Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.5, No.1, 2015

Yield Response of Maize (Zea Mays L.) Hybrids Sown on Various Dates during Kharif in Peshawar-Pakistan

Shahzad Ali[1]* Inamullah[1] Amanullah Jan[1] Miftahud Din[2] Muhammad Habibullah[1]
Department of Agronomy, The University of Agriculture, Peshawar, Pakistan
*Correspondence author: shahzadali320@aup.edu.pk

Abstract
To study the effect of various sowing dates on yield and yield attributes of maize hybrids during kharif season, an experiment was conducted at New Developmental Farm of The University of Agriculture, Peshawar, Pakistan during summer 2011. The experiment was laid out in randomized complete block design with split plot arrangement having four replications. Sowing dates (July 1st, 16th, 30th) were allotted to main plots, while maize hybrids (SUNCROP-3031, PIONEER-3025 and MALKA-TS-1105) were allowed to sub plots. A subplot size of 3m x 4.5m was used. Each subplot consisted of six rows 3m long, 0.75 m apart. Sowing on 1st and 16th July gave significantly maximum at par grains ear^{-1} (562 and 556), 1000 grains weight (445 and 421 g), grain yield (9004 and 7813 kg ha^{-1}) and biological yield (25055 and 23240 kg ha^{-1}) respectively. Hybrids sown on 16th July produced taller plant height (232 cm). Delayed sowing as on 30th July decreased grains ear^{-1} to 460, 1000 grains weight to 391 g, grain yield to 6060 kg ha^{-1}, biological yield to 15972 kg ha^{-1} and plant height to 185 cm. There was no effect of sowing dates on ear m^{-2}. Among the maize hybrids, PIONEER-3025 had the highest number of ears m^{-2} (7), grains ear^{-1} (554), 1000 grains weight (460 g), grain yield (8343 kg ha^{-1}) and biological yield (22129 kg ha^{-1}) while Malka-TS-1105 showed the lowest ears m^{-2} (4.8), grain yield of 7119 kg ha^{-1} and biological yield of 20231 kg ha^{-1}. The hybrids did not differ from each other in plant height. Based on the results, among the tested maize hybrids, PIONEER-3025 is recommended for sowing on either July 1st or 16th in the agro-ecological conditions of Peshawar valley.
Keywords: Maize (Zea mays L.), hybrids, sowing dates, grain yield, yield components

INTRODUCTION

Maize (*Zea mays* L.) belongs to family poaceae and is an annual, determinate crop, having C_4 carbon fixation pathway. It is the third most important cereal crop after wheat and rice in Pakistan. Maize is cultivated both in spring and kharif seasons in Pakistan, due to the availability of temperate as well as tropical genetic material both in hybrids and open pollinated maize varieties. It is a short duration crop and is grown twice a year both for grain and fodder purpose. Maize is a dominant crop in the farming system because it is a staple food crop for much of rural population. Its grain is used for several industrial purposes such as starch, alcohol, corn sugar, corn oil, acetones and lactic acid. Besides its multipurpose uses, corn is getting popularity for its non-cholesterol oil content in the present day world (Martin *et al*., 1975). Maize grain is valuable source of protein (10.4%), fat (4.5%), starch (71.8%), vitamins and minerals like calcium, phosphorous and sulfur. It also provides raw materials to starch industry and is used in the preparation of many products. It is grown throughout Khyber Pakhtunkhwa (Shah, 2007). About two-third of the total world production of maize is used for livestock feed or for commercial starch and oil production (FAO, 2007). In Pakistan, maize was cultivated on an area of 981 ha with a total production of 3658 tones in Pakistan and an average yield of 3805 kg ha^{-1} while during the same season its area of cultivation and production in Khyber Pakhtunkhwa was 512 ha and 1468 tones and average yield of maize crop was 1751 kg ha^{-1} during the reported year (MINFA, 2011). Soil and climatic conditions of Pakistan are highly favorable for maize production yet its average yield is very low. The reasons for low yield are non-availability of high yielding hybrids, improper use of fertilizer, and in-sufficient availability of irrigation water at proper time, improper sowing date and lack of modern production technology. Among the various factors of crop production, improved hybrids and proper sowing dates play key role in boosting production of maize. High yielding hybrids are of primary importance for higher yield. Hybrids play vital role in successful maize husbandry (Inamullah *et al*. 2011a). Yield can be increased to a greater extent provided high yielding hybrids are identified and planted at optimum sowing dates. A comparative study of maize hybrids is necessary in order to sort out the most reliable hybrids for agro-climatic conditions of Peshawar (Inamullah *et al*. 2011b; Rafique *et al*. 2004). The main objective of this experiment was to screen out high yielding hybrid(s) that can mature in short period of time with very little or no effects on yield. As regards date of sowing, the fields of tobacco crops are vacated normally by the end of June to July each year in Khyber Pakhtunkhwa. Therefore, in this experiment three dates of sowing have been used i.e. 1st July, 16th July and 30th July. Sowing of different hybrids on different sowing dates might give us a clue regarding the best hybrid(s) and suitable planting date(s) that might result in higher or at least somewhat normal yield under irrigated condition of Peshawar valley.

MATERIALS AND METHODS

To study the effect of various *kharif* sowing dates on yield and yield attributes of maize hybrids, an experiment was conducted at The University of Agriculture, Peshawar (34° 01' N, 71° 35' E, 359 meters above sea level), Pakistan during summer 2011. The experiment was laid out in randomized complete block design with split plot arrangement having four replications. Previous crop in the field was spring wheat (*Triticum aestivum* L.). Sowing dates were allotted to main plots, while maize hybrids were allotted to sub plots. A subplot size of 3m x 4.5m was used. Each sub plot was consisted of 6 rows having 0.75 m row-to-row distance with row length of 3 m. All the recommended agronomic practices were followed. Three hybrids i.e. SUNCROP-3031, PIONEER-3025 and MALKA-TS-1105 were sown on 1st, 16th and 30th July. Data were recorded on plant height, ears m^{-2}, grains ear^{-1}, 1000 grain weight, grain yield and biological yield. Plant height was measured at harvesting stage. Plant height form ground level to the last node of the ten randomly selected plants in each subplot was measured through measuring tape and averaged. Ears in one meter square area at three different places in each subplot were counted and averaged to record ears m^{-2} area. After harvesting, grains ear^{-1} were recorded by counting grains in three ears randomly selected in each subplot and then averaged. After shelling the ears, thousand grains were selected randomly to record thousand grains weight with the help of electronic balance from the produce of each subplot. Grain yield was recorded with the help of a spring balance after shelling all the ears harvested from the central four rows in each subplot. Grain yield thus obtained was then converted into kg ha^{-1}. Data on biological yield were also recorded from the whole biological matter harvested from the four central rows in each subplot at maturity. After harvest, the plants were sun dried and weighed using spring balance for calculating biological yield. Biological yield per sub plot was then converted into kg ha^{-1}.

Data were analyzed using the statistical package MSTAT-C (Russel and Eisensmith, 1983) and the significant differences among the treatments were determined using least significant difference (LSD) test.

RESULTS AND DISCUSSION

Plant height (cm)

Significant differences were observed in average plant height of maize hybrids sown on various sowing dates; however, maize hybrids were not different from each in plant height (Table 1). Data in Table 1 shows maximum plant height of maize sown on 16th July (232 cm) while minimum plant height was noted in maize sown on 30th July (185 cm). The possible reason could be that the early July sown crop had longer growth period to avail while end of July sown crop had shorter period for growth and therefore, taller and shorter plants were recorded in early and late sowing dates, respectively. Similar results were reported by Sharlway *et al*. (1978) who stated that plant height was reduced by delayed sowing. Abdel-Rahman *et al*. (2001) found that maize plant height was affected by the sowing date, but in their trials taller plants were obtained in the plots sown earliest and dwarf plant height was measure in late sowing dates.

Ears m^{-2}

Data regarding ear m^{-2} are presented in Table 1. Statistical analysis of the data revealed that ears m^{-2} were significantly affected by maize hybrids, while the sowing dates and the interaction of sowing dates and hybrids showed no effect on ears m^{-2}. Mean values showed that higher number of 7 ears m^{-2} were produced by PIONEER-3025 followed by SUNCROP-3031with 5.9 ears m^{-2} while the minimum number of 4.8 ears m^{-2} was recorded in MALKA-TS-1105. Saleem et al. (2007) and Vasic et al. (2001) reported significant differences among the maize hybrids for ears m^{-2}. The possible reason is might be the genetic makeup of the maize hybrids that affected number of ears m^{-2}.

Grains ear^{-1}

Data regarding number of grains ear^{-1} are presented in Table 1. Statistical analysis of the data revealed that number of grains ear^{-1} was significantly affected by the sowing dates and hybrids. The interaction of sowing dates and hybrids for grains ear^{-1} was non-significant. Table 1 shows that higher number of grains ear^{-1} (562) was recorded in the crop sown on 1st July followed by at par value of 556 grains ear^{-1} recorded in the July 16th sown crop while minimum number of 460 grains ear^{-1} was noticed in maize sown on 30th July. Cirilo and Andrade (1996) found that delayed sowing of maize caused decrease in grain number and weight. The reason could be that the early sown crop got optimum growing period while the late crop got a shorter and cooler growing period which probably affected the process of fertilization and grain formation in the crop. Among the hybrids, PIONEER-3025 produced maximum number of 554 grains ear^{-1} followed by SUNCROP-3031with at par number of 534 grains ear^{-1}, while significantly smaller number of 491 grains ear^{-1} was recorded by MALKA-TS-1105. Differences in grains ear^{-1} of the hybrids could be attributed to the genetic potential of the hybrids.

Thousand grains weight (g)

Data regarding thousand grains weight are presented in Table 1. Statistical analysis of the data showed that thousand grains weight was significantly affected by maize hybrids and sowing dates. The interaction of maize hybrids and sowing dates was found significant for thousand grains weight. Table 1 shows that heavier thousand grains weight (445 g) was recorded in the crop sown on 1st July followed by at par value of (421 g) thousand

grains weight recorded in the July 16th sown crop while minimum (391 g) thousand grains weight was noticed in maize sown on 30th July. Cirilo and Andrade (1996) found that delayed sowing of maize caused decrease in grain number and thousand grains weight. The reason could be that the early sown crop got optimum growing period while the late crop got a shorter and cooler growing period which probably affected the process of fertilization and grain formation in the crop. Table 1 shows that maximum thousand grains weight of (460 g) was produced by PIONEER-3025, while SUNCROP-3031and MALKA-TS-1105 produced 400 g and 370 g thousand grains weight which both were at par with each other. Yousaf and Saleem (2001) reported significant differences among maize hybrids for thousand grains weight. The interaction of sowing dates and maize hybrids for thousand grains weight was also found significant at 5% level of probability (Fig.1). Fig.1 shows that thousand grains weight of MALKA-TS-1105 was the lowest (340 g) when sown on July 30th, which increased to 400 g when sown on July 1st and July 16th. Thousand grain weight of SUNCROP-3031 was non-significant i.e. 435, 420 and 400 g when sown on July 1st, 16th and 30th respectively. PIONEER-3025, on the other hand, produced 540 g 1000 grains weight when sown on 1st July which reduced to 440 g and again to 400 g when sown on July 16th and 30th, respectively.

Grain yield (kg ha^{-1})

Data regarding grain yield of maize hybrids as affected by sowing dates are presented in Table 1. Statistical analysis of the data revealed that grain yield was significantly affected by sowing dates and maize hybrids while the interaction effect of sowing dates and hybrids for grain yield was found significant. Crop sown on 1st July produced maximum grain yield (9004 kg ha^{-1}) followed by at par grain yield of 7813 kg ha^{-1} produced by the crop sown on July16th. Significantly minimum grain yield (6060 kg ha^{-1}) was obtained by maize sown on 30th July. Similar results were also obtained by Gill and Mian (1964) who reported that late sowing decreased grain yield. Khan *et al*. (2009) and Widstrom *et al.* (1984) reported that higher grain yields were generally obtained when planting was completed by early May, while yield declined as planting was delayed. Reason for this variation in yield could be the longer growth period and comparatively mild temperature during the grain formation period. Among the maize hybrids, significantly larger grain yield (8343 kg ha^{-1}) was produced by PIONEER-3025. SUNCROP-3031 and MALKA-TS-1105 produced smaller and at par grain yields of 7415 and 7119 kg ha^{-1}, respectively. It showed the genetic superiority of the PIONEER-3025 over SUNCROP-3031 and MALKA-TS-1105 to produce higher grain yield. Among the yield components, ears m^{-2}, grains ear^{-1} and thousand grains weight, probably contributed largely to the higher grain yield of the PIONEER-3025. The interaction of sowing dates and maize hybrids for thousand grains weight was also found significant at 5% level of probability (Fig.2). Fig.2 shows that grain yield of MALKA-TS-1105 was the lowest (5517 kg ha^{-1}) when sown on July 30th, which increased to 8128 kg ha^{-1} when sown on July 1st. PIONEER-3025, on the other hand, produced 9777 kg ha^{-1} grain yield when sown on 1st July which reduced to 8700 kg ha^{-1} and again to 6677 kg ha^{-1} when sown on July 16th and 30th, respectively.

Biological yield (kg ha^{-1})

Data regarding biological yield of maize hybrids affected by sowing dates are presented in Table 1. Statistical analysis of the data revealed that biological yield was significantly affected by the sowing dates. Significant differences were noted among the maize hybrids in biological yield. The interaction effect of sowing dates and hybrids for the biological yield of hybrids was found non-significant. Data in Table 1 shows that at par biological yields of 25055 and 23240 kg ha^{-1} were produced by the maize crop sown on 1st and 16th July while minimum biological yield (15972kg ha^{-1}) was obtained by maize sown on 30th July. Garcia *et al.* (2009) observed decrease in aboveground biomass when planting date was delayed from early March to mid-May in three different maturity groups of corn hybrids. Among the maize hybrids, at par biological yields of 22129 and 21907 kg ha^{-1} were produced by PIONEER-3025 and SUNCROP-3031 while significantly lower biological yield of 20231 kg ha^{-1} was obtained form MALKA-TS-1105. Higher biological yield of PIONEER-3025 might be due to higher grain yield produced by the hybrid.

Table I. Plant height, ears m^{-2}, grains ear^{-1}, thousand grains weight, grain yield and biological yield of maize hybrids as affected by various sowing dates

Treatment	Plant height (cm)	Ears m^{-2}	Grains ear^{-1}	1000 grains weigh (g)	Grain yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Sowing Dates						
1st July	232 a	6.1	562 a	445a	9004 a	25055 a
16th July	211 b	5.8	556 a	421a	7813 a	23240 a
30th July	185 c	5.6	460 b	391 b	6060 b	15972 b
LSD (0.05)	12.0	ns	62.6	30	1304	3290
Sowing Methods						
SUNCROP-3031	213	5.9 b	534 a	400 b	7415 b	21907 a
PIONEER-3025	203	7.0 a	554 a	460 a	8343 a	22129 a
MALKA.TS.1105	212	4.8 c	491 b	370 b	7119 b	20231 b
LSD (0.05)	ns	0.7	40.1	40.2	888	1338
Interaction						
SD x H	ns	ns	ns	*	*	ns

Means in the same category followed by different letters are significantly different at P ≤0.05 levels. ns = non-significant * = significant

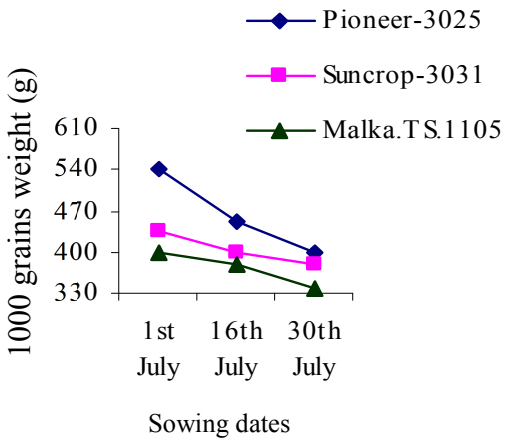

Fig. 3. 1000 grains weight of maize hybrids as affected by sowing dates.

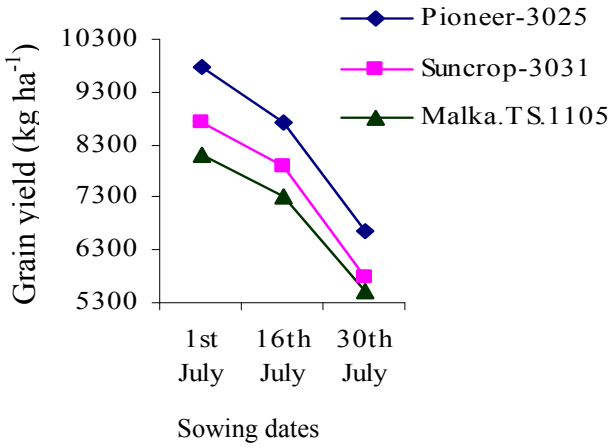

Fig. 4. Grain yield of maize hybrids as affected by sowing dates.

CONCLUSION AND RECOMMENDATIONS

It was concluded that among the hybrids PIONEER-3025 gave significantly higher grain and biological yields followed by SUNCROP-3031 and MALKA-TS-1105. Similarly, higher grain and biological yields were obtained when sowing was carried out on 1st and 16th July as compared with 30th July. Therefore, on the basis of higher grain yield, among the tested maize hybrids PIONEER-3025 is recommended for sowing on July 1st and 16th in the agro-ecological zone of Peshawar valley.

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