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Effect of climatic factors on seedling growth of local and exotic rice varieties

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Abstract
The present study was conducted to determine the influence of climatic factors on seedling growth of local and exotic rice varieties of Namsai circle of Arunachal Pradesh. The effect of temperature, rainfall and humidity were recorded for local rice samples such as Sali, Khampti Lahi and exotic rice variety of Thailand Lahi. The observations with respect to growth of root length and shoot length were recorded along with the root fresh weight, root dry weight, shoot fresh weight and shoot dry weight were obtained from rice varieties. The raw data was analyzed with RBD from square root transformation. The mean temperature ranged from 30-34.14 ºC, mean rainfall7.86-14.84 mm and mean humidity 77.29-80% were obtained among climatic factors. The study found the following findings, where the root length ranged from 29.71-67.86 cm. The lowest root length growth 29.71 cm was observed in Thailand Lahi variety with effect of 34.14 ºC mean temperature, 8.14 mm mean rainfall and 77.43% mean humidity. The highest root length growth was seen in Sali variety by 67.86 cm with influence of 14.34 mm mean rainfall, 77.29% mean humidity and 30 ºC mean temperature. The shoot length range 29.43-70.57 cm was recorded among rice varieties. The mean temperature 34.14 ºC, mean rainfall 8.14 mm and mean humidity 77.43% were observed lowest shoot length growth 29.43 cm from Thailand lahi rice variety. The mean rainfall 7.86 mm, mean temperature 31.86 ºC and mean humidity 80% were reported highest shoot length growth 70.57 cm from Khampti Lahi rice variety. The range of root fresh weight 0.10-0.53 gm, root dry weight 0.028-0.035 gm, shoot fresh weight 0.065-0.474 gm and shoot dry weight 0.041-0.070 gm were obtained among rice varieties. The highest root fresh weight 0.53 gm, root dry weight 0.035 gm, shoot fresh weight 0.065 gm and shoot dry weight 0.049 gm were observed from Sali variety with 30 ºC with mean temperature. The climatic factor influences the seedling growth of rice but the rice variety adapts normal and adverse climatic factors and performs metabolism and growth into the plant system.

Keywords: rice, climatic factors, shoot length, root length, fresh weight, dry weight

Introduction
Rice (*Oryza sativa* L., 2n=24) is a monocot endospermic seed that belongs to Poaceae (Grass) family and genus Oryza. Rice consists of 80% carbohydrate, 7-8% protein, 5% fat and 3% fibre. The intake rice generates 29.3 percent caloric energy in Asia and 29.9 percent caloric energy in India respectively. Rice is second most widely consumed cereal in the world next to wheat. The area of cultivation is 161 million hectare and average productivity 4.53 tonnes per hectare. Rice is cultivated under 43.3 million hectare at India in the world but ranks second in total production. The annual production of rice was 105.48 million tonnes (Faostat, 2016) [4].
The rice varieties Ranjeet HMT Sona, TET 8585, Jaya, IR seires, Pankaj, Bahadur, Chinese Boro, MTU-1010, MTU-7029 and CAU-R-3 etc. are cultivated in Northeast agro climatic zone. Sali and Khampti Lahi are local rice cultivars that are cultivated in Brahmaputra region. Thailand lahi is exotic rice variety. It is normal *kharif* crops, high yielding cultivars and rainfed crops. Sali is short plant, oblong short grain and non-sticky type. Khampti Lahi is long plant, slender long grain and sticky type. Thailand lahi is tall plant, long grain and sticky type. Sali and Khampti Lahi are principal crop of Namsai district, Arunachal Pradesh (Talukdar and Beka, 2005) [22]. Thailand lahi is a secondary introduced variety of Namsai district first tried in the agriculture field of Arunachal University of studies. It was introduced from Thailand country.
Climatic factors like temperature, rainfall, humidity and light etc., performs significant role in growth and development of rice seedling. The specific value of climatic factors drives good metabolism, cell division and morphogenesis in rice seedling. It grows and develops the rice seedling population. The natural and anthropogenic pollution enhances global warming. The global warming disturbs the ecology, ecosystem and climatic factors.

The rice seedling grows and develops with effect of different temperature, rainfall and humidity. It adapts and habitats with effect of different temperature, rainfall and humidity. It performs activity of photosynthesis, respiration, transpiration, synthesis of growth regulators, cell division and morphogenesis to grow and mature rice seedling. The global warming alters the magnitude of climatic factors but rice seedling population adapts and performs physiology and morphological development of in adverse climatic factors. The variable climatic factors are acclimatized and enhanced growth stages of seedling. The disturbed climatic factors are stabilized the physiology by seedling system. The rice system takes more periods for good growth, development and maturation. Yoshida (1973) [23] reported rice seedling growth with 22, 25, 28 and 31 ºC different mean temperatures. Rice seedling development were obtained from 12, 16, 20, 25, 27, 30, 33, 36 and 40 ºC mean temperatures (Hossein *et al*., 2012) [9]. Janusz and Anna (2011) [12] observed seedling growth of Blue lupin cultivar with different rainfall. Suman (2012) [21] observed rainfed rice seedling development from month rainfall. Farooq *et al*. (2004) and Basra *et al*. (2005) [3] reported seedling growth of rice with ample moisture. Ken-Ichi and Jun-Ichi observed seedling growth of rice with different humidity. Rathnayake *et al*. (2016) [17] viewed Rainfed lowland paddy with different relative humidity. The suitable crop was reported by three classes of humidity i.e., 60-80%, 80-85% and more than 85%. With this research literature, the following objective investigated in the university i.e.,

1. Effect of climatic factors on shoot and root length of local and exotic rice varieties.
2. Effect of climatic factors on shoot and root fresh weight or dry weight of local and exotic rice variety.

Materials and Methods

The local rice Sali, Khampti Lahi and exotic rice Thailand ahi were germinated in Arunachal University of Studies field during *kharif* crop cycle. The rice seeds were cultivated by wet method. The duration of wet method is 20-25 days. The chemical fertilizers were not recommended into soil. The seedling root length, shoot length, root fresh weight, root dry weight, shoot fresh weight and shoot dry weight were obtained with effect of climatic factors. The shoot and the root dry weight, fresh weights were observed after 4 weeks. The rainfall and the humidity were received from Meteorology station, Namsai, Arunachal Pradesh.

Data analysis

The raw data of was analyzed with statistical parameters taking two factorial Randomized Block Design (RBD). The figure was computed with square root transformation.

Results and Discussion

1) Effect of climatic factors on root length and shoot length of local and exotic rice varieties

The climatic factor is prime abiotic factor to rice seedling growth. The climatic factors differences were obtained by going through the physiological growth. The statistical data of climatic factors are depicted in Table 1, fig. 1 and fig. 2. Significant differences were observed among the varieties respectively. The magnitude of mean temperature 30-34.14 °C, 29.71-67.86 cm varietal root length and 5.52-5.82 treatments were recorded with temperature. The mean rainfall range 7.86-14.34 mm, varietal root length 29.71-67.86 cm and 1.77-2.90 treatments were observed with rainfall. The variable range of mean humidity 77.29-80 %, varietal root length 29.71-67.86 cm and treatments 8.82-8.97 were observed with humidity. The root length growth with different temperature reported among varieties. The mean temperature 34.14 °C observed lowest root length growth 29.71 cm with Thailand lahi variety. IIoh *et al*. (2014) [10] resulted root length growth with different temperatures. Krishnan *et al*. (2011) [14] reported root length growth with different temperature. The elevated temperature increases the root length growth and rising temperature might be affected the root length growth of rice varieties. It affects critical root functions, respiration and nutritional mechanism (Atkin *et al*., 2000; Awal *et al*., 2003) [1, 2]. Hanzawa *et al*. (2013) [6] found that elevated temperature reduced vacuolar content of the auxin efflux carrier PIN 2, suggesting improved efficiency of PIN 2 localization in the plasma membrane and enhanced shoot ward auxin transport. The root length growth is also dependent on soil temperature. The rising soil temperature is also affect the physiology and morphological development of root length growth (Zheng *et al*., 1993) [24].

The root length growth observed with different rainfall. The mean rainfall 14.34 mm observed highest root length growth 67.86 cm with Sali variety. Ramjit and Teerayut (2013) [18] reported root length growth with effect of rainfall. Naganzoua *et al*. (2016) [15] reported rice grown with average rainfall. Sudha (2012) [20] resulted rice growth with rainfall. The local and the exotic rice variety are mainly cultivated in rainfed agriculture. The good rainfall frequency is recorded by root environment then the physiology and morphological development of root structure, root branches and root hairs are healthy in the soil. It promotes cell division that increases the root length in the soil environment. The heavy rain with short frequencies causes floods into the soil bed that accumulate quantity of water around root horizon. It hurdles free movement of oxygen and toxic compounds. Therefore, it slows down root growth (Nishan, 2016) [16].

The various humidity values were recorded for the root length growth in the rice varieties. The mean humidity 77.29% resulted highest root length growth 67.86 cm in Sali variety. The low humidity promotes more respiration. It regulates more metabolism and morphogenesis. Hira *et al*. (1998) [8] discussed that high humidity with dark period and high humidity elevates the plant height, leaf emergence and root length. Ken-Ichi and Jun-Ichi (2016) resulted morphological development from rice cultivar with several soil moisture content. Rathnayake *et al*. (2016) [17] found rice growth with different relative humidity.

Climatic factors performs significant role in shoot length growth of local and exotic rice varieties. The shoot adapts and habitats a different values of climatic factors. The different value of climatic factor performs anatomical growth and morphological growth and physiology into shoot of rice varieties. This process produces a healthy and mature shoot. This principle is observed in the present experiment. The figure shown in Table 2, fig. 3 and fig. 4. Significant differences observed in rice variety with effect of climatic factors. The mean temperature with a range of 30-34.14 °C showed a shoot length growth of 29.43-70.57 cm in 5.52-5.93 treatments. The range of mean rainfall of 7.86-14.3 mm gave shoot length of 29.43-70.57 cm with 1.77-2.90 treatment was reported in rainfall. The mean humidity range 77.29-80% with shoot length of 29.43-70.57 cm in 8.82-8.97 treatments was observed in humidity. The variable mean temperature observed shoot length development among varieties. The mean temperature 34.14 °C lowest shoot length development

with Thailand Lahi variety. The high temperature influenced shoot length growth in Thailand Lahi variety but the shoot organ adapted and survived the high temperature. It developed the non susceptible and healthy shoots. IIoh *et al*. (2014) [10] reported shoot length h\growth with different temperature in rice. Ashtar *et al*. (2017) resulted shoot length growth with effect of various temperature. The minimum temperature 15-30 °C and maximum temperature 30-40 °C is grow and develop seedling of rice (Hardegree, 2006) [7]. Seedling growth is well upto 35 °C and its growth declines above 40 °C. The seedling growth is stable from 21 to 32 °C temperature. The plant metabolism and cell division enhances the growth and development of seedling population and produces plumule organ. The temperature below 15 °C and above 40 °C retarded the physiology of plant, cell division, morphological development. It enhances the amount of Abscisic acid (ABA) that inhibits the plumule growth (Krishnan *et al*., 2011) [14]. Rainfall is necessary for rainfed farming. The different frequency of rainfall promotes shoot length growth in each variety. The mean rainfall of 7.86 mm recorded the highest shoot length growth with 70.57 cm in Khampti Lahi variety. The availability of rainfall water is less on the soil surface then the physiological activity of shoot is perfect and it develops the nutritious shoot. The rice seedling receiving rainfall for 2-3 days continuously enhances the development of good shoot while irregularities in rainfall still encourages the shoot organs to adapt and survive with effect of different rainfall in order to complete the metabolism, cell division and morphogenesis to grow and mature into the shoot. Sudha (2012) [20] resulted shoot length growth with effect of different rainfall. Blue lupin rice cultivar was acclimatized and survived with effect of different rainfall (Janusz and Anna, 2011) [12]. Suman (2012) [21] reported vegetative growth with effect of different rainfall. Humidity is essential for shoot length growth. It offers moisture to soil and shoot. The different value of humidity promotes shoot length development into the varieties. The mean humidity 80% reported highest shoot length growth 70.57 cm with Khampti Lahi variety. Ken-Ichi and Jun-Ichi (2016) resulted shoot length growth with effect of various moisture. Rathnayake *et al*. (2016) [17] mentioned the classes of relative humidity. The relative humidity ranging from 80-85% is highly suitable for vegetative growth of crops. The rice seedling population drives respiration, transpiration and conducts low photosynthesis, low humidity during growth and development vice-versa. Sato (1969) [19] showed that leaf morphology is mainly influenced by humidity and this affects the photosynthetic rate. The photosynthetic rate of plants that had been grown at a low humidity was higher than that of the plants grown at a high humidity, because the specific leaf weight was greater in the plants grown at a low humidity. It conducts the metabolism, cell division and morphogenesis to grow juvenile seedling into mature seedling with effect of different humidity. The seedling grows and prepares defence agent to prevent scorch with effect of humidity. The seedling nurtures and maintains plant system according nature of humidity.

Table 1: Effect of climatic factors on root length growth of local and exotic rice varieties

Temperature			
Variety	Mean Temperature (°C)	Root Length (cm)	Treatments
Sali	30.00	67.86	5.52
Khampti Lahi	31.86	30.86	5.68
Thailand Lahi	34.14	29.71	5.87
	5.68	5.74	
Rainfall			
Variety	Mean Rainfall (mm)	Root Length (cm)	Treatments
Sali	14.34	67.86	2.90
Khampti Lahi	7.86	30.86	2.43
Thailand Lahi	8.14	29.71	1.77
	2.36	5.69	
Humidity			
Variety	Mean Humidity (%)	Root Length (cm)	Treatments
Sali	77.29	67.86	8.82
Khampti Lahi	80	30.86	8.97
Thailand Lahi	77.43	29.71	8.82
	8.87	5.48	
Coefficient of Variation = 24.58			
CD 5% = 0.86			

Anova Table		
Source of variation	**Degrees of freedom**	**Mean sum of squares**
Replications	6	2.062
Treatments	8	56.161
Factor A	2	222.121
Factor B	2	0.380
A X B	4	1.071
Error	48	1.923
Total	62	-

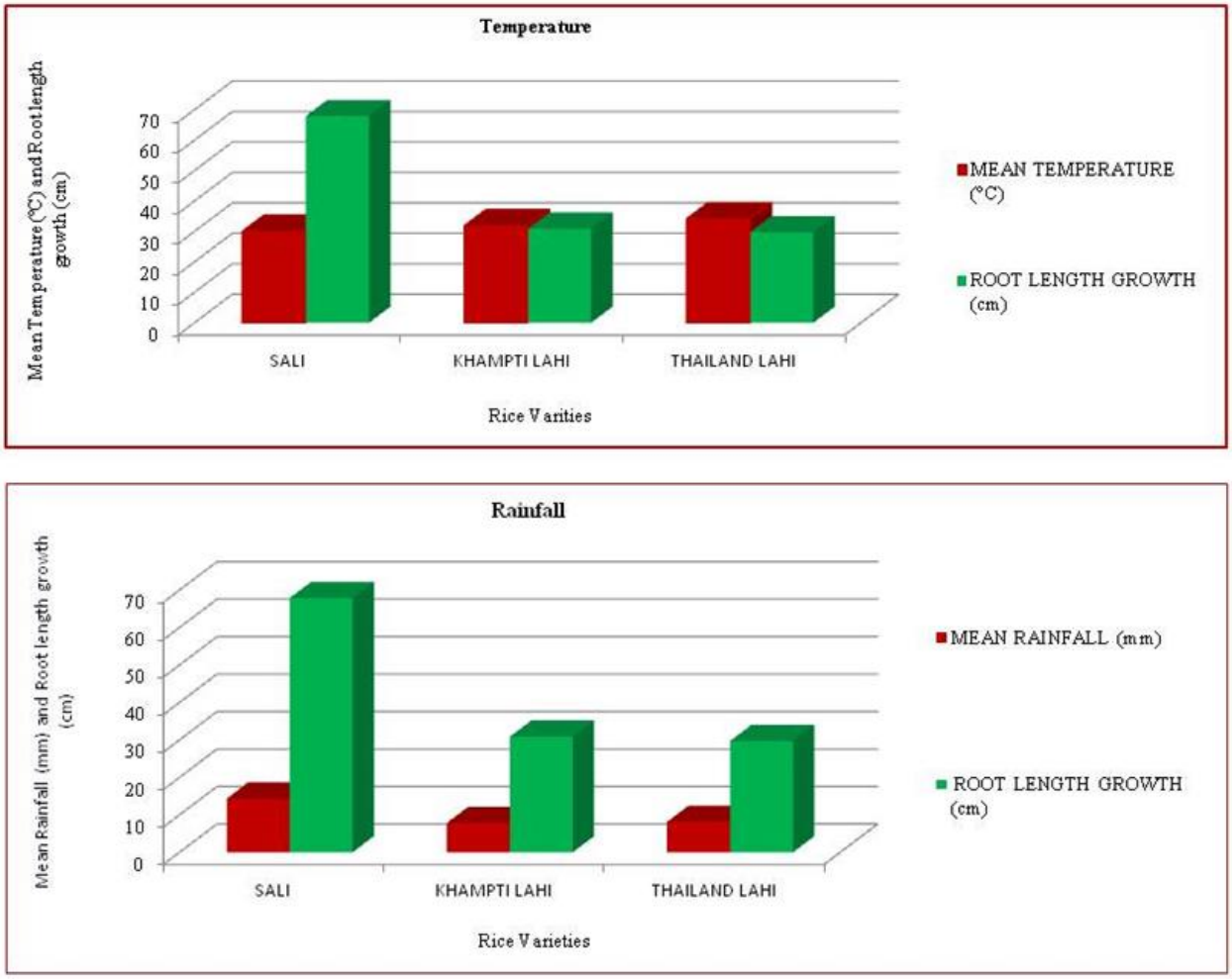

Fig 1: Mean temperature and Mean rainfall effect in root length growth of local and exotic rice varieties

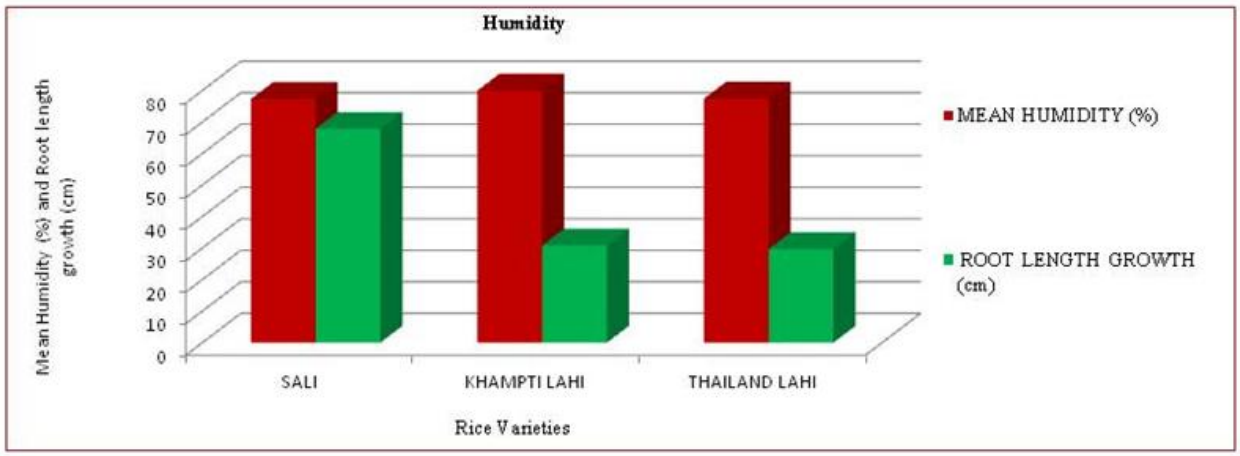

Fig 2: Mean humidity effect in root length growth of local and exotic rice varieties

Table 2: Effect of climatic factors on shoot length growth of local and exotic rice varieties

Temperature			
Variety	Mean Temperature (°C)	Shoot Length (cm)	Treatments
Sali	30.00	69.71	5.52
Khampti Lahi	31.86	70.57	5.68
Thailand Lahi	34.14	29.43	5.93
	5.52	5.74	
Rainfall			
Variety	Mean Rainfall (mm)	Shoot Length (cm)	Treatments
Sali	14.34	69.71	2.90
Khampti Lahi	7.86	70.57	2.43
Thailand Lahi	8.14	29.43	1.77
	2.37	5.64	

Humidity			
Variety	Mean Humidity (%)	Shoot Length (cm)	Treatments
Sali	77.29	69.71	8.82
Khampti Lahi	80	70.57	8.97
Thailand Lahi	77.43	29.43	8.82
	8.87	5.37	
Coefficient of Variation = 25.33			
CD 5%= 0.886			

Anova Table		
Source of variation	**Degrees of freedom**	**Mean sum of squares**
Replications	6	1.293
Treatments	8	56.115
Factor A	2	222.161
Factor B	2	0.777
A X B	4	0.762
Error	48	2.001
Total	62	-

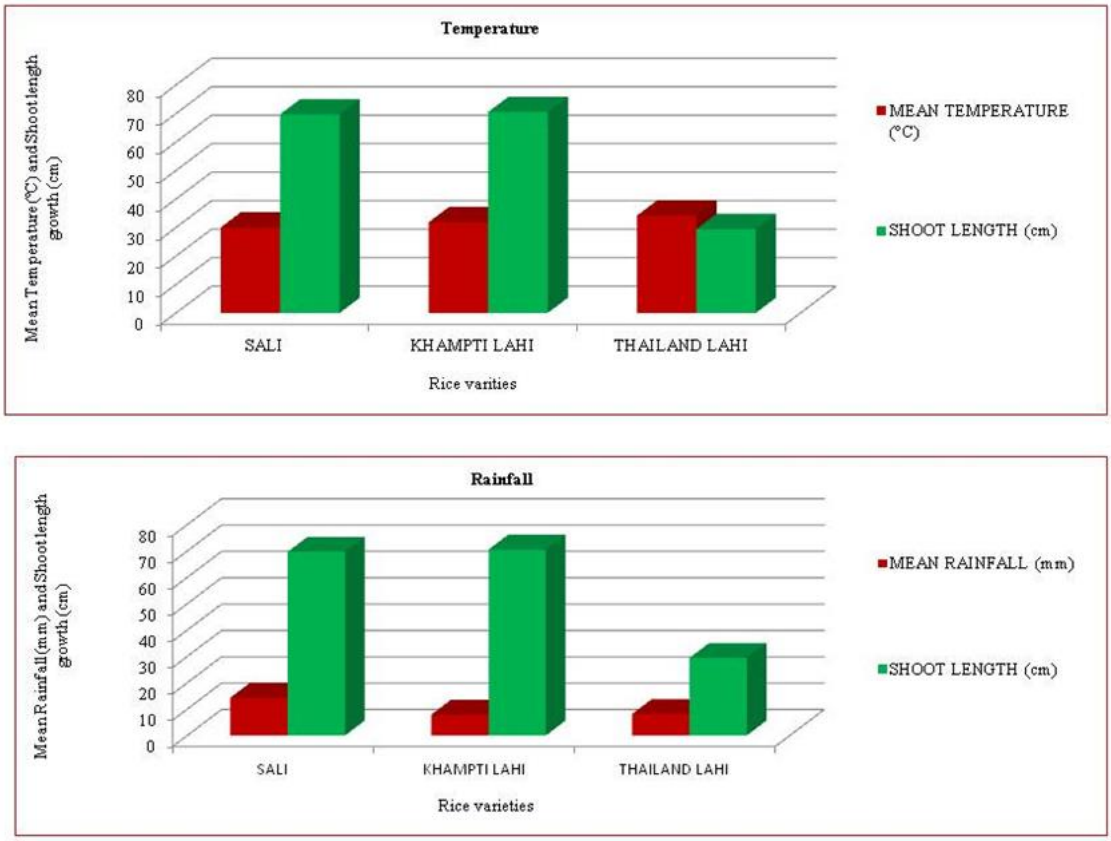

Fig 3: Mean temperature and Mean rainfall effect in shoot length growth of local and exotic rice varieties

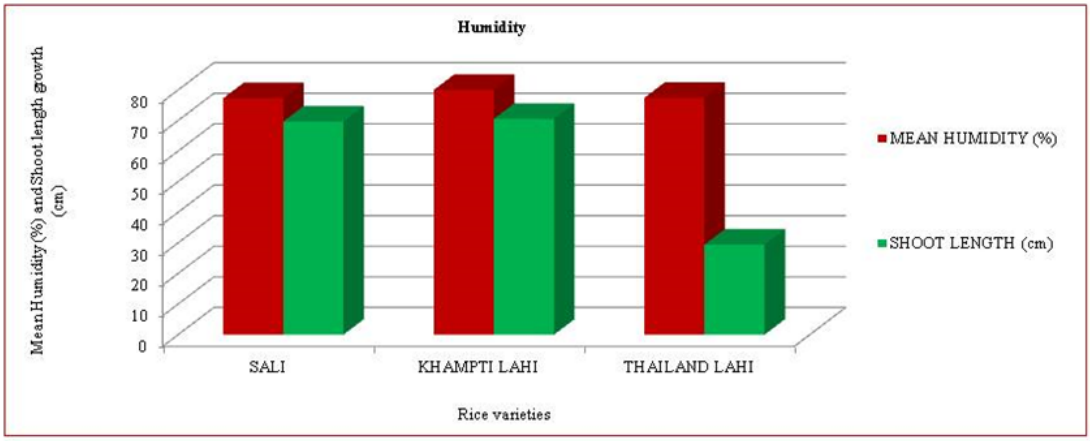

Fig 4: Mean humidity effect in shoot length growth of local and exotic rice varieties

Effect of climatic factors on fresh and dry weight of root and shoot of local and exotic rice varieties

Temperature, Rainfall and Humidity are abiotic factors that influences rice seedling populations and promotes physiological activity and morphogenesis. Different values of climatic factors influences shoot or root fresh weight and dry weight of rice varieties. This principle was reported in the present study. The data is depicted in Table 3 and Fig 5. The fresh weight and dry weight of shoot & root were observed with mean temperature ranging from 34.14 ºC. The root fresh weight of 0.10-0.53 gm and dry weight 0.030-0.035 gm was reported among local and exotic rice varieties respectively while the shoot fresh weight of 0.065-0.474 gm and dry weight 0.041-0.070 gm was observed among local and exotic rice varieties. The root fresh weight 0.53 gm, root dry weight 0.035 gm and shoot fresh weight 0.065 gm, shoot dry weight 0.049 gm from Sali variety was observed with influence of 30 ºC mean temperature. The root fresh weight 0.11 gm, root dry weight 0.030 gm and shoot fresh weight 0.065 gm, shoot dry weight 0.049 gm from Khampti Lahi variety was recorded with effect of 31.86 ºC mean temperature. The root fresh weight 0.10 gm, root dry weight 0.030 gm and shoot fresh weight 0.069 gm, shoot dry weight 0.041 gm from Thailand Lahi rice was obtained with impact of 34.14 ºC mean temperature. The highest root fresh weight 0.53 gm, root dry weight 0.035 gm and shoot fresh weight 0.065 gm, shoot dry weight 0.049 gm from Sali rice variety were observed with 30 ºC mean temperature. Bhaskar *et al*. (2016) resulted fresh weight, dry weight of shoot and root from traditional rice cultivars after 21 days. Solangi *et al*. (2015) obtained fresh weight, dry weight of shoot and root of rice cultivar at 65±5 ºC. Yoshida (1973) [23] resulted dry weight of rice with 22, 25, 28 and 31 ºC mean temperature after 3-4 weeks.

Conclusion

Temperature, Rainfall and Humidity are necessary climatic factor for seedling growth of local and exotic rice varieties. The different values of climatic factors influence physiology and morphogenesis in the rice plant since the rice variety adapts variable climatic factors to perform physiological activities and morphological growth. It adapts and survives at extreme climatic factors. The study tries to show that the local and exotic rice varieties if necessary, adapts and conduct their metabolism and morphological activities successfully even if it is exposed to adverse climatic conditions. Therefore, seedling gets acclimatized and performs during global warming and adverse climatic factors to serve the national economy.

Table 3: Effect of climatic factor on fresh and dry weight of root or shoot of Local and Exotic rice varieties

Variety	Climatic factor	Root		Shoot	
	Mean Temperature (ºC)	Fresh weight (gm)	Dry weight (gm)	Fresh weight (gm)	Dry weight (gm)
Sali	30.00	0.53	0.035	0.065	0.049
Khampti Lahi	31.86	0.11	0.030	0.474	0.070
Thailand Lahi	34.14	0.10	0.028	0.069	0.041

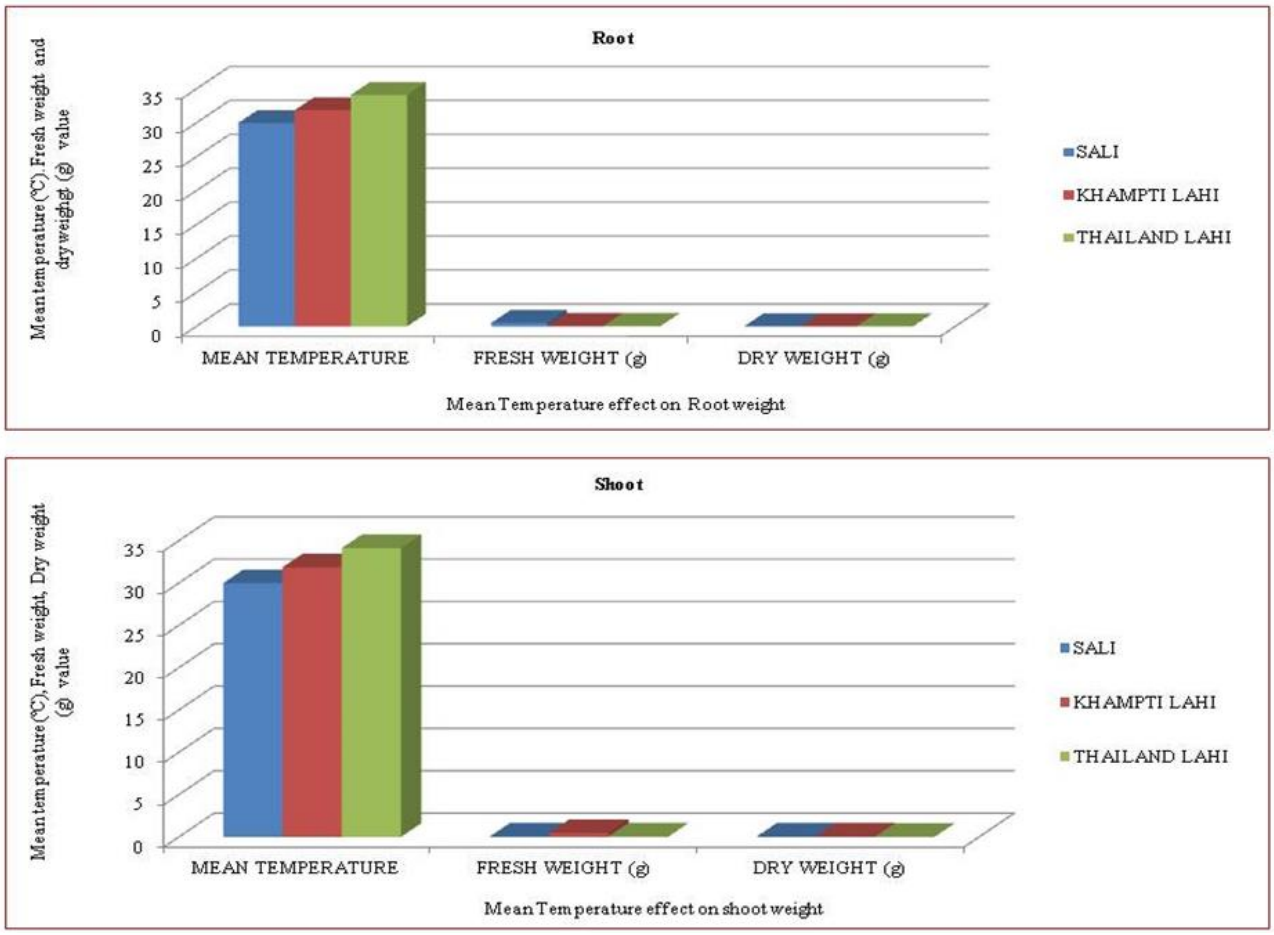

Fig 5: Effect of mean temperature in fresh weight, dry weight of local and exotic rice varieties

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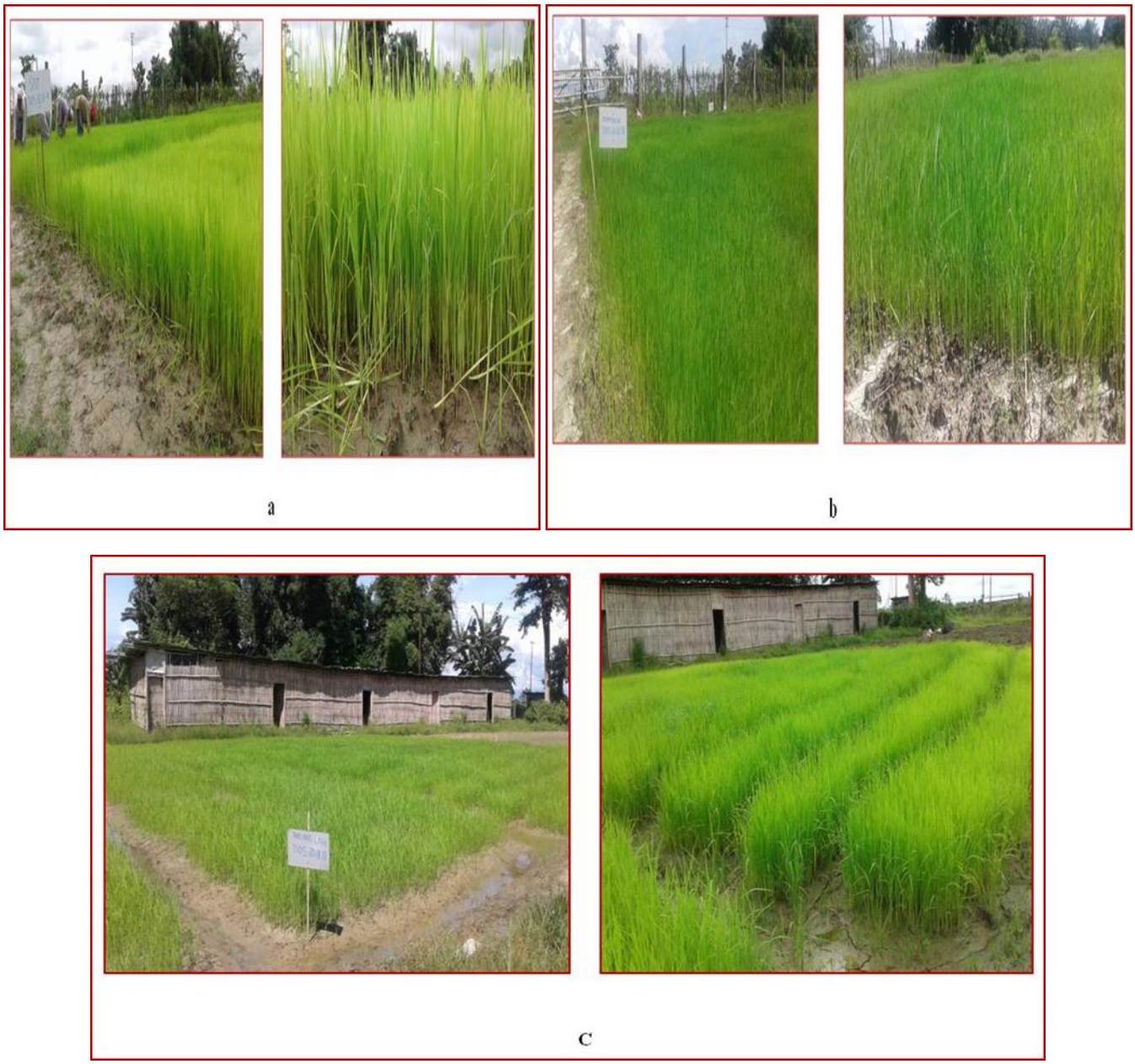

Fig 1: a) Seedling bed of local rice cultivar Sali b) Germination bed of local rice cultivar Khamt i Lahi c) Seedling growth of exotic rice variety Thailand Lahi

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