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Effect of sowing dates and variety on growth and yield attributes of Maize

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Abstract
The sowing date has a significant impact on sweet corn growth, development, and yield. For increased agricultural output, the best sowing date has become increasingly important. Sowing dates have an impact on plant establishment as well as pest and disease occurrence. Sowing dates affect maize differently. Whether it's early or late, sowing dates on sweet corn generate a variety of changes in plants that impact plant growth and development, and these variations may result in a significant yield drop. In a given location, not all cultivars are suited for use in the cropping system, and there is a certain sowing window that yields the best results. Sweet corn varieties also significantly influence the growth and yield attributes of the crop. The impacts of sowing dates and varieties on maize growth, development, and yield parameters are discussed in this article.

Keywords: Varieties, date of sowing, yield, maize

Introduction
The year-to-year variation in plant establishment, pest and disease incidence makes it difficult to predict optimum planting dates for maize crop. For optimization of yield, planting at the appropriate time is very critical as delay in planting date can lead to a linear decrease in grain yields. Despite of all these differences in sowing period, many scientists and farmers opined that early and mid-early sowings in India resulted good yields and high-quality seed. The literature available on effect of sowing date on maize was reviewed and described as under by using various headings.

Effect of date of sowing on growth parameter
Sulochana *et al*. (2015) [26] reported that early sown maize required significantly higher number of days and accumulated GDD to attain various phenophases compared to late sown crops, Higher water use efficiency, dry matter accumulation and LAI were recorded with the early crop and decreased with delay in sowing. Similarly, Sulochana *et al*. (2015) [26] observed that date of sowing brought immense impact and significant variation in number of days required to attain emergence, fifth leaf, knee high and maturity stage. The phenological studies revealed that a smaller number of days needed for initiation and completion of the reproductive phenophases in case of late sowing than early sown crops.
Gaile (2012) [14] concluded that maize emergence time period depends significantly on the sowing date. Early sown maize requires comparatively higher number of days till full emergence. He also emphasized that maize sown on 10 days later had three days early emergence as compared to the early one.
Azadbakht *et al*. (2012) [4] observed that the highest plant height by average of 238.3 cm as compared to the first planting date (29th April) and by postponing the planting date the height reduced as the lowest plant height (213.32 cm) related to fourth planting date (4th June). Comparing two maize varieties 'Ks 704' and 'N 504', with different planting dates (July 5th and 26th) Zarei *et al*. (2012) [29] reported that plant height of 'N 504', when planted on date of July 26th was 14.76% more than the planting date of July 5th. Moosavi *et al*. (2012) [20] studied the effect of planting dates (July 4, July 21 and August 6) on maize in Iran. When sowing is postponed from July 4 to August 6, plant height, stem diameter, leaf area index, and total fresh and dry yield all fall by 15.7, 20.9, 42.1, 24.7, and 25.9%, respectively.
Study conducted at Lativa with four maize hybrids ('Earlystar', 'M-20', 'Tango', and 'Cefran') sown on four dates (25 April, 5 May, 15 May, and 25 May) revealed that earlier sown maize needed more days till emergence and from emergence to silking.

However, further it was found that significantly highest dry matter was obtained when maize had been sown on 5 May (Gaile, 2012) [14]. Dahmardeh, (2010) [10] studied the effect of sowing dates (5 July, 20 July, 5 August and 20 August) on maize hybrids (*viz*. 'S.C 108', 'S.C 704' and 'S.C 604') at Iran. The result of study revealed that the cultivar 'SC 704' attained significantly highest leaf area index, leaf area duration and crop growth rate, when planted on 5th August than other sowing dates. Plant height, leaf area index and dry matter yield were also affected by planting date and optimum planting date contributed to highest growth parameter in South Africa (Kgasago, 2006) [18]. The general decline in dry matter production of maize in later sowing dates compared with early sowing dates indicated that conditions for growth became less favourable with lateness (Aderi and Ndaeyo, 2011) [1]. Delay in sowing date hastened development between seedling emergence and silking. However, late sowing resulted in increased crop growth rate during the vegetative and decreased crop growth rate during grain filling (Cirilo and Andrade, 1994) [9].

In Pakistan a variety 'Sarhad white' sown early on 15 July, reported highest emergence of seedlings per meter square, days to tasselling days to maturity and delayed sowing of 15 August deceased all above parameter (Ahmad *et al*., 2000) [2]. Williams (2008) [28] performed field trials to investigate the effect of five planting dates spanning from mid-April to early July, and found that planting was delayed from mid-April to early July., late sowings decreased the effective rate of grain filling and shortened the effective duration of grain filling compared with earlier sowings. Late sowing of maize in the season has compressed the reproductive stage of development, resulting in a significant reduction in the very late sowing date, which has harmed grain development and resulted in a lower grain index, resulting in a loss of grain yield (Shah *et al*., 2012) [22].

Effect of date of sowing on yield attributes and grain yield

Shrestha *et al. (*2015) [24] opined that the number of ears per hectare was not significant for all sowing dates. The highest kernel row per ear (12.89) and kernels per row (24.47) were observed for maize planting done on 7th April followed by 22nd April. Similarly, 1000 grain weights were higher and statistically similar in maize planted on 7th April (232.0 g) and 22nd April (231.3 g) than 7th May (223.3 g). Also crop sown on 22nd April (14.26 t ha^{-1}) and 7th April (14.35 t ha^{-1}) recorded higher stover yield and harvest index. 7th April planted maize cultivars had highest harvest index (0.347) but remaining both sowing dates had similar and least harvest index.

The interaction of planting dates with hybrids was not significant, according to Khaksar *et al*. (2009) [19], but a comparison of means revealed that the L2V1 (second planting date and SC-704) and L1V2 (first planting date and SC-500) treatments produced the highest and lowest 1,000 g weights, respectively, of 318.1 and 263.1g.

Dahmardeh (2012) [11] reported that the maximum 100 seed weight or seed index was recorded by plants planted on 6th July (34.48 g) which was statistically at equal level with the remaining planting dates, except 20th august (27.26 g), where the 1,00 seed weight was the minimum. Similar trend was recorded for harvest index also. The harvest index for maize planted on August 5th was 45.26 percent, which was identical to the harvest index for maize planted on July 21st and 20th. Late planting after 29th June, reduced total dry matter in Azir, Sudan, Kamara *et al*. (2012) [17]. They stated that sowing on 13th July produced total corn dry matter that was lower than planting on 21st and 20th July in 2006. In 2007, planting on 29th June produced total dry matter that was significantly higher than those produced by corn planted on 29th June, also lowered corn total dry matter. In 2007, total dry matter was nearly equal for sowing dates of 13th and 21st July.

Beiragi *et al*. (2011) [6] evaluated 18 new corn varieties consist of 15 foreign early and mid-mature single cross hybrids and 3 Iranian commercial hybrids ('KSC704', 'KSC647'and 'DC370') with two sowing date (5 and 20 June). Result showed that among all hybrids, 'EXP1' and 'OSSK617' had the highest yields in early planting (5 June) and 'EXP1' and 'KDC370' produced the highest, yields in late planting (20 June). The study conducted at Nigeria, revealed that late sowings grain yield by decreasing kernel weight and kernel number per unit area and strongly decreased dry matter partitioning to grain (Cirilo and Andrade, 1994) [9]. Grain yield and yield components decreased as planting was delayed in the late maturity genotypes while, in the early maturing genotype showed contrasting trend.

Effect of varieties on growth parameters

Among three major hybrids of maize cultivars (Obasuper-2, Oba-98, 9022-13), the hybrid 9022-13 of Nigeria had more mean plant height, number of leaves, leaf area and stem than remaining varieties (Enujeke, 2013). Similarly, Sharifi *et al.* (2009) [23] evaluated the performance of three maize hybrids (Sc-504, Sc-404 and Dc-370) and concluded that there was significant difference in growth of hybrids with maximum plant height of Sc 504 hybrid. The highest chlorophyll content, leaf area index, leaf dry matter was reported to be exhibited by hybrid Korduna (Hokmalipour and Darbandi, 2011) [16].

In Faisalabad, Pakistan, Ahmad *et al*. (2012) [3] observed that the maximum height (199.26 cm) was found to be in variety Pakafgoi followed Sargodha-2002 with a plant height of 178.46 cm and minimum plant height was found to be in variety Neelum (160.90 cm).

In rabi season under irrigated conditions in vertisols, Setty (1981) [21] reported that more or less similar trend in average Leaf area index (LAI) was registered at Dharwad. An average of LAI of 0.85 recorded at 30 days was the lowest and reached the maximum of 60 days (4.56) and gradually decreased up to 90 days (3.35) and then decreased (1.23) rapidly towards physiological maturity. He also reported that among different genotypes, EH-400175 showed LAI at par with Deccan at 30, 60 and 90 days, but higher than Deccan at physiological maturity while G-2 composite and Arabhavi local exhibited significantly lower LAI. Thus, higher LAI was observed.

Sulochana *et al*. (2015) [26] reported that enormous variation was brought by maize varieties in number of days taken to attain first tassel initiation, 50% tasseling, first silk initiation, 50% silking, milking, dough and maturity stage. BIO-9637 variety took highest number of days (55.3) for 5 first silk initiation which was notably superior over Pratap QPM-1, PEHM-2 and Pratap Makka-5, but at par with HQPM-1. Variety BIO-9637 took maximum number of days (93.3) to reach maturity and was significantly higher by 1.6, 3.0, 6.2 and 9.7 days in comparison to HQPM-1, Pratap QPM-1, PEHM-2 and Pratap Makka-5, respectively.

Dolijanovic *et al*. (2007) [12] discovered that medium and late

hybrids of maize (FAO-600 and FAO-700) produced considerably better yield and above ground mass when compared to other FAO groups of maize maturity.

Effect of varieties on yield attributes

In Dharwad and Kalioli, when the performance of two maize genotypes was compared, Deccan-103 recorded 17% higher yield than G-25 composite (Gollar, 1996) [15]. The higher grain yield of Deccan-103 (6.87 t ha^{-1}) was mainly due to higher values with respect to plant height, number of leaves, leaf area index and number of grains per cob and grain yield per plantgrain weight than composite G-25.

Aziz *et al*. (2007) [5] emphasized that maize cultivars differed significantly due to grain yield. Highest grain yield of 5.80 t ha^{-1} was produced by medium maturity cultivar Kissan while lowest yield of 4.80 t ha^{-1} was produced by early maturing cultivar Pahari. Tsimba *et al*. (2013) [27] reported that short duration hybrids unable to fully utilize available solar radiation and other resources at the end of season when maize hybrid planted early. Short season hybrids such as Baber, Pioneer 30P45, and Syngenta 6621 were compared phonologically and yield-wise when planted late. Among the hybrids, Pioneer 30P45 recorded significantly higher and at par values for days to tasseling, silking, maturity as well as grain yield (Staggenborg *et al*., 1999) [25].

Dahmardeh (2012) [10] reported that seed index or 100 seed weight varies significantly among the cultivars. Highest 100 seed weight was recorded in cultivar TVG (37.85 g) whereas cultivar SC 108 produced the minimum 100 seed weight (28.85 g). Significant difference of harvest index was there among the cultivars. Maximum harvest index was recorded by cultivar SC-108 (41.98%), which was at par with SC-704 (39.4%) and TVG (39.3%) but was significantly different from the other two cultivars. The hybrid SC-301 produced the minimum (30.5%) harvest index.

For getting the maximum yields in a particular environment and conditions, an appropriately adapted hybrid with the highest yield potential must be planted at its optimum planting density for grain production. High yields are due to the increased availability of assimilate supply (source) for grain filling as well as the capacity of the reproductive sink component (kernels) to accommodate the available assimilates. When compared to previous hybrids, modern hybrids have a high precision source-sink balance and a substantially higher tolerance of stress during flowering (Campos *et al*., 2004) [8]. To maximize yield, a good match between hybrids and environmental conditions is also required. The right maize hybrid is usually one that can realize the full yield potential of the growing season and the inputs provided by the grower with an acceptable risk level of yield reduction. Under non–limiting season lengths and when both were planted early, Bruns and Abbas (2006) [7] found that long duration hybrids yielded more than early maturing hybrids.

Conclusion

Delayed sowing causes variations in environmental factors such as temperature, solar radiation, and humidity, which cause changes in morphology, plant physiology, and molecular biology. As a result, the sowing date is critical for crop output. Plant varieties react differently depending on when they are sowed. For getting optimum plant population and yield the different plant varieties must be sown on a specified date.

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