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Response of Spring Maize to Different Sowing Schedules and Phosphorous Application

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at the Agronomy Farm, School of Agriculture, Lovely Professional University in 2023 to assess the performance of maize (*Zea mays* L.) under varying sowing schedules along with levels of phosphorus application. The experimental site featured sandy loam soil with pH of 7.34, 0.32% organic carbon content, and an electrical conductivity (EC) 0.423 ds m^{-1}. An experiment comprised different phosphorus levels, including recommended diammonium phosphate (DAP), recommended single superphosphate (SSP), 10% increase in DAP, or 10% increase in SSP applied at three sowing dates. It followed a randomized block design with twelve treatments and three replications. The results indicated that the timing of sowings had a significant impact on all yield attributes, such as cob length (cm), number of rows/cob, number of cobs/m^2 area, grains/cob, grain yield (q/ha), biological yield (kg/ha), and harvest index (%). However, levels of phosphorus application did not exhibit a significant effect on growth and yield attributes. The best results, including taller plants (213.8 cm), a higher number of cobs per m^2 area

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(14), increased number of rows/cob (16), grains per cob (334.7), grain yield (45.2 q/ha), biological yield (97.8 q/ha), and harvest index (53.2 %), were achieved by sowing maize crop at the optimum sowing date (D2).

Keywords: Maize; sowing schedules; levels of phosphorus; spring.

1. INTRODUCTION

Maize (*Zea mays*. L) is a native crop of Mexico that ranks third in terms of area and production among cereal crops, after rice and wheat. Corn plant is one of the most adaptable emerging crops, able to thrive in a variety of agroclimatic situations. Apart from providing essential nourishment for humans and high-quality animal feed, maize is a fundamental raw material used in numerous industrial products such as alcoholic beverages, starch, oil, protein, film, textile, gum, packaging, and paper-making industries. For numerous farmers in developing nations, maize is a significant source of revenue [1]. In addition to having a shorter growing season and the ability to use inputs more effectively, maize has the potential to produce huge amounts of food grains per unit area. It can be grown profitably two times annually, as a spring crop and an autumn crop. Given that it includes roughly 72% starch, 10% proteins, 4.8% oil, 8.5% fibre, 3% sugar, and 1.7% ash, maize has a higher nutritional profile [2]. Farmers receive an adequate yield from it, and green stalks are used as feed.

Numerous research has already been conducted on the use of hybrids and appropriate planting dates as management tactics to boost maize output. In addition to reducing the detrimental impacts of biotic and abiotic stressors, choosing the right planting dates can increased the plant's qualitative as well as quantitative production [3,4,5]. Precise planting schedule is critical to achieving the appropriate yield; if this is delayed, the amount of grain produced would be lower [6]. There is a drop in the amount of dry matter production, yield, and yield parameters of maize grain when cultivation is delayed [7]. It also lengthens the day to flowering and the interval between the development of male and female inflorescences. Postponing the planting date reduces the quantity of kernels per cob and the production of grains.

P usually ranks second position in the majority of soils when it comes to crop limitation. cell division, fat and albumen development, growth, glucose and starch utilisation, physiological and cellular processes all require it. P is frequently the initial element that limits plant growth due to its high fixing by soil particles, particularly in calcium-rich soils [8]. According to studies by Li et al. [9] less than 20% of applied P fertiliser may be consumed by crops during the initial growing period, while the balance 80%, building up in the soil and creating a sizable legacy P soil pool [10]. In unfertilized soils, phosphorus shortage is a typical problem that limits crop development and yield, particularly in soils with high calcium carbonate content, which lowers P solubility. Sufficient P promotes faster growth, earlier maturity, and higher-quality vegetative development. Insufficient phosphorus causes the kernels in maize to twist and form undersized ears, resulting in uneven and missing rows. The secret to higher and more consistent yields of crops is the delivery of essential nutrients to plants in the ideal amount and proportion, using the proper technique and timing [11]. Therefore, an experiment was planned to find out optimum date of sowing and amount of phosphorus fertilization of maize crop for the condition prevailing in Punjab region.

2. MATERIALS AND METHODS

The research experiment was conducted Lovely Professional University, located in Phagwara, Punjab, during the year 2023. The soil of the experimental site was sandy loam in texture, with pH -7.34, O.C.- 0.32% and EC -0.423 with available phosphorus at 13.42 kg/ha and available potassium at 146.72 kg/ha. The experiment followed a randomized complete block design with three replications and 12 treatments comprised of T0: First date of sowing+ Recommended N (Urea) and P (DAP); T1: Second date of sowing+ Recommended N (Urea) and P (DAP); T2: Third date of sowing+ Recommended N (Urea) and P (DAP); T3: First date of sowing + Recommended N (Urea) and P (SSP) ; T4: Second date of sowing+ Recommended N (Urea) and P (SSP); T5: Third date of sowing+ Recommended N (Urea) and P (SSP); T6: First date of sowing + 10 percent increase than Recommended N (Urea) and P (DAP); T7: Second date of sowing+ 10 percent increase than Recommended N (Urea) and P

(DAP); T8: Third date of sowing+ 10 percent increase than Recommended N (Urea) and P (DAP); T9: First date of sowing+ 10 percent increase than Recommended N (Urea) and P (SSP); T10: Second date of sowing+ 10 percent increase than Recommended N (Urea) and P (SSP); T11: Third date of sowing+ 10 percent increase than Recommended N (Urea) and P (SSP). In total, there were 12 treatments, which included three different dates of sowing (February 2nd, February 12th, and February 22nd), two different phosphorus sources, and various levels of phosphorus application. A basal dose of nitrogen (N) and phosphorus (P) was applied. All recommended agronomic practices were implemented consistently throughout the growing season.

3. RESULTS AND DISCUSSION

3.1 Plant Height

The plant height plays a significant role in maize production by affecting light interception, biomass production, weed competition and lodging resistance. Data pertaining to plant height (cm) 30, 60, 90 days after sowing (DAS) presented in Figs. 1, 2 and 3 indicates that sowing schedules and phosphorus application significantly affected the plant height. At 30 DAS maximum plant height (32.63 cm) was noted in treatment T7, followed by T1, T4, and T10, while minimum plant height (21.73 cm) was noted in T5. Whereas, at 60 DAS the maximum plant height (190.47 cm) was observed in T1 which was statistically at par with all treatments except T2, T6, T8 and T11 followed by lowest plant height (142.48 cm) recorded in T5. At 90 DAS maximum plant height (213.80 cm) was recorded in T7 which was statistically at par with T10 followed by T1. However, minimum plant height (153.83 cm) was obtained in T5. The increase in plant height associated with phosphorus is likely due to its promotion of root development and nutrient absorption, which substantially influences overall plant growth performance and leads to taller plants. Cheema [12] and Ayub et. al. [13] have recorded a rise in plant height (cm) following the application of nitrogen at a rate of 200 kg/ha and phosphorus ranging from 60 to 80 kg/ha. The results indicated a significant increase in plant height recorded, across all phosphorus levels Viz., recommended (60kg/ha) and 10 % increase in P (66kg/ha) when sown during the D2 and D1 dates of sowing.

Early sowing had significant effect on plant height, where plants with increased height were obtained by sowing maize earlier as compared to late planting Rahman et. al. [14]. Similarly, Shahzad et. al. [15] also reported higher plant height of wheat under timely sowing dates. Buriro et. al. [6] reported that plant height of various hybrid maize varieties varied significantly due to sowing dates, where maximum height per plant was noted in optimum date of sowing, which confirms the findings Dekhane and dumbre [16]. The early sowing had significant effect on plant stature, where plants with increased height were obtained by sowing maize earlier as compared to late planting Sarvari et. al. [17] and Alam et. al. [18]. The results of various studies have shown that by delaying the planting date of corn, plant height was significantly reduced Baum et. al. [19]. Li et. al. [20] revealed that optimum date of planting of corn increased the length of the growing season, which provide more opportunity for the plant to produce nodes and increased the length of the internodes, which lead to an increase in plant height.

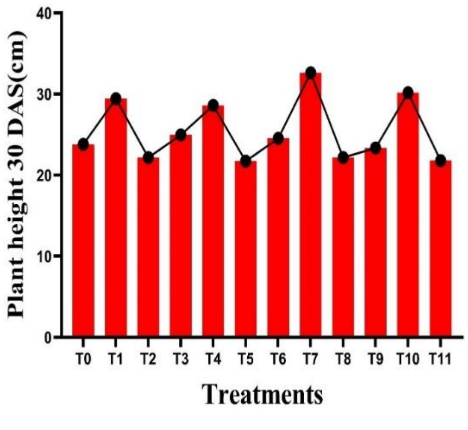

Fig. 1. Effect of different treatments on plant height(cm) at 30 DAS

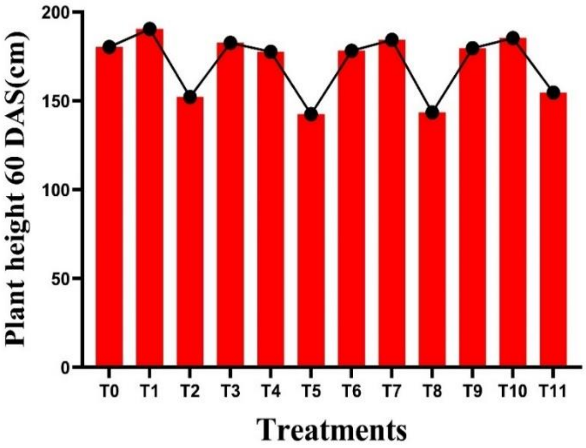

Fig. 2. Effect of different treatments on plant height(cm) at 60 DAS

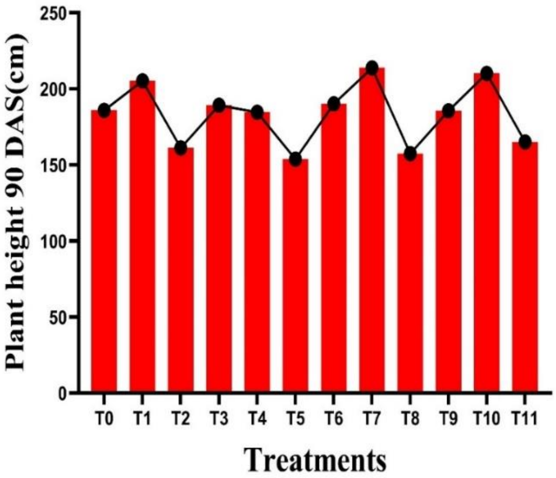

Fig. 3. Effect of different treatments on plant height(cm) at 90 DAS

3.2 Yield Attributing Characters

Data pertaining to yield contributing characters like cob length (cm), number of rows per cob, number of cobs per square meter area, grains per cob are depicted in Figs. 4, 5, 6 and 7. The statistical analysis of the data clearly indicated that all yield attributes were affected statistically, due to different sowing schedules of maize. All yield attributes were drastically reduced with delay sowing of crop beyond February 12th (D2). The cob length was observed maximum (16.1 cm) in treatment T7. However, minimum cob length (8.5 cm) was obtained in treatment T11. Highest number of rows per cob (16) was recorded in treatment T7 which was statistically at par with all the treatments except T2, T8, T11. while lowest number of rows per cob (10.7) was noted in T5. The application of phosphorus @ 60 to 66 kg/ha significantly influenced yield attributes, including the number of cobs per square meter area, number of grains per cob, cob length (cm), and the number of rows per cob. This improvement is credited to the enhanced absorption of nutrients, fostering superior growth and development in the plant, thereby facilitating the enhanced development of traits associated with yield at elevated fertility levels. These outcomes resonate with earlier research conducted by Patel et. al. [21] and Sharma et. al. [22]. The application of P results higher value for yield attributes were due to the effect on root development, energy transformation and metabolic processes of plant and resulted in more translocation of photosynthates towards the sink development Sepat and Rai [23].

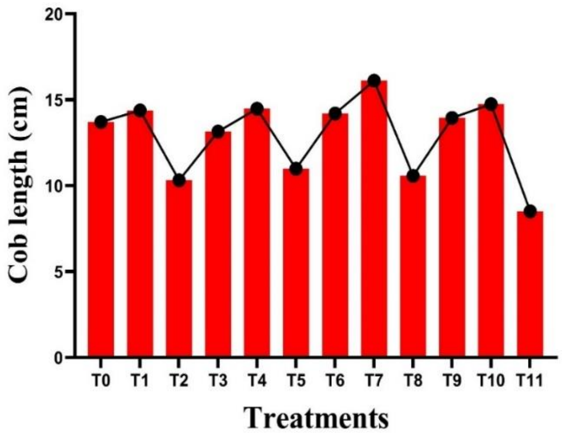

Fig. 4. Effect of different treatments on cob length(cm) of maize

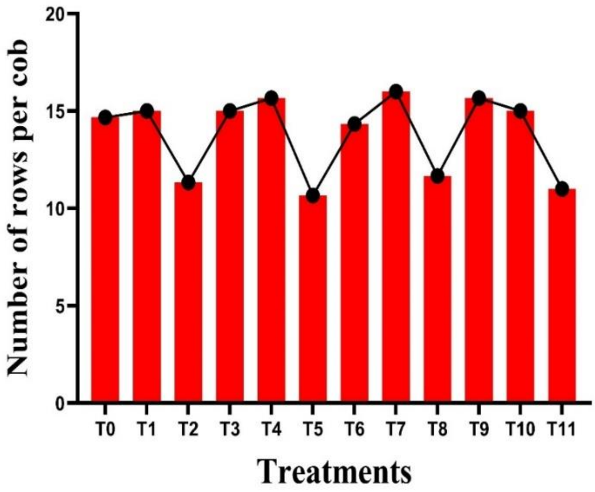

Fig. 5. Effect of different treatments on number of rows per cob

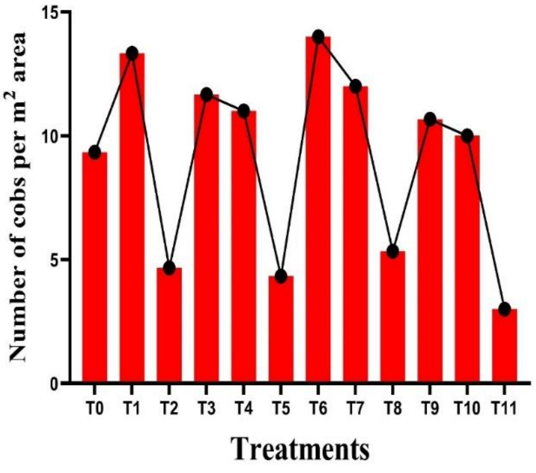

Fig. 6. Effect of different treatments on number of cobs per m^2 area

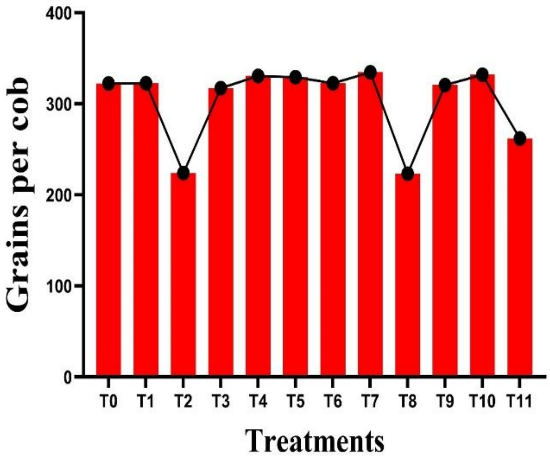

Fig. 7. Effect of different treatments on number grains per cob

Optimum planting date resulted in higher grain yield than early and late planting dates because of higher cob numbers and greater kernel numbers per plant Bhandari et. al. [24]. Bhandari et. al. [24] revealed that variation in yield of corn varieties at different planting dates was associated with differences in the amount of intercepted radiation. Dates of sowing were found to significantly influence the number of cobs per m^2. Amongst all treatments maximum number of cobs (14) per m^2 recorded in T6 which was statistically at par with T1, T7, T3, T4, T9, followed by minimum number of cobs (3) noted in T11. Highest number of grains per cob (334.7) recorded in T7 which was statistically at par with all the treatments except T2, T11. However, lowest number of grains per cob (223.3) recorded in T8. Hence, it is inferred from the above results that D2 (February 12th) sown crop resulted in higher values of yield attributes followed by D1 (February 2nd) and D3 (February 22nd). The results of present study were supported by the earlier findings of Alam et. al. [18]. Early sown maize crop gave highest number of grains per cob and late sown maize crop gave lowest number of grains per cob Amjadian et. al. [25]. Anderson et. al. [26] found drought condition is also responsible for permanent declination of kernel number per row in maize. Therefore, grain yield mainly depends upon total ear number formed, same effect could also occur due to kernal mass reduction as the result of late planting date Maddonni et. al. [27].

3.3 Grain Yield, Biological Yield and Harvest Index (HI)

The data pertaining to grain yield (q/ha), biological yield (q/ha), and harvest index (%) have been presented in Figs. 8, 9 and 10. It is further evident from the data that grain yield, biological yield and harvest index were affected statistically due to different dates of sowing and levels of phosphorus application.

An examination of data indicated that grain yield of maize was significantly maximum (45.2 q/ha) with February 12 (D2) sown crop which was significantly superior over rest of the dates of sowing. It is further noted that crop sown beyond February 12 (D2) reduced grain yield drastically. Significantly maximum biological yield (97.8 q/ha) noted in T10 which was statistically at par with T1, T4 and T7. However, minimum biological yield recorded in T11. Among the treatments highest value of harvest index (53.2 %) recorded in T5, while lowest value harvest index (40.9 %) recorded in T9. The results showed that sowing dates had a significant effect on yield and yield attributes of the crop. Determination of the optimum sowing date for maize is very crucial for better yields. The high grain yield obtained from optimum sowing (D2) is in agreement with the findings of Rahman et. al. [14], who reported that maize grain yield was reduced when sowing was delayed. According to findings delaying sowing reduced the test weight and, therefore, low grain yield was obtained from this planting. Rahman et. al. [14] revealed that variation in maize grain yield due to the decrease in translocation of photosynthesis to the ripening grain.

Among the different dates of sowing, maximum morpho-physiological characters, yield components and yield of maize was obtained on timely sown Alam et. al. [18]. Similar results obtained by Bhandari et. Al. [24]. Shrestha et al. [28] reported that optimum planting results higher growth rate, higher yield and its attributing characters as it was facilitated by relatively favourable temperature. Amgain [29] recorded that delayed planting results poor yield, delayed germination and slow vegetative growth in Nepal. Optimum planting date produced higher yield than the subsequent late plantings. Late planting favoured plant exposure to short growth period, more pest and disease infection, drought, cold temperature, less radiation availability etc. finally reducing grain yield Aldrich et. al. [30] Shrestha et. al. [28]. Late planting cause crop exposure to more thermal condition during its active vegetative stage which leads to over vegetative development reducing dry matter accumulation in kernel that ultimately reduces the final grain yield Otegui and Melon [31] Shrestha et. al. [28]. The result are in confirmation with Jaliya et. al. [32] Namakka et. al. [33] Aziz et. al. [34] and Khan et. al. [35] who reported that grain yield was reduced by delay in sowing. The higher seed yield with early sowing could be attributed to its beneficial influence on yield attributes because the crop has longer growth period and favourable soil moisture and temperature during crop growth period Alam et. al. [36] Jat et. al. [37].

The rise in yield can be credited to the enhancement of yield-related traits, including the number of rows per cob, number of kernels per cob, and test weight, all of which exhibit a positive correlation with grain and biological yield. According to the experimental findings, the sources did not exhibit any notable impact. Different levels i.e., recommended to 10 % increase in P application (60 to 66 kg/ha) significantly influenced the grain yield (q/ha), biological yield (q/ha) and harvest index (%). Grain yield increased with increased phosphorus application (40-60 kg/ha) reported by Hussain et. al. [38]. similar results of enhanced grain and stover yield with increased phosphorus application have been registered by Arya and Singh [39] Kumar and Singh [40] and Hussain [41].

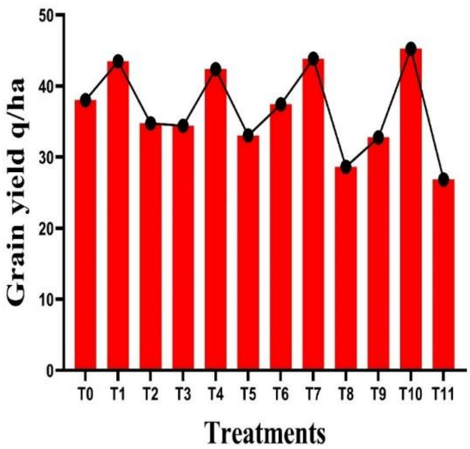

Fig. 8. Effect of different treatments on grain yield (q/ha)

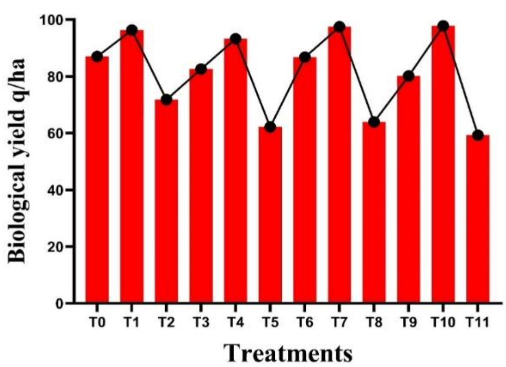

Fig. 9. Effect of different treatments on biological yield (q/ha)

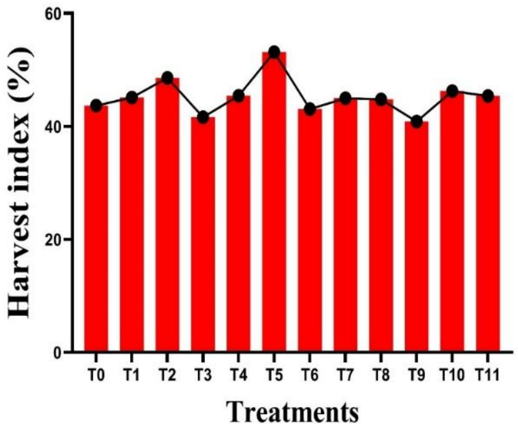

Fig. 10. Effect of different treatments on harvest index (%)

4. CONCLUSION

The findings of the present study concluded that optimal results were achieved for all quantitative traits when hybrid corn varieties were sown on February 12th with increased levels of phosphorus i.e., 60 to 66 kg/ha application. However, any delay in sowing and decreased level of P application adversely impacted plant growth parameters and yield components, ultimately leading to a significant reduction in grain and biological yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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