Effect of different dates of sowing on yield contributing characters and yield of different cultivars of Maize (*Zea mays* L.) under conditions of North-western Himalayas

Abstract

Optimizing sowing dates for maize is one of the crucialpractices for significant yield levels under the scenario of changing climates. Therefore, the present field investigation was conducting during the *Kharif* cropping seasons of 2013 and 2014 to evaluate the effects of different dates of sowing on yield contributing characters and yield of different cultivars of Maize (*Zea mays* L.). The field experiment was conducted in a randomized block design with factorial arrangement consisting of four dates of sowing and three maize cultivars. The study results revealed that sowing of crop by 10th June can have taller plants, significantly better yield contributing characters of maize such as number of cobs per plant (1.1), number of grains per cob and test weight. Similarly, the significantly higher maize grain and Stover yield was recorded with sowing of maize crop by 10th June. Among the maize cultivars, HQPM-1 resulted in substantially higher maize grain and stove yield. Based on the present field investigation, it can be concluded that sowing of maize by 10th June and maize cultivar HQPM-1 can be recommended for better yield levels under the conditions of North-western Himalayas.

Keywords: Cultivars, maize, phenology, sowing dates, yield

Introduction

Maize (*Zea mays* L.)is the most widely cultivated cereal in world with considerable utilization as food, feed grain as well as industrial feedstock. Maize has been cultivated across 170 countries with an area of 203.5 million hectares and production of around 1163.5 million tonnes (FAOSTAT, 2024). Worldwide presence of maize can be attributed to highest production potential among cereals, substantially higher water use efficiency, wider edaphic and environment adaptability (Choudhary *et al.,* 2020). Similarly, maize is significant crop of *Kharif* season in India cultivated on an area of 9.9 million hectares and production of 33.7 million tonnes (FAOSTAT, 2024). Maize has wider cultivation in North-western Himalayan states of India, especially Himachal Pradesh wherein it is cultivated in *Kharif* season. Maize productivity is significantly controlled with innate cultivar genetic potential as well as agronomic practices adopted (Rizzo *et al.,* 2022). Optimizing the choice of suitable cultivar for environmental conditions can be a critical factor to harvest considerable grain from maize crop.

Among agronomic practices, such as fertilizer application, planting date, seed rate and spacing, planting dates have significant influence over maize productivity. Optimizing planting dates offers an opportunity to enhance maize productivity with enhanced utilization of environmental resources such as sunlight, rainfall, and temperature (Djaman*et al.,* 2022). Varying planting dates expose the crop to variable climatic conditions and therefore may alter the crop productivity. Early as well as late planting of the crop may results in significant decline in crop productivity. Growers in rainfed regions of the world depend heavily on deciding suitable planting dates in order to maximize utilization of available rainwater (Jaramillo *et al.*, 2022). Therefore, critically investing a particular planting date is significant to enhance crop productivity. Variable planting dates even for crop cultivars exert significant influence over their productivity (Abbas *et al.*, 2019). However, for a same planting date, variable crop cultivars behave differently in terms of biomass accumulation and grain productivity.

There are significant lacunae of scientific information on effect of planting dates and maize cultivars over maize growth and productivity under North-western Himalayan conditions. Therefore, it is imperative to study the influence of planting dates and maize cultivars over maize productivity under North-western Himalayan conditions. The objectives of the study were to analyze effect of variable planting dates and maize cultivars over maize growth, phenology, yield attributes and yield. The novelty of the study lies in its exploration of optimizing maize production through the interplay of planting dates and cultivar selection which remains a relatively underexplored area in maize agronomy. The present study will address effect of climatic variability and cultivar specific response over maize productivity.

Material and methods

The field experiments were conducted during *kharif* seasons of 2013 & 2014 at research farm of Department of Agronomy,CSK HPKV, Palampur (Himachal Pradesh) ($32^{0}6^{'}$ N, $76^{0}3^{'}$ E) at an elevation of about 1290.8 m above mean sea level The field experiments were conducted in randomized block design with factorial arrangementinvestigating four dates of sowing and three maize cultivars (*Girija*, *Bajaura Makka* and HQPM-1), replicated three times.During crop growing season from May to September 2013, the weekly maximum and minimum temperature ranged between 24.0 to 32.4 ^{0}C and 12.9 to 20.8 ^{0}C during 2013 and 23.4 to 33.6 ^{0}C and 11.8 to 21.2 ^{0}C during 2014, respectively with rainfall of mm 1333 during 2013 and 2629.4 mm during 2014 and sunshine duration ranged 9.1 hours during 2013- and 11.7-hours day^{-1} respectively.

In case of observations recorded, crop development parameters such as days to complete emergence, days to knee high stage, days to tasselling and days to physiological maturity were recorded. For growth and yield attributes plant height, leaf area index, number of cobs plant^{-1}, number of grains cobs $^{-1}$, 1000-grain weight, grain yield and stover yield were recorded.

Results and discussion

The data for effect of maize cultivars and dates of sowing on number of days taken to different phenological stage during 2013 and 2014 have been presented in Table 1. A perusal of the data revealed that maize cultivars were not significantly different in terms of number of days to complete different phenological stages such as complete emergence, knee high stage, tasselling and physiological maturity.

However, significant influence of different dates of sowing over number of days to attain different phenological stages was observed. The crop sown on 30th May and 10th June attained different phenological stages such as complete emergenceknee high stage, tasselling and physiological maturity in statistically equivalent number of days. However, crop sown on 20th and 30th June completed various phenological stages such as complete emergence, knee high stage, tasselling and physiological maturity in comparably shorter duration. Especially, crop sown on 30th June has shorter reproductive duration in terms of tasselling and physiological maturity. Reduction in number of days or duration of reproductive stages was significantly reduced with delayed sowing of maize was also observed by Shrestha and his co-workers in 2016. Similarly, Cao et al. 2024 reported similar findings to the present study wherein accelerated reproductive growth or shortened reproductive period of maize was observed with delayed sowing.

Table 1. Effect of dates of sowing on number of days taken to different phenological stage during 2013 and 2014.

	Days taken to

Dates of sowing	Complete emergence		Kneehigh stage		Tasselling		Physiological maturity	
	2013	2014	2013	2014	2013	2014	2013	2014
Girija	7.8	6.6	34.7	34.3	58.6	57.1	109.8	106.7
Bajaura Makka	7.1	5.8	34.3	33.8	58.4	56.2	108.8	106.0
HQPM-1	7.1	6.1	34.8	34.4	59.8	57.7	110.9	108.0
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS
Date of sowing								
30thMay	7.4	6.2	36.0	35.8	61.0	59.9	113.8	109.6
10th June	7.0	5.8	34.4	34.4	60.1	57.1	112.1	108.3
20th June	7.1	6.0	34.1	33.3	59.2	56.2	108.8	106.1
30th June	7.8	6.7	33.8	33.2	56.3	54.4	106.7	104.6
CD (5%)	NS	NS	1.63	1.94	3.30	2.85	3.00	2.85

Growth and yield attributes

Plant height

The data for plant height of maize crop plants for *Kharif* 2013 and 2014under the influence of various planting dates and maize cultivars has been presented in Table 2. The insights into the data revealed that plant height was significant influence with different dates of sowing of maize crop however no significant influence was observed with different maize cultivars over plant height.

The crop sown on 10th June (261.5 and 265.2 cm; for 2013 and 2014) resulted in the tallest plant of maize crop, however crop sown on rest of swing dates such as 30th May (251.3 and 255.0 cm; for 2013 and 2014), 20th (251.0 and 255.0 cm; for 2013 and 2014) and 30th June (250.9 and 254.6 cm; for 2013 and 2014) results in comparatively shorter plants. It was observed that advanced as well as delayed sowing before and after 10th June, respectively resulted in significant decrease in plant height of maize crop. The results of the present investigation are in consistent with the finding reported by Akther et al. 2024 wherein they reported declined plant height of maize with delayed sowing. Significantly higher plant height for optimized date of sowing was due to considerable growth duration available for biomass accumulation and contributing to increased stature of crop plants (Akther *et al.,* 2024).

Yield attributes

The data for effect of maize cultivars and dates of sowing on yield attributes of maize such as cobs per plant, grains per cob and test weight in *Kharif* 2013 and 2014have been presented in Table 2. Various dates of sowing exerted significant influence over yield attributes of maize whereas no significant influence of various maize cultivars was observed over the yield attributes such as cobs per plant, grains per cob and test weight.

The cobs per plant of maize were recorded to be the highest for the crop sown on 10th June for both the cropping seasons of 2013 (1.1) and 2014 (1.1) whereas the crop sown on 30th May (1.0 and 1.0; for 2013 and 2014), 20th June (1.0 and 1.0; for 2013 and 2014) and 30th June (1.0 and 1.0; for 2013 and 2014) resulted in comparatively lower values for various yield attributes in both the cropping seasons of 2013 and 2014. The grains per cob for maize were recorded to be the highest for the crop sown on 10th June (258.7 and 268.3 for 2013 and 2014) for both the cropping seasons of 2013 and 2014 whereas the crop sown on30th June (229.9 and 237.9 for 2013 and 2014) resulted in the lowest values for grains per cob. The test weight for maize were recorded to be the highest for the crop sown on 10th June (268.5 and 271.6 g for 2013 and 2014) for both the cropping seasons of 2013 and 2014 whereas the crop sown on30th June (258.7 and 261.7 g for 2013 and 2014) resulted in the lowest values for grains per cob. Reduction in yield attributing characters of maize with delayed sowing can be contributed to shortened reproductive period duration for late planting windows. Similarly, to the present investigation reduction in yield attributes of maize was reiterated by Buriri et al. 2015 and Akther et al. 2024.

Yield levels

The data for effect of maize cultivars and different sowing dates on maize yield levels have been presented in Table 2. A perusal of the data revealed that significant effects of maize cultivars and different sowing dates were observed on maize grain and stover yield.

Maize grain yield was recorded to be the highest for maize cultivar HQPM-1 (53.9 and 56.5 q/ha for 2013 and 2014, respectively) for both the cropping seasons of 2013 and 2014. However, Maize cultivars such as *Girija*(47.9 and 50.1 q/ha for 2013 and 2014, respectively) and *BajauraMakka*(47.4 and 49.5 q/ha for 2013 and 2014, respectively) preformed significantly inferior toHQPM-1 in terms of maize grain yield for the cropping seasons of 2013 and 2014. Similarly, performance in terms of maize stover yield was recorded with various maize cultivars i.e., highest yield for HQPM-1 (102.9 q/ha and 104.1 q/ha for 2013 and 2014, respectively) and significantly inferior for *Girija* (97.6 and 98 q/ha for 2013 and 2014, respectively) and *BajauraMakka*(92.1 and 95.9 q/ha for 2013 and 2014, respectively).

Among different dates of sowing, crop sown on 10th June resulted in significantly higher grain (57.3 and 60.1 q/ha for 2013 and 2014, respectively) and stover yield (108.8 and 109.2 q/ha for 2013 and 2014, respectively) for both the cropping seasons of 2013 and 2014 whereas considerably lower maize grain and stover yield was recorded for the crop sown on 30th May, 20th and 30th June (Table 2). Substantially lower maize yield for delayed planting windows can be attributed to lower values of growth and yield attributing characters such as plant height, number of cobs per plant, number of grains per cob and test weight for maize. Reduction in yield of maize with delayed sowing was also reported by Cao et al. 2024 during a field study investigating effect of sowing dates on yield of maize in subtropical monsoon region of China. Zhiipao et al. 2023 also reported reduction in maize yield levels with delayed sowing of maize.

Table 2. Effect of sowing dates and varieties on growth yield attributes and yield of maize during 2012-13 and 2013-14.

	Plant height (cm)		Number of cobs plant^{-1}		Number of grains cobs^{-1}		1000 grain weight (g)		Grain yield (q ha^{-1})		Stover yield (q ha^{-1})	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Varieties												
Girija	254.3	258.0	1.0	1.0	242.4	250.4	264.0	267.0	47.9	50.1	97.6	98.0
Bajaura Makka	252.5	256.2	1.0	1.0	242.1	250.1	261.5	264.5	47.4	49.5	92.1	95.9
HQPM-1	254.6	258.3	1.1	1.1	246.5	255.7	265.3	268.3	53.9	56.5	102.9	104.1
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	3.07	5.52	6.7	6.10
Date of sowing												
30th May	251.3	255.0	1.0	1.0	242.8	250.8	263.1	266.1	47.9	50.0	94.8	98.0
10th June	261.5	265.2	1.1	1.1	258.7	268.3	268.5	271.6	57.3	60.1	108.8	109.2
20th June	251.2	255.0	1.0	1.0	243.3	251.3	264.1	267.1	48.1	50.3	98.1	99.9
30th June	250.9	254.6	1.0	1.0	229.9	237.9	258.7	261.7	44.6	46.6	88.4	90.2
CD (5%)	8.2	8.2	0.09	0.06	5.89	6.62	4.81	4.81	3.50	6.37	7.7	7.04

Conclusion

Based on the present field investigation, it can be concluded that 10th June can be recommended as the optimum sowing date for significantly considerable yield levels for maize under the conditions of North-western Himalayas of India. Growth, yield contributing characters and yield were significantly higher with sowing date of 10th June. Among, maize cultivars, HQPM-1 performed significantly superior in termsof maize yield levels.

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