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Crop Weather Relationship of Kharif Maize in Southern Agro Climatic Zone of Andhra Pradesh

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ABSTRACT: A field experiment was conducted during kharif season, 2016 at S.V. Agricultural college, Tirupathi to study the 'Crop Weather relationship of kharif maize in Southern Agroclimatic Zone of Andhra Pradesh.' The experiment was laid out in split plot design with twelve treatments. Three maize hybrids D.S 900M, Pinnacle and CP818 with four dates of sowing (June II FN, July I FN, July II FN and August I FN). The results indicated climatic variables has major effect on crop growth. Among them temperature has major effect. Among the dates of sowing D_1 (June II FN) recorded significantly higher yield (3684.36 kg ha^{-1}) than D_2 (3207.72 kg ha^{-1}), D_3 (2628 kg ha^{-1}) and D_4 (August I FN) recorded significantly lower yields (1724.26 kg ha^{-1}). Among the hybrids Pinnacle recorded numerically higher yield (3006.58 kg ha^{-1}) than D.S 900 M (2748 kg ha^{-1}) but was significantly higher than CP818 (2678.4 kg ha^{-1}) due to increased dry weight of grains and higher optimum temperatures during grain filling phase. Increased dry matter production of D1 and Pinnacle is known to be proportional to the total amount of intercepted radiation, which itself is largely determined by the size of leaf area and its distribution with time, ultimately determining the yield.

KEYWORDS: Climate, Temperature, Dry matter , Leaf area and Yield.

I.INTRODUCTION

Maize is the third most important cereal crop species in the world after wheat and rice. It is grown across a wide range of climates, but mainly in the warmer temperate regions and humid subtropics. Maize has multiple uses, including human foods, animal feeds and the manufacture of pharmaceutical and industrial products. It is the staple food source for people in many countries. It is becoming increasingly important in many countries for industrial and pharmaceutical applications. It can be used to produce starch, ethanol and plastics and as a base for antibiotic production.

Over the past 40 years the total global area sown to maize has increased by about 40 per cent, and production has doubled. The United States produces 40 per cent of the world's harvest, other top producing countries include China, Brazil, Mexico, Indonesia, India, France and Argentina. Worldwide production of maize is more than rice and wheat. Maize is cultivated on nearly 178 m ha in about 160 countries and contributes to 50 per cent to the global grain production. In India maize constitutes 9 per cent of total volumes of cereals and is third most important crop after rice (42%) and wheat (32%).

Global climate change has been increasing significantly in industrial era. The major green house gases like CO2, NH4, N2O and CFC has been increasing at alarming rate in the recent past. Intergovernmental Panel on Climate Change (IPCC) projects that with the current scenario the global mean temperature rises between 1.56 to 5.44°C by the year 2100 (IPCC, 2007). The change in the climate has spatiotemporal variations. Global climate change has effect on the crop productivity in the world and particularly in India.

Climatic variability has great impact on food production. The variation is especially related to abnormal rainfall, drought, temperature and photoperiodism. Of these changes temperature and photoperiod has great influence on the crop production.

The experiment is conducted at Tirupati located at 13.65°N and 79.42°E, which is situates in southern agro climatic region of Andhra Pradesh. Studies on effect of photoperiod and temperature on physiological indices due to climatic variation was less attempted. In southern zone variability in photoperiod is less compared to temperature which is highly variable. Accordingly, maize crop yields are highly variable in this region across the seasons as well as among different dates of sowing. Hence studies on Crop Weather relationship of kharif maize in Southern Agroclimatic Zone of Andhra Pradesh was carried out.

II.SIGNIFICANCE

The paper mainly provides basic principles to understand the phenology and follow proper planting dates for different genotypes over temporal and spatial separations. The study of literature survey is presented in section III,Methodology in Section IV,Section V covers experimental results of the study and section VI discusses the future study and conclusion.

III.LITERATURE SURVEY

Rouanet et al. reported the ideal temperature requirement for germination of maize crop is from 16 to 32°C.

Grezesaik et al. observed increased leaf area and dry weight of maize at 15°C night temperature and reduced relative growth and net assimilation rate with decrease in night temperature (<15°C).
Hunter et al. the duration of grain filling decreased with increasing temperature, and the shorter grain-filling period was often associated with lower grain yield.

Birch et al. The critical photoperiod for maize is 12.5 hr. photoperiod extension increased the duration of the period from emergence to tassel initiation and increased the number of leaves

Sulochana et al. indicated that the maximum dry matter accumulation plant-1of maize was produced in June 30 sown crop but on par with July 15 sown crop. Date of sowing did not influence dry matter accumulation plant-1 at 15, 45 and 75 DAS by Pratap makka-5 at 30 DAS (3.27 g), 45 DAS (39.04 g) and harvest (157.13 g) which was significantly superior over PEHM-2, HQPM-1 and Pratap QPM-1 by 6.2, 9.4, 10 per cent at 30DAS, 8.1, 12.2 and 14.2 per cent at 45 DAS and 4, 5.3 and 6.1 per cent at harvest, respectively but on par with BIO-9637.
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Daynard et al. found a reduction in leaf dimension in maize when the day/night temperature was raised from 25°C / 20°C to 30°C / 25°C. The optimal average temperature for leaf size and leaf area per plant appears to be in the range of 20-25oC, since leaf dimension and leaf area per plant. It also decrease by lowering the average temperature below 20^{o}C.

Majumder et al. reported the regression analysis between temperature and grain yield under different treatments showed negative relation indicating a decrease in grain yield of maize by 2.8 q ha-1 with increase in canopy temperature by 1°C. Global warming has adverse impact on maize productivity

IV.METHODOLOGY

The experiment was conducted during kharif season, 2016 at S.V. Agricultural college, Tirupati located at 13.65°N and 79.42°E, which is situated in southern agro climatic region of Andhra Pradesh. The experiment was laid out in split plot design with twelve treatments and three replications. The experiment was raised with hybrids as major treatments and dates of sowing as sub treatments. The maize hybrids D.S 900M, Pinnacle and CP818 were sown at four dates of sowing (June II FN, July I FN, July II FN and August I FN). The dates of occurrence of different phenological events viz., emergence, six leaf stage, tasselling stage, silking stage, soft dough stage, hard dough stage and physiological maturity stage.

The daily meteorological data from the regional meteorological office situated 1km away from the experimental field, were used. The mean maximum, minimum and diurnal variations prevailed over different over different phenophases prevailed in maize hybrids across sowing dates listed in table 1.

There was considerable variation across sowing dates. During the period of study from the time of sowing to physiological maturity, the mean maximum temperature for D.S 900M (H1), Pinnacle (H2) and CP818 (H3) ranged from 34.4 to 33.7°C across the dates of sowing and the mean minimum temperature ranged from 25.6°C to 23.1°C.

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V.EXPERIMENT RESULTS

The data recorded during the crop growth period of three maize hybrids sown at different dates of sowing expressed in °C are presented in Table 4. The variation in climate is especially related to solar radiation, day length, relative humidity, rainfall and temperature.

A.Radiation : Radiation is one of the important environmental parameters in maize growth and development, it is responsible for the formation of dry matter through photosynthesis. From the time of sowing to physiological maturity, sunshine hours of maize hybrids ranged from 9.4 hours to 3 hours across the dates of sowing. The variation in sowing date in maize modifies the radiative and thermal conditions during its growth. The amount of incident radiation and its proportional that is intercepted by the crop directly determines crop growth rate.

B.Day Length: Day length period of maize hybrids ranged from 11.94 to 12.25 across the four dates of sowing. Highest day length of 12.55 from sowing to emergence in D1 (June II FN) and least day length of 11.34 from sowing to emergence in D4 (August I FN). However there was no much variation in day length across the sowing dates.

C. Relative Humidity: Mean Relative humidity (RH) and evaporation ranged from 63.6 to 60.1 per cent and 5.4 K Pa to 3.4 K Pa. Highest RH I and evaporation of 70.7 per cent from sowing to emergence in D1 (June II FN) and least RH I of 53.8 per cent from sowing to emergence in D4 (August I FN). Highest evaporation of 7.6 K Pa from sowing to emergence in D4 (August I FN) and least evaporation of 3.4 KPa from sowing to emergence in D1 (June II FN).

D. Rainfall: From the time of sowing to physiological maturity, total rainfall ranged from 295mm. Highest rainfall of 121.2 55 mm from emergence to six leaf stage in D2 (July I FN) and least rainfall of 0.0 mm at different growth stages.

E. Temperature: Maize hybrids has recorded least minimum temperature of 29.4°C and highest maximum temperatures of 32°C from sowing to emergence in D1 (June II FN). Wereas from D4 (August I FN sowing) mean minimum and maximum temperatures were 19.6 °C from soft dough stage to hard dough and 36.3°C from sowing to emergence respectively. The optimum temperatures for maize from 21 to 33°C (Grezesaik, 2008). Mean maximum temperature of 33.8°C and 24.9 °C during the grain filling period resulted in maximum grain size in D1. The decreased temperatures during the grain filling stage decreased drymattter, LAI and grain yield in D4. The results are in conformity with the findings of Endres and Mudstock (1989).

F. LAI AND Total Dry Matter: Among the dates of sowing total dry matter increased exponentially from six leaf stage to Physiological stages presented in table 1 and 2. Significantly highest total dry matter and Leaf area was observed in D1 (June II FN) sowing (313.8 g, 4532 cm^2 $plant^{-1}$)) and lowest was recorded by D4 sowing (232.7 g, 1541.2 cm^2 $plant^{-1}$) respectively at physiological maturity. Similar results were reported by Nielson *et al*. (2002), Sulochana *et al*. (2015) and Zaker *et al.* (2014). Total dry matter production of a crop is known to be proportional to the total amount of intercepted radiation, which itself is largely determined by the size of leaf area and its distribution with time.

G.KerneL Yield: The net effect of sowings resulted in reduced yields with delay in sowing as presented in table 3. Among the dates of sowing D_1 (June II FN) recorded significantly higher yield (3684.36 kg ha^{-1}) than D_2 (3207.72 kg ha^{-1}), D_3 (2628 kg ha^{-1}) and D_4 (August I FN) recorded significantly lower yields (1724.26 kg ha^{-1}). D_4 (August I FN) recorded significantly lower yields (1724.26 kg ha^{-1}). Among the hybrids Pinnacle recorded numerically higher yield (3006.58 kg ha^{-1}) than D.S 900 M (2748 kg ha^{-1}) but was significantly higher than CP818 (2678.4 kg ha^{-1}) due to increased dry weight of grains and higher optimum temperatures during grain filling phase. The results are in conformity with the Hossein *et al.* (2014).

VI.CONCLUSION

Climatic variables has major effect on crop growth. Among them temperature has major effect. Maize requires particular temperature and day length in various developmental stages for successful growth and yield. Six leaf stage to tasseling minimum and maximum temperature, 25.5°C and 34.6°C respectively and 12.36 hours of day length; from tasseling to silking 25.5 and 33.3°C minimum and maximum temperature, respectively and 12.24 hours of day length ; from silking to soft dough stage 25.1 and 33.8°C minimum and maximum temperature, respectively and 12.18 hours of day length; from soft dough stage to hard dough stage 24.8 and 33.2°C minimum and maximum temperature, respectively and 12.10 hours of day length and hard dough stage to physiological maturity 25 and 34.5°C minimum and maximum temperature, respectively and 11.84 hours of day length. Temperature plays a dominant role during vegetative growth and grain filling. Increased temperatures during grain filling reduced the capacity for continued metabolism due to kernel moisture decrease which lead to reduced grain filling period. This shortened grain filling can

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lead to a complete cessation of kernel growth through formation of a black abscission layer. Resulting artificial shortening of the grain filling duration reduced kernel size (sink) and ultimately yield. Thus, maize in rained cultivation in August I FN in Southern Agroclimatic Zone of Andhra Pradesh is risky and the increase in temperature beyond optimum level decreases yields.

Table 1 leaf area (cm^2) of maize hybrids sown at different dates of sowing

Treatments	6 leaf stage	Tasseling stage	Silking stage	Soft dough stage	Hard dough stage	Physiological maturity
Hybrids						
H_1 : D.S 900M	501.4	2666.4	2766.7	1929.3	1305.9	51.8
H_2 : Pinnacle	467.7	2582.1	2911.1	1998.1	1350.3	49.1
H_3 : CP818	493.3	2462.3	2847.3	1876.7	1201.8	47.9
CD (P=0.05)	NS	NS	NS	NS	77.5	1.6
Dates of Sowing						
D_1 : June II FN	831.3	4495.7	4532.1	2976.9	2460.7	62.2
D_2 : July I FN	501.4	2537.7	2876.2	2096.1	1222.7	51.7
D_3 : July II FN	356.0	1870.4	1937.1	1417.3	850.5	49.2
D_4 : August I FN	261.0	1380.2	1541.2	1249.7	610.3	35.3
CD (P=0.05)	176.5	180.5	812.2	NS	152	2.3

Table 2: Total dry matter (g $plant^{-1}$) of maize hybrids sown at different dates of sowing

Treatments	6 leaf stage	Tasseling stage	Silking stage	Soft dough stage	Hard dough stage	Physiological maturity
Hybrids						
H_1 : D.S 900M	11.9	87.2	115.9	152.2	242.8	274.1
H_2 : Pinnacle	11.15	80.8	112.3	147.4	237.8	273.1
H_3 : CP818	10.85	73.7	110.6	145.9	234.4	266.2
CD (P=0.05)	NS	2.9	3.1	3.4	3.3	3.1
Dates of Sowing						
D_1 : June II FN	21.71	119.5	139.5	181.9	280	313.8
D_2 : July I FN	14.52	96.7	122.5	157.7	253.4	282.3
D_3 : July II FN	4.93	62.8	104.3	135.8	221	256
D_4 : August I FN	3.92	43.3	85.5	118.4	199.5	232.73
CD (P=0.05)	0.6	4.9	5.9	5.8	3.3	4.1

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Table 3 Grain yield (kg ha^{-1}) of maize hybrids as influenced by different dates of sowing

Treatments	Grain yield (kg ha^{-1})
Hybrids	
H_1 : D.S 900M	2748.9
H_2 : Pinnacle	3006.6
H_3 : CP818	2678.4
CD (P=0.05)	304.7
Dates of Sowing	
D_1 : June II FN	3684.4
D_2 : July I FN	3207.7
D_3 : July II FN	2628.8
D_4 : August I FN	1724.3
CD (P=0.05)	238.8

Table 4: Mean of different weather parameters during various phenophases of maize hybrids (D.S 900M, Pinnacle and CP818)

Phenophases	Temperature (°C)		Relative humidity (%)		Relative humidity mean (%)	Sun shine hours (hrs)	Rain fall (mm)	Evaporation (K pa)	Day length
	Maximum	Minimum	Morning	Afternoon					
Sowing to emergence									
D_1 : June II FN	32.0	29.4	82.5	58.8	70.7	1.1	40.0	3.4	12.55
D_2 : July I FN	33.7	24.1	80.8	55.0	67.9	4.9	37.2	6.0	12.5
D_3 : July II FN	34.2	25.6	76.8	51.0	63.9	1.8	4.8	3.9	12.49
D_4 : August I FN	36.3	26.7	68.5	39.3	53.9	9.3	0.0	7.6	12.48
Emergence to six leaf stage									
D_1 : June II FN	34.7	25.6	76.4	49.6	63.0	4.3	55.0	5.5	12.50
D_2 : July I FN	32.9	24.8	76.9	55.4	66.1	3.0	121.2	4.1	12.45
D_3 : July II FN	35.8	26.2	69.9	43.7	56.8	8.0	0.0	7.0	12.44
D_4 : August I FN	33.7	25.5	74.6	49.9	62.3	4.0	54.3	5.3	12.40
Six leaf stage to tasseling stage									
D_1 : June II FN	34.6	25.5	73.2	48.8	61.0	5.8	121.8	4.1	12.36
D_2 : July I FN	35.0	25.9	72.7	46.0	59.3	6.4	54.3	6.3	12.28
D_3 : July II FN	34.6	25.5	73.2	48.8	61.0	5.8	121.8	5.8	12.27

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D_4 : August I FN	34.1	25.1	78.2	48.1	63.2	3.9	29.6	4.9	12.26
Tasseling to silking stage									
D_1 : June II FN	33.3	25.5	79.8	53.9	66.8	2.7	53.9	4.1	12.24
D_2 : July I FN	32.9	24.9	75.1	54.0	64.6	2.5	16.0	3.9	12.22
D_3 : July II FN	34.4	25.2	80.7	46.2	63.4	4.3	7.2	5.3	12.14
D_4 : August I FN	35.4	20.8	73.8	35.3	54.5	8.2	0.0	5.6	12.13

Table 4.1. Contd…

Phenophases	Temperature (°C)		Relative humidity (%)		Relative humidity mean (%)	Sun shine hours (hrs)	Rain fall (mm)	Evaporation (K pa)	Day length
	Maximum	Minimum	Morning	Afternoon					
Silking to soft dough stage									
D_1 : June II FN	33.8	25.1	71.4	47.6	59.5	4.9	0.4	6.0	12.18
D_2 : July I FN	33.6	25.3	79.2	51.5	65.4	3.6	6.4	5.0	12
D_3 : July II FN	35.7	23.7	73.4	37.9	55.7	6.1	0.0	5.4	11.57
D_4 : August I FN	34.0	22.3	79.0	44.2	61.6	5.5	11.2	4.7	11.56
Soft dough to hard dough stage									
D_1 : June II FN	33.2	24.8	78.4	53.0	65.7	3.6	23.9	4.3	12.10
D_2 : July I FN	34.9	24.8	80.3	43.3	61.8	4.7	7.2	5.0	11.59
D_3 : July II FN	35.4	20.4	81.4	35.5	58.4	7.9	0.0	5.4	11.45
D_4 : August I FN	33.3	19.6	73.4	41.4	57.4	7.6	0.0	5.2	11.44
Hard dough to physiological maturity									
D_1 : June II FN	34.5	25.0	81.6	44.9	63.3	4.4	6.9	5.3	11.84
D_2 : July I FN	35.7	22.6	72.8	36.7	54.8	7.3	0.0	5.5	11.49
D_3 : July II FN	33.4	21.6	74.8	43.8	59.3	5.9	11.6	4.8	11.36
D_4 : August I FN	31.3	19.6	78.8	48.5	63.6	5.9	70.8	4.1	11.34
Sowing to physiological maturity									
D_1 : June II FN	34.1	25.6	76.3	50.1	63.2	4.5	301.9	5.3	12.25
D_2 : July I FN	34.3	25.0	72.0	46.9	63.6	9.4	242.2	5.4	12.16
D_3 : July II FN	34.4	24.3	75.2	45.4	60.3	5.5	145.4	5.4	11.96

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D_4 : August I FN	33.7	23.1	76.4	45.8	61.1	3.0	165.9	3.4	11.94

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