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Heat Unit Requirement of Different Rice Varieties Under Chhattisgarh Plain Zones of India

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Abstract

Field experiment was carried out during *kharif* season of 2012 at Research and Instructional Farm of Indira Gandhi Agricultural University, Raipur to examine yield and Heat unit requirement of rice with three genotypes as influenced by three sowing dates in factorial Randomized Block Design. Higher grain yield was recorded with Mahamaya as compared to Karma Mahsuri and MTU-1010 under 10th June sowing also with respect to heat units the cumulative growing degree day at maturity stage was (2410°C) for Karma Mahsuri followed by Mahamaya (2365°C) and MTU-1010 (2161°C) when sown on 10th June. Maximum growing degree days were observed in early sown crop (10June) as compared to late sown crop (20 and 30June). Similar results were found in the case of photo thermal unit and helio thermal unit also. At maturity stage, highest radiation use efficiency in 10th June sowing might be due to better conversion of light in to dry matter, better yield component and harvest index in 10th June sowing as compared to 30th June sowing.

Keywords: Growing degree days; Pheno thermal unit; Heat use efficiency; Helio thermal unit; Sowing dates

Introduction

Weather and climate greatly influence the agricultural productivity in any region. Agricultural production and productivity of any region is being regulated by the prevailing climate of that area through temperature, rainfall, light intensity, radiation, sunshine duration etc. [1]. The importance of temperature and humidity in enhancing plant nutrient availability and absorption and also the role they play in disease and pest infestation is well documented.

Rice is the most consumed cereal grain in the world constituting the dietary staple food of more than half of the world population. Apart from food rice is intimately involved in the culture as well as economy of many societies. India is the second largest producer of rice after China having an over of 44.10 million hectare with the production of 105.31 million tonnes (United State Department of Agriculture, 2011-12).

Chhattisgarh popularly known as "Rice Bowl of India" occupies an area around 3610.47 thousand hectare with the production of 5.48 Mt and productivity of 1517 kg per hectare [2].

Materials and Methods

The experiment was set at Research and Instructional farm of Indira Gandhi Krishi Vishwavidyalaya; Raipur situated in Eastern Central part of Chhattisgarh at latitude of 21°.16' N, longitude 81°.36' E and altitude 289.5 m above mean sea level. The present experiment was conducted during the *kharif* season of 2012. Three rice cultivars, *viz*. Karmamasuri, Mahamaya and MTU-1010 were used and cultivated in a factorial Randomized Block Design (RBD) with three sowing dates. The GDD, PTU, HTU, PAR and HUE were computed by using following formula:

Accumulated Growing Degree Days (GDD)

$$GDD = \sum [(Tx + Tn)/2 - Base\ temperature]$$

where,

Tx=Daily maximum temperature

Tn=Daily minimum temperature

Accumulated Photothermal Unit (PTU)

PTU is calculated by multiplying GDD with maximum possible sunshine hours (N)

$$PTU = GDD\ X\ N$$

where,

N = maximum possible sunshine hour.

Accumulated Heliothermal Unit (HTU)

HTU is calculated by multiplying GDD with actual sunshine hours (n)

$$HTU = GDD\ X\ n$$

where,

n = actual sunshine hour.

Heat Use Efficiency (HUE)

Heat Use Efficiency (HUE) for total dry matter was obtained as under

$$HUE\ \left(g/m^{2^-}/^{0^-}day\right) = \frac{Biomass\ \left(g\ /\ m^2\right)}{GDD\ \left(^0 days\right)}$$

Radiation Use Efficiency (RUE)

$$RUE\ (gMJ^{-1}) = Biomass\ (g/m^2)\ /\ Radiation\ intercepted\ (M\ J/m^2/day)$$

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Grain yield (kg/ha)												
Varieties												
	D_1-10 June			**D_2-20 June**			**D_3-30 June**			**Mean**		
	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
Karma Mahsuri	5170	4559	6358	4870	4220	5885	3341	3505	5608	4460	4095	5950
MTU 1010	4789	3796	5446	4167	3339	5356	3163	3253	4847	4040	3462	5216
Mahama ya	4726	3790	6258	5156	3632	5181	4352	3554	4758	4744	3659	5399
Mean	4895	4048	6021	4731	3730	5474	3619	3437	5071	4415	3739	5522
	Dates			**Varieties**			**DX V**					
SEm±	116	78	131	116	78	131	201	135	227			
CD (P=0.05)	348	233	393	348	233	393	603	NS	NS			
CV (%)							7.9	6.24	7.13			

Table 1: Grain yield (kg/ha) of rice varieties as influenced by different sowing dates

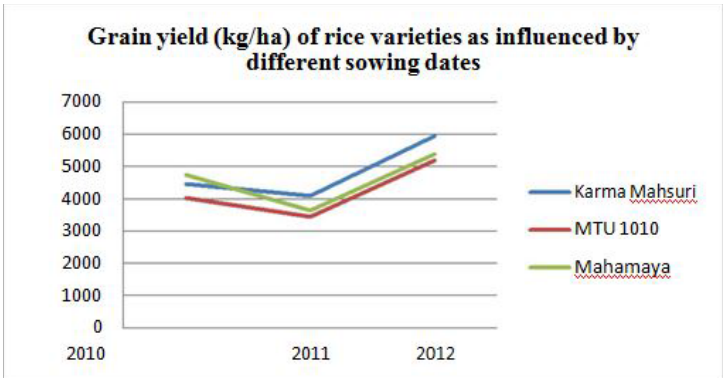

Figure 1: Grain yield trend of different rice varieties as influenced by different sowing dates in three successive years.

Results and Discussion

Grain yield (kg/ha)

Grain yield as influenced by different sowing dates are given in Table 1. Sowing dates and verities showed significant variation on grain yield. On the mean basis the higher grain yield (5950 kg/ha) was recorded in variety Karma Mahsuri followed by Mahamaya (5399 kg/ha) and MTU 1010 (5216 kg/ha). On an average the first date of sowing shows maximum yield (6021 kg/ha) followed by second date of sowing and then third date of sowing.

Figure1 shows on an average basis Grain yield trend of different rice varieties as influenced by different sowing dates in three successive years. It is clear from figure that karma masuri is the highest yielding verity (5950 Kg/ha) in the region followed by Mahamaya (5399 kg/ha).

Phenology and heat units

The heat units acquired by different varieties during growth stages are shown in Table 2.The higher GDD was accumulated in the first date of sowing during all the growth stages starting from planting to maturity. Among the different varieties the higher GDD was accumulated in Karma Mahsuri whereas, the least GDD accumulated in MTU 1010. From the table it was also observed that the highest Photo thermal Unit during maturity was recorded in 10th June sowing followed by 20th June sowing. Among the varieties the higher PTU was observed in variety Karma Mahsuri followed by Mahamaya, while the least PTU is observed in variety MTU-1010.

With regard to phenol thermal index the minimum values were recorded in 30th June sowing during all the stages and the maximum values were recorded in 10th June sowing. Among different rice varieties, Karma Mahsuri recorded minimum phenol thermal index whereas, the maximum phenol thermal index was observed in variety MTU-1010.

Yield attributes

The data on yield attributes are shown in Table 3. It was observed from the table that sterility % straw yield and harvest index were recorded highest with 10th June sowing, whereas the number of grains/panicle was recorded highest with 20th June sowing but the test weight and number of panicle/m^2 were recorded maximum with 30th June sowing among the different dates of sowing. Among the different varieties, the maximum values of number of grains/panicles, sterility %, number of panicle/m2 and harvest index was recorded in variety Karma Mahsuri. Whereas the maximum values of test weight were recorded in Mahamaya, straw yield was maximum in MTU-1010. It was also observed that first date of sowing D1 (10th June) got highest harvest index (45.96) followed by third date of sowing D3 (30th June) 42.73.

Highest radiation use efficiency in 10th June sowing might be due to better conversion of light in to dry matter, better yield component and harvest index in 10th June sowing as compared to 30th June sowing. Similar results are also reported [3-6].

Conclusion

Based on the above findings it was concluded that higher grain yield and straw yield along with the heat units *viz.* accumulated growing degree days, photo thermal unit, helio thermal unit, radiation use efficiency and heat use efficiency were recorded maximum in crop sown on 10th June as compared to on 20th June and 30th June sown.

Physiological	Karma Mahsuri			MTU 1010			Mahamaya		
Stages	**D1**	**D2**	**D3**	**D1**	**D2**	**D3**	**D1**	**D2**	**D3**
Phenology (Days)									
Planting	28	25	22	28	25	22	28	25	22
Tilliring	61	60	56	59	61	56	63	58	56
Panicle initiation	91	86	84	74	77	72	89	84	80
PanicleEmergence	108	102	99	89	94	88	105	100	93
Milking	114	109	106	98	102	97	112	108	102
Grain filling	126	119	116	108	112	107	112	118	111
Maturity	136	133	131	120	123	120	133	130	125
Growing degree-days (Cumulative)=Mean temp.-base temp.									
Planting	567	472	402	567	471	402	567	471	402
Tilliring	1114	1047	955	1078	1065	955	1147	1012	955
Panicle initiation	1640	1507	1458	1335	1349	1245	1605	1472	1385
Panicle Emergence	1945	1795	1729	1605	1650	1530	1891	1758	1621
Milking	2055	1922	1841	1765	1765	1693	2017	1903	1780
Grain filling	2256	2080	1995	1945	1972	1856	2195	2064	1920
Maturity	2410	2287	2209	2161	2143	2055	2365	2748	2210
Photothermal Units (Cumulative)=GDD*day length									
Planting	7530	6245	5313	7530	6245	5313	7530	6245	5313
Tilliring	14688	13723	12450	14237	13947	12450	15113	13278	12450
Panicle initiation	21357	19496	18702	17518	17557	16075	20924	19066	17808
Panicle Emergence	25701	23034	21971	20924	21259	19582	24441	22588	20707
Milking	26446	24528	23274	22889	23034	21551	25996	24316	22563
Grain filling	28793	26383	25085	25101	25120	23451	28082	26195	24204
Maturity	30604	28807	27533	17690	27116	25787	30098	28344	26542
Heliothermal Units (Cumulative)=GDD*SShr									
Planting	2449	1967	1399	2449	1967	1399	2449	1967	1399
Tilliring	3332	2851	2304	3239	2851	2304	3367	2817	2304
Panicle initiation	5035	4485	4270	3821	3955	3426	4923	4359	4030
Panicle Emergence	6474	6180	6340	4923	5040	4735	6125	5849	5532
Milking	7447	7110	7226	5581	6180	6061	7148	6950	6803
Grain filling	8964	8433	8452	6474	7573	7367	8541	8280	7956
Maturity	10190	10036	9644	8232	8994	8956	9962	9726	9436
Phenothermal index=GDD/days taken for each phenophase									
Planting	20	19	18	20	19	18	20	19	18
Tilliring	18	17	17	18	17	17	18	17	17
Panicle initiation	18	18	17	18	18	17	18	18	17
Panicle Emergence	18	18	17	18	18	17	18	18	17
Milking	18	18	17	18	18	17	18	18	17
Grain filling	18	17	17	18	17	20	17	17	17
Maturity	18	17	17	17	17	18	21	17	17

D1:-10 June 2012, D2:- 20 June 2012 and D3:-30 June 2012

Table 2: Influence of sowing dates on phenology and heat units of different rice varieties.

Treatments	Plant height (cm)	Number of grains/ panicle	Sterility (%)	Test wt. (g)	Straw yield (kg/ha)	Numbers of Panicle/m^2	Harvest Index
Sowing Dates							
D_1-10 June	83.8	145	20.2	26.2	7080.9	306	45.96
D_2-20 June	77.8	153	18.7	25.6	7022.1	298	43.80
D_3-30 June	80.0	148	19.3	25.5	6805.6	286	42.73
SEm±	0.82	0.38	0.7	0.3	175.9	5.8	1.87
CD (P=0.05)	NS	NS	2.1	NS	NS	NS	NS
Varieties							
Karma Mahsuri	76.0	214	25.0	18.48	7365.2	316	44.71
MTU 1010	84.1	108	12.8	26.84	6334.1	267	45.08
Mahamaya	81.5	124	20.5	31.90	7209.4	307	42.70
SEm±	1.42	6.6	0.7	0.3	175.9	5.8	1.08
CD (P=0.05)	2.46	11.4	2.1	0.8	527.3	10.1	NS
SEm ± (DxV)	1.42	6.6	1.2	0.5	304.7	10.3	1.87
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS
CV (%)		8	10.9	2.5	7.57	5.9	7.31

Table 3: Yield attributes of rice as influenced by different sowing dates.

On the other hand it can be concluded that early sowing dates is better than delayed sowing. With respect to varieties Karma Mahsuri recorded maximum grain yield and straw yield along with heat units *viz*. growing degree day, photo thermal and helio thermal units whereas, radiation use efficiency and heat use efficiency were maximum in Mahamaya.

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