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Effect of temperature and rainfall different growth stages and yield of rice (*Oryzae sativa* L.)

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Abstract
Effect of temperature and rainfall is the most important environmental factors influencing crop growth, development, and yield processes. The experiment was conducted at Sam Higginbottom Institute of Agriculture, Technology & Sciences Allahabad during summer season where temperature during July and August reaches above and lowest 36^0 C, with different date of sowing and varieties (D_1 V_1, D_2 V_2 and D_3V_3 with gap 10days) the plant material were subjected to different temperature and rainfall at productive stage. The seed yield was highest under D_2 which sown mid of July where temperature is 35^0C followed by D_1 which sown first week of July where temperature is 37^0C and lowest yield was recorded in D_3 which sown on first week of august where temperature is 30^0C which is not suitable for rice yield production.

Keywords: temperature, variety, rice and rainfall.

Introduction
Rice is the most important crop in Asia, which is home to three-fifths of humanity. The area sown under rice crop is 3.8 million hectare. The prime cause of low productivity of rice in the state is that, only 21.7% area is under irrigated and rest is rainfed (Sharma, 2006) [5]. High temperature (heat) stress is considered to be one of the major environmental factors limiting crop growth and yield. This stress induces many biochemical, molecular, and physiological changes and responses that influence various cellular and whole plant processes that affect crop yield and quality. The impacts of environmental stress, particularly those of drought and heat, have been studied, independently. However, under field conditions, both of these stresses often occur in combination (Mittler, 2006). Heat stress (increase in above-optimum air temperature) often occurs, but they can have very different effects on various physiological growths, development, and yield processes. The rise in atmospheric temperature causes detrimental effects on growth, yield, and quality of the rice crop by affecting its phenology, physiology, and yield components
(Singh 2001, Sheehy *et al.* 2005, Peng *et al.* 2004) [7, 6, 3]. The sensitivity of rice to high temperature varies with growth phase, an increase in day/night temperature and genotype (Yoshida 1981, Singh 2001, Peng *et al.* 2004) [7, 3]. The growth of a rice plant can be broadly divided into three phases: vegetative, reproductive and ripening or grain filling (Maclean *et al.* 2002 and Yoshida, 1981). The vegetative phase culminates with panicle initiation (PI), the reproductive phase with anthesis (flowering) and grain-filling at grain maturity. The genotype of the rice plant largely defines the characteristics of each phase, although the growth environment of the plant also contributes to the overall source-sink dynamics of the plant (Dingkuhn and Kropff, 1996). The impact of increased temperature has an accumulative effect on the later phases of plant development; changes in the vegetative and ripening phase will alter the grain-filling phase and thus, the grain quality of the rice. The present study was undertaken with the following major objectives: To understand the effect of temperature and rainfall stress on yield of rice.

Materials and Methods
The present study was conducted at the Research Farms, Sam Higginbottom Institute of Agriculture, Technology & Sciences Allahabad. The climate conditions of Allahabad is subtropical where temperature during July and august reaches above 40 ^{O}C. The temperature during Summer season (2014). Different date of transplanting (D) 13/07/2014, 23/07/20114 and 03/08/2014 with different verities (V) pusa basmati 1121, pusa basmati 1 and SHIATS Dhan1. In our experiments we tried to expose our genotypes to high temperature at reproductive stage, which is a serious problem of this region. To coincide with the high

temperature during reproductive stage of crop three different dates of sowing was done. The experimental details are presented in table 1. All the normal agronomic practices were followed to raise a good crop.

Five competitive plants were selected from each entry, each replication and from each environment for the recording of the observations on yield and yield attributing parameters. The parameter was recorded shoot length (cm), number of tillers, panicle length (cm), and yield.

The data was subjected to RBD design with two replication for various statistical analysis *viz.*, analysis of variance (Fisher, 1935).

Results and discussion

Table no. 1 show that the all growth parameters such as shoot length (95.00, 96.73 and 87.95 cm), number of tillers (24.40, 25.240 and 23.30), panicle length (29.11, 30.33 and 29.133 cm) and number of grain per panicle (172.14, 173.23 and 170.23) was highest recorded in first week of July followed by mid week of July where, shoot length (84.17, 87.16 and 83.00 cm), number of tillers (21.30, 23.06 and 21.03), panicle length (27.20, 28.13 and 27.06 cm) and number of grain per panicle (166.26, 168.26 and 165.23) and lowest shoot length (81.53, 82.76 and 79.57 cm), number of tillers (18.36, 19.48 and 18.31) panicle length (26.06, 28.26 and 27.20 cm) and number of grain per panicle (159.23, 160.26 and 157.26) was recorded in first week of august, where three variety are used *viz* Pusa basmati 1121, Pusa basmati 1 and SHIATS Dhan 1. Similar accordance Prerna Shrivastava *et al* 2012 [4] evaluate the temperature effect against the rice growth parameters and yield. Singh 2001, Peng *et al.* 2004 [7, 3] also reported the vegetative phase culminates with panicle initiation (PI), the reproductive phase with anthesis (flowering) and grain-filling at grain maturity. The genotype of the rice plant largely defines the characteristics of each phase, although the growth environment of the plant also contributes to the overall source-sink dynamics of the plant

Indicate (table no.1) the maximum yield was recorded in Pusa basmati 1121 (44.13q/ha), Pusa basmati 1(43.13q/ha) and SHIATS Dhan 1 (43.10q/ha), when transplanting done on first week of July followed by Pusa basmati 1121 (42.10q/ha), Pusa basmati 1(40.50q/ha) and SHIATS Dhan 1(40.03q/ha), which planting done on mid week of July and minimum yield was recorded in first week of august where, yield 39.63q/ha (Pusa Basmati 1121), 38.76q/ha (Pusa Basmti 1) and 37.96q/ha (SHIATS Dhan 1) Similar accordance kernel elongation is probably independent of physio-chemical properties, shape, size and weight of rice grain (Hussain *et al.* 1987) [2]. Auffhammer *et al* 2011 [1] also reported the climatic change and monsoon directly affect the rice yield.

Table 1: Effect of different date of transplanting and verities on the growth parameters and yield of rice

	Date of transplanting (D)	Varieties (V)			CD (0.05%)
		V_1	V_2	V_3	
Plant height (cm)	D_1 (13 July 2014)	95.000	96.733	87.956	Due to Varieties = 18.404
	D_2 (23 July 2014)	84.170	87.166	83.000	Due to Date = 8.152
	D_3 (03 August 2014)	81.533	82.766	79.576	Due to interaction = 5.459
Number of tillers	D_1 (13 July 2014)	24.403	25.240	23.300	Due to Varieties = 8.399
	D_2 (23 July 2014)	21.300	23.066	21.036	Due to Date = 2.652
	D_3 (03 August 2014)	18.366	19.483	18.313	Due to interaction = 0.534
Number of grain/ panicle	D_1 (13 July 2014)	172.143	173.233	170.233	Due to Varieties = 19.518
	D_2 (23 July 2014)	166.266	168.266	165.233	Due to Date = 4.52
	D_3 (03 August 2014)	159.233	160.266	157.266	Due to interaction = 0.919
Panicle length	D_1 (13 July 2014)	29.116	30.333	29.133	Due to Varieties = 3.842
	D_2 (23 July 2014)	27.200	28.133	27.066	Due to Date = 2.274
	D_3 (03 August 2014)	26.066	28.266	27.200	Due to interaction = 1.179
Yield q/ha	D_1 (13 July 2014)	43.133	44.033	43.300	Due to Varieties = 7.059
	D_2 (23 July 2014)	40.500	42.100	40.033	Due to Date = 2.326
	D_3 (03 August 2014)	38.766	39.633	37.966	Due to interaction = 1.152

V1= Pusa Basmati 1121, V2= Pusa Basmati 1 and V3= SHIATS Dhan 1

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