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Impact of weather variables on rice growth and development in special zone of problem areas

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Abstract

Research was conducted at the Regional Agricultural Research Station, Kumarakom, Kerala Agricultural University, to evaluate the impact of weather factors on rice growth and development. The field experiment was conducted in two popular medium-duration rice varieties, viz., *Uma* (MO 16) and *Pournami* (MO 23), during the *Puncha* season of 2022-23. The study of the relationship between weather factors and the duration of phenological stages showed a substantial impact of weather variables on rice development. The overall crop duration was reduced when planting dates were delayed. The maximum temperature exhibited a negative correlation during the stages of seedling to active tillering, panicle initiation to booting, and from 50 percent flowering to physiological maturity in both varieties. Evaporation and BSS also showed negative correlation with crop duration. Rainfall, the number of rainy days, and relative humidity exhibited a positive relationship with the duration of crop phenophases in both varieties. It is inferred from the study that the duration of both *Uma* and *Pournami* reduced with the advancement of planting date and *Uma* took fewer days for physiological maturity compared to the *Pournami* variety on all five dates of planting.

Keywords: Rice phenology, Effect of planting dates, Crop-weather relationship, Kuttanad

Introduction

Rice serves as the main food source for more than half of the global population, establishing itself as the world's most vital food crop. In Asia, which accounts for 60% of the global population, over 90% of the world's rice is both cultivated and consumed (Fukagawa and Ziska, 2019) ^[1]. Rice being the staple food for a sizable section of the world's population, climate change has the potential to have a big impact on rice production. According to Krishnan *et al.* (2020) ^[2], it is expected that the average temperature in India will rise by approximately 4.4 degrees Celsius by the end of the twenty-first century. In the medium emission scenario, climate change in India will result in 3–5% reduction in total rice yield, and in the high emission scenario, 3.5–10% reduction. With global rice cultivation projected to increase by only 0.4% in the coming years, the primary factor determining total rice production will be productivity levels across different regions (Palanisami *et al.*, 2017) ^[3]. Despite advancements in production systems, rice growing remains a risky endeavour in unfavourable environmental conditions due to its susceptibility to weather fluctuations. During the reproductive phase, excessively high temperatures can affect fertilization, the production of grains or fruits, and the viability of pollen (Hatfield *et al.*, 2008; Hatfield and Prueger, 2011) ^[4, 5]. Prolonged exposure to extreme temperatures during the pollination period or early stages of grain or fruit development can lead to a decrease in yield potential.

Kuttanad, located in the Indian state of Kerala, spans across the districts of Alappuzha, Kottayam, and Pathanamthitta is renowned for its vast paddy fields and distinctive geological characteristics. This region is one of the rare areas globally where agriculture takes place at elevations ranging from 1.2 to 3.0 meters below sea level. The region has the lowest altitude all over India and is highly vulnerable to floods during monsoon season due to its peculiar geographic features. To mitigate the negative impacts of high-water table and frequent flooding, rice growing in north Kuttanad is mainly timed to coincide with the *Puncha* season (Oct/Nov – Feb/Mar), where sowing is initiated after the cessation of south west monsoon. Hence, there are high chances for exposure of the crop cultivated in the area to high temperature during its reproductive stage. High temperature negatively affects the crop duration, particularly during critical stages viz., panicle

initiation and development, anthesis, and seed set, resulting in lower grain yield under heat stress conditions. Further, crop physiological characteristics and yield-attributing parameters are also negatively impacted, which results in substantial decrease in yield. Comprehending the unique meteorological conditions in Kuttanad, located in the designated special zone of problem area of Kerala, it is highly essential to formulate climate smart approaches to alleviate their influence on rice phenology. Many studies have been conducted to understand the effect of meteorological factors on rice growth and development in Kerala. However, limited research exists on the widely grown rice variety, *Uma* (MO-16), and the new promising variety from KAU, *Pournami* (MO-23). Therefore, this study was undertaken to examine the influence of weather parameters on rice phenology in special zone of problem areas during the Puncha season, using these promising varieties.

Materials and Methods

A study was carried out at the Regional Agricultural Research Station, Kumarakom, Kerala Agricultural University, using two medium-duration rice varieties, *Uma* and *Pournami*, during the Puncha season of 2022-23. The experiment followed a Randomized Complete Block Design. The research station is situated 0.6 meters below mean sea level (MSL) at a latitude of 9°3' N and longitude of 76°3' S, within the Special Zone of Problem Areas. The treatments consisted of five dates of planting for the two varieties, viz., D1-5th September, D2-20th September, D3-5th October, D4-20th October, D5-5th November, with four replications.

Uma is the leading rice variety in Kerala, accounting for over 60% of the state's rice cultivation area and more than 80% of the acreage in the Kuttanad region. *Pournami*, the newest variety developed by KAU, is known for its resilience to high temperatures and acidic conditions. In the experimental field, crop management and pest control practices were carried out as per KAU package of practices recommendations. Observations on plant characters were recorded at critical stages. Weather data was collected from the Agromet Observatory at RARS, Kumarakom. The data collected was statistically analyzed to establish a relationship between weather, various growth stages and yield attributes of rice.

Results and Discussion

The study on phenology revealed that crop duration decreased from early planting to late planting in both the varieties. The crop duration decreased from 113 to 102 days in *Uma* and 115 to 105 days in *Pournami* (Table 1). September 20th planting had the highest crop duration, while planting on November 5th had the lowest crop duration, in both the varieties. Generally, it was found that crop duration tends to decrease from early planting to late planting in both the varieties. The height of the plant was found to be significantly higher for September 5th planting and October 5th planting in *Uma*, while in *Pournami*, no significant difference was found among crops of different dates of planting (Table 2). This might be due to the low amount of rainfall received during whole growth period of the late planted crop (Fig.1). Total amount of rainfall received during the entire growing period of September 5th planting was 683.8 mm for both the varieties whereas, it was only 259.1 mm and 266.4 mm during the November 5th planting for both the varieties. The findings were consistent with those of Singh *et al.* (2012) [6] and Safdar *et al.* (2013) [7], who reported that plant height was significantly influenced by sowing dates, with early sowing resulting in taller plants compared to delayed sowing.

The leaf area index remained relatively unaffected by varying planting dates in both varieties (Table 3). However, dry matter accumulation showed a decrease in late-planted crops in both varieties (Table 4). Bright sunshine hours, showed significant negative influence on dry matter (Fig.2) whereas rainfall showed positive correlation with dry matter accumulation (Fig.3.) The results, indicating decreased dry matter accumulation in late planted crops, align with the findings of Reedy and Reedy (1992) [8]. They asserted that delayed sowing leads to accelerated development stages, with each stage's duration decreasing exponentially as planting is delayed. Studies by Singh *et al.* (2012) [6] supported the observation of higher dry matter accumulation in early-sown crops. Akram *et al.* (2007) [9] also reported a reduction in biomass production associated with a delay in planting.

Phenophase duration

Uma exhibited a shorter duration for reaching active tillering compared to *Pournami*. The number of days required for active tillering increased between the September 5th and September 20th plantings but decreased towards later planting dates in both the varieties. *Uma* took 24-34 days from transplanting to active tillering, while the *Pournami* variety required 27-37 days for the covering the same period. The minimum temperature, mean temperature, wind speed, rainy days, and evaporation had significant positive effect, whereas the maximum temperature, forenoon relative humidity, afternoon relative humidity, and mean relative humidity had significant negative effect on the duration of phenophases for *Uma* variety (Table 5). In *Pournami*, the minimum temperature and rainy days had significant positive influence, while, the maximum temperature, mean temperature, mean relative humidity, and rainfall had significant negative influence on the phenophase duration (Table 6.)

Number of days for panicle initiation for *Uma* and *Pournami* initially increased from the September 5th to September 20th planting and then decreased towards the later planting dates. The number of days for panicle initiation ranged from 47-53 for *Uma* and 48-55 for *Pournami*. Both the varieties exhibited significant positive correlation with minimum temperature, mean temperature, wind speed, afternoon relative humidity, and rainfall. Additionally, significant negative correlation was observed with forenoon relative humidity for *Uma* variety.

The number of days taken for attaining booting stage in *Uma* ranged from 54 to 63 days, while for *Pournami*, it was 57 to 66 days. Days for booting increased from the September 5th to September 20th planting and decreased towards the last planting, for both the varieties. Significant positive correlation with afternoon relative humidity, number of rainy days and evaporation, while, significant negative correlation with forenoon relative humidity and BSS were observed in *Uma* variety. In *Pournami* variety, minimum temperature and afternoon relative humidity had significant positive correlation whereas wind speed, forenoon relative humidity and BSS had significant negative correlation.

The time taken for heading ranged from 63 to 72 days for *Uma* and from 64 to 73 days for *Pournami*. *Uma* took fewer days than *Pournami* for attaining heading stage. In *Uma* and *Pournami*, days for heading initially increased in the September 20th planting and then reduced towards the last planting. *Uma* variety exhibited significant positive correlation with minimum temperature, RH 1, RH 2, and RH mean, in contrast, for the *Pournami* variety, factors such as minimum temperature, RH 1, RH 2, mean RH, rainfall, and the number of rainy days had a significant positive impact. Meanwhile, maximum temperature, wind speed, and BSS

significantly negatively affected the number of days to heading in both varieties.

Uma reached 50 per cent flowering in a shorter period compared to *Pournami*. It took *Uma* 73 to 80 days after transplanting, while *Pournami* took 75 to 83 days. The influence of weather parameters on the number of days taken for 50 per cent flowering showed the same trend in *Uma* and *Pournami* varieties. Both the varieties exhibited an initial increase followed by a decreasing trend. The two varieties under investigation showed a significant positive correlation with minimum temperature, mean temperature, RH 1, RH 2, RH mean, rainfall, and rainy days, whereas maximum temperature, wind speed, BSS, and evaporation had a significant negative correlation.

The duration for *Uma* to reach physiological maturity after transplanting varied between 102 and 113 days, while for *Pournami*, it ranged from 105 to 115 days. Both the varieties exhibited an initial increasing trend up to the second planting, followed by a subsequent decrease towards the last planting date. Significant positive correlation was noticed with minimum temperature, mean temperature, RH1, RH 2, RH mean, rainy days and rainfall, while, significant negative correlation was noticed with wind speed and BSS to days for attaining physiological maturity in *Uma* variety. In *Pournami* variety, rainfall and rainy days had significant positive correlation, While, wind speed and BSS had significant negative influence on number of days taken for physiological maturity, in both varieties.

Maximum temperature showed negative correlation during active tillering to panicle initiation period on duration of phenophases (Fig. 4). The findings aligned well with the study conducted by Rani and Maragatham (2013) [10]. Their research indicated that higher temperature impacts the duration of rice crops, causing them to reach phenological stages earlier, while, accumulating fewer growing degree days. The number of rainy days significantly decreased from September 5th to November 5th during the planting to active tillering stage (Fig. 2). This reduction in rainy days may be the reason for the shorter growing period observed in late-planted crops. These results are consistent with the research by Sujariya *et al.* (2020) [11], who demonstrated that the distribution of rainfall during the rice cultivation growth phase had direct impact on both the growing period and the crop yield.

In general, studies to analyse the relationship between weather variables and crop duration revealed that maximum temperatures, WS (Wind speed), BSS (Bright Sunshine Hours), and evaporation during booting (P3) to physiological maturity (P6) stage had significant negative impact on both the varieties. Minimum temperature, rainfall, and rainy days showed significant positive influence during heading (P4) to physiological maturity (P6) stages.

Yield and yield attributes

The planting dates had a significant impact on grain yield in both *Uma* and *Pournami* varieties. September 5th planting resulted in the highest grain yield for both *Uma* (4388.8 kg ha⁻¹) and *Pournami* (3715 kg ha⁻¹), whereas November 5th planting recorded the lowest yield in *Uma* (2118.8 kg ha⁻¹) and *Pournami* (2313.8 kg ha⁻¹) (Table 7). This might be due to the slight increase of maximum temperature during critical period of rice like the vegetative stage and maturity stage (Fig. 6). Increasing temperature may speed up the growing period in the late planted crops and lead to accumulation less growing degree days compared to early planted crops. This finding was similar to the result observed by Peng *et al.* (2004) [12], who stated that decreased yield is due to increased temperature during critical periods. Jalota *et al.* (2009a) [13] also reported similar outcomes. The higher grain yield observed in the early planting on September 5th for both varieties may be due to a favourable relationship with the number of productive tillers per hill, spikelets per panicle, and filled grains per panicle (Table 7). This aligns with the research by Hassan *et al.* (2003) [14], which emphasizes that grain yield is influenced by the interaction of different yield components, including the number of productive tillers, spikelets per panicle, and filled grains. The results are consistent with earlier research by Iqbal *et al.* (2008) [15] and Ram *et al.* (2004) [16], indicating that optimal rice yield occurs when the crop is planted early in the season. Varied sowing dates can alter growth periods, impacting biomass accumulation by changing the duration of photosynthetic activity (Yao *et al.*, 2012) [17]. Consequently, the timing of sowing significantly affects grain yield by influencing the overall rice cultivation processes (Mo *et al.*, 2016) [18].

Table 1: Duration of phenological stages in rice variety *Uma* (U) and *Pournami* (P)

Phenophases	Days from date of transplanting									
	D1		D2		D3		D4		D5	
	U	P	U	P	U	P	U	P	U	P
AT	31	32	34	37	31	32	26	28	24	27
PI	51	53	53	55	51	51	48	49	47	48
B	57	58	63	66	59	61	56	58	54	57
H	70	71	72	73	69	71	64	66	63	64
50% flowering	77	79	80	83	77	80	74	76	73	75
PM	110	111	113	115	110	112	104	107	102	105

D1-September 5th, D2-September 20th, D3 - October 5th, D4 - October 20th, D5 - November 5th

AT - Transplanting to active tillering; PI - Transplanting to panicle initiation; B – Transplanting to booting

H – Transplanting to heading; Transplanting to 50% flowering; PM – Transplanting to physiological maturity

Table 2: Effect of date of planting dates on plant height (cm) at weekly intervals for *Uma* (U) and *Pournami* (P) rice varieties

Date of planting	Week 1		Week 2		Week 3		Week 4		Week 5		Week 6		Week 7	
	U	P	U	P	U	P	U	P	U	P	U	P	U	P
D1	19.9	21.6 ^{bc}	27.7 ^b	27.5	35.3	34.5	43.5	43.5	46.9 ^{ab}	48.0 ^a	48.1 ^a	50.1 ^a	59.5 ^a	59.8 ^a
D2	20.1	21.3 ^c	27.4 ^b	27.7	35.0	35.5	43.8	43.8	46.6 ^b	47.8 ^{ab}	47.5 ^a	49.8 ^{ab}	57.0 ^{bc}	59.6 ^{ab}
D3	20.2	22.6 ^a	28.4 ^a	27.4	34.9	35.6	44.1	43.4	48.3 ^a	47.5 ^{ab}	47.7 ^a	49.1 ^{ab}	57.2 ^b	59.2 ^{ab}
D4	20.3	22.6 ^b	28.4 ^a	27.2	34.7	35.7	43.1	42.7	44.1 ^c	46.5 ^{ab}	46.1 ^b	48.2 ^b	56.0 ^{bc}	58.4 ^b
D5	20.4	22.4 ^a	27.6 ^b	27.4	34.2	35.5	43.3	43.4	44.3 ^c	46.0 ^b	46.2 ^b	48.3 ^b	55.7 ^c	58.9 ^{ab}
CD	NS	0.5	0.5	NS	NS	NS	NS	NS	1.5	1.7	1.1	1.6	1.3	1.3

Date of planting	Week 8		Week 9		Week 10		Week 11		Week 12		Week 13		Week 14	
	U	P	U	P	U	P	U	P	U	P	U	P	U	P
D1	64.8 ^a	68.4	67.4 ^{ab}	70.3 ^{ab}	68.7	72.0	70.6	74.8	77.1	78.7	84.9	89.4 ^a	91.3 ^a	92.2
D2	64.5 ^a	67.7	67.7 ^a	70.6 ^a	68.0	71.9	70.3	74.6	76.0	78.5	85.0	88.3 ^{ab}	90.7 ^{ab}	92.3
D3	64.4 ^a	67.5	66.7 ^{bc}	70.2 ^{ab}	68.0	71.5	70.2	74.7	76.1	78.6	85.3	88.9 ^{ab}	91.6 ^a	92.4
D4	62.9 ^b	67.3	66.5 ^{bc}	70.0 ^{bc}	67.6	71.2	70.5	73.9	76.0	78.3	85.2	88.4 ^{ab}	89.3 ^b	91.4
D5	63.1 ^b	67.6	66.3 ^c	69.7 ^c	67.5	71.4	70.0	73.8	76.5	78.4	85.2	87.9 ^b	89.5 ^b	91.8
CD	1.2	NS	0.9	0.4	NS	NS	NS	NS	NS	NS	NS	1.2	1.4	NS

D1-September 5th D2-September 20th D3 - October 5th D4 - October 20th D5 - November 5th

NS- Non significant

Table 3: Effect of date of planting dates on Leaf area index (LAI) at Fortnightly intervals for Uma (U) and Pournami (P) rice varieties

Date of planting	Week 2		Week 4		Week 6		Week 8		Week 10		Week 12		Week 14	
	U	P	U	P	U	P	U	P	U	P	U	P	U	P
D1	0.28	0.29	1.19 ^a	1.21	2.46	2.61	3.16	3.39 ^a	4.93	5.03	5.52	5.74	4.59	4.60
D2	0.25	0.32	1.12 ^{ab}	1.19	2.24	2.49	3.15	3.04 ^b	4.97	4.73	5.65	5.66	4.67	4.53
D3	0.24	0.28	1.13 ^{ab}	1.17	2.42	2.47	3.12	3.14 ^b	4.89	4.69	5.61	5.73	4.55	4.84
D4	0.32	0.30	1.05 ^b	1.16	2.27	2.35	3.03	2.98 ^b	4.86	4.48	5.48	5.55	4.23	4.41
D5	0.25	0.31	1.10 ^{ab}	1.21	2.30	2.39	3.04	3.05 ^b	4.77	4.70	5.46	5.54	4.58	4.38
CD	NS	NS	0.1	NS	NS	NS	NS	0.2	NS	NS	NS	NS	NS	NS

Table 4: Effect of date of planting dates on Dry matter accumulation at Fortnightly intervals for Uma (U) and Pournami (P) rice varieties

Date of planting	Week 2		Week 4		Week 6		Week 8		Week 10		Week 12		Week 14	
	U	P	U	P	U	P	U	P	U	P	U	P	U	P
D1	545	559	2834	2869	6087 ^a	6103	9457 ^a	9235 ^a	13731 ^a	13292 ^a	12628 ^a	12183 ^a	11697 ^a	11472 ^a
D2	544	553	2910	2875	6076 ^a	6291	9339 ^{ab}	9334 ^a	13314 ^a	12911 ^a	12222 ^a	11867 ^a	11148 ^a	10650 ^{ab}
D3	550	540	2908	2807	6072 ^a	6043	9540 ^a	8798 ^{ab}	13598 ^a	11955 ^{ab}	12655 ^a	11315 ^a	11333 ^a	9895 ^{bc}
D4	521	516	2773	2784	5858 ^a	5888	9043 ^{ab}	7893 ^b	10191 ^b	10738 ^b	9572 ^b	9696 ^b	8712 ^b	9057 ^c
D5	532	564	2758	2883	5523 ^b	5948	8820 ^b	7851 ^b	10561 ^b	10525 ^b	9885 ^b	9470 ^b	8737 ^b	9569 ^{bc}
CD	NS	NS	NS	NS	282	NS	569.7	993	1045	1680	1208	1420	1314	1426

D1-September 5th D2-September 20th D3 - October 5th D4 - October 20th D5 - November 5th

NS- Non significant

Table 5: Correlation between weather parameters and phenophase duration for variety, *Uma*

Crop stages	Tmax	Tmin	Tmean	WS	RH 1	RH 2	RHmean	RF	RD	BSS	Ep
P1	-0.389	0.869**	0.891**	0.899**	-0.588**	-0.737**	-0.644**	-0.077	0.475*	0.439	0.979**
P2	0.000	0.520*	0.854**	0.779**	-0.601**	0.828**	0.218	0.692**	0.244	-0.036	-0.294
P3	-0.197	0.346	0.009	-0.311	-0.595**	0.800**	0.020	0.312	0.498*	-0.524*	0.562**
P4	-0.654**	0.654**	0.409	-0.447*	0.497*	0.814**	0.811**	0.432	0.443	-0.472*	-0.074
P5	-0.362	0.796**	0.604**	-0.952**	0.634**	0.885**	0.860**	0.944**	0.915**	-0.542*	-0.901**
P6	-0.078	0.523*	0.535*	-0.649**	0.478*	0.504*	0.516*	.627**	0.583**	-0.675**	-0.361

* - Significant at 5% level ** - Significant at 1% level

P1 – Transplanting to active tillering

P3 – Panicle initiation to booting

P5 – Heading to 50% flowering

P2 – Active tillering to panicle initiation

P4 – Booting to heading

P6 – 50% flowering to physiological maturity

Table 6: Correlation between weather parameters and phenophase duration for variety, *Pournami*

Crop stages	Tmax	Tmin	Tmean	WS	RH1	RH2	RHmean	RF	RD	BSS	Ep
P1	-0.730**	0.808**	-0.476*	0.390	0.291	0.374	-0.641**	-0.541*	0.592**	-0.405	0.126
P2	0.092	0.769**	0.930**	0.945**	-0.389	0.723**	0.944**	0.771**	-0.223	0.103	0.337
P3	-0.257	0.595**	0.116	-0.460*	-0.481*	0.496*	0.230	0.098	0.404	-0.773**	0.260
P4	-0.741**	0.624**	0.195	-0.461*	0.648**	0.884**	0.863**	0.637**	0.641**	-0.522*	0.021
P5	-0.278	0.820**	0.727**	-0.916**	0.544*	0.839**	0.877**	0.371	0.606**	-0.613**	-0.858**
P6	-0.030	0.275	0.360	-0.529*	0.362	0.347	0.366	0.569**	0.521*	-0.557*	-0.414

Tmax- Maximum temperature; Tmin- Minimum temperature; Tmean- Daily mean temperature; RH1- Morning relative humidity; WS- Windspeed
RH2- Afternoon relative humidity; RHmean- Daily mean relative humidity; RF-Rainfall; RD- Rainy days; BSS- Bright sunshine hours; Ep- Evaporation

P1 – Transplanting to active tillering

P3 – Panicle initiation to booting

P5 – Heading to 50% flowering

P2 – Active tillering to panicle initiation

P4 – Booting to heading

P6 – 50% flowering to physiological maturity

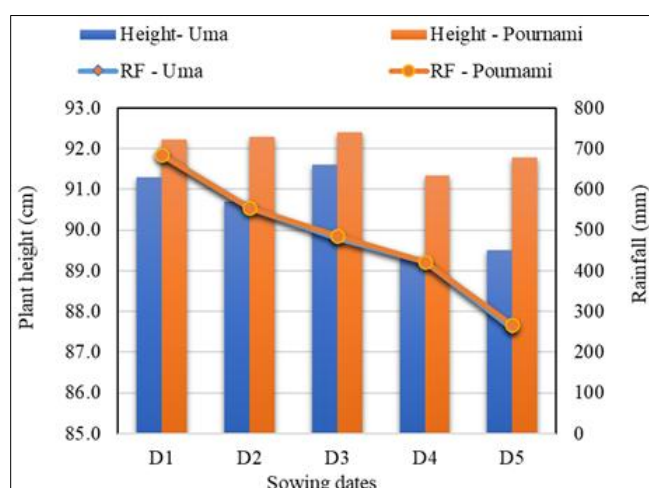
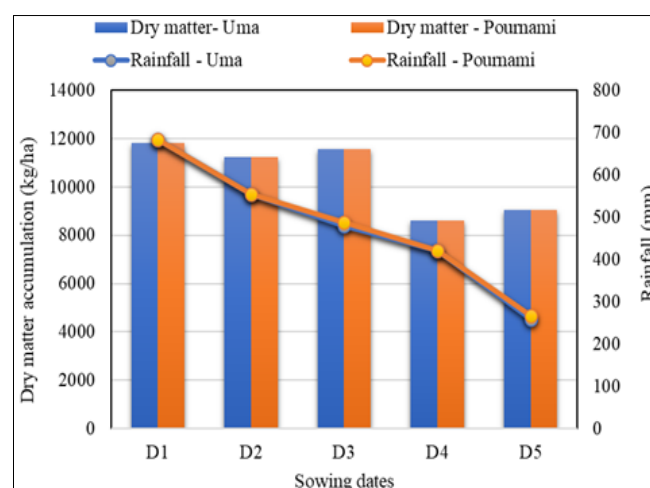
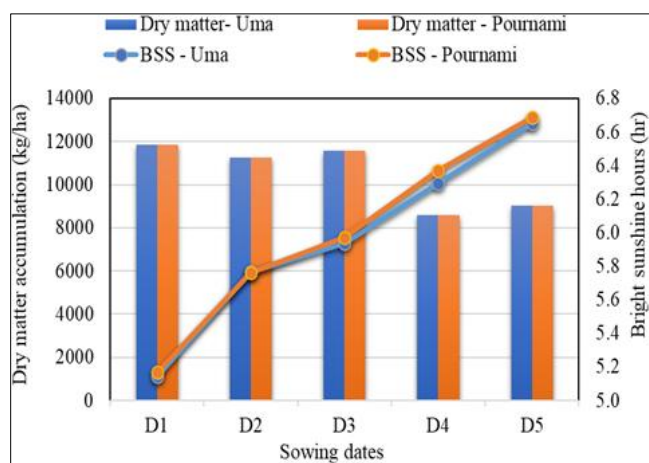
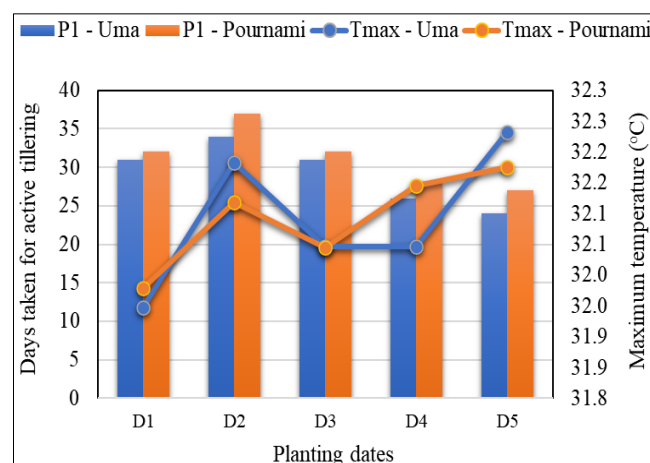
Table 7: Effect of date of planting on yield and yield attributes for Uma (U) and Pournami (P) rice varieties

Date of planting	Grain yield (kg/ha)		No. of tillers/hill		No. of Panicles/hill		No. of Spikelets/panicle	
	U	P	U	P	U	P	U	P
D1	4388.8 ^a	3715.0 ^a	10.1 ^a	8.80 ^a	8.00 ^a	7.45	103.85 ^a	92.48 ^a
D2	3306.3 ^b	2607.5 ^b	10.0 ^a	8.88 ^a	7.88 ^a	7.30	100.13 ^{ab}	91.15 ^a
D3	3920.0 ^a	3490.0 ^a	9.85 ^a	8.83 ^a	7.95 ^a	7.33	101.43 ^{ab}	90.00 ^{ab}
D4	3037.5 ^b	2496.3 ^b	9.5 ^a	8.70 ^{ab}	8.00 ^a	7.35	94.75 ^b	85.25 ^{bc}
D5	2118.8 ^c	2313.8 ^b	8.53 ^b	8.58 ^b	7.7 ^b	7.30	86.85 ^c	83.40 ^c
CD	504.2	346.8	0.7	0.2	0.2	NS	7.2	5.3

Date of planting	No. of filled grains/panicle		1000 grain weight		Straw weight	
	U	P	U	P	U	P
D1	84.5 ^a	72.75 ^a	25.6	28.4	5707.5 ^a	5625 ^a
D2	82.75 ^a	61.00 ^b	25.3	28.7	5436.25 ^a	4937.5 ^b
D3	83.0 ^a	71.5 ^a	24.8	28.3	5422.5 ^a	5450 ^a
D4	61.5 ^b	57.25 ^b	25.3	28.3	4462.5 ^b	4237.5 ^c
D5	51.75 ^c	49.25 ^c	24.5	28.5	3781.25 ^b	4288.75 ^c
CD	6.4	4.8	NS	NS	789.2	509.4

D1-September 5th D2-September 20th D3 - October 5th D4 - October 20th D5 - November 5th

NS- Non significant

**Fig 1:** Influence of rainfall on plant height in Uma and Pournami varieties**Fig 3:** Influence of rainfall on dry matter accumulation in Uma and Pournami varieties**Fig 2:** Influence of bright sunshine hours on dry matter accumulation in Uma and Pournami varieties**Fig 4:** Influence of maximum temperature on duration at active tillering stage in Uma and Pournami varieties

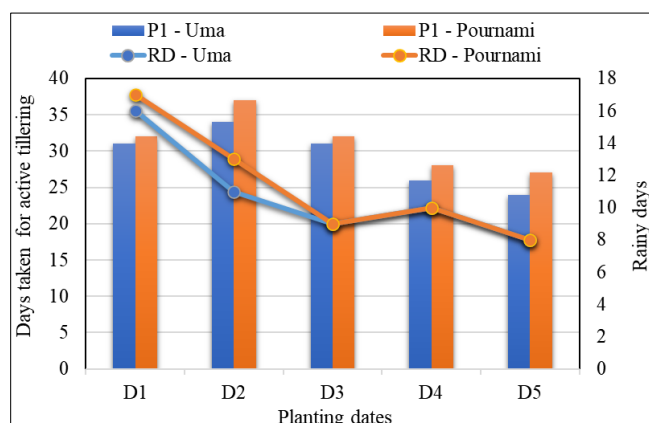


Fig 5: Influence of rainy days on duration at active tillering stage in Uma and Pournami

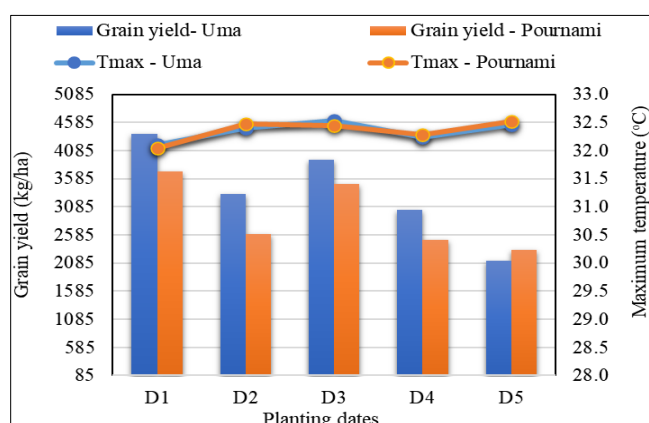


Fig 6: Influence of maximum temperature on grain yield at physiological maturity stage in Uma and Pournami

Conclusion

The study revealed that different planting dates had significant effect on rice phenology. The phenophase duration significantly reduced from early planting to delayed planting in both *Uma* and *Pournami*, rice varieties. The significant negative influence of maximum temperature, BSS and evaporation rate during panicle initiation to physiological maturity periods affected the crop duration in both the varieties under study, viz., *Uma* and *Pournami*. The reduction in rainfall and rainy days during critical stages of growth also influenced the duration of rice. It was observed that *Uma* (MO16) variety performed better than the new variety *Pournami* (MO 23) during the field experiment. The study on phenology revealed that crop duration decreased from early planting to late planting in both varieties. Grain yield was significantly affected by the planting dates in both varieties. September 5th planting produced the highest grain yield in both *Uma* (4388.8 kg ha⁻¹) and *Pournami* (3715 kg ha⁻¹) varieties, while November 5th planting produced the lowest yield in *Uma* (2118.8 kg ha⁻¹) and *Pournami* (2313.8 kg ha⁻¹). Planting dates also had a significant impact on yield attributes, following a similar pattern. The study's findings demonstrated that the ideal time to plant the most popular variety *Uma* and promising new variety *Pournami* is crucial for any crop to reach its maximum yield potential because it is impacted by a number of meteorological factors. In order to allow the crop to better exploit the weather factors, the study advises early sowing of the crop starting on September 5th instead of late sowing in October/November.

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