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Agrometeorological Indices Influenced by Varying Planting Windows and Varieties of Brinjal (*Solanum melongena* L.) in Maharashtra, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

An experiment was carried out at the Faculty of Agriculture Department of Agricultural Meteorology Farm, Centre for Advanced Agricultural Meteorology,College of Agriculture, Pune during Kharif seasons of 2014 and 2015.The experiment was laid out a split plot design with three replications.The treatment comprised of three brinjal hybrids viz.,V1:Phule Arjun, V2: Krishna, V3: Panchganaga as main plot and four planting windows viz., P1: 31st MW (30 July-5 August), P2: 32ndMW (6-12August), P3:33rdMW (13-19 August) and P4: 34thMW (20-26 August) as subplot treatments. Micrometeorological studies of Cumulative GDD, HTU, and PTU at the end of each growth stage showed that the numerically higher requirement was observed in hy.Phule Arjun over hy.Krishna and hy.Panchganga hybrids during both the years 2014 and 2015 experimentation period.Whereas, the lowest canopy temperature was found in hy.Phule Arjun (29.0 ^{0}C) than the rest

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of the brinjal hybrids. Canopy reflected PAR and transmitted PAR was higher in (191.54 and 188.62 µ mol $m^{-2}s^{-1}$) Panchganaga hybrids among the brinjal hybrids. Amongst all the brinjal hybrids, Phule Arjun hybrids were found significantly superior under extended planting windows followed by Krishna and Panchganga. Planting during 31st MW (1st week of August) was observed to be most suitable and optimum for brinjal considering the growth and yield attributes. This planting window was at par with the 32nd MW planting window. Linear correlation analysis for brinjal fruit yield with weather parameters was significantly positively correlated with maximum temperature and minimum temperature.

Keywords: Agrometeorological indices; micrometeorological study; Kharif seasons; eggplant.

1. INTRODUCTION

Brinjal or eggplant (*Solanum melongena* Linnaeus) is from the Solanaceae family belonging to the genus *Solanum* and is known as the "King of vegetables". It is a native of India. It is an important vegetable crop grown throughout the country all year round. Brinjal crop requires a long warm climate for its growth. Temperatures ranging between 25-32^{0}C are suitable for its cultivation. It does not prefer cool or frosty weather and requires silt loam to clay loam soil [1,2]. "Determination of optimum planting windows is considered an important effort to have optimum yields and keep insect pest damage below economic threshold level (ETL) both quantitative and qualitative traits of crops depend on planting on the proper windows and growing season. In India, higher brinjal quality Prolonged periods of low or high temperatures or sudden changes in them adversely affect insect development. Different levels of humidity and rainfall, likewise, increase or reduce the population of certain insect pest species" [3,4-6]. "These factors affect the life cycle, propagation, and outbreaks of insects to such an extent that they are either compelled to adapt themselves to the changing climatic conditions and is extensively cultivated in Kharif and Rabi season. Timings of the management activities are crucial for the implementation of pest management tactics and consuming higher doses of pesticides. High yield and quality of vegetables depend on high seed quality of improved cultivars, in addition to the optimum cultural practices. Information on crops, their stages, and the week-by-week weather during the crop season is essential for proper management of agriculture and better crop yield" [7,8,9].

2. MATRIALS AND METHODS

The field experiment was conducted at the Department of Agricultural Meteorology Farm, College of Agriculture, Pune during the kharif seasons of 2014 and 2015. "The experiment was conducted in a split-plot design with three replications. The treatments were allotted randomly to each replication by keeping the gross plot size 4.5m x 3.75 m2 and net plot size 2.7 m x 2.7 m2 with 90 x 75 cm spacing. There were twelve treatment combinations. The experiment was laid out in a split plot design with three replications. The treatment comprised of three brinjal hybrids viz., V1: Phule Arjun V2: Krishna, V3:Panchganga as main plot and four planting windows viz., P1: 31MW (30 July-3Aug), P2:32nd MW (6 Aug- 12 Aug),P3: 33rd MW (13Aug- 19 Aug) P4: 34th MW (20 Aug- 26 Aug) as subplot treatments" [7].

2.1 Growing Degree Days (GDD)

Temperature is a major environmental factor that determines the rate of plant development. The temperature requirement and range of optimum temperature varied with species and the genotype. The thermal response of genotype can be quantified by using the heat unit or thermal time concept. There is a high probability of successfully predicting the development of brinjal by heat unit. Thermal time or growing degree days were calculated according to the equation.

$$GDD = [(T_{max.} + T_{min})/2 – Tb]$$

Where,

GDD = Growing degree days
$T_{max.}$ = Daily maximum temperature of i^{th} day (^{0}C)
$T_{min.}$ = Daily minimum temperature of i^{th} day (^{0}C)
Tb = Base temperature of brinjal (11^{0}C)

2.2 Photo-thermal Units (PTU)

Photo-thermal units were determined by GDD multiplying with maximum possible sunshine hours (N).

Determination of maximum possible sunshine hours: Maximum possible sunshine hours was calculated by using following equation

N=COS (RADIANS ((COS(RADIANS(((A91172)*2*180)/365)))*23.5))

2.3 Helio Thermal Units (HTU)

Heliothermal units for various growth stages are calculated by the formula given. HTU = GDD x Bright sunshine hours [10].

3. RESULTS AND DISCUSSION

3.1 Determination of Growing Degree Days (GDD)

Data regarding phenophases wise growing degree days (GDD) and total growing degree days availed by different treatments, Hybrids, and planting windows are presented in Table 1 for the years of 2014 and 2015. The accumulated growing degree days to reach various growth stages showed variation among the different treatments, hybrids, and planting windows. The accumulated growing degree days were reasonably higher during the reproductive stage as compared to the vegetative stage.

3.2 Effect of Hybrids

The GDD in different hybrids varied from 35.41 to 72.3^{0}C for emergence, 444.48 to 481.76^{0}C days for vegetative growth, 512 to 575^{0}C for 50 % flowering, 568.65 to 681.66^{0}C days for first fruit setting and 1154.11^{0}C to 1183.7^{0}C days for final harvest. The highest values of GDD were recorded in hybrids Phule Arjun and the lowest values of GDD were recorded in hybrids Panchganaga.

3.3 Effect of Planting Windows

The GDD in different planting windows varied from 37.85 to 61^{0}C for emergence, 452.2 to 484.6^{0}C days for vegetative growth, 512.45 to 597.55^{0}C for 50 % flowering, 611.05 to 658.66^{0}C days for first fruit setting and 1128.85^{0}C to 1183.2^{0}C days for final harvest. The highest values of GDD were recorded in the 31st MW planting windows and the lowest values of GDD were recorded in the 34th MW planting windows [11].

3.4 Determination of Heliothermal Units (HTU)

The data regarding heliothermal units as influenced periodically by different hybrids and planting windows are presented in Table 2.

The total HTU required for the completion of the growth of the brinjal crop was 9244^{0}C days.

3.5 Effect of Hybrids

The HTU in different hybrids varies from (151.88 to 351.86) units for emergence, (1450.24 to 3539.83) units for vegetative growth, (1698.43 to 4357) units for 50 % flowering, (1893.69 to 4993.37) units for first fruit setting and (5282.36 to 9286.87) units for final harvest. The highest values of HTU were recorded in hybrids Phule Arjun and the lowest values of HTU were recorded in hybrids Panchganaga.

Table 1. Cumulative growing degree days (GDD) of brinjal as influenced stage wise different by treatments in 2014 and 2015

Treatment	EM		VG		50% FL		First FR		At final harvest	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
A) Hybrids(H)										
V_1 :Phule Arjun	59.6	72.3	481.76	478.3	575.5	568.65	681.66	645.7	1178.43	1183.7
V_2: Krishna	47.56	47.63	470.28	467.48	552.18	535.01	623.38	602.55	1166.28	1170.42
V_3: Panchganga	35.41	46.13	447.2	444.48	540.26	512.55	599.13	568.65	1154.11	1157.22
B) Planting Windows(D)										
P_1:31 MW (30 July– 5 August)	53.75	61	46.45	484.6	525.5	597.55	631.8	658.6	1135.55	1183.2
P_2:32 MW (6August 12August)	45.25	59.4	453.3	464.9	530.85	554.53	624.3	641.35	1143.25	1161.85
P_3:33MW (13August –19 August)	39.1	50.4	457.5	471.85	526.45	543.25	616.4	621	1128.95	1152.1
P_4:34M(20-26August)	37.85	38.65	452.2	469.65	512.45	539.05	611.05	611.4	1129.65	1143.4
General mean	45.50	53.64	401.24	468.75	537.60	550.08	626.82	621.32	1148.03	1164.56

Table 2. Cumulative heliothermal units (HTU) of brinjal as influenced stage wise by different treatments in 2014 and 2015

Treatment	EM		VG		50% FL		First FR		At final harvest	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
A) Hybrids(H)										
V_1 :Phule Arjun	249.97	351.86	1544.45	3539.83	1893.69	4357.69	2142.17	4993.37	5376.94	9190.09
V_2: Krishna	161.48	195.88	1450.24	3247.27	1698.43	4047.63	1893.69	4555.53	5282.36	9286.87
V_3: Panchganga	15188.	271.31	1508.33	3435.54	1763.81	4164.83	2014.88	4902.32	5370.95	9086.14
B) Planting Windows										
P_1:31 MW (30 July– 5 August)	251.24	34.785	1628.53	1982.23	1930.74	2767.46	2333.667	4904.23	4899.03	9970.4
P_2:32 MW (6August 12August)	145.055	344.27	1277.85	3927.96	1673.78	4770.45	1852.04	5303.45	5027.52	10154.52
P_3:33MW (13August –19 August)	93.96	411.98	1553.68	4044.66	1684.69	4629.4	1915.68	5318.79	5587.88	10145.44
P_4:34M (20August-26August)	184.64	100.255	1353.01	3658.41	1695.25	4177.76	2058.23	3223.48	5989.48	6877.1
General mean	178.26	244.33	1473.73	3405.13	1762.91	4130.75	2030.05	4743.02	5362.02	9244.37

3.6 Effect of Planting Windows

The HTU in different planting windows varies from (93.96 to 411.98) for emergence, (1277.85 to 4044.66) units for vegetative growth, (1673.78 to 4770.45) units for 50 % flowering, (1852.04 to 3223.48) units for first fruit setting and (4899.03 to 10154.52) units for final harvest. The highest values of HTU were recorded at the 31st MW planting window and the lowest values of HTU were recorded at the 34thMW planting window. This might be due to delayed planting completed each phenophases earlier than the late planted crop [12].

4. CONCLUSIONS

Heat unit requirement or GDD has been used for characterizing the thermal response in the brinjal crop. GDD for entire crop growing period decreased with the subsequent delay in planting. HTU and PTU were also decreased during later planting windows condition. GDD in different stages in that emergence (59.6 and 72.3), vegetative growth (481 and 478), 50% flowering (575 and 568), first harvesting (681 and 645), last harvesting (1178 and 1183) was observed in hybrid Phule Arjun during 2014 and 2015, respectively. Lower GDD was observed in hy.Panchaganaga in 2014 and 2015, respectively.

The highest HTU was observed in the 31st MW planting windows in hybrids Phule Arjun (5376 and 9190.4).This was followed by hy.krishna and Panchganaga (5370 and 9086) in 2014 and 2015, respectively. The Highest HTU was observed in 31st MW in hybrids Phule Arjun followed by hy.krishna and lower in panchganga.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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