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Influence of agroclimatic indices on tuber yield and some predictive models for agroclimatic condition at Jorhat

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Abstract
Potato (*Solanum tuberosum* L.) is one of the most important food crops after wheat, maize and rice, contributing to food and nutritional security in the world. This tuber crop of the family solanaceae has about 200 wild species. Abovethe present study was conducted during *Rabi* season, 2016-17 at the Instructional-Cum-Research (ICR) Farm of Assam Agricultural University, Jorhat to study crop-weather relationships of potato grown under different micro-climatic environments: MR-I: 16th November, MR-II: 1st December and MR-III: 16th December with three varieties: KufriJyoti, KufriPokhraj and Local following a split plot design with four replications. The results revealed that weekly mean maximum and minimum temperatures, morning and evening relative humidities, duration of bright sunshine hours and pan evaporation ranged from 24.0 to 30.2 °C, 8.0 to 18.0 °C, 91 to 100%, 44 to 66%, 3.2 to 8.8 Hours and 1.3 to 4.7mm per day, respectively. Most of the agroclimatic indices yielded higher correlation coefficients with final yield irrespective of varieties and microclimatic regimes for all growth stages. Tuber yield gave highest correlation coefficient of 0.77 against Accumulated morning relative humidity (ARH-I) corresponding to vegetative stage. A few predictive models involving accumulated indices was also developed combined over both varieties and microclimatic regimes corresponding to some selected crop growth stages. Most efficient predictive models were found for Accumulated Minimum Temperature (AMINT), Accumulated Morning Relative Humidity (ARH-I) and Accumulated Bright Sunshine Hours (ABSSH) corresponding to vegetative and reproductive stages.

Keywords: Potato (*Solanum tuberosum* L.), *Agroclimatic indices,* tuber yield, predictive models

Introduction
Today Potato (*Solanum tuberosum* L.) is the fifth most important crop worldwide, after wheat, corn, rice and sugar cane. It is contributing to food and nutritional security in the world. Over the past few decades, potato has become the fastest growing staple crop and for vegetable purposes, it has now become one of the most popular crops in India. Potato is a plant typical mainly of temperate climate and when day length is shorter. It is characterized by specific temperature requirements. India potato is generally grown when maximum day temperature below 35 °C and night temperature not more than 20 °C. Optimum temperature for potato growth is 15 to 20 °C. Under high temperature conditions, tuberization is significantly inhibited and photo assimilate partitioning to tubers is greatly reduced (Ewing, 1981) [1]. High temperature (more than 25 °C) may have two effects. One is to extend the period of leaf growth and hence prolong the growth cycle (Marinus and Bodlaender, 1975) [2]. High temperature also increases the leaf senescence rate (Menzel, 1985) [3] and through this they shorten the growth cycle of crop. RH is an important factor in tuber weight loss and the occurrence and severity of diseases and pests. Potato plants grown under 85% RH produced higher tuber yield. The optimum precipitation of early potato ranges from 250 to 350mm.

Materials and Methods
The experience was conducted at Jorhat district of Assam during 2016-17 with split plot design. Planting dates (3nos) were assigned to main plots and three varieties (V_1: KufriJyoti, V_2: KufriPokhraj and V_3: local) were assigned as a subplot. Jorhat is located in a sub-tropical belt with hot and humid summers and cold and dry winters. The station receives 7.5, 26.2 and 3.7 percent of annual rainfall, respectively. Monthly morning relative humidity of the station always remains above 85 percent, whereas monthly evening relative humidity varies from 61 to 76 percent throughout the year. The monthly average maximum and minimum temperatures vary from 22.6 to 32.7 °C and 8.0 to 25.2 °C, respectively. Daily data of weather variables, *viz.* maximum and minimum temperature, morning and evening relative humidity,

Rainfall, pan evaporation and bright sunshine hours (BSSH) for the entire crop growing season was collected from the meteorological observatory of the Department of Agro-meteorology, AAU, and Jorhat-13. Statistical analysis was carried out for correlation, the methods suggested by Gomez and Gomez (1984) [4] were followed and computer software SPSS (version 20) was used. Predictive models (regression models) were developed involving tuber yield and selected accumulated agroclimatic indices corresponding to different crop growth stages.

Results and Discussion

The daily weather data recorded at the Meteorological Observatory of Assam Agriculture University, Jorhat during *Rabi*, 2016-17 for the crop growing period covering from 46th Standard Meteorological Week (SMW) to 12th SMW were collected. From the daily data collected, weekly mean values were computed. The distribution of weekly weather parameters is shown in Table 1.

Table 1: Weekly weather parameters (mean) at Jorhat during *Rabi*, 2016-17

SMW	MAXT (°C)	MINT (°C)	RH (%)		RF(mm)	EVP(mm/day)	BSSH(hr)
			I	II			
46	30.2	18.0	96	66	0.0	1.8	3.3
47	27.5	12.3	98	63	0.0	2.0	8.8
48	27.7	13.8	95	62	0.0	1.8	8.2
49	27.6	11.8	99	61	0.0	1.6	8.0
50	26.5	9.7	100	58	0.0	1.6	8.8
51	26.0	12.6	99	62	0.0	1.3	5.8
52	25.0	12.6	99	66	43.5	1.5	5.8
1	25.9	10.7	99	56	0.1	1.6	8.2
2	24.0	9.3	98	61	0.0	1.4	6.6
3	24.3	8.0	99	57	0.0	1.6	8.1
4	26.8	9.1	96	51	0.0	1.7	7.6
5	25.5	11.3	97	59	2.0	1.7	7.3
6	27.4	12.6	93	55	0.0	1.9	4.3
7	27.9	11.0	94	44	0.0	2.1	7.1
8	25.6	15.0	96	66	37.4	2.3	4.5
9	25.9	15.0	94	60	0.0	2.6	3.2
10	26.3	14.6	91	62	19.2	3.2	5.0
11	26.8	14.3	91	53	10.6	3.3	6.7
12	26.3	15.2	95	61	26	2.9	4.9

SMW: Standard Meteorological Weeks, MAXT: Maximum temperature, MINT: Minimum temperature, RH-I: Relative humidity, morning, RH-II: Relative humidity, evening, RF: Rainfall, EVP: Pan evaporation, BSSH: Bright sunshine hour.

Table 2: Tuber yield (tonnes/ha) in Potato during *Rabi*, 2016-17

Treatment	Yield (Tonnes/HA)
Variety	
KufriJyoti	21.27
KufriPokhraj	22.60
Local	19.58
Mean	21.15
SE(V)	2.63
CD at 5%	NS
Microclimatic Regimes	
MR-I	22.05
MR-II	23.28
MR-III	18.12
Mean	21.15
SE(MR)	2.02
CD at 5%	4.28
CD at 5% (V×MR)	NS
CD at 5% (MR×V)	NS

The data on tuber yield as affected by different growing environments are presented in the Table 2. Although the potato cultivars are not differing much in current yield realization within themselves, even then if planting is delayed, yield will be affected. Tuber yield of KufriPokhraj was highest i.e., 22.60 tonnes/ha followed by KufriJyoti and Local. Goswami *et al.* (2018) [5] also reported that KufriPokhraj is likely to remain as a viable cultivar at agro-climatic condition of Jorhat under climatic change scenario.

Many as different accumulated agroclimatic indices *viz.* AMAXT, AMINT, AMEANT, ARH-I, ARH-II, ADRF, AEVP, ABSSH were computed and correlated with tuber yield. The results are presented in Table 3. At Vegetative stage all parameters were found to be significant at 5% level except ADRF. ADRF was found to be negatively correlated and not even statistically significant. At reproductive stage all parameters were not statistically significant but positively correlated except ADRF. At physiological maturity all parameters was positively correlated but not statistically significant. At total crop growing period all parameters were found to be significant at 5% level except temperatures and rainfall.

Table 3: Correlation between tuber yield and accumulated agro climatic indices in potato, 2016-17

Phase	AMAXT (°C)	AMINT (°C)	AMEANT (°C)	RH (%)		ADRF (mm)	AEVP (mm/day)	ABSSH (hr)
				ARH-I	ARH-II			
Vegetative	0.760*	0.747*	0.757*	0.770*	0.769*	-0.637	0.710*	0.706*
Reproductive	0.561	0.514	0.553	0.563	0.563	-0.409	0.443	0.609
Maturity	0.406	0.391	0.403	0.416	0.414	-	0.394	0.446
Total	0.526	0.660	0.199	0.754*	0.758*	-0.016	0.671*	0.707*

*****and******significant at 5 and 1 percent levels, respectively

AMAXT: Acc. max. temp., AMINT: Acc. min. temp., AMEANT: Acc. mean. temp., ARH-I: Acc. relative humidity morning, ARH-II: Acc. relative humidity evening, ADRF: Acc. daily rainfall, AEVP: Acc. pan evaporation, ABSSH: Acc. bright sunshine hours.

Predictive models were developed using accumulated agroclimatic indices corresponding to different crop growth stages in Table 4 and also graphically depicted in Fig.1.

Table 4: Predictive Models involving tuber yield and accumulated agro-climatic indices in potato during *Rabi*, 2016-17 (Combined over varieties and microclimatic regimes)

Phenological Events	Model	R^2
Vegetative	Y=0.192AMINT + 0.007 ARH-I - 0.220ABSSH -21.45	0.653
Reproductive	Y= 0.240 AMINT - 0.029 ARH-I + 0.082 ABSSH - 6.60	0.684
Total	Y= 0.010 ARH-II - 36.82	0.588

ABSSH: Accumulated bright sun shine hours, ARH-I: Accumulated relative humidity morning, AMINT: Accumulated minimum temperature, ARH-II: Accumulated relative humidity evening

From the Table 4 it is evident that among the accumulated agroclimatic indices, the best model was found for AMINT, ARH-I and ABSSH corresponding to the reproductive and vegetative phase with higher value of coefficient of determination of 0.684and 0.653 respectively.

Using some selected predictive models, yields were estimated for different crop phenological stages in potato. Then the percent variation (PCV) between the predictive and actual yields was worked out for all the 9 different treatment combinations and the results are presented in Table 5.

Using some selected predictive models, yields were estimated for different crop phenological stages in potato. Then the percent variation (PCV) between the predictive and actual yields was worked out for all the 9 different treatment combinations and the results are presented in Table 5. From the Table 5 it is evident that the percent variation between predicted and actual yields of MR-II were low (less than 13%) irrespective of crop phonological stages. It was further observed that among the accumulated agroclimatic indices, the best predictive model with higher coefficients of determination (R^2) were found for accumulated minimum temperature (AMINT), accumulated relative humidity morning (ARH-I) and accumulated bright sun shine hours (ABSSH) at vegetative and reproductive phase. Such low percent variation (PCV) indicates that the predictive yields are very close to their corresponding actual yields. Therefore, it can be inferred that such predictive models can successfully be used for predicting tuber yield of potato well ahead of crop maturity under the prevailing agroclimatic conditions of Jorhat.

Table 5: Percent variations between predicted and actual yields in potato (Accumulated agroclimatic indices)

Predictive Model	**Y=0.192AMINT + 0.007 ARH-I - 0.220ABSSH -21.45 (R^2=0.653)**			
Phenophase	**Treatment**	**Y**	**Y^**	**PCV**
Vegetative	V_1D_1	19.13	20.148	5.078
	V_1D_2	22.14	25.052	11.635
	V_1D_3	22.58	18.610	-21.299
	V_2D_1	24.94	23.506	-6.089
	V_2D_2	25.56	23.947	-6.743
	V_2D_3	17.30	18.610	7.044
	V_3D_1	22.12	21.912	-0.949
	V_3D_2	22.15	22.203	0.241
	V_3D_3	14.49	16.403	11.678
	Y= 0.240 AMINT - 0.029 ARH-I + 0.082 ABSSH - 6.60 (R^2=0.684)			
Reproduction	V_1D_1	19.13	20.624	7.270
	V_1D_2	22.14	20.534	-7.810
	V_1D_3	22.58	19.040	-18.565
	V_2D_1	24.94	22.796	-9.395
	V_2D_2	25.56	27.024	5.407
	V_2D_3	17.30	19.040	9.139
	V_3D_1	22.12	21.952	-0.766
	V_3D_2	22.15	22.712	2.472
	V_3D_3	14.49	16.674	13.111
Predictive Model	**Y= 0.010 ARHII - 36.82 (0.588)**			
Total	V_1D_1	19.13	22.039	15.240
	V_1D_2	22.14	23.326	5.371
	V_1D_3	22.58	18.641	-17.424
	V_2D_1	24.94	23.527	-5.653
	V_2D_2	25.56	25.669	0.417
	V_2D_3	17.30	18.641	7.754
	V_3D_1	22.12	21.094	-4.635
	V_3D_2	22.15	20.169	-8.940
	V_3D_3	14.49	17.284	19.304

Y: Actual yield Y^: Predictive yield, PCV: Percent variation

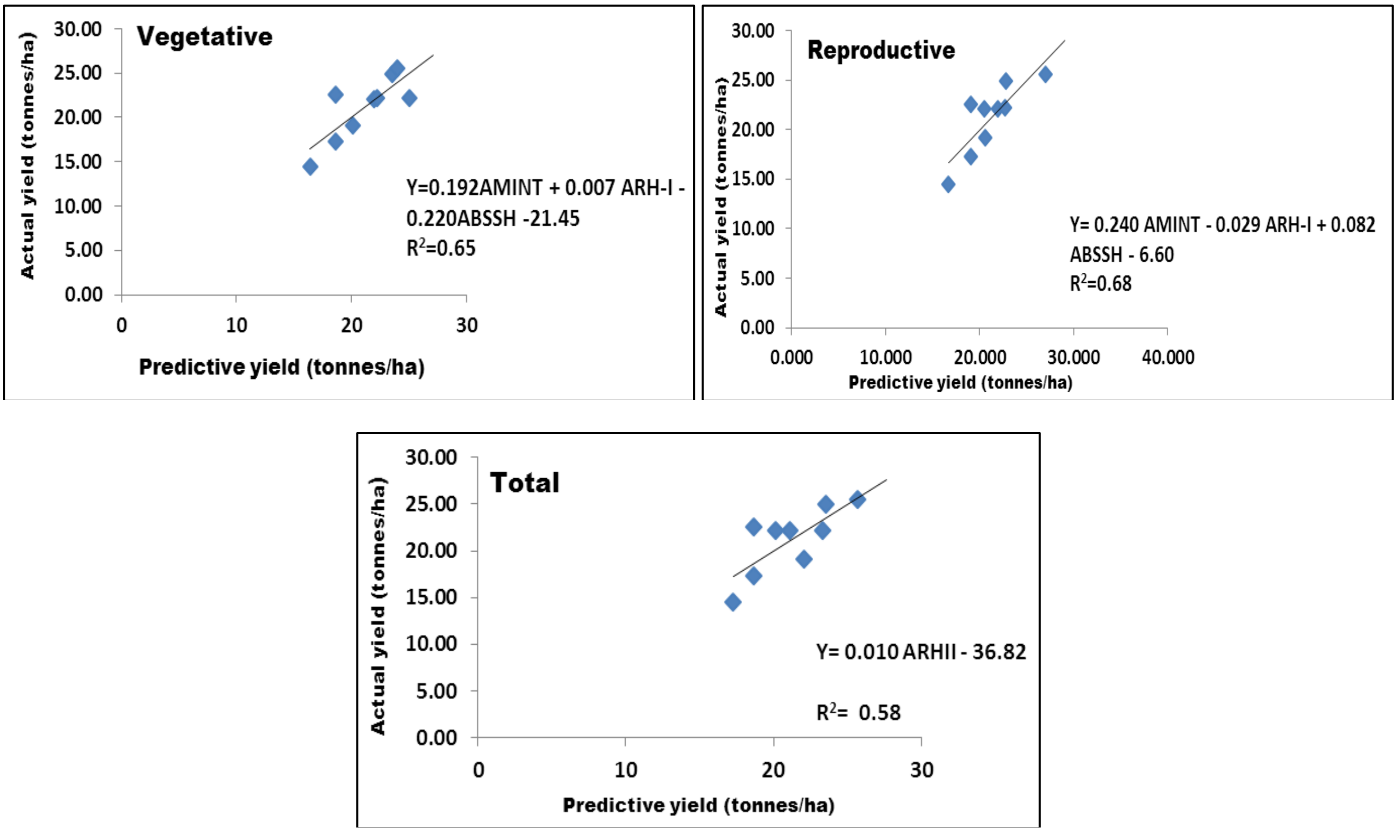

Fig 1: Predictive Models Involving Tuber Yield and Accumulated Agroclimatic Indices in Potato during *Rabi*, 2016-17

Conclusion

The variation in the weather variables throughout the crop growth period had significant impact on the growth, development and yield of potato. Accumulated agroclimatic indices significant correlation with final tuber yield corresponding to various crop growth stages. AMINT, ARH-I and ABSSH in both vegetative and reproductive stages showed best predictive model with percent variations of <13% between predicted and actual yields of MR-II which is indicative of the efficacy of the models. Such predictive models would be very useful for predicting of crop yield in ahead of crop harvest which would help the state government policy makers regarding export/import planning of commodities.

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