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Phenological growth and development of Rabi maize (*Zea mays* L.) under various moisture regimes

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Abstract
A field experiment was carried out at Agronomy Research Farm, Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during Rabi season of 2016-17 to study the "Phenological growth and development of Rabi maize (*Zea mays* L.) under various moisture regimes." The experiment comprised of nine treatment combinations and conducted in Split plot design and replicated four time. Experiment consisted of three crop growing environment viz. 60x 20 cm spacing, 60 x 25 cm and 60 x 30 cm spacing were kept in main plots with three moisture regimes Viz. 0.6 IW/CPE ratio, 0.9 IW/CPE ratio and 1.2 IW/CPE ratio were kept in sub plot. Result reveal that crop growing environment, sowing done at 60x20 cm spacing recorded higher days taken from sowing to maturity while among moisture regime 1.2 IW/CPE ratio recorded higher days taken from sowing to maturity. Moisture regimes of 1.2 IW/CPE ratio was found suitable for higher growth and development of Rabi maize.

Keywords: maize, phenophases, LAI, yield attribute

Introduction

Maize (*Zea mays* L.) belongs to family poaceae is one of the most important cereal crop in the world after wheat and rice. The importance of maize lies in its wide industrial applications besides serving as human food and animal feed. Maize is called 'queen of cereal' as it grown throughout year due to its photo-thermo-insensitive character and highest genetic yield among the cereals. Being a C_4 plant, it is very efficient in converting solar energy in to dry matter. Over 85% of maize produced in the country is consumed as human food. Green cobs are roasted and consumed by people with great interest. Maize seed contains 10% protein, 4% oil and 2-3% crude fiber. Several food dishes including chapaties are prepared out of maize flours and grains. Green maize plants are used as succulent fodder. Popping the corn is a method of starch cookery. Maize is a raw material for a number of products viz., starch, glucose, dextrose, sorbitol, dextrine, high fructose syrup, maltodextrine, germ oil, germ meal, fiber rand gluten products which have application in industries such as alcohol, textile, paper, pharmaceuticals, organic chemicals, cosmetics and edible oil. Maize has got very high yield potentiality and wide adaptability under various agro climatic conditions than any other cereal crops (Singh, 2013) [6]. The cultivation of winter maize was started in 1983-84 with the introduction of cold resistant varieties (Khehra and Dhillon 1984) [1]. The main idea was to give impetus to maize production because winter maize had high yield potential due to low incidence of insect-pest and diseases, lodging tolerance as compared to kharif season crop (Lal *et al* 2000) [3]. However, the practice of growing winter maize also could not catch up with the farmers due to its variable response to suboptimal temperatures, chilly winds and frequent incidences of frost in early period of growth in different areas of Punjab. Therefore, the Punjab Agricultural 2 University has also recommended maize sowing in the month of August. August sown maize has significantly lower maize borer attack, higher monetary returns (Srinivasulu *et al* 2008, Lal 1973) [7, 2], higher values of grain yield, stover yield, gross returns, net returns, benefit: cost ratio and per day gross returns as compared to sown in June and July (Panchanathan *et al* 1992) [4]. Maize responds relatively better to management factors especially irrigation and nitrogen (Prasad *et al* 1987) [5]. Assured irrigation is an important factor for the August sown maize. In Punjab, monsoon rains mostly recede by 15th September.

The maize crop sown during August completes almost half of its growth period and whole of reproductive period till maturity in a weather regime which is quite different from the one encountered by the main kharif season maize, in the sense that as the crop progresses from about knee-high stage onwards the temperature goes on falling and as is the evapotranspiration rate so there is possibility of reduced irrigation water requirement for August sown maize. Thus, there is every likelihood that irrigation needs of August sown maize may differ from main kharif season maize. Maize lacks tillering capacity to adjust the loss of optimal crop stand. Optimum plant density should be characterized and maintained with uniform stand which is essential for higher and sustained productivity. Sub optimum plant population results in declined productivity due to inefficient utilisation of resources by crop, while excessive plant population leads to severe inter-plant competition for basic resources. In addition to plant population, proper crop geometry, is important from the point of intercepting sunlight for photosynthesis besides efficient use of plant nutrients and soil moisture. Therefore, proper irrigation schedule with optimum plant stand is essential to achieve targeted yield. In order to achieve higher cob yields, optimum plant density is the most important factor. A spatial arrangement of plant governs the shape and size of the leaf area per plant, which in turn influences efficient interception of radiant energy as well as proliferation and growth of roots and their activity. Maximum yield can be expected only when plant population allows individual plant to achieve their maximum inherent potential. Thus, there is need to find out an optimum population density.

Materials and Methods

The experiment was conducted at Agronomy Research Farm of N.D university of Agriculture & Technology, Kumarganj, Faizabad (UP). On the topic entitled "Phenological growth and development of Rabi maize (*Zea mays* L.) Under various moisture regimes." It is situated on Faizabad-Raibareily road at the distance of 42km from Faizabad district head quarter. Geographically experimental site falls under sub-tropical climate of Indo-gangetic plains having alluvial soil and is located at 26° 47' N latitude and 82° 12' E longitude and at an altitude of 113 meters above mean sea level. The details of materials and methods employed & techniques adopted during the course of experimentation has been described in this experiment. The experiment was conducted in Split Plot Design (SPD) and replicated the four times. The different growth parameters studied were maize as phenophases, plant height, Leaf area index and Yield attributing characters.

Results

Phenophases of maize as affected by crop growing environment and moisture regimes at different phenological stages have been presented in (Table-1). The maximum days taken from emergence to maturity were recorded (154.0days) at crop growing environment of 60x20 spacing while minimum days taken from emergence to maturity (153.0 days) was observed under crop growing environment (60x25cm) and (60x30cm). Different moisture regimes had marked influence on the days taken to different phenophases of rabi maize at all the phenophases. Days taken to different phenophases ranged from 150 to 156 irrespective of different moisture regimes. Maximum days taken (156.0) from emergence to maturity was obtained in moisture regime 1.2IW/CPE ratio while minimum days taken (150.0) was obtained in moisture regimes 0.6 IW/CPE ratio from emergence to maturity of rabi maize.

Plant height of maize as affected by crop growing environment and moisture regimes at different growth stages have been presented in (Table -2). Plant height of maize increased progressively with advance in the age of the crop. Plant height of maize measured at different growth stages was significantly influenced by crop growing environment and moisture regimes. The higher plant height of maize was recorded with a spacing of 60×20 cm which was significantly superior than 60 x 25 cm while lower plant height were recorded in 60 x 30 cm spacing moisture regime had significant influence on plant height at all the stages. The taller plants were produced with 1.2 IW/CPE ratio which was at par with IW/CPE ratio of 0.9 while significantly taller than IW/CPE ratio of 0.6. Interaction effect of crop growing environment and moisture regimes on plant height was not significant.

Leaf area index of maize as affected by crop growing environment and moisture regimes at different growth stages have been presented in (Table-3). Leaf area index increased progressively with advance in the age of the crop. LAI of maize recorded at different growth stages was significantly influenced by crop growing environment and moisture regimes. Significantly higher LAI of maize which was recorded with a spacing of 60×20cm was at par with 60x25 cm while significantly taller than 60×30 cm spacing. Higher LAI were produced with the highest level of irrigation tried with IW/CPE ratio of 1.2 which was significantly taller than with those under IW/CPE ratio of 0.9, while Lower LAI were recorded with IW/CPE ratio of 0.6. Interaction effect of crop growing environment and moisture regimes on Leaf area index was not significant.

No of cob, per plant of Rabi maize was significantly influenced by crop growing environment and moisture regimes have been presented in (Table-4). As regards the crop growing environment, significantly the higher no of cob, per plant of maize was recorded with the crop growing environment level of 60 × 30 cm which was at par with 60 x 25cm while significantly over 60x20 cm spacing. The higher no of cob per plant of maize was recorded with the highest level of moisture regime *i.e.*, IW/CPE ratio of 1.2 which was at par with IW/CPE ratio of 0.9 IW/CPE ratio. The lowest no of cob per plant of maize was recorded with lower level of moisture regime *i,e.*, IW/CPE ratio of 0.6. Interaction effect of crop growing environment and moisture regimes on no of cob per plant was significant. Length of cob of Rabi maize was significantly influenced by crop growing environment and moisture regimes have been presented in (Table-4). Among crop growing environment, the highest cob length was recorded with 60×30 cm which was at par with 60 x 25 cm while significant over 60 x 30 cm spacing. Higher cob length was recorded significantly with the highest level of irrigation tried *i.e*, IW/CPE ratio of 1.2 which was at par with IW/CPE ratio of 0.9. While significantly higher than IW/CPE ratio of 0.6. Interaction effect of crop growing environment and moisture regimes on Length of cob was not significant. No of grain rows per cob in Rabi maize was significantly influenced by crop growing environment and moisture regimes have been presented in (Table-4). As regards the crop growing environment, the highest no. of grain rows per cob of maize was recorded with the crop growing environment level of 60 × 30 cm which was at par with 60 x 25cm while significant over 60 x 20 cm spacing. The highest no of grain rows per cob of maize was recorded with the highest level of moisture regime *i.e.*, IW/CPE ratio of 1.2 which was at par with IW/CPE ratio of 0.9 while significantly superior to that with IW/CPE ratio 0.6. Interaction effect of crop growing environment and moisture regimes on no of grain rows per cob was not significant. No of grains per row of Rabi maize was significantly influenced by crop growing environment and moisture regimes have been presented in (Table-4). As regards the crop growing environment, the higher No of grains per row of maize was recorded with the crop growing environment level of 60 × 30cm which was at par with 60 x 25cm while significant over 60 x 20 cm spacing. The higher No of grains per row of maize was recorded with the highest level of moisture regime *i.e.*, IW/CPE ratio of 1.2 which was at par with IW/CPE ratio of 0.9 IW/CPE ratio while significantly superior over 0.6 IW/CPE ratio. Interaction effect of crop growing environment and moisture regimes on No of grains per row was not significant. Number of grains per cob of Rabi maize as significantly influenced by crop growing environment and moisture regimes have been presented in (Table-4). As regards the crop growing environment, the highest No of grains per cob of maize was recorded with the crop growing environment level of 60×30cm which was significant over 60x25 cm and 60x20 cm planting geometry. The higher No of grains per cob of maize was recorded with 1.2 IW/CPE ratio 1.2 while significantly superior to that with 0.9 and 0.6 IW/CPE ratio. Interaction effect of crop growing environment and moisture regimes on no. of grains per cob was significant.

Table 1: Days taken to different phenophases of rabi maize as affected by Crop growing environment and Moisture regime.

Treatments	Days taken to different phenophases				
	Emergence	Knee high stage	Tasseling	Silking	Maturity
Crop growing environment					
60 × 20 cm	5.0	57.0	93.0	104.0	154.0
60 × 25 cm	6.0	55.0	91.0	103.0	152.0
60 × 30 cm	6.0	55.0	90.0	104.0	152.0
Moisture regimes					
0.6IW/CPE ratio	6.0	55.0	89.0	103.0	150.0
0.9IW/CPE ratio	7.0	57.0	91.0	104.0	154.0
1.2IW/CPE ratio	6.0	56.0	94.0	105.0	156.0

Table 2: Plant height (cm) of Rabi maize as affected by crop growing environment and moisture regimes.

Treatments	Plant height (cm)				
	30DAS	60 DAS	90 DAS	120 DAS	At harvest
Crop growing environment					
60 × 20 cm	43.7	92.6	140.7	149.4	149.5
60 × 25 cm	36.7	84.0	135.3	148.0	148.4
60 × 30 cm	38.0	80.6	130.3	146.5	147.4
SEm±	0.93	1.98	2.89	3.38	3.52
CD at 5%	3.24	6.87	9.95	11.63	12.12
Moisture regimes					
0.6IW/CPE ratio	38.4	81.5	133.9	144.5	144.5
0.9IW/CPE ratio	40.9	86.6	147.9	154.2	153.9
1.2IW/CPE ratio	42.1	89.2	155.8	164.7	164.9
SEm±	0.75	1.59	2.71	3.63	3.73
CD at 5%	2.234	4.733	7.88	10.55	10.81

Table 3: Leaf area index of Rabi maize as affected by crop growing environment and moisture regimes.

Treatments	Leaf Area Index			
	30DAS	60 DAS	90 DAS	120 DAS
Crop growing environment				
60 × 20 cm	0.86	2.46	3.54	4.54
60 × 25 cm	0.79	2.28	3.44	4.5
60 × 30 cm	0.75	2.16	3.33	4.45
SEm±	0.019	0.055	0.05	0.05
CD at 5%	0.066	0.191	0.18	0.16
Moisture regimes				
0.6IW/CPE ratio	0.76	2.19	2.40	3.28
0.9IW/CPE ratio	0.81	2.32	3.55	4.40
1.2IW/CPE ratio	0.83	2.39	3.69	4.62
SEm±	0.015	0.042	0.05	0.05
CD at 5%	0.044	0.126	0.14	0.14

Table 4: Yield attributes of Rabi maize as affected by crop growing environment and Moisture regimes

Treatments	Number of cobs per plant	Length of cob (cm)	No of grain rows per cob	No of grains per row	No of grains per cob
Crop Growing Environment					
60 × 20 cm	1.36	15.23	12.22	29.07	355.93
60 × 25 cm	1.40	16.36	13.13	30.60	402.56
60 × 30 cm	1.44	17.01	13.65	32.13	439.43
SEm±	0.03	0.38	0.26	0.58	10.25
CD	0.12	1.33	0.93	2.01	35.49
Moisture regimes					
0.6IW/CPE ratio	1.34	15.23	12.22	28.76	352.14
0.9IW/CPE ratio	1.41	16.44	13.20	31.06	410.57
1.2IW/CPE ratio	1.44	16.93	13.59	31.98	435.20
SEm±	0.02	0.29	0.25	0.57	7.64
CD at 5%	0.08	0.87	0.75	1.70	22.72

Conclusion

It is concluded that study in recorded higher days taken from sowing to maturity while among moisture regime 1.2 IW/CPE ratio recorded higher days taken from sowing to maturity. Moisture regimes of 1.2 IW/CPE ratio was found suitable for higher growth and development of Rabi maize.

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