***Original Research Article***

# Effect of Sowing Dates and Fertility Levels on Growth of Baby C~~c~~orn (*Zea mays* L.) under Temperate Conditions

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## Abstract

There are several factors affecting the growth of maize; however, the optimum date of sowing is important for maize so that the crop grown can complete its life cycle under optimum environmental conditions and managing the fertilizer is one of the most important factors affecting maize growth. A field experiment was conducted to study the e~~E~~ffect of sowing dates and fertility levels on growth of Baby corn (*Zea mays* L.) under temperate conditions at Crop Research Farm of Division of Agronomy, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadura during Kharif 2018. The experiment comprised of two factors with four sowing dates viz., 18$^{th}$ Standard Meteorological Week ((SMW) (30$^{th}$ April - 6$^{th}$ May)), 21$^{st}$ SMW (21$^{st}$ May – 27$^{th}$ May), 24$^{th}$ SMW (11$^{th}$ June – 17$^{th}$ June) and 27$^{th}$ SMW (2$^{nd}$ July – 8$^{th}$ July) as main plot treatments and four fertility levels viz., unfertilized control ($F_0$), 100:50:25 N:$P_2O_5$:$K_2O$ kg ha$^{-1}$ ($F_1$), 120:60:30 N:$P_2O_5$:$K_2O$ kg ha$^{-1}$ ($F_2$) and 140:70:35 N:$P_2O_5$:$K_2O$ kg ha$^{-1}$ ($F_3$) as sub-plot treatments laid out in split plot design with three replications. The results of the experiment revealed that different growth parameters of baby corn viz., plant height, leaf area index, dry matter accumulation and mean crop growth rate were significantly influenced by sowing dates and among different sowing dates, 18$^{th}$ SMW(Standard Meteorological Week) recorded significantly higher plant height, leaf area index, dry matter accumulation and mean Crop Growth Rate (CGR). The results of the present investigation also revealed that fertility levels had a significant effect on different growth parameters of baby corn and it was found that among different fertility levels $F_3$ fertility level (140:70:35 N: $P_2O_5$: $K_2O$ kg ha$^{-1}$) recorded significantly higher plant height, leaf area index, dry matter accumulation and mean crop growth rate than other fertility levels whereas control treatment recorded significantly lower growth.


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***Keywords*:**Baby corn, Ssowing dDates, Growth and fFertility levels.

## 1. Introduction:

Maize (*Zea mays* L.) is the third-largest cereal crop in the world, after rice and wheat. It is referred to as the "Queen of Cereals" because of its great production, simplicity in processing, and affordability compared to other cereals (Jaliya*et al.*, 2008).In addition to being used as human food and animal feed, it has several industrial uses. Over 190 million hectares of land are under maize cultivation globally, producing 1438 million tonnes annually (FAO, 2019).Maize is grown on an area of 9.50 million hectares, with an annual yield of 27.23 million tonnes and a productivity of 2.87 tonnes hectare$^{-1}$in India (DES, 2019).It is the second most important cereal crop after rice in the union territory of Jammu and Kashmir, and is cultivated over an area of 0.31 million hectares, with a production of 0.51 million tonnes and an average productivity of 1650 kg ha$^{-1}$(DES, 2019).

Baby corn, sweet corn, popcorn, and other types of special purpose corn have enormous commercial potential both domestically and abroad. Growing maize for vegetables, often known as baby corn, is being considered for the purpose of diversifying and adding value to maize as well as the expansion of the food processing sector. Baby corn is dehusked maize ear harvested young especially when the silk havehas either not emerged or just emerged and no fertilization has taken place or we can say the shank with unpollinated silk is baby corn. Baby corn is light yellow in colour with regular row arrangement, 10 to 12 cm long and diameter 1 to 1.5 cm arrangement are preferred in the market (Golada*et al.*, 2013).



People are looking for high-quality meals rather than bulky things due to the rapid change in standard of life and growing concern for health. As a healthy and reliable vegetable, baby corn holds a prominent place. However, the crop does not yet have any location-specific technologies. Agro-techniques to increase productivity are thus necessary today. Because it is crucial for improved utilisation of the crop's available moisture and nutrients, sowing time has a significant impact on how well the crop performs. The best environmental conditions for growth and a better crop utilisation of the available moisture and nutrients are provided by the sowing period, which has a significant impact on the performance of the crop.According to Lee *et al.* (2007), the timing of the sowing had a significant impact on maize growth. It has long been known that the addition of certain growth inputs could enhance the growth and productivity of maize. Inputs for growth include fertilisation, which is essential. NPK fertilisation has been shown to increase maize productivity, according to Rajanna*et al.* (2006). There hasn't been much research done in this area on how fertility levels and sowing dates affect the growth of baby maize.In view of these facts the study entitled"Effect of sowing dates and fertility levels on growth of Baby corn (*Zea mays* L.) under temperate conditions".

## 2. Materials and Methods

The experiment was conducted at Crop Research Farm of Division of Agronomy, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Wadura,Sopore during *Kharif*, 2018.The experiment comprised of two factors with four sowing dates *viz.*, $18^{th}$ Standard Meteorological Week ((SMW) ($30^{th}$ April - $6^{th}$ May)), $21^{st}$ SMW ($21^{st}$ May – $27^{th}$ May), $24^{th}$ SMW ($11^{th}$ June – $17^{th}$ June) and $27^{th}$ SMW ($2^{nd}$ July – $8^{th}$ July) as main plot treatments and four fertility levels viz., unfertilized control ($F_0$), 100:50:25 $N:P_2O_5:K_2O$ kg $ha^{-1}$($F_1$), 120:60:30 $N:P_2O_5:K_2O$ kg $ha^{-1}$ ($F_2$) and 140:70:35 $N:P_2O_5:K_2O$ kg $ha^{-1}$($F_3$) as sub-plot treatments laid out in split plot design with three replications.

Plant height of randomly tagged or marked plants in each plot was taken at 15 days interval from base of plant to the apex of flag leaf. The height was averaged and recorded as plant height in centimetres.Plant samples in each plot were collected from the net plots at 15 days interval from sowing date up to harvesting stage. After drying for 5-6 days, the samples were oven dried at 60-65$^{o}$C to a constant weight. Dry weight of plant samples ~~were~~was recorded as gram per plant and then converted to q $ha^{-1}$.Total number of leaves of 10 randomly marked plants in each plot were counted at 15 days interval and averaged as number of leaves per plant. Leaf area index was worked out by using the following formula:

$$Leaf area index (LAI) = \frac{Total leaf area}{Ground area}$$



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Crop growth rate ($gm^{-2}day^{-1}$) represents dry weight gained per unit area per unit time($gm^{-2}day^{-1}$). It was calculatedwith the help of following formula:

$$CropGrowthRate(CGR) = W - W1 \div T2 - T1 \times 1/A$$



$W_1$ = dry matter production (g) at time $T_1$

$W_2$ = dry matter production (g) at time $T_2$

$T_1$ = days to first reading

$T_2$ = days to second reading

A = Plant area ($m^2$)

## 3. Results and Discussion

### 3.1 Plant height

In order to monitor the overall architecture of the plant's canopy and to control the orientation of the leaves, which further controls how effectively a plant uses the sun's energy for photosynthetic processes, plant height is a key growth indicator. As presented in Table 1, the 18th SMW sowing ($S_1$) had significantly higher plant height than other sowing dates,



**Table 1: Effect of dates of sowing and fertility levels on plant height (cm) of baby corn(~~*Zea mays L.*~~)at 15 days interval**

| Treatments | 15DAS | 30DAS | 45DAS | 60DAS | Harvest |
|---|---|---|---|---|---|
| **MAIN PLOT** | | | | | |
| **Dates of sowing** | | | | | |
| $18^{th}$SMW($S_1$) | 6.01 | 31.76 | 102.73 | 159.81 | 186.63 |
| $21^{st}$SMW($S_2$) | 6.10 | 34.41 | 97.60 | 151.90 | 177.72 |
| $24^{th}$SMW($S_3$) | 6.20 | 37.67 | 90.53 | 142.31 | 160.27 |
| $27^{th}$SMW($S_4$) | 6.26 | 40.61 | 83.92 | 135.54 | 144.59 |
| **SEm±** | **0.02** | **1.13** | **1.41** | **2.01** | **2.28** |

| | | | | | |
|---|---|---|---|---|---|
| **CD ($p \leq 0.05$)** | **0.08** | **3.92** | **4.89** | **6.96** | **7.87** |
| **SUB PLOT** | | | | | |
| **Fertility levels ($N:P_2O_5:K_2O$ kgha$^{-1}$)** | | | | | |
| Unfertilized control ($F_0$) | 6.13 | 27.75 | 77.10 | 129.96 | 145.22 |
| 100:50:25 ($F_1$) | 6.14 | 35.80 | 90.77 | 143.84 | 164.50 |
| 120:60:30 ($F_2$) | 6.15 | 38.72 | 100.32 | 154.43 | 176.64 |
| 140:70:35 ($F_3$) | 6.15 | 42.19 | 106.59 | 161.33 | 182.85 |
| **SEm±** | **0.01** | **1.13** | **1.51** | **2.41** | **1.98** |
| **CD ($p \leq 0.05$)** | **N.S.** | **3.30** | **4.42** | **3.89** | **5.78** |

SMW= Standard Meteorological Week, DAS = Days after sowing

while the 27th SMW sowing ($S_4$) had the lowest plant height. The temperature was high during the delayed sowing period, which might have led to growth rate. Because early-sown crops had more time to make use of the available growth resources, they grew taller than delayed-sown crops. The findings are also consistent with the observation made by Moosavi et al. (2012) that there is a significant decline in plant height with the delay in maize sowing time. This significant decline in plant height following the delay in sowing may be related to higher temperatures that the delayed sowing date plants experienced, which constrained their growing period and prevented them from assimilate building because of the early maturity of the plants.However, up to 30 days after sowing, the late-sown crop (27$^{th}$ SMW) was taller than the early-sown crop (18th SMW), followed by the crop sown in the 24$^{th}$ SMW. This is because the late-sown crop was exposed to comparatively higher temperatures than the early-sown maize. Early crop development in late-sown crops was accelerated by the rapid accumulation of heat units, which might have caused an initial faster increase in plant height.

In comparison to the other fertility levels, the $F_3$ fertility level (140:70:35 N: $P_2O_5$: $K_2O$ kg ha$^{-1}$) recorded significantly higher plant height, whereas the $F_0$ fertility level recorded the lowest plant height (Table 1).The higher plant height observed at higher fertiliser levels might

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have result from a balanced supply of enough nutrients delivered in the right proportions and in appropriate amounts during crop growth and development. Both Sobhana et al. (2012) and Ashok Kumar (2009) observed that increased fertilisation had similar impacts on baby corn.

### 3.2 Leaf area index

Because optimal leaf area is necessary for maximum light absorption, which leads to higher photosynthesis, leaf area index is extremely important for all crop plants. From 45 to 60 days after sowing, the 18$^{th}$ SMW sowing ($S_1$) had the maximum leaf area index, which thereafter steadily decreased until harvest (Table 2). The leaf area index of baby corn (*Zea mays* L.) significantly decreased as a result of the delayed seeding. The shorter growing season may have played a role in the LAI reduction with delayed sowing. Similar findings were reported by Moosavi et al. (2012) and Williams and Lindquist in 2007.

With $F_3$ fertility level (140:70:35 N: $P_2O_5$: $K_2O$ kg $ha^{-1}$), a significantly higher leaf area index was observed. As fertility levels were reduced, the leaf area index decreased until it reached its lowest value with $F_0$ fertility level (Table 2). At 60 days after sowing, the maximum leaf area index was noted. From then, it gradually decreased till maturity. This could be attributed to the reason that the crop received enough nitrogen and phosphorus from the soil at the $F_3$ fertility level.Higher levels of both nitrogen and phosphorus might have encouraged more vegetative buds, which in turn led to more green leaves and an improved leaf area index (LAI). Senescence of the leaves brought on by the maturation of lower leaves might be the cause of the falling trend in the leaf area index from 60 days after sowing until harvest. These findings are consistent with those of Choudhary et al. (2007) and Maurya et al. (2004).

**Table-2: Effect of dates of sowing and fertility levels on leaf area index of Bb~~b~~aby corn~~(*Zea mays* L.)~~at 15 days interval**

| Treatments | 15DAS | 30DAS | 45DAS | 60DAS | Harvest |
|---|---|---|---|---|---|
| **MAIN PLOT** | | | | | |
| **Dates of sowing** | | | | | |
| 18$^{th}$SMW($S_1$) | 0.23 | 0.83 | 3.51 | 5.37 | 5.02 |

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| 21st SMW($S_2$) | 0.24 | 1.00 | 3.35 | 5.08 | 4.86 |
| 24th SMW($S_3$) | 0.28 | 1.18 | 3.13 | 4.66 | 4.42 |
| 27th SMW($S_4$) | 0.30 | 1.21 | 2.98 | 4.28 | 4.00 |
| **SEm±** | **0.01** | **0.01** | **0.04** | **0.07** | **0.04** |
| **CD ($p \leq 0.05$)** | **0.03** | **0.05** | **0.14** | **0.25** | **0.15** |
| **SUB PLOT** | | | | | |
| **Fertility levels ($N:P_2O_5:K_2O$ kgha$^{-1}$)** | | | | | |
| Unfertilized control ($F_0$) | 0.25 | 0.91 | 2.46 | 3.72 | 3.57 |
| 100:50:25 ($F_1$) | 0.26 | 1.03 | 3.17 | 4.65 | 4.27 |
| 120:60:30 ($F_2$) | 0.26 | 1.10 | 3.58 | 5.38 | 5.10 |
| 140:70:35 ($F_3$) | 0.28 | 1.19 | 3.76 | 5.64 | 5.36 |
| **SEm±** | **0.01** | **0.02** | **0.06** | **0.08** | **0.07** |
| **CD ($p \leq 0.05$)** | **N.S.** | **0.08** | **0.20** | **0.24** | **0.22** |

SMW= Standard Meteorological Week, DAS = Days after sowing

**3.3 Dry matter accumulation and mean crop growth rate**

Another crucial characteristic to express plant growth and metabolism, which ultimately affect yield, is the ~~buildup~~build-up of dry matter. When baby corn was delayed in being sown, the dry matter production and crop growth rate (CGR) (Tables 3 and 4) were both significantly lower. Rapid phenological development with delayed sowing might have been

**Table- 3: Effect of dates of sowing and fertility levels ondry matter accumulation (q ha$^{-1}$) of B~~B~~aby corn~~(*Zea mays* L.)~~at 15 days interval**

| Treatments | 15DAS | 30DAS | 45DAS | 60DAS | Harvest |
|---|---|---|---|---|---|
| **MAIN PLOT Dates of sowing** | | | | | |
| 18th SMW($S_1$) | 4.06 | 15.92 | 55.09 | 91.14 | 116.68 |

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|---|---|---|---|---|---|
| $21^{st}$ SMW($S_2$) | 4.16 | 17.54 | 52.32 | 86.06 | 109.98 |
| $24^{th}$ SMW($S_3$) | 4.36 | 19.62 | 48.85 | 78.87 | 96.27 |
| $27^{th}$ SMW($S_4$) | 4.54 | 22.60 | 46.37 | 73.35 | 89.84 |
| **SEm±** | **0.05** | **0.49** | **0.69** | **1.25** | **1.16** |
| **CD ($p\leq0.05$)** | **0.17** | **1.69** | **2.38** | **4.32** | **4.01** |
| **SUB PLOT** | | | | | |
| **Fertility levels ($N:P_2O_5:K_2O$ kgha$^{-1}$)** | | | | | |
| Unfertilized control ($F_0$) | 4.26 | 16.48 | 44.93 | 66.53 | 79.08 |
| 100:50:25 ($F_1$) | 4.28 | 18.48 | 48.88 | 81.49 | 102.83 |
| 120:60:30 ($F_2$) | 4.28 | 19.79 | 53.08 | 87.86 | 111.70 |
| 140:70:35 ($F_3$) | 4.30 | 20.93 | 55.75 | 93.54 | 119.15 |
| **SEm+** | **0.04** | **0.37** | **0.56** | **1.35** | **2.36** |
| **CD ($p\leq0.05$)** | **N.S.** | **1.10** | **1.65** | **3.96** | **6.91** |

SMW= Standard Meteorological Week, DAS = Days after sowing

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caused by a rise in temperature, which also increased respiration rates and lowered net gains, which led to the production of less dry matter.Additionally, the temperature might be favourable for baby corn on the 18th SMW sowing ($S_1$), which led to a larger production of dry matter because of a higher net gain of photosynthates. These results are in confirmation with the findings of Oktem*et al.* (2004).

In comparison to other fertility levels, the $F_3$ fertility level (140:70:35 N: $P_2O_5$: $K_2O$ kg ha$^{-1}$), significantly increased dry matter production, and it dropped as fertility levels decreased (Table 3). The higher plant height and leaf area index that resulted in improved light absorption by the crop, which in turn produced more photosynthates and dry matter, may be the cause of the $F_3$ fertility level's increased dry matter accumulation. Theseresultsare well supported by the findings of Sutaliya and Singh (2005) and Arunkumar et al. (2004). The results of the current study also indicated that $F_3$ fertility level (140:70:35 N: $P_2O_5$: $K_2O$ kg ha$^{-1}$) recorded higher crop growth rate at 15 days interval from 15 DAS up to harvest. The crop growth rate (CGR) indicates the increase in dry matter per unit area per unit time. The higher crop growth rate attained during the investigation under the above treatment is the reflection of accumulation of dry matter at the respective periods (Table 4). These results are in agreement with those of Mahmood *et al.* (1999).

**Table-4:Mean crop growth rate (gm$^{-2}$day$^{-1}$) of baby corn (*Zea mays* L.) as influenced by dates of sowing and different fertility levels**

| Treatments | 15-30 DAS | 30-45 DAS | 45-60 DAS | 60 DAS - harvesting |
|---|---|---|---|---|
| **MAIN PLOT** | | | | |
| **Dates of sowing** | | | | |
| 18th SMW ($S_1$) | 8.74 | 22.29 | 27.03 | 17.03 |
| 21st SMW ($S_2$) | 9.08 | 20.18 | 25.32 | 15.94 |
| 24th SMW ($S_3$) | 10.00 | 16.78 | 22.84 | 11.53 |
| 27th SMW ($S_4$) | 10.55 | 14.65 | 20.67 | 10.99 |
| **SEm+** | **0.30** | **0.38** | **0.58** | **0.43** |
| **CD ($p \leq 0.05$)** | **1.04** | **1.31** | **2.00** | **1.51** |
| **SUB PLOT** | | | | |
| **Fertility levels ($N:P_2O_5:K_2O$ kgha$^{-1}$)** | | | | |
| Unfertilized control ($F_0$) | 7.98 | 16.63 | 16.90 | 8.36 |
| 100:50:25 ($F_1$) | 9.13 | 17.90 | 24.40 | 14.17 |
| 120:60:30 ($F_2$) | 10.17 | 19.03 | 26.52 | 15.89 |
| 140:70:35 ($F_3$) | 11.09 | 20.35 | 28.04 | 7.07 |
| **SEm±** | **0.26** | **0.37** | **0.56** | **0.81** |
| **CD ($p \leq 0.05$)** | **0.76** | **1.08** | **1.64** | **2.38** |

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~~Conclusion~~

## Conclusions

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From results of the present study, is has been found that sowing dates as well as fertility levels had a significant effect on growth of baby corn and among different sowing dates, early sowing date recorded higher growth and among different fertility levels, fertility level 140:70:35N: $P_2O_5$: $K_2O$ kg ha$^{-1}$recorded higher growth as compared other fertility levels and control treatment. ~~Therefore~~Therefore, it can be concluded that in order to obtain higher growth of baby corn under temperate conditions, we should go for early sowing and it should be fertilized with140:70:35 dose of N: $P_2O_5$: $K_2O$ kg ha$^{-1}$.

## References

Arunkumar, M.A.. Fertilizer requirement of sweet corn (*Zea mays*saccharata) grown on vertisols of zone-8 of Karnataka. Thesis submitted for M.Sc. (Agri.) degree to U.A.S. Dharwad2004.

Ashok Kumar. Influence of varying plant population and nitrogen levels on growth, yield, economics and nitrogen use efficiency of pop corn (*Zea mays*evertasturt). *Crop Research*. 2009; **37**(1, 2&3): 19-23.

Choudhary, M.L., Singh, A. and Parihar, C.M.Forage production potential of maize (*Zea mays* L.) under different nitrogen levels and crop geometry. *Agronomy Digest*.2007;**7**:17-18.

DES; 2019.

FAO; 2019.

Goalada, S. L., Sharma, G. L. and Jain, H. K. Performance of baby corn (*Zea mays* L.) as Influenced by spacing, nitrogen fertilization and plant growth regulators under sub humid conditions in Rajasthan, India. *African Journal of Agricultural Research*. 2013;8(12): 1100-1107.

Jaliya MM, Falaki AM, Mahmud M, Abubakar IU and Sani YA. Response of quality protein maize (QPM) (*Zea mays* L.) to sowing date and NPK fertilizer rate on yield & yield components of Quality Protein Maize. Savannah Journal of Agriculture. 2008;3:24-35.

Lee, S., Yang, S. B. and Hong. Optimum plant population of a super sweet corn hybrid at different planting date. *Korean Journal of Crop Science*. 2007;52 (3): 334-334.

Mahmood, T., Saeed, M. and Ahmad, R. Water and potassium management for enhanced maize (*Zea mays* L.) productivity. *International Journal of Agriculture Biology*. 1999;1(4): 314-317.

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Maurya, K.L., Sharma, H.P., Tripathi, H.P. and Sher Singh. Effect of fertility levels of nitrogen and sulphur on growth, yield and quality of winter maize (*Zea mays* L.). *Haryana Journal of Agron*omy. 2004;20(1): 80-81.

Moosavi, S.G., Seghatoleslami, M.J. and Moazeni, A. Effect of planting date and plant density on morphological traits, LAI and forage corn yield. *InternationalResearchJournalofAppliedandBasicScience*. 2012;3(1):57-63.

Oktem, A., Eulumoketem, A. and Coskun, Y. Determination of sowing dates of sweet corn under Sanliurfa condition. *Turkish Journal Agriculture*. 2004;**28**:83-91.

Rajanna, A.E., Ramachandrappa, B. K., Nanjappa, H.V. and Soumya, T. M. Soil plant water status and yield of baby corn (*Zea mays* L.) as influenced by irrigation and fertility levels. *Mysore Journal of Agricultural Sciences.* 2006;**40:** 74-82.

Sobhana, V., Ashok Kumar, Idnani, L.K., Ishwar Singh and Shivdhar. Plant population and nutrient requirement for baby corn (*Zea mays* L.) hybrids. *Indian Journal of Agronomy*. 2012;57(3): 294-296.

Sutaliya R. and Singh, R.N. Effect of planting time, fertility level and phosphate solubilizing bacteria on growth, yield and yield attributes of winter maize (*Zea mays* L.) under rice (*Oryza sativa*)- maize cropping system. *Indian Journal of Agronomy*. 2005;50(3): 173-175.

Williams, M.M. and Lindquist, J.L. Influence of planting dates and weed interference on sweet corn growth and development. *Agronomy Journal*. **99**:1066-1072.