RESEARCH ARTICLE

Effect of various planting dates on performance of different maize hybrids

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Maize (*Zea mays* L.) is an important grain as well as fodder crop. A study was conducted to assess the effect of planting date on different maize hybrid at College of Agriculture, University of Sargodha, Pakistan during the year 2014 and 2015. The experiment was designed with randomized complete block design (RCBD) with split plot arrangement keeping sowing dates (25th Feb, 6th Mar and 14th Mar) in main plots and maize hybrids i.e. (DK-6142, DK-6525 and DK-9108) hybrids in sub plots having three replications. The R×R and P×P distance was maintained 75 cm and 20 cm respectively. The crop was sown manually in ridges. The crop was sown with seed rate of 10 kg ha^{-1}. Seed were treated with "Confidor". All other management practices were kept normal. Recorded data was shown that all the maize hybrids differed significantly in case of yield components with mean values. i.e. plant height (145.86 cm), number of cobs per plant (1.45 cob), no. of grains per cob (425.67), grains rows per cob (31.67), 1000- grains weight (272.55 g), biological yield (12831 kg^{-1}), grain yield (4069.4 kg ha^{-1}) and Harvesting index (31.53%). It may be concluded from this study that sowing date (25th Feb) and Maize hybrid (DK-6142) is recommended for achieving high yield under semi-arid conditions of Sargodha.

Key Words: *Maize; Hybrids; Sowing dates; Sargodha*

INTRODUCTION

Agriculture is an important sector of Pakistan's economy and our population is directly supported by agricultural sector [1]. Its share is about 24% in gross domestic product (GDP) [2]. Maize belongs to family poaceae and being a versatile crop it can be grown over range of agro climatic zones i.e. in tropical, subtropical and temperate climate throughout the world. Corn (*Zea mays* L.) is the 3rd most imperative cereal crop of Pakistan serving the purpose of food, feed and fodder in the country [3-10] and contributes about 20% of calories to the diet [11]. Out of 1.1 billion tons of course produced in the world for food, feed and industrial purpose, maize accounts for 74% of aggregate output [12]. It has greater nutritional value as it contains starch 72%, protein 10%, oil 4.8%, fiber 8.5%, sugar 3% and ash 1.7% [13]. Worldwide maize is produced on an area of 159 million hectares with total yield of 796.46 million tones [14]. In our country cultivated on an area of 1.08 million hectares maize has total production of 4631 thousand tones and average grain yield is 4.26 tones ha^{-1} [15]. The average yield of Pakistan is very low than other maize producing countries like USA (9840 kg ha^{-1}), Italy (9668 kg ha^{-1}), France (9474 kg ha^{-1}), Canada (9193 kg ha^{-1}) and Egypt (8173 kg h^{-1}) [16]. In Pakistan, Punjab and KPK contribute about 97% of total maize production. Pakistan is ranked, 24th among the com producing countries [17]. Average corn yield in Pakistan is very low due to abnormal plant density, insufficient fertilizer usage, scarcity of irrigation water, weeds problems, insect pest attack and the selection of unsuitable varieties under a given set of environmental conditions [18]. Even with an excessive potential, the average maize yield is still presenting a miserable picture which may be due to the cultivation of lesser potential maize hybrids, water stress [19], unsuitable planting time and varieties [20-21]. Planting dates has great impact on crop production [22]. For obtaining high yield, sowing of maize at the proper time is very critical [23]. To get maximum yield of maize determination of proper sowing time and selection of appropriate variety is very important. Keeping in view a comprehensive study was conducted to check out the effect of planting dates on different maize hybrids as well as sort out the best time of sowing and high yielding maize hybrid.

MATERIALS AND METHODS

Site and location

The experiment was conducted at agronomic research area College of agriculture, University of Sargodha, Pakistan during two growing season, 2014 and 2015. The study was carried out with the objectives to establish the relationship among sowing time, phenology, growth and yield of different corn hybrids.

Experimental detail

The experiment was design with randomized complete block design (RCBD) with split plot arrangement having 3 replications keeping sowing dates (25th Feb,6th Mar and 14th Mar) in main plots and maize hybrids i.e. (DK-6142, DK-6525 and DK-9108) hybrids of "Monsanto" in sub plots. The net-plot size was 2.25 × 6 m maintaining R × R distance of 75 cm and P × P distance of 20 cm. The crop was sown manually on ridges. The crop was sown with seed rate of 10 kg acre^{-1}. At time of sowing metrological data was shown in Table 1. All other agronomic practices were kept normal. The crop was planted on a well-prepared seed bed on the respective sowing dates which was prepared with 2-3 cultivations followed by planking. Finally, soil was pulverized by rotavator. Seed was treated with "Confidor" at the rate of 5 g per kg of seed to avoid seed deterioration and fungus attack before sowing. Seed was sown uniformly at 75 cm apart in rows using l0 kg ha^{-1} seed rate. Thinning was done leaving 23 cm apart plant to plant distance at early stages of crop development. Fertilizer was incorporated in proportion of 250:125:125 kg ha^{-1} NPK. All the P and K and one-third of N were applied just after sowing. The remaining nitrogen was added in two split doses, with first irrigation and at tasseling. Urea was used as nitrogen source and SOP as source of phosphorus and potassium. Insecticide 'olmidacloprid" was sprayed at the rate 125 g per acre with the help of knapsack hand sprayer at 2-3 leaf stage to protect the crop against shoot fly. "Furadan" was also applied at 4-5 leaf stage manually at the rate of g kg per acre to protect the crop against stem borer. Hoeing was also done at different intervals to keep the crop free from weeds. The first irrigation was applied twenty days after sowing, while subsequent irrigations adjusted according to crop requirements, avoiding over irrigation and severe wilting of maize crop. All the other cultural practices were normal for all the treatments; Soil was got analyzed for NPK etc. before sowing. The crop was harvested manually at maturity according to respective sowing dates.

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TABLE 1

Mean monthly weather data for maize growing season for the year 2014 and 2015.

Month	Mean Temp (°C)		Max. Tem (°C)		Min. Temp (°C)		R.H (%)		Rainfall (mm)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
March	18.7	18.2	23.8	22.8	13.7	13.6	60.4	69.8	293.63	973.84
April	24.1	25.3	29.7	30.7	16.4	19.9	51.6	56	342.9	30.22
May	29.7	31.2	35.2	37.2	23.9	25	43.4	37.7	114.05	33.02
June	34.7	31.2	40.8	36.4	28.8	25.7	37.6	48.3	259.85	277.11
July	32.4	30.7	36.1	34.3	28.4	27.4	57.7	63.5	199.9	221.23
August	31.2	30.4	35.2	34.2	27.2	26.7	59.4	70.2	113.03	211.59

Observations

Following observations were documented during the course of study total dry matter (TDM), plant height, cob diameter, grain cob^{-1}, 1000-grain weight, grain yield, biological yield and harvesting index.

Statistical analysis

The collected data was statistically analyzed by using Fisher's Analysis of Variance Technique by computer software MSTATC [24] by least significant difference (LSD) test at 5% probability level.

RESULTS AND DISCUSSION

Plant height

Plant height is a vital morphological trait which is function of combined effect of genetic makeup of plant, seed vigor, soil nutrient status and ecological conditions under which during it is growth and developmental stages. It is a function of both genetic and environmental conditions to which plant is subjected during its growth and development stages. Data from the Table 2 showed the effects of sowing dates on plant height were non-significant. Early sowing date (25th Feb) improved plant height as compared to other sown in later. Maximum plant height was observed in hybrid H_1 (Dk-6142), while minimum was observed in H_3 (Dk-9108), which is statistically equal to H_2 (Dk-6525). The combined effects of sowing dates and Maize hybrids on plant height were non- significant. However, the improvement in plant height was observed among the different sowing dates and maize hybrids. These outcomes are in conformity with those reported by Khan et al. [25] and Azadbakht et al. [26]. The relationship between plant height and grain yield is shown in Figure 1.

Number of cobs per plant

Data regarding the effect of sowing dates on number of cobs per plant was given in Table 2 that was non-significant. However, some improvement was observed. Sowing date SD_1 (25th Feb.) contains more number of cobs per plants as compared to sown at later on dates. The effects of hybrids on the number of cobs per plant are also presented in Table 2 it is obvious from the Table that an effect of maize hybrids on number of cobs per plant was significant. In hybrid H_1 (DK-6142) maximum number of cobs per plant was seen. Minimum number of cobs per plant the effect was observed in hybrid H_3 (DK-9108) which is statistically equals to H_2 (DK-6525). The interactive effects of hybrids and sowing dates on no of cobs per plant were non- significant. However, the variation in number of cobs per plant was observed in different interactions. The similar results were also reported by Lashkari et al. [27].

Grain rows per cob

The quantity of grain rows per cob is also very central and key factor in determining the yield of maize. The data pertaining to the effects of sowing dates on grain rows per cob is given in Table 3 the effect of sowing date on number of cobs per plant was seen significant. In this table, the maximum number of grain rows per cob was observed in SD_2 (6th Mar) which was statistically equals to SD_1 (25th Feb). Minimum was observed in SD_3 (14th Mar). The effect of sowing dates and Maize hybrids is presented in Table 2. It is evident from the table that an effect of Maize hybrids on grain rows per cob was also found significant. Maximum number of grain rows per cob was observed in hybrid H_1 (Dk-6142). Minimum was observed in hybrid H_3 (Dk-9108) which was statistically equals to H_2 (Dk-6525). Interactive effect of sowing dates and various maize hybrids was also significant. Maximum number of grain rows per cob was recorded in H_1 (Dk-6142), when it was sown at SD_1 (Feb. 25th), which was statistically equals to when H_1 (Dk-6142) sown at March 6th, 14th and H_2 (Dk-6525) sown at SD_1 (Feb 25th) and SD_2 (Mar 6th) and H_3 (Dk-9108) sown at SD_2 (Mar 6th). The lowest no grain rows per cob was recorded in H_2 (Dk-6525) when it was sown at SD_3 (Mar14th), however it was statistically equals to H_3 (Dk-9108) sown at SD_1 (25th Feb, and SD_3 (Mar 14th). Similar findings were reported by Kanagarasu et al. [28], and Kumar and Sundari [29].

TABLE 2

Plant height and Number of cobs per plant as influenced by different sowing dates and maize hybrid.

Treatment	Plant height			Means	No. of cob per plant			Means
	Hybrids				Hybrids			
	DK-6142	DK-6525	DK-9108		DK-6142	DK-6525	DK-9108	
SD_1	181.67	132.57	123.33	145.86	1.7	1.56	1.1	1.45
SD_2	174.33	111.78	115.43	133.85	1.46	1.16	1.2	1.27
SD_3	174.33	111.78	115.43	133.85	1.48	1.06	1.1	1.21
Means	174.44 ^{A}	119.34 ^{B}	115.92 ^{B}		1.54 ^{A}	1.26 ^{B}	1.13 ^{B}	
LSD 5%	Hybrids=34.43	Sowing dates=22.30	Interactions=NS		Hybrids=0.20	Sowing dates=0.32	interaction=NS	

Values in the column or means of hybrids within the row sharing the same letter did not differ significantly with each other at 5% probability level. SD_1=25th Feb, SD_2=6th March, SD_3=14th March

TABLE 3

Grain row per cobs and number of grains per cobs as influenced by different sowing dates and maize hybrid.

Treatment	Grain row per cob			Means	No. of grains per cobs			Means
	Hybrids				Hybrids			
	DK-6142	DK-6525	DK-9108		DK-6142	DK-6525	DK-9108	
SD_1	37.17 ^{a}	33.73 ^{a}	24.10 ^{b}	31.67 ^{A}	500	430	347.33	425.67 ^{A}
SD_2	35.10 ^{a}	33.37 ^{a}	35.08 ^{a}	34.52 ^{A}	427.33	360	279.67	355.67 ^{B}
SD_3	33.93 ^{a}	20.45 ^{b}	21.67 ^{b}	25.39 ^{B}	407.33	325.33	232.33	321.67 ^{B}
Means	35.40 ^{A}	29.18 ^{B}	26.94 ^{B}		444.89 ^{A}	371.78 ^{B}	286.3 ^{C}	
LSD	Hybrids=3.31	Sowing dates=5.87	interaction=significant		Hybrids=21.98	Sowing dates=55.93	interaction=NS	

Values in the column or means of hybrids within the row sharing the same letter did not differ significantly with each other at 5% probability level. SD_1=25th Feb, SD_2=6th March, SD_3=14th March

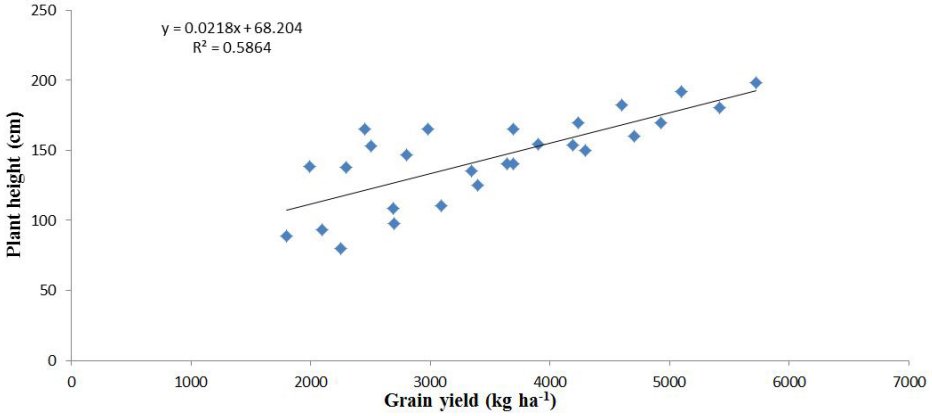

Figure 1) *Relationship between grain yield (kg ha-1) and plant height (cm).*

Number of grains per cob

Cob yield is a function of combined effect of individual yield mechanisms, which are affected by various agronomic practices and ecological factors. The number of grains per cob is very imperative and key factor in defining the yield performance of maize. More number of grains on cob will ultimately effect on final yield of maize crop. Table 3 showed the effects of sowing dates on the number of grains per cob which was found significant. Maximum grains per cob were experiential in hybrid in SD_1 (25th Feb.). While the minimum grains per cob were observed in SD_3 (14th Mar), which is statistically, equals to SD_2 (6th Mar). Data regarding the effects of hybrids on number of grains per cob was significant. Maximum grain per cob was observed in hybrid H_1 (Dk-6142), while minimum grain per cob was seen in hybrid H_3 (Dk-9108). The interactive effect of sowing dates and hybrids was found non- significant. But the early sowing dates gave more number of grains per cob as compared to later sown. Table showed that interactions of early sowing date and early hybrid was gave the maximum grains per cob as compared to lateral ones. These results were in line up with as demonstrated by Ali [30]. These results are also related to Tahir et al. [18].

1000- Grain weight (g)

The grain test weight is very essential factor for obtaining of maximum final crop yield. 1000-grain weight is also an important aspect that shows the potential of a crop that ultimately effect on grain yield of a crop. Data pertaining the Effect of sowing dates on 1000-grain weight was non-significant. However little improvement was observed. The early sowing date had better 1000-grain weight as compared to later sown ones. Data presented in Table 4 to evaluate the effects of hybrids on 1000-grain weight that was significant. Hybrid H_1 (Dk-6142) contains maximum 1000-grain weight; while minimum 1000-grain weight was observed in H_3 (Dk-9108) and hybrid H_2 (DK-6525) have 1000-grain weight which differs from both hybrids 1000-grain weight. Interactive outcomes of sowing dates and hybrid on 1000-grain weight were found non- significant. While the variations among the different sowing dates and hybrids were easily observed from the table. These findings are similar with those reported by Azadbakht et al. [31].

Grain yield (Kg ha^{-1})

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. Thus any distinctions in them are responsible to bring about a change in grain yield. The grain yield is the final output of a crop, which shows the yield potential of a crop. Data regarding the effects of sowing dates on grain yield it was significant. Maximum grain yield was initiate in sowing date SD_1 (25th Feb). While the minimum was obtained in sowing date SD_3 (14th Mar) which was statistically equals to sowing date SD_2 (6th Mar). The evaluation of sowing dates and hybrids effects is given in Table 4 it is clear from the table that an effect of hybrid on grain yield was significant. Maximum grain yield was observed in H_1 (Dk-6142). while the minimum was easily observed in H_3 (Dk-9108). The combined effect of sowing dates and hybrids on grain yield (Kg ha^{-1}) was found non-significant. However, some improvements in grain yield among different hybrids and sowing dates can be these results are in contour with those of McCutcheon et al. [32], who reported significant differences between maize hybrids for grain yield. These results are also in according with Tahir et al. [18]. Comparison between plant height and grain yield were shown in Figure 1.

Biological yield (Kg ha^{-1})

Biological yield is the total biomass produced on dry matter accumulation basis, as a result of ecological conditions and soil nutrient uptake by plant. Table 5 showing the effect of sowing date on biological yield non-significant. However, some improvement was observed in sowing dates, the early planting dates had more biological yield as compared to postponing dates. According to table effects of hybrids on biological yield was found significant. Maximum biological yield was observed in hybrid H_1 (Dk-6142), while the minimum was occurred in hybrid H_3 (Dk-9108). This was due to genetic characteristics of maize hybrids. The cumulative effect of hybrids and sowing dates was seen non-significant. These interpretations are profuse supported by McCutchen et al. [32]. The relationship between biological yield and grain yield is shown in Figure 2.

TABLE 4

1000-grain weight and grain yield as influenced by different sowing dates and maize hybrid.

Treatment	1000-grain weight			Means	Grain yield			Means
	Hybrids				Hybrids			
	DK-6142	DK-6525	DK-9108		DK-6142	DK-6525	DK-9108	
SD_1	306.33	255.97	213.13	272.55	4550	4019.7	3638.7	4069.4 ^{A}
SD_2	307.41	278.59	232.6	258.48	3833.3	3466.7	3000	3433.3 ^{B}
SD_3	299	230.3	191.32	240.17	3585.3	3166.7	2733.3	3161.8 ^{B}
Means	304.26 ^{A}	254.95 ^{B}	221.98 ^{C}		3989.6 ^{A}	3551.0 ^{B}	3124.0 ^{C}	
LSD	Hybrids=27.88	Sowing dates=28.28	Interaction=NS		Hybrids=124.38	Sowing dates=375.25	Interaction=NS	

Values in the column or means of hybrids within the row sharing the same letter did not differ significantly with each other at 5% probability level. SD_1=25th Feb, SD_2=6th March, SD_3=14th March

TABLE 5

Biological yield and harvesting index as influenced by different sowing dates and maize hybrids.

Treatment	Biological yield			Means	2Harvesting index			Means
	Hybrids				Hybrids			
	DK-6142	DK-6525	DK-9108		DK-6142	DK-6525	DK-9108	
SD_1	13552	12720	12219	12831	33.86	31.76	29.24	31.53
SD_2	12061	10697	9706	10821	31.14	31.49	30.23	31.05
SD_3	11367	10150	9111	10209	31.06	30.64	29.43	30.38
Means	12327 A	11189 B	10345 C		32.02 A	31.30 A	29.63 B	
LSD	Hybrids=391.89	Sowing dates=2466.9	Interactions=NS		Hybrids=1.59	Sowing dates=6.43	Interactions=NS	

Values in the column or means of hybrids within the row sharing the same letter did not differ significantly with each other at 5% probability level. SD1=25th Feb, SD2=6th March, SD3=14th March.

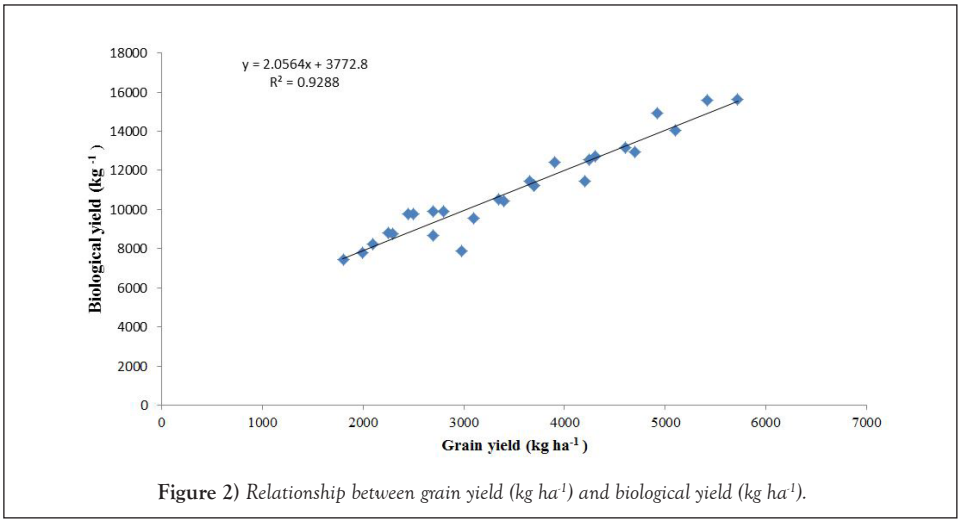

Figure 2) *Relationship between grain yield (kg ha-1) and biological yield (kg ha-1).*

Harvest index (%)

Harvest index is actually the degree of physiological productivity of a crop plant to convert photosynthetic product into the economically part of plant. An effect of sowing dates on harvest index was found non-significant. However, some improvement in Harvest index was observed in the early sowing dates as compared to postponing dates. Data concerning the effects of hybrids on Harvest index in maize was significant was shown in Table 5. Maximum harvest was obtained from hybrid H_1 (Dk-6142) which was statistically equals to H_2 (Dk-6525) while minimum was found in hybrid H_3 (Dk-9108). Collective effects of hybrids and sowing dates were found non-significant but improvement in harvest index was also in early sowing dates and early hybrids while the decreasing Harvest index was observed in postponing sowing dates. The same results are reported by Andrata et al. [33]. Azadbakht et al. reported the contradictory results about hybrids also contradictory were found in case of sowing dates and maize hybrids [26].

CONCLUSION

Finally, recorded data was shown that all the maize hybrids differed significantly in case of yield components with mean values. i.e. plant height (145.86 cm), number of cobs per plant (1.45 cob), no. of grains per cob (425.67), grains rows per cob (31.67), 1000- grains weight (272.55 g), biological yield (12831 kg^{-1}), grain yield (4069.4 kg ha^{-1}) and Harvesting index (31.53%). It may be concluded from this study that sowing date (25th Feb) and Maize hybrid (DK-6142) is recommended for achieving high yield under semi-arid conditions of Sargodha.

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