111.3 ^{b}	122.9 ^{b}	25.6 ^{bc}	22.1 ^{c}	1058 ^{c}	1250^{d}
5th August	354^{a}	370 ^{bc}	147.1 ^{a}	144 ^{a}	23.3 ^{c}	25.15 ^{bc}	2849 ^{b}	2269^{c}
CD	66.75		23.03		3.44		413.9	

A high maximum temperature experienced between 50% flowering to physiological maturity was the reason for reduction in grain yield during July 20th planting in case of both varieties (Figure 5 and 6). Rain fall received between 50% flowering to physiological maturity was least in case of July 20th planting (Figure 7 and 8). Water stress experienced during this stage also lead to the reduction in yield during July 20th planting. A higher yield recorded during June 5th planting was attributed to higher 1000 grain weight. Similar findings were suggested by Vysakh *et al.* (2016) [6]. The effect of maximum temperature experienced between 50% flowering to physiological maturity on thousand grain weight is depicted in Figure 9. Higher maximum temperature experienced during this stage was the reason for reduced thousand grain weight and yield during July 20th planting. This result was in accordance with the findings of Shi, *et al.*, 2016 [3].

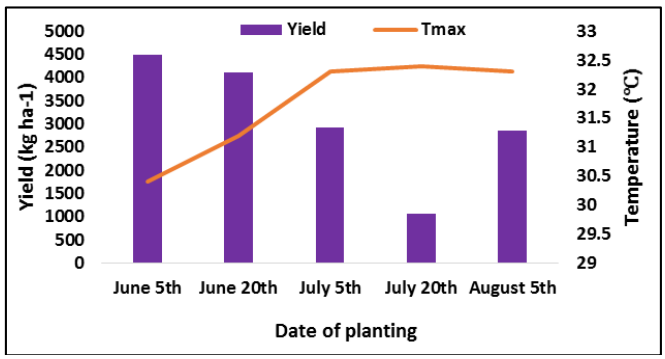

Fig 5: Effect of maximum temperature experienced between 50% flowering to physiological maturity on grain yield in Jaya

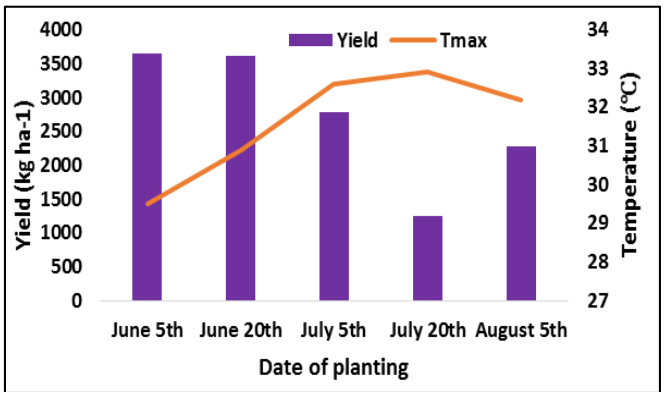

Fig 6: Effect of maximum temperature experienced during 50% flowering to physiological maturity on grain yield in Jyothi

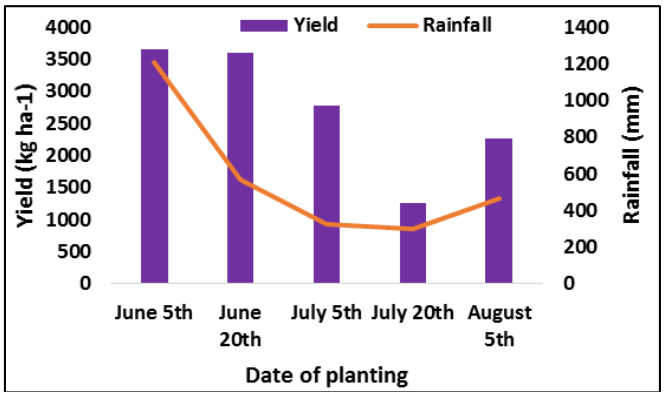

Fig 7: Effect of rainfall experienced during 50% flowering to physiological maturity on grain yield in Jaya

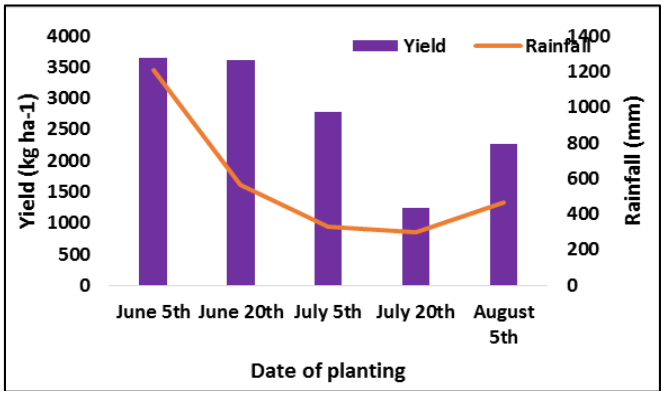

Fig 8: Effect of rainfall experienced during 50% flowering to physiological maturity on grain yield in Jyothi

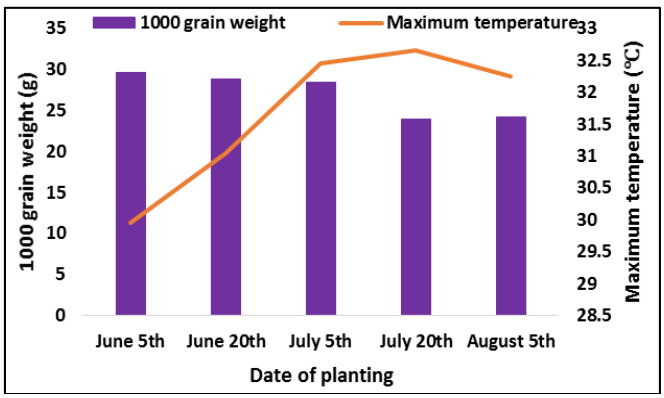

Fig 9: Effect of maximum temperature experienced during 50% flowering to physiological maturity on 1000 grain weight

Conclusion

Experiment conducted during *kharif* season, 2019 revealed that weather parameters like maximum temperature, bright sunshine hours and evaporation experienced during latter stages of crop is having a detrimental effect on yield. Rain fall received during ripening stage of crop enhances grain yield. Among the five dates of planting June 5th planting and June 20th planting can be considered as the optimum dates of planting. The decline in yield during July 20th planting was due to higher maximum temperature and rain fall received during ripening period. Among the two varieties yield obtained under Jaya was higher than Jyothi. Yield can be improved by adopting the optimum date of planting.

References

1. Bhattacharya T, Panda RK. Effect of climate change on rice yield at Kharagpur, West Bengal. Int. J Food, Agric. Vet. Sci. 2013; 4(2):6-12.
2. Korres NE, Norsworthy JK, Burgos NR, Oosterhuis DM. Temperature and drought impacts on rice production: An agronomic perspective regarding short-and long-term adaptation measures. Water resources and rural development. 2017; 9:12-27.
3. Shi P, Zhu Y, Tang L, Chen J, Sun T, Cao W *et al*. Differential effects of temperature and duration of heat stress during anthesis and grain filling stages in rice. Environmental and Experimental Botany. 2016; 132:28-41.
4. Sridevi V, Chellamuthu V. Impact of weather on rice – A review. Int. J Appl. Res. 2015; 1(9):825-831.
5. Thiyagarajan TM, Selvaraju R. Water-saving rice production systems. Nanjing University, 2001, 15-45.
6. Vysakh A, Ajithkumar B, Naziya, John LC. Response of rice (*Oryza sativa*) to changing weather conditions. Green farming. 2016; 7(2):1232-1235.