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Effect of chemical priming on growth characteristics of few varieties of rice (*Oryza sativa* L.) under moisture stress condition

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Abstract
A pot experiment was conducted to investigate the effect of chemical priming treatments on growth performance of rice varieties during *kharif* season of 2019 at poly house of College of Agriculture, Central Agricultural University, Imphal. Treatment consists of three variety of rice viz. CAU-R1, keibu-chiro and Kiophou and two priming chemical viz. 2% KNO_3, and 50 ppm Salicylic acid with one control (no priming). Water stress were created in each pot by maintaining soil moisture level at 32% by using soil moisture meter. The results revealed that seeds primed with 2% KNO_3 had significantly higher in plant height, number of leaves per plant, leaf length, leaf area and leaf area index as compared to 50 ppm salicylic acid and control. Among varieties, CAU-R1 showed greater in number of leaves per plant, leaf area and leaf area index. However, plant height and leaf length was found maximum in Kiophou variety.

Keywords: Chemical priming, KNO_3, rice and water stress

Introduction
Rice (*Oryza sativa* L.) is the staple food for more than half of the world's population and is grown in at least 95 countries (IRRI, 2002) [10]. It is one of the most widely cultivated cereals of the world and can be grown in different habitats as lowland, irrigated and upland. It is a nutritious cereal crop, provided 20% of the total calories and 15% of protein requirements of world population. Drought is the major obstacle for rice production in rainfed ecosystems and becoming a serious constraint for crop productivity worldwide. Reduction of plant growth is the most typical symptom of drought stress (Sairam and Srivastava, 2001) [18]. The reaction of plants to dry season pressure is complex and being the most significant natural pressure, dry spell leads to changes in their morphology, physiology and metabolism that seriously influenced plant development and advancement more than some other ecological components. According to climate models prediction, drought is expected to threat more than 50% of arable lands by 2050 (kalhori *et al*. 2018) [12].
Pre sowing seed treatment i.e. seed priming is used as an alternate means to overcome the deleterious effects of abiotic stresses in agricultural production because of its low cost and risk. It enhances seed germination and seedling vigour particularly under unfavourable condition, leading to better stand establishment and yield. Seed priming is the repeated soaking and control seed hydration in solution containing organic or inorganic solutes followed by re-drying that allows pre-germinative metabolic activities but prevent radical rise. Seed hardening treatments improves seeds vigour by protecting structure of the plasma membrane against injury during environmental stress. For selecting the rice varieties that can tolerant drought, several morphological, physiological, and biochemical traits associated with the crops need to be identified. Rice varieties response differently with respect to seed priming treatments under drought condition. Hence, identification of rice varieties which performed better under moisture stress environment is necessary to enhanced most of the seedling performance, plant growth characteristics and yield of crops. Therefore, the present study was undertaken to evaluate the effect of chemical priming techniques on growth performance of different rice varieties under moisture stress conditions.

Materials and Methods
The present investigation was conducted as pot experiment at the poly house of College of Agriculture, CAU, Imphal during *kharif* seasons of 2019.

The experimental site is located at 24.45^0N latitude and 93.56^0E longitudes at an elevation of 790 m above mean sea level. Soil is clayey and acidic in nature (pH 5.6), high in available organic carbon (1.3%), medium in available nitrogen (306.4 kg/ha), available phosphorus (22.97 kg/ha) and available potassium (227.3 kg/ha). The experiment was laid out in factorial randomized block design (FRBD) with 9 treatments and 3 replications. Treatment consists of three variety of rice (V_1: CAU-R1, V_2: keibu-chiro and V_3: Kiophou) and two priming chemical with one control (no priming) (C_0: control, C_1: 2% KNO_3, and C_2: 50 ppm Salicylic acid). Before sowing, seeds of rice varieties were soaked overnight (12 hours) separately in KNO_3 (2%) and salicylic acid (50ppm) solution. Then seeds were toughly washed with distilled water and soaked in it for another 8 hours before kept to germinate. Non primed seeds were taken as untreated control. After 15 days of sowing, seedlings were thinned retaining only four seedlings per pot with spacing 10cm x 10cm. Required quantities of fertilizers for 10 kg of soil were calculated from the recommended dose of NPK 60:40:30 Kg/ha and applied by mixing with soil using urea, single super phosphate and murate of potash as a source of N, P, and K, respectively. Half of the nitrogen and full dose of P_2O_5 and dose of K_2O were applied as basal dose just a day before the sowing of germinated seeds and well incorporated into the soil. The remaining half dose of nitrogen was applied at the active tillering stage and panicle initiation stage respectively. Data were recorded at 30, 60 90 DAS and at harvest stage. Leaf area was calculated by using the formula (Murata *et al*. 1967) [15].

Leaf area= Number of leaves per hill x Average leaf length x Average leaf width x 0.66

The data obtained were subjected to analysis of variance (ANOVA) for testing the significance of the treatment effects and interpretation of the result (Gomez and Gomez,1984).

Results and Discussion

Influence on growth parameters

Effect of varieties

The data of the present study showed that different variety response significantly different with respect to growth attributes due to variation in genetic characteristics of varieties under a given environmental conditions. Plant height differ significantly due to different variety from 60 DAS onwards. Data on Table 1 regarding plants height showed that variety Kiophou recorded significantly higher plant height as compared to CAU-R1 and Keibu-chiro. The variation in plant height might be due to the genetic variability and variation in growth behaviour as reported by Hossain *et al.(*2016) [8] in rice crop. The number of leaves per plant did not differ significantly at 30 DAS but showed significant effect at 60, 90 DAS and at harvest stage. Significantly maximum number of leaves per plant was recorded in CAU-R1 (Table 1). Table 2 represents leaf length of different rice varieties and recorded that highest leaf length was obtained in variety Kiophou which was significantly superior to Keibu-chiro and CAU-R1. When plant leaf area increased, photosynthetic activity also increased. Among different varieties, CAU-R1 recorded significantly maximum leaf area at all the stages of crop growth over the rest of the variety (Table 3). The variation may be due to inherent characteristics of varieties. Study regarding leaf area index of rice varieties (Table 3) showed that significantly highest leaf area index was recorded in variety CAU-R1 and lowest value in Kiophou variety. To know the size of photosynthetic machinery of a plant, leaf area index is measured. The leaf area index (LAI) of rice plant increased up to 90 DAS and thereafter it decreased gradually towards maturity due to senescence of leaves. The difference in leaf area index among variety might be due to the variation in the genetic makeup of the variety. Similar results was also recorded in rice by Hussain *et al*. (2014) [9] who reported that leaf area index influenced by variety.

Effect of Chemical priming

Seed priming had significant positive effect on growth attributes of different rice varieties. 2% KNO_3 treated seeds maintained significantly superior plant height at all stages of crop growth except 30 DAS (Table 1). The increase in plant height might be due to enhancement of cell elongation, cell division and enlargement by chemical priming. These findings are in accordance with the results reported by Jalilian *et al*. (2014) [11] in barley, Abnavi and Ghobadi (2012) [1] in wheat. The present results that KNO_3 priming increased plant height is in conformity with the study done by Sharma and Bose (2006) [19] in wheat and Srivastava and Bose (2012) [20] in rice. The plant height was lowest in control, results indicated that plant height decreased with increasing soil moisture stress. It might be due to inhibition of cell division or cell enlargement under water stress. Data on Table 1 showed that chemical priming of seeds with 2% KNO_3 obtained maximum leaves number per plant which was significantly higher over the 50 ppm salicylic acid treatment and control. Increased in leaves number may be due priming treatment with potassium nitrate which improved nutrient uptakes of the plants. Similar results also reported in wheat by Misra and Dwivedi (1980) [14], Pawar and kadam (1981) [16] and Srivastava and Bose (2012) [20] in rice. The lowest leaves number was obtained in control. Water stress restrict photosynthesis and produce less amount of assimilates which resulted in lower number of leaves. The results of the experiment are in agreement with Hossain (2001) [7] in rice. Table 2 represent leaf length of rice varieties under moisture stress conditions. Data predicted that leaf length was significantly influenced by chemical priming from 60 DAS onwards. Seeds primed with 2% KNO_3 obtained maximum leaf length which was significantly superior to 50 ppm salicylic acid priming and control which recorded the minimum leaf length. This might be due the positive effect of KNO_3 priming that stimulate the biosynthesis of nucleic acids, proteins and enhancing the cell division along with improving metabolic activity of the plant resulting in the increased uptake of nutrients and enhanced the crop growth (Pawar *et al*. 2003) [17], also due to improvement in root development and maintain turgor pressure which helps in leaf expansion. Significantly maximum leaf area was recorded in treatment with 2% KNO_3 (Table 3). This might be due increased in nutrient uptake by seeds priming which improved root development and vegetative growth of plants resulted in increased leaf area of the plant. The present finding is in conformity with the study of Pawar and kadam (1981) [16] and Misra and Dwivedi (1980) [14] in wheat, Srivastava and Bose (2012) [20] and Galahitigama and Wathugala (2016) [5] in rice. The minimum leaf area was obtained in control which may be due to water stress that affected leaf expansion. Hence, reduction in leaf area results in reduction in area of photosynthetic tissue as well photosynthesis causes a great deal when plant exposed to water stress. Decreased soil moisture levels produced lower leaf area which might be due to inhibition of cell division of meristematic tissue under water stress condition. The results of the experiment are in agreement with Aggarwall and Kodundal (1988) [2] in wheat, and Hossain (2001) [7] in rice cultivars. At all the stages of recording, seeds primed with 2% KNO_3 recorded maximum leaf area index which was significantly superior to 50 ppm salicylic acid and control (Table 3). Increased in leaf area index with seed priming may be due to enhancement of physiological activities which provide food reserve to developing seeds and improved the performance of growing plants. Present study is in conformity with the finding of Eshanna and Kulkarni (1990) [3] in maize, Maitra *et al*. (1998) [13] in fingermillet, Pawar and kadam (1981) [16] in wheat and Farooq *et al*. (2006) [4] in rice.

Table 1: Plant height and number of leaves per plant as influenced by chemical priming on different rice variety

Treatment	Plant height				Number of leaves per plant			
	30 DAS	60 DAS	90 DAS	Harvest	30DAS	60 DAS	90 DAS	Harvest
Variety								
V_1	35.66	63.96	97.58	101.14	6.42	10.08	13.77	11.17
V_2	35.64	62.18	94.49	97.19	6.16	9.12	12.02	10.23
V_3	37.11	78.79	119.1	120.12	5.66	7.74	9.76	7.84
SE d (±)	0.72	0.89	0.72	0.87	0.30	0.21	0.14	0.34
CD (P=0.05)	NS	1.88	1.53	1.84	NS	0.45	0.29	0.71
Chemical priming								
C_0	35.52	65.00	101.04	102.69	5.69	7.56	9.33	7.72
C_1	36.43	71.35	106.01	109.49	6.36	10.04	13.52	11.24
C_2	36.45	68.48	104.11	106.17	6.18	9.34	12.70	10.29
SE d (±)	0.72	0.89	0.72	0.87	0.30	0.21	0.14	0.34
CD (P=0.05)	NS	1.88	1.53	1.84	NS	0.45	0.29	0.71
Interaction (VxC)								
SE d (±)	1.25	1.53	1.25	1.50	0.52	0.37	0.24	0.58
CD (P=0.05)	NS	3.25	2.65	3.19	NS	0.79	0.50	1.23

Table 2: Leaf length (cm) as influenced by chemical priming on different rice variety

Treatment	Leaf length (cm)			
	30 DAS	60 DAS	90 DAS	Harvest
Variety				
V_1	26.39	40.17	52.26	49.24
V_2	24.84	38.31	49.64	46.82
V_3	24.30	44.23	55.22	53.68
SE d (±)	0.99	0.68	0.62	0.69
CD (P=0.05)	NS	1.45	1.32	1.46
Chemical priming				
C_0	24.19	38.54	49.92	47.18
C_1	25.89	43.32	54.57	52.03
C_2	25.45	40.84	52.63	50.53
SE d (±)	0.99	0.68	0.62	0.69
CD (P=0.05)	NS	1.45	1.32	1.46
Interaction (VxC)				
SE d (±)	1.71	1.18	1.08	1.19
CD (P=0.05)	NS	2.51	2.3	2.53

Table 3: Leaf area and Leaf area index as influenced by chemical priming on different rice variety

Treatment	Leaf area				Leaf area index (LAI)			
	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest
Variety								
V_1	61.77	260.01	514.07	277.69	0.62	2.60	5.14	2.78
V_2	50.49	230.23	408.36	249.47	0.50	2.30	4.08	2.49
V_3	58.37	213.59	381.37	220.47	0.58	2.14	3.81	2.20
SE d (±)	2.67	4.09	5.45	7.06	0.03	0.04	0.05	0.07
CD (P=0.05)	5.64	8.67	11.55	14.98	0.05	0.09	0.12	0.15
Chemical priming								
C_0	50.61	184.19	333.97	200.88	0.51	1.84	3.34	2.01
C_1	63.29	269.38	493.96	285.52	0.63	2.69	4.94	2.86
C_2	56.74	250.27	475.86	261.24	0.57	2.50	4.76	2.61
SE d (±)	2.67	4.09	5.45	7.06	0.03	0.04	0.05	0.07
CD (P=0.05)	5.64	8.67	11.55	14.98	0.05	0.09	0.12	0.15
Interaction (VxC)								
SE d (±)	4..61	7.09	9.43	12.24	0.05	0.07	0.09	0.12
CD (P=0.05)	9.78	15.02	20.00	25.94	0.1	0.15	0.20	0.26

Conclusion

Moisture stress resulted in deleterious effect on rice crop. However, the present findings concluded that seeds priming improved the growth performance of rice through enhanced in metabolic activity and greater mobilization of reserved food to the growing points. Application of 2% KNO_3 recorded the maximum plant height, leaf length, leaves number/plant, leaf area and leaf area index. It was observed that among variety, CAU-R1 gave the better performance in most of this traits. These priming chemical could be effectively used in rice crop for mitigating the effect of drought stress.

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