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Effect of Sowing Dates and Maize Hybrids on Maize Productivity in Southern Rajasthan

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Abstract

A field experiment was conducted during *kharif* season of 2011 to find out appropriate date of sowing with suitable hybrids of maize in a clay loam textured soil at Agriculture Research Station (MPUAT) Banswara, Rajasthan. The experiment consisted of four dates of sowing *viz*., D_1: 25 standard week (18-24 June), D_2: 26 standard week (25June-01July), D_3: 27 standard week (02-08 July), and D_4: 28 standard week (9-15 July) and three hybrids *viz*. Bio-9681, Prabal and PEHM-2 was laid out in split plot design with three replications. The sowing was done on 18th June, 25th June, 2 July and 9th July being the first day of standard weeks 25, 26, 27 and 28, respectively. The result revealed that date of sowing has maximum bearing the grain yield of maize during rainy season. The highest grain yield of 53.36q/ha was recorded when maize was planted on 18th June which was significantly superior over the following sowing dates which there was reduction in yield by 9.8, 17.74 and 37.71 percent at D_2,D_3 and D_4, respectively. The crop sown on 18th June calculated maximum GDD of 1693^0 days^{-1} and maximum heat use efficiency of 7.52 kg/ha^0 day^{-1}. The lowest yield of 33.46 q/ha was recorded when the crop was planted on 9 July which calculated 37.71 percent yield reduction compared to sowing on 18 June. Among the hybrids tried, The Bio-9681 hybrid was most responsive, giving rise to 52.32 q/ha of grain yield and use maximum growing degree days (1775^{0}day^{-1}) compared to prabal (1553^{0}day^{-1}). The PEHM-2 hybrid was low yielder (38.96q/ha) with least utilization of GDD (1531^{0}day^{-1}) with lowest HUE of 6.88 kg/ha^0 day^{-1}. The yield components and economics were found highest at first date of sowing with maize hybrid var. Bio-9681 which observed sequential reduction in next sowing date. The results indicated that advanced planting of maize in 25 standard week with medium to late maturity hybrids obtained higher yield might be because of efficient utilization of weather resources.

Keywords: Date of sowing, yield, maize, hybrids, net return, GDD, HUE

Introduction

Maize (*Zea mays* L) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. It has tremendous potential in ensuring sustainability and food security of India after rice and wheat. In recent years, it is growth rate in cultivated area (2.6%), production (6.4%) and productivity (3.6%) has been increased in India, which estimated in highest order of other cereal crops (DMR, 2011). Maize is also leading staple food crop of sub humid zone of southern Rajasthan have a major cultivated area about 1.0 m ha but the productivity is very low due to crop is dependent on weather conditions during rainy season. Three weather parameters viz. temperature, rainfall and sunshine are most important factor for growth and development of a crop. The temperature pays a vital role in all most biological processes of crop plants while, rainfall provides water to plant there by plant absorbes nutrients from soil and sunshine has a major role for photosynthesis. Sowing time is associated with weather parameters which plays a vital role in quantification in weather influences during a single season in terms of productivity. Appropriate sowing time enables the crop to take full advantage of favourable weather conditions. Generally sowing time during rainy season depends on the onset of monsoon but the onset of monsoon is not regular. Several workers reported that the delay in sowing beyond optimum date the maize yield was gone down. Most suitable temperature for germination is 21^{0}C and for growth is 32^{0}C (Jain, 1973). The heat unit or growing degree days (GDD) concept assumes that there is a direct and linear relationship between growth of plants and temperature. The scientific

assessing and quantifying the effect of temperature and photoperiod on plant growth, development and yield are by GDD theory which advocates that a define temperature requirement to pass through a conducted to certain growth phenophage. Thus, the rate of development of maize from planting to anthesis is a function of temperature rather than photosynthesis (Girijesh *et al*, 2011). So a field trial was conducted to determine the impact of sowing dates on crop production and productivity of maize hybrids under southern Rajasthan.

Materials and Methods

The field experiment was conducted during rainy season at Agriculture Research Station (MPUAT), Banswara. The geographical situations of this station are 24^0 33'N latitude, 73^0 27' E longitude and altitude of 220 m above mean sea level. The annual rainfall of centre is 855mm, most of which (90%) is contributed by south west monsoon during June to September. The soil was clay loam in texture having pH-7.8, 240.8 kg ha^{-1} available nitrogen, 38 kg ha^{-1} available phosphorus and 352 kg ha^{-1} available potassium. The experiment consisted of four dates of sowing *viz*., D_1: 25 standard week (18-24 June), D_2: 26 standard week (25 June-01July), D_3: 27 standard week (02-08 July), and D_4: 28 standard week (9-15 July) with three hybrids of maize *viz*. Bio-9681, Prabal and PEHM-2. The experimental design was split plot with three replications, dates of sowing were done in main plots and hybrids were planted in sub-plots. The sowing was done on 18th June, 25th June, 2 July and 9th July is being the first days of standard weeks 25, 26, 27 and 28, respectively. The crop was raised by using recommended agronomic package of practice for the zone.

Maximum and minimum temperature data during crop growing season were used for calculating degree day requirement of the crop. Weather parameters of crop growing period are given in table-1. Periodical observation on phonological development, yield and yield attributing characters were recorded. Growing degree days (GDD) were calculated using base temperature of 10^o C from daily mean temperature as suggested by Monteinth (1984). The thermal use efficiency and heat use efficiency were measured through giving formula by Rajput (1980).

1. Growing Degree Days (GDD) = $\{(T_{max} + T_{min}) /2\}-T_b$
2. Heat use efficiency (HUE) = Total dry matter (kg ha^{-1})/GDD^o day^{-1}).

Results and Discussion

Rainfall pattern and rainy days

The weekly rainfall pattern and rainy days for experimental periods are presented in table-1 and Fig.1. The maize growing season, precipitation from 25th standard week (18-24 June) to 38th standard week (17-23 September) was received 967.20mm in 49 rainy days. All the hybrids were matured up to 95 days. The maturity date was recorded earlier in the early sowing date and delayed maturity in later sowing dates. The grain yield in first sown on 18 June was greater 5.3t /ha but in lasted sown on 09th July was found lesser than 3.5 t/ha for all hybrids. Among the hybrids, maximum yield decreased with delayed sowing dates in late maturity hybrid (Bio-9681) as compared to early and medium maturity hybrids namely PEHM-2 and Prabal, respectively. The rains received up to maturity of first sowing date whereas, rain was not received during maturity by beyond sowing dates. There are several possibilities for why later sowing decreased the maize yield. But the water availability is one of the major important factors for maize production. The present study data conformed to the related finding, reported by Ladda *et al* (2010).

Growing degree day (GDD)

The maximum heat units of 1693 degree days from sowing to physiological maturity were recorded with first sowing in 25 standard week which was declined with delayed sowing after 25th week and minimum GDD of 1614 degree days was recorded at sowing in 28 standard week. Among the hybrids, Bio-9681 utilized maximum GDD of 1775 degree days followed by Prabal and PEHM-2. The data presented in table 2 showed the crop sown on 18th June accumulated maximum GDD and produced the highest grain and biological yields. These similar findings were reported by Dahmardeh (2012).

Heat use efficiency (HUE)

The biological yield per hectare was found to be significant at harvest. The highest biological yield of all hybrids was recorded with first date of sowing in 25 standard week. The progressive reduction was recorded in biological yield with each delay in sowing from first date of sowing. There was an overall reduction of 8.09 and 19.46% reduction in biological yield at D_3 and D_4, respectively when compared to first sowing in 25 standard week (Table-2). The results of study showed that when the decreased the temperature towards the maturity of the plant, the biological yield decreased. Difference among different sowing dates might be due to the different climatic conditions which are based on temperature during the crop life cycle. Girjesh et al (2011) reported that heat use efficiency for maize genotypes as influenced by dates of sowing.

Growth and yield attributes

The data presented in Table 2 shows that all measured yield components were significantly reduced by delaying sowing from 25 standard week to 28 standard week. The maximum biological yield (127.61q/ha) was recorded in first date of sowing on 18th June of 25 standard week which significantly reduced by 19.46% in delay sowing at 28 standard week. Similarly, maximum harvest index (41.22%) was calculated on the first sowing date and minimum (31.65%) recorded in last sowing in 28 standard week. The maximum number of cobs (60190/ha) and cob yield (64.03q/ha) were recorded when crop was sown in 25 standard week compared for delaying dates of sowing. The number of cob and cob yield/ha were reduced by 16.60 and 34.67% from first to last date of sowing respectively. Among the hybrids, highest biological yield (132.06q/ha), harvest index (39.02%), no. of cobs (64880/ha) and cob yield (63.52q/ha) were recorded by hybrid Bio- 9681 followed by prabal and PEHM-2. The present study

shows that dates of sowing produced different Nos of cobs and cob's yield and biological yield and harvest index, the result also shows that the hybrid, which remained for longer duration in the field produced higher test weight as compared to the hybrid which remained for shorter duration. Andrade (1995) reported that yield attributes decreased with delayed sowing from normal date and he was also reported that yield attributes were varied with different maturity period of cultivars.

Grain yield and economics

The effect of sowing dates and hybrids on the yield are shown in table 3 and Fig 2. First date of sowing (25^{th} standard week) produced highest grain yield 53.36 q/ha which was recorded 9.80, 17.74, and 37.71 per cent significantly superior over delay sowing on 26, 27 and 28 standard weeks, respectively. The lowest grain yield 33.46 q/ha was found when crop was planted in 28 standard week. The hybrids grown to vary significantly in their yield potential. The highest grain yield (52.32 q/ha) was obtained from the hybrid Bio-9681, while the lowest (38.96 q/ha) was produced by the hybrid PEHM-2. The maize hybrid Bio-9681was recorded significantly superior over prabal and PEHM-2 hybrids by 20.0 and 25.54 % respectively. The interaction effect of date of sowing and maize hybrids on grain yield was found significantly. The maximum yield (62.97q/ha) of Bio-9681 was obtained at sowing on 25 standard week. The grain yield reduction of maize due to delayed sowing was to an extent of 40.45, 37.82 and 32.33 % in bio-9681, prabal and PEHM-2, respectively compared to first date of sowing (25 standard week). Extent yield reduction was more with long duration hybrids as compared to short duration hybrid.

The maximum net return Rs. 37360/ha and B:C ratio 2.34 (Table 3 & Fig.3) were observed under first sown crop in 25 standard week, which gradually reduction with delay sowing by 14, 25 and 53 % of net return in D_2, D_3 and D_4 from D_1, respectively. Simultaneously, B: C ratio, reduced with delay of sowing and minimum net return (Rs 17463/ha) and B: C ratio (1.09) calculated by last sowing in 28 standard week. Among the hybrids, maximum net return (Rs.36323) and B:C ratio (2.27) was recorded with Bio-9681 which calculated significantly superior over prabal and lowest net return (Rs 22959) and B:C ratio (1.43) was recorded with PEHM-2.The present study shows that seed yield is the function of the combined effect of all the yield components under the influence of a particular set of environmental conditions. The seed yield was decreased with delay in sowing dates the lowest seed yield was obtained at late planting in 28 standard week. The delay in planting gradually decreased the yield because of low availability of soil moisture in field and decreased in temperature at the end of the season. These results clearly indicated that economy is also associated with grain yield. The results obtained from the present study agree well with the finding of Beiragi *et al* (2011) who reported that both planting date and hybrid had significantly effect on grain yield and yield components.

Conclusion

Determination of the optimum sowing date for maize is very crucial for better crop yields. The results show that maize sown in the 25 standard week was significantly better as compared to 28 standard week for the studied parameters of yield and yield components and economics. The degree day required by maize to reach maturity was dependant on temperature and date of sowing. It is therefore better to sow the plant by mid of June at the environmental condition of southern Rajasthan, because late sowing date can result in fewer yields. The lower yield can be seen in an unfavourable weather conditions. The results show that Bio-9681 has the highest no. of cobs, cob's yield, biological yield, seed yield and harvest index net return and B: C ratio. This hybrid had the highest GDD as compared to other hybrids. Thus, results indicated that advance sowing of medium to full season maturity hybrids gave higher yield might be maximum utilization of soil and weather resources.

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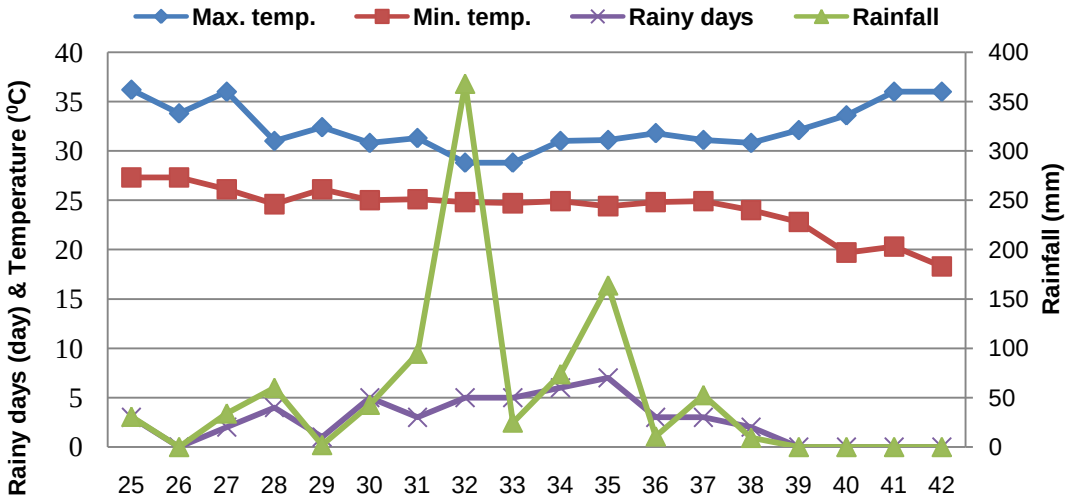

Fig. 1 Weather parameters during crop growing

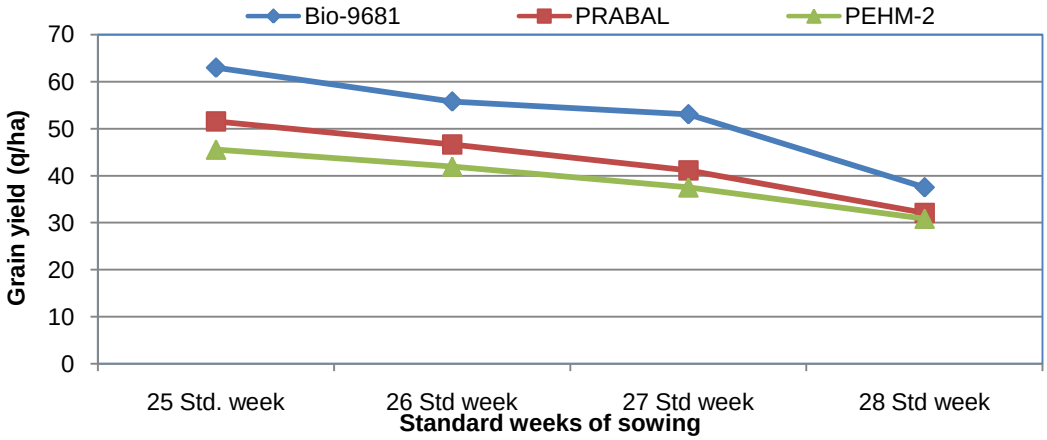

Fig. 2 Effect of sowing dates and hybrids on grain yield (q/ha) of maize

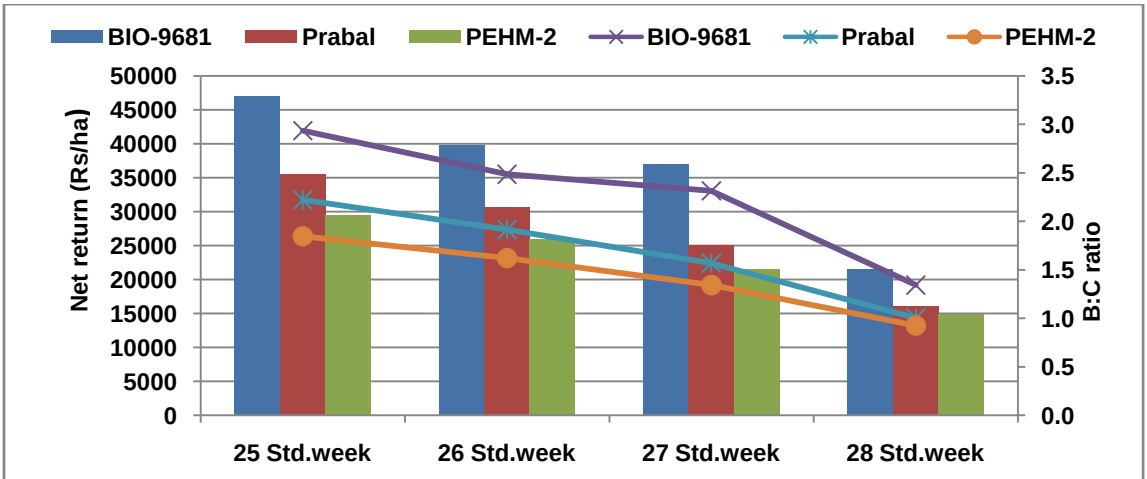

Fig. 3: Effect of dates of sowing and hybrids on net return and B: C ratio

Table 1
Meteorological weekly mean data during crop growing season *kharif* 2011

St. week no.	Date	Date	Max. C.	Min. C.	Humidity (in present)		Rain Fall (in mm.)	Rainy Days
			I	II	I	II	I	
25	18.06. 11	24.06. 11	36.2	27.3	74	55	030.7	3
26	25.06. 11	01.07. 11	33.8	27.3	74	52	000.0	0
27	02.07.11	08.07. 11	36.0	26.1	77	52	034.0	2
28	09.07. 11	15.07. 11	31.0	24.6	86	73	059.9	4
29	16.07. 11	22.07. 11	32.4	26.1	83	68	002.0	1
30	23.07. 11	29.07. 11	30.8	25.0	89	73	042.8	5
31	30.07. 11	05.08. 11	31.3	25.1	88	72	094.6	3
32	06.08. 11	12.08. 11	28.8	24.8	90	85	368.2	5
33	13.08. 11	19.08. 11	28.8	24.7	90	76	024.8	5
34	20.08. 11	26.08. 11	31.0	24.9	89	73	073.8	6
35	27.08. 11	02.09. 11	31.1	24.4	89	69	163.8	7
36	03.09.11	09.09. 11	31.8	24.8	87	69	010.7	3
37	10.09. 11	16.09. 11	31.1	24.9	88	73	052.6	3
38	17.09. 11	23.09. 11	30.8	24.0	87	65	009.3	2
39	24.09. 11	30.09. 11	32.1	22.8	84	54	000.0	0
40	01.10. 11	07.10. 11	33.6	19.7	83	50	000.0	0
41	08.10. 11	14.10. 11	36.0	20.3	76	37	000.0	0
42	15.10. 11	21.10. 11	36.0	18.3	79	30	000.0	0

Table 2
Effect of sowing dates and hybrids on growth degree days, heat use efficiency, numbers of cobs and cob's yield of maize

Treatments	GDD (^{0} day^{-1})	HUE (kg/ha^0 day^{-1})	No.of cobs/ha (000 cobs)	Cobs yield (q/ha)
Date of sowing				
D_1	1693	7.52	60.19	64.03
D_2	1664	7.39	56.60	57.75
D3	1640	7.13	55.15	53.54
D4	1614	6.35	50.20	41.83
CD=0.05%		0.18	4.36	3.82
Hybrids				
BIO-9681	1775	7.43	64.88	63.52
Prabal	1653	6.99	53.19	52.02
PEHM-2	1531	6.88	48.52	47.32
CD=0.05%		0.24	3.18	1.56

Table 3
Effect of sowing dates and hybrids on yield and economics of maize

Treatments	Grain yield (q/ha)	Biological yield (q/ha)	Harvest Index (%)	Net return (Rs/ha)	B:C
Date of sowing					
D1	53.36	127.61	41.22	37360.00	2.34
D2	48.13	123.23	38.60	32126.67	2.01
D3	43.89	117.32	35.64	27888.89	1.74
D4	33.46	102.78	31.65	17463.33	1.09
CD=0.05%	3.11	3.27	2.25	2357.76	0.19
Hybrids					
BIO-9681	52.32	132.06	39.02	36323.33	2.27
Prabal	42.85	115.60	36.92	26846.67	1.68
PEHM-2	38.96	105.54	34.39	22959.17	1.43
CD=0.05%	1.28	3.72	1.76	1574.47	0.07