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Research Article

STUDY OF PHYSIOLOGICAL RESPONSE AND YIELD OF RICE (*ORYZA SATIVA* L.) VARIETY HASANTA UNDER DIFFERENT DATES OF TRANSPLANTING AND NITROGEN LEVELS

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Abstract: A field experiment was conducted during Kharif season of 2018 at Research Farm of Odisha University of Agriculture and Technology, Bhubaneswar, India to study the physiological response accumulated growing degree days (GDD) and photo thermal units (PTU) of rice variety 'Hasanta' under different dates of transplanting and nitrogen levels. The rice variety 'Hasanta' was transplanted on four dates viz., 20th July, 30th July, 10th August and 20th August laid in main plot with three levels of nitrogen 75%, 100% and 125% of recommended dose of fertilizer, respectively laid in sub plot replicated thrice. The crop transplanted on 20th July took maximum duration to attain physiological maturity (143 days). Highest growing degree days (2651) for maturity and photo thermal units (31498 degree day hours) accumulated when transplanted on 20th July. Planting on 20th July with application of 125% recommended dose of nitrogen produced maximum grain yield of 47.02 q ha^{-1}.

Keywords: *Rice variety 'Hasanta', Dates of transplanting, Nitrogen levels, Yield, GDD and PTU*

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Introduction

Rice is the staple food for more than 65 per cent of the people and it provides employment and livelihood security to 70 per cent of Indian population and providing 21% of the total calorie intake [1]. Globally, rice occupies an area of 163 million hectares, with a production of 744.4 million tonnes [2]. In India, it occupies an area of 43.8 million ha and a production of 105 million tonnes, with average productivity of 2.21 t/ha. Demand for rice growing is increasing every year, and it is estimated that by 2025 AD, its requirement would be 140mt. To meet the future generations food requirement and to make self-sufficient for present food requirement, the annual productivity of India should increase by 3% [3]. The production of rice is mainly affected by various meteorological variables like rainfall, temperature and solar radiation etc [4]. During crop growth period, the occurrence of various phenological events can be estimated by computing accumulated growing degree days [5]. Crop phenology is an essential component of weather based dynamic crop growth and yield simulation models and can be used to estimate the most appropriate date and time of specific development process .In the present study, an attempt is made to predict the growth and yield of rice with agro-climatic indices viz. growing degree days, photo-thermal units. Planting time is the major factor that determines the productivity of a crop. Optimum planting time for a crop is location specific. It increases the rain water use efficiency as compared to the delayed planting. It ensures that vegetative growth occurs during a period of satisfactory temperatures and high levels of solar radiation. Sowing on time guarantees that grain filling occurs when milder autumn temperatures are more likely, hence good grain quality is achieved [6]. Among all the elements present in soil, Nitrogen is the key element for the production of rice and gives a better result. The management of N fertiliser is another important factor that influences the growth and development along with the yield and yield components of transplanted rice. Balanced application of fertilisers ensures the growth of plant properly and helps to increase the dry matter of the plant. Application of imbalanced fertilizer than the optimum never shows a better result. Nitrogen application in right time in right dose has to be ensured as yield and quality of rice crop which requires as much as possible at an early and mid tillering stages to maximize panicle numbers and during reproductive stages to produce a greater number of spikelets per panicle and percentage filled spikelets [7]. Keeping these points in view, an experiment was conducted to observe the growth and yield of rice variety under different dates of transplanting and levels of nitrogen.

Materials and methods

The field experiment was carried out during kharif season of 2018 at Research Farm of College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, situated at an elevation of 25.9 m above mean sea level at 20°15'N latitude and 85° 52'E longitude. It falls under the East & South East Coastal Plain of Odisha. The weekly mean maximum temperature during the crop growth period ranged from 27.1 to 35.7 °C, with a weekly average of 32.3 °C, whereas, the monthly mean minimum temperature varied from 14 to 25.9 °C with a weekly average of 22.9 °C. The mean bright sunshine hour received during the crop growth period varied from 4.4 to 8 hours, with a weekly average of 6.2 hours. The total rainfall received during the crop growth period was 766.8 mm with total of 47 rainy days. The experiment was laid out in a split plot deign with four dates of transplanting *i.e.* 20th July (D1), 30th July (D_2), 10th August (D_3) and 20th August (D4) in main plots and three levels of nitrogen 75% (N_1), 100% (N_2), 125% (N_3) of RDF in sub plots replicated thrice. The recommended dose of fertilizer was (RDF) 80:40:40 kg NPK ha^{-1}. Test variety 'Hasanta' is one of the highly adaptable rice cultivars of Odisha. It is a semi-dwarf, late duration variety (140-150 days). It is most suitable for rain fed low lands ecosystem and is moderately resistant to leaf blast, BLB and tolerant to sheath rot.

Table-1 *Meteorological data during cropping season*

Month	Temperature		Relative Humidity		Bss	Rainfall
	Max.	Min.	Max.	Min.	(Hour)	(Mm.)
June	34.6	25.8	90	67.5	5.15	210.2
July	32.4	26.0	93.6	77.8	2.44	602.8
August	32.3	25.9	93.5	78.7	3.32	456.7
September	32.6	25.3	93.5	73.7	4.75	345.9
October	32.5	22.7	94	59.8	6.7	233.2
November	31.3	18.1	92.2	45.7	7.4	0.0
December	28.8	15.9	91	43.5	5.4	0.0

Table-2 *Physio-chemical properties of experimental soil*

SOIL PROPERTIES	VALUES
Soil Texture	Clayey loam
Bulk Density (g cm^{-3})	1.16
pH	5.55
EC (dSm^{-1})	0.90
OC (%)	1.02
Available N (kg ha^{-1})	168.35
Total P_2O_5	22.14
Total K_2O	290

Table-3 *Effect of treatments on crop duration, plant height, Dry matter, and LAI at maturity*

Treatment combination	Crop Duration (Days)	Plant height at maturity (cm)	Dry matter Production (g/m^2)	LAI
D1N1	141	124.1	1245.2	3.47
D1N2	143	124.7	1390.1	3.83
D1N3	145	123.4	1532.5	3.95
D2N1	142	111.2	1066.9	3.46
D2N2	144	111.3	1245.9	3.65
D2N3	145	110.7	1349.0	3.85
D3N1	141	110.7	879.7	2.8
D3N2	143	111.2	1023.9	3.51
D3N3	145	112.0	1110.2	3.51
D4N1	139	112.2	822.1	2.7
D4N2	142	110.4	979.0	3.32
D4N3	143	110.5	1075.9	3.31
SEm ±	-	1.99	48.03	0.10
CD (0.05)	-	6.24	140.2	0.28

Table-4 *Effect of treatments on yield and yield attributes*

Treatment combinations	No. of Panicles/sq.m.	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})	Harvest Index (%)	TEST Weight (g)
D1N1	281.25	37.25	47.03	44.2	21.16
D1N2	295.01	45.60	52.68	46.4	21.69
D1N3	300.26	47.02	53.02	47.0	21.76
D2N1	279.9	36.08	48.22	42.8	21.12
D2N2	293.66	43.60	50.16	46.5	21.65
D2N3	298.91	45.90	50.53	47.6	21.73
D3N1	276.76	33.20	49.18	40.3	21.04
D3N2	290.52	37.10	49.58	42.8	21.57
D3N3	295.76	38.95	50.80	43.4	21.65
D4N1	264.86	30.10	43.32	41.0	20.56
D4N2	278.62	32.10	45.25	41.5	21.09
D4N3	283.87	33.25	45.36	42.3	21.17
SEm ±	4.07	1.48	0.46	0.40	0.17
CD (0.05)	11.86	4.32	1.48	1.29	0.51

Phenological observations like plant height, no. of tillers/hill, canopy coverage (LAI), dry matter, yield and yield attributes like no. of effective tillers or panicles/hill, no. of filled grains/panicle and test weight were taken in growth stage wise. Harvest index, HTU, PTU, GDD and economics of cultivation were computed.

Growing degree days (GDD), HTU and PTU were calculated through these formulae.

$GDD = [(T_{max} + T_{min})/2] \times T_{base}$

Where,

T_{base} = Minimum threshold/base temperature (°C),

T_{max} = Daily maximum temperature (°C),

T_{min}= Daily minimum temperature (°C)

$HTU = \Sigma \{GDD \times BSS (n)\}$

Where,

GDD = growing degree days,

BSS (n) = bright sun shine hours (hrs)

$PTU = \Sigma (GDD \times N)$

Where,

GDD = Growing degree days,

N = Maximum possible sunshine hours or day length (hrs)

Results and Discussion

Crop duration of HASANTA variety of rice varied between 139-145 days, depending upon different dates of transplanting and levels of Nitrogen. Highest plant height documented in D1N2 (124.7cm) followed by D1N1 (124.1cm) whereas, least plant height found in D4N2 (110.4cm). Early transplanting gave higher plant height may be because of more temperature in July.

At the maturity stage significantly the highest amount of dry matter production found in D1N3 (1532.5g/m^2) and the lowest amount observed in D4N1 (822.1g/m^2). The highest Leaf Area Index (LAI) observed in D1N3 (3.95) and minimum Leaf Area Index (LAI) observed in D4N1 (2.7). The number of panicles/m^2 not much varied among different treatments which was found highest in D1N3 (300.26) and the minimum number of panicles/m^2 was found in D4N1 (264.86). The grain yield of Rice variety HASANTA obtained maximum in D1N3 (47.02 q ha^{-1}) followed by D2N3(45.90 q ha^{-1}) and D1N2(45.60 q ha^{-1}). The least grain yield obtained in D4N1 (30.10 q ha^{-1}). The highest amount of straw yield found in D1N3 (53.02 q ha^{-1}) whereas, lowest in D4N1 (43.32 q ha^{-1}). The Harvest index at maturity stage was found maximum in D3N1 (40.3%) and the minimum in D2N3 (47.6%). The test weight of HASANTA rice variety not influenced by different levels of nitrogen but late planting (D4) leads significantly lower test weight.

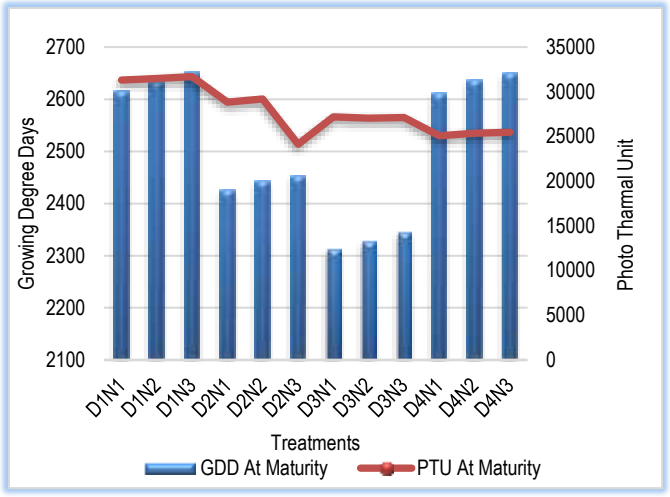

Fig-1 Variation of GDD and PTU over treatments

Data presented in [Fig-1] showed that planning dates have significantly differences for GDD and PTU. Planting on D1 and D3 accumulated highest GDD whereas; the rate of GDD accumulation is lesser in D2 and least in D3. Higher PTU accumulation (31498) calculated in early planting date (D1). Early plantings are more likely to react to changes in temperature than later plantings [8].

Conclusion

Transplanting in early July with recommended dose of nitrogen can produce higher rice yield and accumulate higher GDD.

Application of research: To find out the future crop yield by changing temperature (GDD & PTU)

Research Category: Agro-meteorology

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Study area / Sample Collection: Research Farm of College of Agriculture, Bhubaneswar, 751003, Odisha, India

Cultivar / Variety / Breed name: *Oryza sativa* L

Conflict of Interest: None declared

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Ethical Committee Approval Number: Nil

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