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# Effect of Different Planting Dates of Maize on Infestation of Stem Borer (*Chilo partellus* Swinhoe)

**Bendangsenla Longkumer, Pankaj Neog, Waluniba, Hijam Shila Devi**

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## ABSTRACT

The studies were carried out at the School of Agricultural Sciences and Rural Development, Medziphema Campus, Nagaland University during 2019. The experiment was laid out in a Split Plot Design (SPD) having three replications. The cultivars viz., Zarsi, Sipho, Ronimi, Khoi and HQPM-1 were sown on 3 different dates i.e., 6th March, 21st March and 5th April. Among the five cultivars used the local cultivar 'Sipho'was found to be the most tolerant and performed better than the composite variety 'HQPM-1' and the different dates of sowing, 5th April was found to be the most successful with the least infestation by *Chilo partellus*. The maize sown on 21st March recorded the highest grain yield (4.12 t/ha). Among the four cultivars and one composite variety evaluated, the highest grain yield was recorded from cultivar Sipho with 4.13 t/ha, while the lowest from cultivar Ronimi with 3.11 t/ha.

Bendangsenla Longkumer[1]*, Pankaj Neog[2], Waluniba[3], Hijam Shila Devi[4]

[2]Associate Professor, [3, 4] Assistant Professor
[1, 2, 3, 4]Department of Entomology, Nagaland University, School of Agricultural Sciences and Rural Development, Medziphema Campus 797106, India

Email : asenjamir7800@gmail.com
*Corresponding author

**Keywords** Maize, Date of sowing, Split plot design, Cultivars, *Chilo partellus*.

## INTRODUCTION

Maize (*Zea mays* L.) is an important cereal and nutritious crop in the Tropics and sub-tropics. It is the most widely cultivated cereal crop in India. It is a staple and an important source of carbohydrate in human diet and also serves as a source of animal feed (Onasanya *et al.* 2009), an important source of industrial and pharmaceutical production in the country (Olaniyan 2015). Maize crop is attacked by many insects viz., army worm, stem borer, thrips, aphids, termites, white grub, seed corn maggots, root worms, Indian meal moth, grain borer and grain weevil during storage of these, stem borer (*Chilo partellus*) and fall army worm (*Spodoptera frugiperda*) has been identified as one of the major limiting factors to maize production throughout the world. Among these pests, *Chilo partellus* (Lepidoptera : Pyralidae) is one of the most dangerous pests and causes tremendous damage to maize crop (Kavita *et al*. 2016, Yonow *et al.* 2017). In case of severe damage, it can cause yield reduction up to 75% (Sharma *et al.* 2010). It is the principal pest in lowland areas (Yonow *et al.* 2017). Dates of planting significantly influence the growth, development and yield due to such climate changes that occur during the cropping season (Lansigan *et al.* 2000, Casini 2012, Dahmardeh 2012). Manipulation of sowing dates of crops is an important cultural practice to avoid the peak infestation of insect pests on the crop. In this context, the information pertaining to dates

of sowing on the incidence of major pest infestation in maize and also in yield has been lacking in the regions of Nagaland.

## MATERIALS AND METHODS

Field experiment on was carried out in Entomological farm of SASRD, Nagaland University, Medziphema Campus, Nagaland during the period from March to July 2019. It is located at an altitude of 304.8 m above mean sea level and geographically located at 25° 45′ 45′′ North latitude and 93° 53′ 04′′ East longitude, in the foot hills of Nagaland. The site of experimental farm area enjoys a sub-tropical with high humidity and moderate temperature range (21-32°C), having average rainfall (2000- 3000 mm) and RH of 70–80%. The design was Split Plot Design (SPD) with 3 replications, keeping planting dates in the main plot and cultivar in the sub plot. The main plot was divided into 5 subplots in order to accommodate 5 cultivars. Three dates of planting were allotted to main plot and the whole set up was replicated three times. Spacing was maintained at 60 × 25 cm between rows and plants respectively with the plot size of 4.2 × 1 m. Observation were recorded fortnightly starting from 15 DAS. In the same plot ten plants were selected randomly. The plant showing pin holes, shot holes or dead heart and exit holes on stem was recorded as infested plants and the percentage of infestation was calculated using the formula.

$$\text{Percentage of infestation} = \frac{\text{No. of infested plant} \times 100}{\text{Total no. of plants}}$$

The data's relating to stem borer infestation percentage; dead heart percentage, percentage of stem infestation and percentage of stalk breakage were transformed using arc sin transformation while square root transformation was used to transform the data's relating to number of exit holes using the formula $\sqrt{x+0.5}$ , before subjecting them to statistical analysis.

## RESULTS AND DISCUSSION

**Infestation of leaf by maize stem borer (*Chilo partellus*) on maize :** The study on the influence of date of sowing and cultivars on infestation by maize stem borer was exhibited at 15 days interval starting from 30 DAS till the end. The data's collected are represented in Tables 1–2.

**Table 1.** Effect of different sowing dates and cultivars on percent leaf infestation caused by *Chilo partellus* on maize. Note : Figures in the table are mean values and those in parenthesis are angular transformed values.

| Treatments | Percent leaf infestation caused by *Chilo partellus* | | |
|---|---|---|---|
| | 30 DAS | 45 DAS | 60 DAS |
| Sowing dates | | | |
| $D_1$: 6th March | 9.34 (17.72) | 11.72 (19.96) | 15.21 (22.92) |
| $D_2$: 21st March | 6.85 (15.08) | 9.12 (17.52) | 12.36 (20.55) |
| $D_3$: 5th April | 5.27 (13.23) | 7.04 (15.33) | 10.23 (18.61) |
| **Sem±** | **0.12** | **0.14** | **0.17** |
| **CD (p=0.05)** | **0.48** | **0.54** | **0.68** |
| Cultivars | | | |
| $C_1$: Zarsi | 7.94 (16.27) | 10.28 (18.64) | 13.74 (21.70) |
| $C_2$: Sipho | 6.60 (14.72) | 8.40 (16.73) | 11.57 (19.83) |
| $C_3$: Ronimi | 8.87 (17.21) | 11.26 (19.50) | 14.68 (22.48) |
| $C_4$: Khoi | 7.04 (15.24) | 9.27 (17.59) | 12.76 (20.85) |
| $C_5$: HQPM-1 | 5.33 (13.30) | 7.25 (15.56) | 10.25 (18.61) |
| **Sem±** | **0.20** | **0.19** | **0.11** |
| **CD (p=0.05)** | **0.59** | **0.56** | **0.33** |

**Infestation at 30 DAS :** As presented in (Table 1) maize stem borer infestation at 30 DAS showed significant variation. The highest percentage of infestation (9.34%) was exhibited on 1st DOS followed by 2nd DOS with 6.85% and the lowest (5.27%) was recorded on 3rd DOS.

**Infestation at 45 DAS :** As presented in (Table 1) the influence of sowing dates was found to be significant at 45 DAS. The highest percentage of infestation (11.72) was exhibited at 1st DOS and the lowest percentage (7.04) was exhibited at 3rd DOS.

**Infestation at 60 DAS :** As presented in (Tables 1–2) the present study revealed that at 60 DAS, the influence of dates of sowing was found to be significant.

**Table 2.** Interaction effect of different sowing dates and cultivars on percent leaf infestation caused by *Chilo partellus* on maize. Note: Figures in the table are mean values and those in parenthesis are angular transformed values.

| Sowing dates × Cultivars | Percent leaf infestation caused by *Chilo partellus* 30 DAS | 45 DAS | 60 DAS |
|---|---|---|---|
| $D_1C_1$ | 10.32 (18.72) | 12.68 (20.85) | 16.50 (23.96) |
| $D_1C_2$ | 9.25 (17.68) | 11.15 (19.50) | 14.15 (22.09) |
| $D_1C_3$ | 10.76 (19.14) | 13.67 (21.69) | 17.36 (24.62) |
| $D_1C_4$ | 9.82 (18.26) | 12.33 (20.55) | 15.65 (23.30) |
| $D_1C_5$ | 6.54 (14.82) | 8.75 (17.21) | 12.40 (20.61) |
| $D_2C_1$ | 7.25 (15.62) | 9.70 (18.14) | 13.53 (21.58) |
| $D_2C_2$ | 5.76 (13.85) | 7.86 (16.28) | 11.12 (19.48) |
| $D_2C_3$ | 9.62 (18.07) | 11.78 (20.06) | 14.37 (22.28) |
| $D_2C_4$ | 6.45 (14.71) | 8.92 (17.38) | 12.69 (20.87) |
| $D_2C_5$ | 5.20 (13.18) | 7.35 (15.73) | 10.10 (18.53) |
| $D_3C_1$ | 6.24 (14.47) | 8.47 (16.92) | 11.20 (19.55) |
| $D_3C_2$ | 4.78 (12.63) | 6.20 (14.41) | 9.45 (17.91) |
| $D_3C_3$ | 6.22 (14.42) | 8.32 (16.75) | 12.32 (20.54) |
| $D_3C_4$ | 4.86 (12.73) | 6.57 (14.85) | 9.96 (18.39) |
| $D_3C_5$ | 4.25 (11.89) | 5.65 (13.75) | 8.24 (16.68) |
| **Sem±** | **0.35** | **0.34** | **0.20** |
| **CD (p=0.05)** | **1.03** | **0.98** | **0.58** |

**Table 3.** Effect of different sowing dates and cultivars on percent dead heart caused by maize stem borer on maize. Note: Figures in the table are mean values and those in parenthesis are angular transformed values.

| Sowing dates × Cultivars | Percent dead heart caused by *Chilo partellus* 30 DAS | 45 DAS | 60 DAS |
|---|---|---|---|
| $D_1C_1$ | 9.85 (18.28) | 13.52 (21.57) | 17.86 (24.99) |
| $D_1C_2$ | 6.25 (14.47) | 10.86 (19.23) | 15.48 (23.17) |
| $D_1C_3$ | 11.20 (19.55) | 15.35 (23.06) | 19.05 (25.87) |
| $D_1C_4$ | 8.54 (17.00) | 12.30 (20.53) | 16.67 (24.08) |
| $D_1C_5$ | 5.16 (13.13) | 9.24 (17.69) | 13.43 (21.50) |
| $D_2C_1$ | 8.76 (17.21) | 11.35 (19.69) | 15.48 (23.17) |
| $D_2C_2$ | 5.87 (14.02) | 9.76 (18.20) | 13.10 (21.21) |
| $D_2C_3$ | 8.62 (17.07) | 12.32 (20.54) | 16.67 (24.09) |
| $D_2C_4$ | 6.56 (14.84) | 10.25 (18.66) | 14.30 (22.21) |
| $D_2C_5$ | 4.26 (11.87) | 7.87 (16.29) | 11.90 (20.18) |
| $D_3C_1$ | 4.45 (12.17) | 7.92 (16.33) | 11.92 (20.19) |
| $D_3C_2$ | 3.22 (10.34) | 6.54 (14.81) | 10.72 (19.11) |
| $D_3C_3$ | 4.87 (12.74) | 8.52 (16.97) | 12.70 (20.88) |
| $D_3C_4$ | 3.86 (11.33) | 7.45 (15.84) | 11.24 (19.58) |
| $D_3C_5$ | 2.98 (9.92) | 5.88 (14.03) | 9.52 (17.97) |
| **Sem±** | **0.24** | **0.36** | **0.31** |
| **CD (p=0.05)** | **0.70** | **1.06** | **0.89** |

The highest percentage of infestation (15.21%) was exhibited at 1st DOS and the 3rd DOS gave the lowest percentage of infestation (10.23%) by maize stem borer. It was observed from the data that maximum infestation was recorded during May i.e., 60 days after sowing. Accordingly, the data collection shows variation in infestation percentage at different dates of sowing. Infestation percentage was highest at 1st DOS i.e. 6th March in contrast with 2nd DOS (21st March) and 3rd (5th April) DOS.

The present finding indicates that late sowing performed better in regards to infestation by maize stem borer than early sowing. The present finding in agreement with Bhandari *et al.* (2018) who reported that effect of planting dates of maize on the incidence of borer. The data on the three dates of sowing showed that the maize sowed on 5th April suffered the least maize infestation followed by maize sowed on 21st March, in contrast with the maize sowed on 6th March, which recorded the highest infestation. This outcome of the study indicated that late sowing (April) is effective in reducing stem borer infestation on maize. Therefore, late sowing escapes much of the stem borer infestation than early sowing.

## Dead heart

The data on influence of date of sowing on dead heart was recorded three times interval at 15 days interval

**Table 4.** Interaction effect of different sowing dates and cultivars on percent dead heart caused by maize stem borer on maize. Note: Figures in the table are mean values and those in parenthesis are angular transformed values.

| Sowing dates × Cultivars | Percent dead heart caused by *Chilo partellus* 30 DAS | 45 DAS | 60 DAS |
|---|---|---|---|
| $D_1C_1$ | 9.85 (18.28) | 13.52 (21.57) | 17.86 (24.99) |
| $D_1C_2$ | 6.25 (14.47) | 10.86 (19.23) | 15.48 (23.17) |
| $D_1C_3$ | 11.20 (19.55) | 15.35 (23.06) | 19.05 (25.87) |
| $D_1C_4$ | 8.54 (17.00) | 12.30 (20.53) | 16.67 (24.08) |
| $D_1C_5$ | 5.16 (13.13) | 9.24 (17.69) | 13.43 (21.50) |
| $D_2C_1$ | 8.76 (17.21) | 11.35 (19.69) | 15.48 (23.17) |
| $D_2C_2$ | 5.87 (14.02) | 9.76 (18.20) | 13.10 (21.21) |
| $D_2C_3$ | 8.62 (17.07) | 12.32 (20.54) | 16.67 (24.09) |
| $D_2C_4$ | 6.56 (14.84) | 10.25 (18.66) | 14.30 (22.21) |
| $D_2C_5$ | 4.26 (11.87) | 7.87 (16.29) | 11.90 (20.18) |
| $D_3C_1$ | 4.45 (12.17) | 7.92 (16.33) | 11.92 (20.19) |
| $D_3C_2$ | 3.22 (10.34) | 6.54 (14.81) | 10.72 (19.11) |
| $D_3C_3$ | 4.87 (12.74) | 8.52 (16.97) | 12.70 (20.88) |
| $D_3C_4$ | 3.86 (11.33) | 7.45 (15.84) | 11.24 (19.58) |
| $D_3C_5$ | 2.98 (9.92) | 5.88 (14.03) | 9.52 (17.97) |
| **Sem±** | **0.24** | **0.36** | **0.31** |
| **CD (p=0.05)** | **0.70** | **1.06** | **0.89** |

starting from 30 DAS. The data's secured are shown on (Tables 3 - 4). The outcomes of the results of dead heart are discussed below.

### *Dead heart at 30 DAS*

The data recorded at 30 DAS revealed that date of sowing had significant effect on the percentage of dead heart (Table 3). The highest dead heart percentage (8.20) was recorded on maize sown on 1st DOS followed by 2nd DOS (6.82) and the lowest (3.88) was recorded on the maize sown on 3rd DOS.

**Table 5.** Effect of different sowing dates and cultivars on tunnel length, number of exit holes exit holes and stalk breakage caused by maize stem borer on maize. Note: Figures in the table are mean values and those in parenthesis ( ) and ( )* are square root and angular transformed values respectively.

| Treatments | Infestation caused by *Chilo partellus* Tunnel length (cm) | Number of exit holes | Stalk breakage (%) |
|---|---|---|---|
| Sowing dates | | | |
| $D_1$: 6th March | 16.81 | 3.44 (1.97) | 24.67 (29.60)* |
| $D_2$: 21st March | 14.12 | 2.93 (1.84) | 22.00 (27.77)* |
| $D_3$: 5th April | 11.45 | 2.69 (1.78) | 19.33 (25.79)* |
| **Sem±** | **0.12** | **0.04** | **0.81** |
| **CD (p=0.05)** | **0.46** | **0.16** | **3.16** |
| Cultivars | | | |
| $C_1$: Zarsi | 15.45 | 3.58 (2.02) | 25.56 (30.31)* |
| $C_2$: Sipho | 12.99 | 2.43 (1.71) | 18.89 (25.73)* |
| $C_3$: Ronimi | 16.75 | 4.12 (2.15) | 30.00 (33.18)* |
| $C_4$: Khoi | 14.24 | 2.86 (1.83) | 22.22 (28.11)* |
| $C_5$: HQPM1 | 11.20 | 2.11 (1.61) | 13.33 (21.28)* |
| **Sem±** | **0.24** | **0.08** | **0.49** |
| **CD (p=0.05)** | **0.69** | **0.23** | **1.42** |

### *Dead heart at 45 DAS*

The data recorded at 45 DAS revealed that the different sowing dates had a significant effect on dead heart. The highest dead heart percentage (11.72) was recorded from the maize sown on 1st DOS followed by 2nd DOS (9.12) and the lowest (7.4) was recorded from the maize sown on 3rd DOS (Table 3).

### *Dead heart at 60 DAS*

At 60 DAS, the data recorded on the different date of sowing was found to have a significant effect on the infestation by maize stem borer as dead heart (Tables 3–4). According to the information collected, the highest percentage (16.50) of dead heart was recorded on the plots that were sowed on 1st DOS and the lowest percentage (11.22) was recorded on the

**Table 6.** Interaction effect of different sowing dates and cultivars on tunnel length, number of exit holes and stalk breakage caused by maize stem borer on maize. Note: Figures in the table are mean values and those in parenthesis ( ) and ( )* are square root and angular transformed values respectively.

| Sowing dates × Cultivars | Infestation caused by *Chilo partellus* Tunnel length (cm) | Number of exit holes | Stalk breakage (%) |
|---|---|---|---|
| $D_1C_1$ | 18.20 | 4.20 (2.17) | 30.00 (33.21)* |
| $D_1C_2$ | 15.52 | 2.60 (1.76) | 20.00 (26.57)* |
| $D_1C_3$ | 20.05 | 4.80 (2.30) | 33.33 (35.26)* |
| $D_1C_4$ | 17.00 | 3.20 (1.92) | 23.33 (28.88)* |
| $D_1C_5$ | 13.27 | 2.40 (1.70) | 16.67 (24.08)* |
| $D_2C_1$ | 15.90 | 3.37 (1.97) | 23.33 (28.88)* |
| $D_2C_2$ | 12.65 | 2.40 (1.70) | 20.00 (26.57)* |
| $D_2C_3$ | 17.10 | 3.83 (2.08) | 30.00 (33.21)* |
| $D_2C_4$ | 14.22 | 3.00 (1.87) | 23.33 (28.88)* |
| $D_2C_5$ | 10.75 | 2.03 (1.59) | 13.33 (21.34)* |
| $D_3C_1$ | 12.25 | 3.17 (1.91) | 23.33 (28.86)* |
| $D_3C_2$ | 10.80 | 2.30 (1.67) | 16.67 (24.05)* |
| $D_3C_3$ | 13.10 | 3.73 (2.06) | 26.67 (31.07)* |
| $D_3C_4$ | 11.52 | 2.37 (1.69) | 20.00 (26.57)* |
| $D_3C_5$ | 9.60 | 1.90 (1.54) | 10.00 (18.43)* |
| **Sem±** | **0.41** | **0.14** | **0.84** |
| **CD (p=0.05)** | **1.20** | **0.40** | **2.45** |

plots sowed on 3rd DOS.

The results from the present investigation shows that the different sowing dates had significant effect on dead heart formation. Accordingly, at 30 DAS, high percentage of dead heart was recorded which indicated that the younger plants are more likely to be attacked by maize stem borer. The highest dead heart percentage (8.20) was exhibited at 1st DOS and the lowest (3.88) was exhibited on maize sowed at 3rd DOS at 30 DAS. The highest dead heart percentage (11.72) was exhibited at 1st DOS and the lowest (7.04) was exhibited on maize sowed at 3rd DOS at 45 DAS. The information that was exhibited at 60 DAS showed that 1st DOS had the highest percentage (16.50) of dead heart while the least percentage (11.22) was exhibited on maize sowed on 3rd DOS. However, on analyzing the data from all the different dates of observation, it indicated that the late sowed maize escaped much of the stem borer attack and had less degree of infestation compared to early sowing.

Gaurav and Khan (2006) revealed that out of 5 sowing dates, the maximum total infestation occurred in delayed sowing dates caused by maize stem borer. This is in accordance with the present findings where 3rd date of sowing was found to be more effective in avoiding severe infestation of maize stem borer that caused dead heart as compared to 1st date of sowing.

**Stem tunneling :** The study stem tunneling, the stems were uprooted after harvest and the height of the stem were measured and later dissected to measure tunnel lengths. The information was collected and presented on Tables 5 - 6. The different date of sowing was observed to have a significant effect with regard to stem tunneling by maize stem borer. The data showed that the maize sowed on 1st DOS recorded a mean of 16.81cm of tunnel length. A mean of 14.12 cm tunnel length was recorded on maize sown on 2nd DOS and 11.45 cm tunnel length was observed on maize sown on 3rd DOS. Significant variation was shown among cultivars. The cultivar 'Ronimi' exhibited the highest tunnel length (16.75 cm) and the lowest (11.20 cm) was exhibited on the variety 'HQPM-1. The data revealed that the interaction among the cultivars and sowing dates were significant. The interaction revealed the longest stem tunneling (20.05 cm) was observed on $D_1C_3$ i.e. cultivar 'Ronimi' in 1st DOS. The least (9.60 cm) was recorded on $D_3C_5$ i.e. the variety 'HQPM-1 sowed on 3rd DOS. The lesser stem tunneling in the variety 'HQPM-1 might be due to the plant characteristics such as leaf toughness, hard and tough stem and sugar content. Manzoor *et al.* (2015) studied the stem borer in maize stubbles and stalks in two maize cultivars, local white and hybrid revealed that hybrid is more susceptible to maize stem borer infestation. However, the present findings revealed that the hybrid variety HQPM-1 was least preferred as compared to the local cultivars.

**Table 7.** Effect of different sowing dates and cultivars on yield attributes of maize.

| Treatments | Number of cobs plant$^{-1}$ | Cob length (cm) | Cob diameter (cm) | Fresh cob weight (g cob$^{-1}$) | Cob yield kg plot$^{-1}$ | Cob yield t ha$^{-1}$ | Grain yield kg plot$^{-1}$ | Grain yield t ha$^{-1}$ |
|---|---|---|---|---|---|---|---|---|
| Sowing dates | | | | | | | | |
| $D_1$: 6$^{th}$ March | 1.48 | 12.00 | 4.41 | 176.49 | 7.35 | 4.17 | 5.51 | 3.13 |
| $D_2$: 21$^{st}$ March | 1.61 | 14.20 | 4.64 | 214.39 | 9.69 | 5.49 | 7.27 | 4.12 |
| $D_3$: 5$^{th}$ April | 1.55 | 13.53 | 4.49 | 194.84 | 8.45 | 4.79 | 6.34 | 3.59 |
| Sem± | 0.001 | 0.12 | 0.01 | 1.51 | 0.07 | 0.04 | 0.05 | 0.03 |
| CD (p=0.05) | 0.004 | 0.48 | 0.03 | 5.94 | 0.26 | 0.15 | 0.20 | 0.11 |
| Cultivars | | | | | | | | |
| $C_1$: Zarsi | 1.45 | 13.44 | 4.52 | 194.45 | 7.92 | 4.49 | 5.94 | 3.37 |
| $C_2$: Sipho | 1.62 | 14.44 | 4.74 | 214.04 | 9.71 | 5.50 | 7.28 | 4.13 |
| $C_3$: Ronimi | 1.38 | 12.56 | 4.32 | 188.29 | 7.32 | 4.15 | 5.49 | 3.11 |
| $C_4$: Khoi | 1.55 | 12.00 | 4.26 | 180.00 | 7.85 | 4.45 | 5.89 | 3.34 |
| $C_5$: HQPM1 | 1.73 | 13.78 | 4.72 | 199.42 | 9.69 | 5.49 | 7.27 | 4.12 |
| **Sem±** | **0.002** | **0.13** | **0.01** | **1.73** | **0.07** | **0.04** | **0.05** | **0.03** |
| **CD (p=0.05)** | **0.005** | **0.37** | **0.04** | **5.05** | **0.20** | **0.11** | **0.15** | **0.09** |

**Exit holes:** The number of exit holes was counted from the maize stem uprooted after harvest. The data collected are presented in Tables 5 - 6. The highest number of exit holes (3.44) was exhibited from the maize sowed at 1$^{st}$ DOS followed by 2$^{nd}$ DOS with 2.93 and the lowest (2.69) was exhibited on the maize sowed at 3$^{rd}$ DOS. The highest number of exit holes (4.12) was exhibited on the cultivar 'Ronimi' and the variety 'HQPM -1 exhibited the lowest (2.11) number of exit holes. The data revealed that the interaction among the cultivar and sowing dates have significant effect. The interaction $D_1C_3$ i.e. the 1$^{st}$ date of sowing and cultivar 'Ronimi' gave the highest number of exit holes (4.80), whereas the interaction $D_3C_5$ i.e. 3$^{rd}$ date of sowing and variety HQPM-1 gave the least number of exit holes (1.90). The variety '*HQPM-1*' was the most tolerant among the different cultivars evaluated showing superior morphological characters and genotypic variations in comparison with other cultivars as revealed in the experiment undertaken. Among the five different maize cultivars, it was noticed that 'Ronimi' was the most affected cultivar; this might be due to the cultivars morphological character like compact whorl, soft stem and long internodes. This is in agreement with Bamaiyi and Joan (2011).

**Stalk breakage :** The total number of plants with broken stem below the ear was counted at time of harvest. The data collected is presented on (Tables 5 - 6) 1$^{st}$ DOS exhibited the highest percentage (24.67) of stalk breakage and the lowest (19.33) was exhibited from the 3$^{rd}$ DOS. It also revealed that the influence of cultivar has a significant effect on the percentage of stalk breakage. The highest (30.00%) was exhibited on the cultivar 'Ronimi' and the lowest (13.33%) was exhibited on the variety 'HQPM-1. With regards to stalk breakage, the interaction between sowing dates and cultivar was found to be significant. The interaction $D_1C_3$ gave the highest percentage (33.33%) of stalk breakage i.e. 1$^{st}$ DOS and cultivar 'Ronimi' and the least (10.00) was observed on the interaction $D_3C_5$, i.e. 3$^{rd}$ DOS and variety HQPM-1. on detailed examination, it was shown that the sowing dates had significant effect on stalk breakage by maize stem borer. The data showed that 1$^{st}$ DOS had the highest percentage (24.67) of stalk breakage and the lowest (19.33) was exhibited on 3$^{rd}$ DOS. All the cultivar and the variety used had a significant effect on stalk breakage. These results may be due to the difference in morphological characters and genotypic variation among the cultivars. The cultivars 'Ronimi' recorded the highest percentage (33.33) of stalk breakage and the lowest (10.00) was recorded from the variety 'HQPM-1. It is easy to perceive from the data observed that the cultivar 'Ronimi' was the most susceptible among the different cultivars used during the present study.

**Table 8.** Interaction effect of different sowing dates and cultivars on yield attributes of maize.

| Sowing dates × Cultivars | Number of cobs plant$^{-1}$ | Cob length (cm) | Cob diameter (cm) | Fresh cob weight (g cob$^{-1}$) | Cob yield kg plot$^{-1}$ | Cob yield t ha$^{-1}$ | Grain yield kg plot$^{-1}$ | Grain yield t ha$^{-1}$ |
|---|---|---|---|---|---|---|---|---|
| $D_1C_1$ | 1.38 | 12.33 | 4.40 | 176.27 | 6.83 | 3.87 | 5.12 | 2.90 |
| $D_1C_2$ | 1.56 | 13.67 | 4.63 | 200.38 | 8.73 | 4.95 | 6.55 | 3.71 |
| $D_1C_3$ | 1.32 | 11.00 | 4.23 | 167.22 | 6.20 | 3.51 | 4.65 | 2.63 |
| $D_1C_4$ | 1.48 | 10.33 | 4.20 | 158.47 | 6.61 | 3.75 | 4.96 | 2.81 |
| $D_1C_5$ | 1.66 | 12.67 | 4.57 | 180.10 | 8.39 | 4.75 | 6.29 | 3.57 |
| $D_2C_1$ | 1.52 | 14.33 | 4.67 | 212.88 | 9.04 | 5.12 | 6.78 | 3.84 |
| $D_2C_2$ | 1.67 | 15.33 | 4.85 | 234.40 | 10.98 | 6.23 | 8.24 | 4.67 |
| $D_2C_3$ | 1.45 | 13.67 | 4.43 | 204.72 | 8.31 | 4.71 | 6.23 | 3.53 |
| $D_2C_4$ | 1.62 | 13.00 | 4.37 | 204.53 | 9.26 | 5.25 | 6.94 | 3.94 |
| $D_2C_5$ | 1.80 | 14.67 | 4.90 | 215.40 | 10.86 | 6.15 | 8.14 | 4.62 |
| $D_3C_1$ | 1.45 | 13.67 | 4.50 | 194.20 | 7.88 | 4.47 | 5.91 | 3.35 |
| $D_3C_2$ | 1.62 | 14.33 | 4.75 | 207.35 | 9.41 | 5.33 | 7.05 | 4.00 |
| $D_3C_3$ | 1.38 | 13.00 | 4.30 | 192.92 | 7.45 | 4.23 | 5.59 | 3.17 |
| $D_3C_4$ | 1.55 | 12.67 | 4.20 | 177.00 | 7.68 | 4.35 | 5.76 | 3.27 |
| $D_3C_5$ | 1.73 | 14.00 | 4.70 | 202.75 | 9.82 | 5.57 | 7.37 | 4.18 |
| **Sem±** | **0.003** | **0.22** | **0.02** | **3.00** | **0.12** | **0.07** | **0.09** | **0.05** |
| **CD (p=0.05)** | **0.009** | **0.63** | **0.07** | **8.75** | **0.35** | **0.20** | **0.26** | **0.15** |

## Yield attribute

***Cobs plant$^{-1}$*** **:** The number of cobs per plant was counted from the maize stem uprooted after harvest. The data collected are presented in Tables 7–8. The outcomes of the results are briefly described below.

The highest number of cobs per plant (1.61) was exhibited from the maize sowed at 2nd DOS followed by 3rd DOS (1.55) and the lowest (1.48) was exhibited on the maize sowed on 1st DOS.

The highest number of cobs per plant (1.73) was exhibited on the variety HQPM-1 and the cultivar exhibited the lowest (1.38) number of cobs per plant. The interaction $D_2C_5$ i.e. the 2nd date of sowing and variety HQPM-1 gave the highest number of cobs per plant (1.80), whereas the interaction $D_1C_3$ i.e. 1st date of sowing and cultivar gave the least number of cobs per plant (1.32) undertaken.

***Cobs length*** **:** To study of cobs length, the cobs was collected after harvest and the length of the cobs were measured. The data were collected and presented on Tables 7–8.

The different date of sowing was observed to have a significant effect with regard to cobs length. The data showed that the maize sowed on 1st DOS recorded a mean of 12.00 cm of cobs length. A mean of (14.20 cm) cobs length was recorded on maize sown on 2nd DOS and (13.53 cm) of cob length was observed on maize sown on 3rd DOS. Significant variation was shown among cultivars. The cultivar 'Sipho' exhibited highest cob length of (14.44 cm) and the lowest (12.00 cm) by cultivar 'Khoi'. The data also revealed that the interaction among the cultivars and sowing dates were significant.

The interaction revealed that the longest cob length of (15.33 cm) was exhibited on $D_2C_2$ i.e. cultivar 'Sipho' in 2nd DOS, whereas the least (10.33 cm) was recorded on $D_1C_4$ i.e. the variety 'Khoi' sowed on 1st DOS. The data revealed that the cultivars and variety on cobs had a significant effect. Hence, it is proved from the data collected that the cultivar 'Khoi' exhibited the lowest (12.00 cm) cobs length.

***Cob diameter*** **:** To study the cobs, the cobs were collected after harvest and the cob diameter were measured. The information was collected and presented on Tables 7–8. The different date of sowing was observed to have a significant effect with regard to cob diameter. The data presented showed that the maize sowed on 1st DOS recorded a mean of (4.41cm) cob diameter followed by (4.64 cm) in 2nd DOS and (4.49 cm) in 3rd DOS. Significant variation was shown among cultivars. The cultivar 'Sipho' exhibited the

longest cob diameter (4.74 cm) and the lowest (4.26 cm) was exhibited on the variety 'Khoi'. The data revealed that the interaction among the cultivars and sowing dates were significant. The interaction revealed the longest cob diameter (4.90 cm) was observed on $D_2C_5$ i.e. variety 'HQPM-1' in 2nd DOS. Whereas the least (4.20 cm) was recorded on $D_1C_4$, which is at par with $D_3C_4$ (4.20 cm) i.e. the cultivar 'Khoi' sowed on 1st DOS and 3rd DOS, respectively.

The data revealed that the cultivars and variety on cob diameter had a significant effect. Hence, it is proved from the data collected that the cultivar 'Khoi' exhibited the lowest (4.26 cm) cob diameter. The variety 'Sipho' was the most tolerant among the different cultivars evaluated. It showed superior morphological characters and genotypic variations in comparison with other cultivars as revealed in the experiment undertaken.

***Cobs weight*** **:** The data was collected and presented on Tables 7 - 8. The different date of sowing was observed to have a significant effect with regard to cob weight. The data presented showed that the maize sowed on 1st DOS recorded a mean of 176.49 g, 214.39 g on 2nd DOS and 194.84 g on 3rd DOS. Significant variation was shown among cultivars. The cultivar 'Sipho' exhibited the highest cob weight (214.04 g) and the lowest (180.00 g) was exhibited on the cultivar 'Khoi'. The data revealed that the interaction among the cultivars and sowing dates were significant. The interaction revealed the highest cob weight (234.40 g) was observed on $D_2C_2$ i.e. cultivar 'Sipho' in 2nd DOS. Whereas the least (158.47 g) was recorded on $D_1C_4$ i.e. the cultivar 'Khoi' sowed on 1st DOS. The data revealed that the cultivars and variety on cob weight had a significant effect. Hence, it is proved from the data collected that the cultivar 'Khoi' exhibited the lowest (180.00 g) cob weight. The variety 'Sipho' was the most tolerant among the different cultivars evaluated. It showed superior morphological characters and genotypic variations in comparison with other cultivars as revealed in the experiment undertaken. Increase in plant density improve the morphological traits accordingly increased the maize yield. This is in agreement with Farnia and Meysam (2015).

***Cob yield (t/ha)*** **:** To study cob yield, the cob was collected after harvest and the cob yield were measured. The data were collected and presented on Tables 7–8. The different date of sowing was observed to have a significant effect with regard to cob yield. The data presented showed that the maize sowed on 1st DOS recorded a mean of 4.17 t/ha followed by 5.49 and 4.79 t/ha on 2nd and 3rd DOS, respectively. Significant variation was shown among cultivars. The cultivar 'Sipho' exhibited the highest cob yield (5.50 t/ha) and the lowest (4.15 t/ha) was exhibited on the cultivar 'Ronimi'. The data revealed that the interaction among the cultivars and sowing dates were significant. The interaction revealed the highest cob yield (6.23 t/ha) was observed on $D_2C_2$ i.e. cultivar 'Sipho' in 2nd DOS. Whereas the least (3.51 t/ha) was recorded on $D_1C_3$ i.e. the cultivar 'Ronimi' sowed on 1st DOS. The data revealed that the cultivars and variety on cob yield had a significant effect. Hence, it is proved from the data collected that the cultivar 'Ronimi' exhibited the lowest (4.15 t/ha) cob yield. The cultivar 'Sipho' was the most tolerant among the different cultivars evaluated.

***Grain yield (t ha$^{-1}$)*** **:** To study the grain yield (t/ha), the grain of the cob was collected after harvest and the grain weight were measured. The data were collected and presented on (Tables 7–8) The different date of sowing was observed to have a significant effect with regard to grain yield (t/ha). The data presented on 1st DOS recorded a mean of 3.13 t/ha followed by 4.12 t/ha on 2nd DOS and 3.59 t/ha on 3rd DOS. Significant variation was shown among cultivars. The cultivar 'Sipho' exhibited the highest grain yield (4.13 t/ha) and the lowest (3.11 t/ha) was exhibited on the cultivar 'Ronimi'. The data revealed that the interaction among the cultivars and sowing dates were significant. The interaction revealed the highest grain yield (4.67 t/ha) was observed on $D_2C_2$ i.e. cultivar 'Sipho' in 2nd DOS. Whereas the least (2.63 t/ha) was recorded on $D_1C_3$ i.e. the cultivar 'Ronimi' sowed on 1st DOS. The data revealed that the cultivars and variety on grain yield had a significant effect. Hence, it is proved from the data collected that the cultivar 'Ronimi' exhibited the lowest grain yield. The cultivar 'Sipho' was the most tolerant among the different cultivars evaluated.

From the above discussion it can be concluded that the late sown 2nd DOS crop i.e. sown on 21st march proved the best one as it gave the highest grain yield of 4.12 t/ha than that sown early on 1st DOS (i.e. sown during first week of March). The findings of Chaudhary and Sharma (1992) are also in accordance with the present studies. They reported that *C. partellus* infestation was maximum in the early sown crop and minimum in the late sown crop.

***Grain yield (kg/plot$^{-1}$)*** **:** The study grain yield kg/plot, the grain of the cob was collected after harvest and the grain were measured. The information were collected and presented on Tables 7 - 8) The outcomes of the results are presented below. The different date of sowing was observed to have a significant effect with regard to grain yield kg/plot. The data presented in (Table 7) showed that the maize sowed on 1st DOS recorded a total of 5.51. A total of grain yield kg/plot (7.27) was recorded on maize sown on 2nd DOS and (6.34) grain yield kg/plot was observed on maize sown on 3rd DOS.

Significant variation was shown among cultivars. The cultivar 'Sipho' exhibited the highest grain yield kg/plot (7.28) and the lowest (5.49) was exhibited on the cultivar 'Ronimi'. The data (Table 7) revealed that the interaction among the cultivars and sowing dates were significant. The interaction revealed the highest grain yield kg/plot (8.24) was observed on $D_2C_2$ i.e. cultivar 'Sipho' in 2nd DOS. Whereas the least (4.65) was recorded on $D_1C_3$ i.e. the cultivar 'Ronimi' sowed on 1st DOS (Table 8). The data revealed that the cultivars and variety on grain yield kg/plot had a significant effect. Hence, it is proved from the data collected that the cultivar 'Ronimi' exhibited the lowest (5.49) grain yield kg/plot. The cultivar 'Sipho' was the most tolerant among the different cultivars evaluated.

***Grain yield (t ha$^{-1}$)*** **:** The study grain yield (t ha), the grain of the cob was collected after harvest and the grain were measured. The information was collected and presented on Tables 7–8. The outcomes of the results are presented below. The different date of sowing was observed to have a significant effect with regard to grain yield (t ha). The data presented in (Table 7) showed that the maize sowed on 1st DOS recorded a total of 3.13. A total of grain yield (t ha), (4.12) was recorded on maize sown on 2nd DOS and (3.59) grain yield was observed on maize sown on 3rd DOS.

Significant variation was shown among cultivars. The cultivar 'Sipho' exhibited the highest grain yield (t ha), (4.13) and the lowest (3.11) was exhibited on the cultivar 'Ronimi'. The data (Table 7) revealed that the interaction among the cultivars and sowing dates were significant. The interaction revealed the highest grain yield (t ha), (4.67) was observed on $D_2C_2$ i.e., cultivar 'Sipho' in 2nd DOS. Whereas the least (2.63) was recorded on $D_1C_3$ i.e., the cultivar 'Ronimi' sowed on 1st DOS (Table 8). The data revealed that the cultivars and variety on grain yield (t ha), had a significant effect. Hence, it is proved from the data collected that the cultivar 'Ronimi' exhibited the lowest (3.11) grain yield kg/plot. The cultivar 'Sipho' was the most tolerant among the different cultivars evaluated.

From the above discussion it can be concluded that the late sown 2nd DOS crop i.e. sown on 21st march proved the best one as it showed the lower incidence of *C. partellus* and gave higher mean maize grain yield (Table 7) than that sown early on 1st DOS (i.e. sown during first week of March). The findings of Chaudhary and Sharma (1992) are also in accordance with the present studies. They reported that *C. partellus* infestation was maximum in the early sown crop (June 5 and 7) and minimum in the late sown crop (July 20 and 22).

## CONCLUSION

Maize stem borer, *Chilo partellus* Swinhoe were found major insect pests of maize. Maize sown on 1st week of April recorded the lowest infestation by stem borer. Among the local cultivars evaluated, best performance was exhibited by Sipho, which recorded minimum infestation and maximum grain yield. The result of the present field study indicates that late planting of maize is an effective tactic in reducing the infestation by maize stem borer (*Chilo partellus* Swinhoe). The potential of the local cultivars especially in hilly region of Nagaland, need further study for a more conclusive report for being used in breeding program to develop resistant or tolerant cultivars against *Chilo partellus*.

**REFERENCES**


Bamaiyi LJ, Joan OMI (2011) Management of stem borers on some quality protein maize borers. *Journal of Agricultural Sciences* 56 (3) : 197—205.

Bhandari G, Thapa RB, Giri YP, Manandar HK (2018) Effect of planting dates of maize on the incidence of borer complex in Chitwan, Nepal. *Journal of Agriculture and Forestry University* 4(1): 107—118.

Chaudhary RN, Sharma VK (1992) Incidence and abundance of maize stalk borer, *Chilo partellus* (Swinhoe) in *kharif* season. *Indian Journal of Agriculture Research* 26 : 25—29.

Casini P (2012) Maize production as affected by sowing date, plant density and row spacing in the Bolivian Amazon. *Journal of Agriculture and Environment for International Development* 106 (2) : 75—84.

Dahmardeh M (2012) Effects of sowing date on the growth and yield of maize cultivars (*Zea mays* L.) and the growth temperature requirements. *African Journal of Biotechnology* 11 (61) : 12450—12453.

Farnia M, Meysam M (2015) Study on morphological characteristics of maize (*Zea mays* L.) cultivars under different plant densities. *Indian Journal of Natural Sciences* 5: 30.

Gaurav, Khan BS (2006) Effect of date of sowing and damage caused by maize stem borer (*Chilo partellus*) (Swinhoe) in *kharif* maize in district Nawanshahr (Punjab). *Environment and Ecology* 24 (special 3A) : 920—922.

Kavita H, Manjunatha M, Adarsha S, Sharanabasappa K (2016) Management of *Chilo partellus* (Swinhoe) and *Sesamia inferens* (Walker) through different intercropping systems and organic manures in maize ecosystem. *International Journal of Agricultural Science* 8 (7) : 1053—1056.

Lansigan FP, De los Santos WI, Coladilla JO (2000) Agronomic impacts of climate variability on rice production in the Philippines Agriculture. *Ecosystems and Environment* 82 : 129—137.

Manzoor AM, Farman U, Sajjad A, Kamran S, Muhammad U, Syed FS (2015) Infestation of maize stem borer, *Chilo partellus* (Swinhoe) in maize stubbles and stalks. *Academia Journal of Agricultural Research* 3 (7) : 094—098.

Olaniyan AB (2015) Maize : Panacea for Hunger in Nigeria. *African Journal of Plant Science* 9 : 155.

Onasanya RO, Aiyelari OP, Onasanya A, Oikeh S, Nwilene FE, Oyelakin OO (2009) Growth and Yield Response of Maize (*Zea mays* L.) to Different Rates of Nitrogen and Phosphorus Fertilizers in Southern Nigeria. *World Journal of Agricultural Sciences* 5 (4) : 400—407.

Sharma PN, Thapa RB, Gautam P, Giri YP (2010) Assessment of stem borer (*Chilo partellus* Swinhoe) severity in summer, winter and spring maize. Paper presented at 26th National Summer Crops Research Workshop held at National Maize Research Program, Rampur, Chitwan, Nepal. 2: 19—21.

Yonow T, Kriticos DJ, Ota N, Berg JVD, Hutchison WD (2017) The potential global distribution of *Chilo partellus*, including consideration of irrigation and cropping patterns. *Journal of Pest Science* 90 (2) : 459—464.