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Performance of Maize Hybrids to Adapt to Rainfall Changes and Climatic Aberrations

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ABSTRACT

A field experiment was conducted under AICRP on Maize Improvement Project Scheme at Agricultural Research Station, Karimnagar, Telangana state during *kharif* 2012-13. The Grain yield obtained is significantly higher with 15 days advance sowing from normal date of sowing, June, 20th (8167 Kg/ha) and is on par with normal date of sowing, June 5th (8164 kg/ha). This is followed by July 20th, i.e., 15 days delayed sowing (7210 kg/ha) which is 11.7% decreased yield over normal date of sowing and further 30 days delayed sowing from normal date of sowing, Aug 5th (4348 kg/ha) has resulted in 43.7% reduced yield over normal date of sowing, July 5th. Among different hybrids, the full season hybrid 30V92 has recorded significantly higher grain yield (8150 kg/ha) as compared to all other hybrids. This is followed by grain yield of medium maturity maize hybrid, DHM 117 (7394 kg/ha) which showed 9.3% decreased yield over full season hybrid. The early maturity hybrid, DHM 115 (6411 kg/ha) was found to be on par with extra early maturity hybrid, QPM 9 (6091 kg/ha). The interaction effect showed that full season 30V92 hybrid recorded significantly higher grain yield (10083 kg/ha) with June 20th, i.e., 15 days advanced sowing and is on par with same hybrid at normal date of sowing (9713 kg/ha). The early sowing, 15 days advance sowing from normal date of sowing, June 20th (Rs 61374 /ha and 2.57) and the normal date of sowing, June 5th (Rs 61346/ha and 2.57) resulted in significantly higher and on par net returns and B:C ratio respectively. While the 30 days delayed sowing than normal date of sowing, August 5th recorded significantly lowest net returns and B:C ratio.

Keywords Maize hybrids, Advanced date of sowing, Delayed date of sowing, Grain yield, Economics.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important agricultural crop in the world owing to its diversity, high adoptability and great nutritional value and one of the most efficient crops, which gives high biological yield as well as grain yield in short period of time due to its unique photosynthesis mechanism being C_4 nature. It ranks third among most important food grain crop after paddy, wheat in India providing food, feed, fodder and for number of industrial products. During 2020-21, in India, maize area has reached to 9.86

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millon ha with 31.5 millon tons of Production and productivity of 3.20 t/ha (Annonymous 2020). In India maize is principally grown in two seasons, *kharif* and *rabi* seasons. *Kharif* maize represents around 83% of maize area in India, while maize in rabi corresponds to 17% of maize area which indicates over 70% of *kharif* maize area is grown under rainfed conditions with prevalence of biotic stress which include deficit or excess rainfall temperature, cloud cover, incidence of pests, diseases and weeds, restriction of sunshine hours for photosynthesis, rainfall which washes off the pollen and leaches the fertilizer nutrients.

It is seen in last two decades that changing climate, effects the crop plant in changing variety of ways. Mid season or terminal drought is the major limiting factor in achieving the higher productivity levels across the rainfed growing areas. This situation is likely to be exacerbated in coming decades due to climate change with inadequate and or uneven pattern of rainfall distribution during the cropping season (Govind Prasad *et al.* 2017). The productivity of maize crop can be increased by adjustment of sowing window with suitable single cross hybrids of different maturity durations, which are best suited to different climatic conditions and soil types. Planting date is one of the most important aspects of management in agriculture system which can affect yield through influencing emergence date, plant density, normal growth, pollination and maturity date. Planting dates has great impact on crop production, for obtaining the high yield, sowing of maize at proper time is very critical. Hence it was realized to evaluate the performance of different maturity maize hybrids under different dates of sowings in red sandy loam soils Telangana to analyze maize production in *kharif* season.

MATERIALS AND METHODS

Experiment site

A field experiment was conducted under AICRP on Maize Improvement Project Scheme at Agricultural Research Station, Karimnagar, Telangana state during *kharif* 2012-13. The experimental site is geographically situated at 18°26'N latitude and 79°5' E longitude and altitude of 229 m above mean sea level. It is covered under semi arid tropical climate with dry, hot summer and cool winters with an average annual rainfall of 1190 mm, most of which falls from June to October. The rainfall during the experimental period (June to October) was 721.2 mm in 2012. During experimentation period, the mean maximum and minimum temperatures are 33.1°C and 24.9°C and the mean relative humidity I and II are 75.6 and 56.4% respectively. The overall weather conditions were quite favorable for the growth and development of hybrid maize during the year of experimentation. The soil of the experimental field was red sandy loam in texture and good in soil fertility status with neutral pH of 7.09, electrical conductivity of 0.26 dSm^{-1} (non saline), medium in organic carbon status (0.71%), low in available nitrogen (176 kg/ha), high in available phosphorus and potassium of 37 and 392 kg/ha respectively.

Experimental treatments

The experiment was conducted in factorial RBD with factor A as four dates of sowings, 1) 20th June (15 Days advance from normal date of sowing). 2) 5th July (normal date of sowing), 3) 20th July (15 days delayed from normal date of sowing), 4) 5th August (30 days delayed from normal date of sowing) and factor B as four maize hybrids of different maturity group. H_1- QPM 9 (extra early maturity), H_2-DHM 115 (early maturity), H_3- DHM 117 (medium maturity), H_4- 30V92 (full season maize hybrid) replicated three time. The recommended dose of fertilizer applied was 200-60-50 kg N - P_2O_5 - K_2O per hectare. The N, P and K were applied through urea (46% N), single super phosphate (16% P) and muriate of potash (60% K). The full dose of phosphorus and 1/3 dose of nitrogen and ½ dose of potassium were applied at the time of sowing as basal application, whereas the remaining dose of nitrogen was applied in two equal splits at knee high and tasseling stage along with half dose of potassium. All herbicides were applied using water @ 500 l/ha with the help of knapsack sprayer fitted with flat fan nozzle. All other practices were followed as per recommendations of crop. The seed of maize hybrids was dibbled manually at a spacing of row to row as 60 cm and plant to plant distance of 20 cm using 20 kg seed per hectare as per the dates of sowing and the plants were thinned to single plant/hill to have the desired plant population. Intercultivations

Table 1. Maize crop growth and yield attributes as affected by dates of sowing and different maturity maize hybrids.

Treatments	Plant height at harvest (cm)	Ear height at harvest (cm)	Cob length (cm)	Ear diameter (mm)	Kernel rows/cob	Kernels/ row
			Main plots : Dates of sowing			
D_1 : 15 days advance from normal date of sowing, June 20th	211.1	85.4	18.1	15.3	14.6	34.8
D_2 : Normal date of sowing, July 5th	215.3	89.0	18.5	15.3	14.5	34.8
D_3 : 15 days delayed from normal date of sowing, July 20th	199.9	82.7	18.5	15.3	14.2	35.3
D_4 : 30 days delayed from normal date of sowing, Aug 5th	190.0	79.3	17.7	14.5	14.2	30.8
CD at 5%	13.1	8.3	1.3	0.5	0.5	3.3
F (5%)	S	NS	NS	S	NS	S
			Sub plots : Hybrids of different maturity			
H_1 : Extra early – QPM 9	205.3	85.9	17.4	15.4	14.9	34.5
H_2 : Early – DHM 115	189.0	80.8	18.2	14.2	14.2	31.6
H_3 : Medium maturity – DHM 117	215.6	92.1	18.7	16.1	14.4	35.4
H_4 : Full season – 30 V 92	206.4	77.7	18.4	14.7	14.0	34.2
CD at 5%	13.1	8.3	1.3	0.5	0.5	3.3
CV (%)	7.7	11.8	8.4	4.2	4.5	11.8
F (5%)	S	S	NS	S	S	NS

was carried out twice with bullock drawn guntaka and earthing up done. Preemergence herbicide Atrazine was applied after sowing. Acephate @1.5g l^{-1} was applied for control of stem borer. Data on yield and yield attributes were recorded. Five plants from each treatment plot were labeled randomly to record the observations of plant growth and yield attributes from the selected plants. The data relating to yield and yield attributes were analyzed for analysis of variance by using statistically procedure given by Gomez and Gomez (2010) and significance by F test at 5% probability.

RESULTS AND DISCUSSION

The response of maize crop growth

Maize crop growth in terms of plant height at harvest was significantly influenced by different dates of sowings and different maturity hybrids while interaction was not significant (Table 1). The plant height at harvest resulted significantly higher with July 5th, normal date of sowing (215.3 cm) and is on par with June 20th, 15 days advance from normal date of sowing (211.1 cm). The later is in turn on par with July 20th, 15 days delayed to normal date of sowing (199.9 cm). This in turn found to be on par with Aug 5th, maize crop sowing with 30 days delayed from normal date of sowing (190.0 cm). Ali *et al*. (2020) reported that early sowing date improved plant height as compared to other sown later. The higher plant height was mainly due to prevailing maximum and minimum temperature and cloud cover which affect the quick growth of plants since temperature plays a key role in the physiological and morphological development of crops (Govind Prasad *et al* 2017). Similar results have been reported by Panahi *et al.* (2010) and Azadhakht *et al*. (2012). Plant height is a vital morphological trait which is a function of combined effect of genetic makeup of plants, seed vigor, soil nutrient status and ecological conditions under which crop grows during its growth and development stages. Among the hybrids, significantly higher plant height was recorded with, medium

Table 2. Grain yield (kg/ha) as influenced by dates of sowing and different maize maturity hybrids during *kharif* 2012.

Treatments	Extra early maturity QPM 9	Early maturity DHM 115	Medium maturity DHM 117	Full season 30 V 92	Mean
D_1 : 15 days advance from normal date of sowing, June 20th	6797	7094	8334	10083	8577
D_2 : Normal date of sowing, July 5th	6990	7518	8557	9713	8195
D_3 : 15 days delayed from normal date of sowing, July 20th	6371	6749	7561	7587	7067
D_4 : 30 days delayed from normal date of sowing, August 5th	4205	4284	5126	5218	4708
Mean	6091	6411	7395	8150	
				SEd	CD (0.05)
Date of sowing				186	376
Different maize maturity hybrids				228	461
Date of sowing × Different maize maturity hybrids				456	922

maturity maize hybrid, DHM 117 (215.6 cm) and was on par with full season maize hybrid, 30 V 92 (206.4 cm) and extra early maturity hybrid, QPM 9 (205.3 cm). The early maturity hybrid, DHM 115 recorded significantly lowest plant height at harvest (189.0 cm) compared to all other maturity hybrids. This implies that plant height is a function of both genetic and environmental conditions to which plant is subjected during its growth and development stages. Beiragi *et al.* (2011) also reported difference in palnt height of different maize hybrids. These outcome are in conformity with those reported by Khan *et al*. (2002) and Azadhakht *et al. (*2012). The ear height at harvest did not differ with dates of sowings while, among different hybrids, the medium maturity maize hybrid, DHM 117 recorded higher ear height (92.1 cm) on par with extra early maturity hybrid, QPM 9 (85.9 cm) and full season maize hybrid, 30 V 92 recorded lower cob placement (Table 1).

Maize yield attributes **:** The cob length and kernel rows were not significantly influenced by the dates of sowings, while the cob girth resulted significantly higher with 15 days advance sowing, June 20th (15.3 cm) and is on par with July 5th, normal date of sowing (15.3 cm) and July 20th, i.e., 15 days delayed sowing (15.3 cm). While August 5th, the 30 days delayed sowing recorded significantly least cob girth (14.5 cm). Similarly kernel number also resulted significantly higher with July 20th, 15 days advance to normal date of sowing (35.3) on par with July 5th, normal date of sowing (34.8) and maize sown 15 days advance sowing i.e., June 20th (34.8) and similarly lowest kernel number recorded with August 5th i.e., 30 delayed from normal date of sowing (30.8) Khan *et al*. (2002). Also observed less number of grain in the cobs with delayed planting (Table 1).

Among the hybrids, the cob length and kernel no/ row were not significantly influenced by the hybrids. While, the Cob girth resulted significantly highest with medium maturity hybrid, DHM 117 (16.1 cm) over all other hybrids. This was followed by extra early maturity hybrid, QPM 9 (15.4 cm) which recorded significantly highest than compared to other two hybrids. The Kernel rows/cob was significantly higher with extra early maturity hybrid, QPM 9 (14.9) and is on par with medium maturity hybrid, DHM 117 (14.4). The later is on par with other two hybrids (Table 1).

Maize grain yield **:** Grain yield is a function of mutual effects of separate yield components, growth and development of entire crop which are affected by various agronomic practices and environmental factors to which crop is subjected during its growth and development. The grain yield is the final output of a crop which shows the yield potential of a crop (Ali

Table 3. Net returns (Rs./ha) as influenced by dates of sowing and different maize maturity hybrids during *kharif*, 2012.

Treatments	Extra early maturity QPM 9	Early maturity DHM 115	Medium maturity DHM 117	Full season 30 V 92	Mean
D_1 : 15 days advance from normal date of sowing, June 20th	44532	48186	63439	84943	60275
D_2 : Normal date of sowing, July 5th	46907	53397	66174	80401	61970
D_3 : 15 days delayed from normal date of sowing, July 20th	39286	43935	53921	54248	47848
D_4 : 30 days delayed from normal date of sowing, Aug 5th	12647	13625	23976	25101	18837
Mean	35843	39786	51878	61174	
				SEd	CD (0.05)
Date of sowing				2292	4629
Different maize maturity hybrids				2808	5670
Date of sowing × Different maize maturity hybrids				5615	11339

et al. 2020). The data on effect of different dates of sowing indicated that significantly higher grain yield is obtained with 15 days advance sowing from normal date of sowing, June, 20th (8597 kg/ha) and is on par with normal date of sowing, June 5th (8193 kg/ha). This is followed by July 20th, i.e., 15 days delayed sowing (7067 kg/ha) which is 13.7% decreased yield over normal date of sowing and further 30 days delayed sowing from normal date of sowing, Aug 5th (4348 kg/ha) has resulted in 42.5 % reduced yield over normal date of sowing, July 5th (Table 2). The growth rate was slow in 30 days delayed sowing August 5th because of fall in ambient temperature. These results are also in accordance with Badu-Aparaku *et al.* (1983), Ahmed *et al.* (2000) and Amjadian *et al.* (2013). The increase in yield at normal date of sowing or with 15 days advance sowing from normal date of sowing, June 20th is due to the favorable environment coupled with good growth and development (Govind Prasad *et al.* 2017). Further the significant increase in crop growth and yield attributes of ear diameter and kernels/row also contributed to high yield at normal date of sowing.

Among different hybrids, the full season hybrid, 30 V 92 has recorded significantly higher grain yield (8150 kg/ha) as compared to all other hybrids. This is followed by grain yield of medium maturity maize hybrid, DHM 117 (7395 kg/ha) which showed 9.3% decreased yield over full season hybrid. The early maturity hybrid, DHM 115 (6411 kg/ha) was found to be on par with extra early maturity hybrid, QPM 9 (6091 kg/ha). The higher yield of full season and medium maturity maize hybrid may be attributed to the potentiality of the hybrid, good growth and yield by utilizing the available resources for longer time (Manjulatha and Sumalini *et al.* 2021). The interaction effect of sowing dates and different hybrids showed that full season 30V92 hybrid recorded significantly higher grain yield (10083 kg/ha) with June 20th, i.e., 15 days advanced sowing and is on par with full season hybrid at normal date of sowing (9713 kg/ha). This is followed by grain yield of medium maturity maize hybrid, DHM 117 at normal date of sowing, July 5th (8557 kg/ha) and is on par with, 15 days advance sowing from normal date of sowing, June, 20th (8334 kg/ha). Significantly lowest grain yield was obtained with 30 days delayed sowing than normal date of sowing, Aug 5th with extra early hybrid QPM 9 (4205 kg/ha) and early maturity hybrid, DHM 115 (4284 kg/ha) (Table 2). Similar trend is recorded with cob yield. Variation in grain yield with different maturity hybrids was also reported by Kagasago (2006) and Tsimba *et al. (*2013). These results are in contour with those of Contarero *et al. (*2000).

Economics **:** The data on net returns and B:C ratio

Table 4. B : C ratio as influenced by dates of sowing and different maize maturity hybrids during *kharif*, 2012.

Treatments	Extra early maturity QPM 9	Early maturity DHM 115	Medium maturity, DHM 117	Full season 30 V 92	Mean
D_1 : 15 days advance from normal date of sowing, June 20th	2.14	2.23	2.62	3.17	2.54
D_2 : Normal date of sowing, July 5th	2.20	2.37	2.69	3.06	2.58
D_3 : 15 days delayed from normal date of sowing, July 20th	2.01	2.13	2.38	2.39	2.23
D_4 : 30 days delayed from normal date of sowing, Aug 5th	1.32	1.35	1.62	1.64	1.48
Mean	1.92	2.02	2.33	2.57	
				SEd	CD (0.05)
Date of sowing				0.06	0.12
Different maize maturity hybrids				0.07	0.15
Date of sowing × Different maize maturity hybrids				0.14	0.29

obtained is significantly influenced by different dates of sowings and different maturity hybrids and interaction was also significant (Tables 3—4). The normal date of sowing, July 5th resulted significantly higher (Rs 61970 /ha and 2.58) and on par net returns and B:C ratio respectively with that of 15 days advanced date to normal date of sowing, June 20th (Rs 60275/ ha and 2.54). While the 30 days delayed sowing than normal date of sowing, Aug 5th recorded significantly lowest net returns and B:C ratio (Tables 3—4). Among the hybrids, the full season maize hybrid, 30V92 recorded significantly higher net returns (Rs 61174/ha) and B:C ratio (2.57) over all other hybrids followed by medium maturity maize hybrid, DHM 117 with net returns of (Rs 51878/ha) and B:C ratio (2.33). While the net returns and B:C ratio of early maturity hybrid, DHM 115 (Rs 39786 /ha and 2.02) respectively was significantly on par with that of extra early maturity hybrid, QPM 9 (Rs 35843/ha and 1.92) respectively. The higher grain yield in full season and medium maturity has resulted in higher net returns and B:C ratio. These interpretations are profuse supported by Contarero *et al*. (2000). In interaction, the full season 30 V 92 hybrid recorded significantly higher net returns of Rs 84943/ha and B : C ratio of 3.17 with June 20th i.e., 15 days advanced sowing from normal date and is on par with same hybrid at normal date of sowing (Rs 80401/ha and 3.06) respectively.

CONCLUSION

The full season and medium maturity maize hybrids recorded higher and on par grain yield, net returns and B:C ratio at early sowing of 15 days advance sowing from normal date of sowing, June 20th and normal date of sowing, July 5th. While at 15 days delayed sowing, July 20th sowing, the full season, 30 V 92, medium maturity hybrid (DHM 117) and early maturity hybrid (DHM 115) have given significantly on par grain yield and returns emphasizing that with delay in sowings, early maturity maize hybrids can be choosen for higher yields and returns. The 30 days delayed sowing from normal date of sowing, Aug 5th has witnessed 42.5% reduced yield over normal date of sowing, July 5th.

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