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# Influence of planting ratios and micronutrients on various morphological traits in single cross maize hybrids under temperate ecologies

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## Abstract
The present study was under taken during *Kharif 2019, Rabi 2019-20, Kharif 2020 and Rabi 2020-21* at Dry Land Agriculture Research Station (DARS) Srinagar, Faculty of Agriculture Wadura and Winter Nursery Centre Hyderabad. Experimental materials comprised of two early maturing single cross maize hybrids *viz* SMH-3 (Shalimar Maize Hybrid-3) and SMH-5 (Shalimar Maize Hybrid-5). Three treatment combinations *viz*. M1: RDF (150:75:40 NPK kg/ha) + ZnSO4 10 kg/ha, M2: RDF (150:75:40 NPK kg/ha) + FeSO4 10 kg/ha and M3: RDF (150:75:40 NPK kg/ha) + 10 kg ZnSO4 + FeSO4 10 kg/ha with two maize inbreds which were allotted in main plots are female and male inbred for four planting ratios *viz*: P1: 4:1 (Female: Male), P2: 4:2 (Female: Male), P3: 5:1 (Female: Male)and P4: 6:2 (Female: Male). Five plants were tagged at random for recording various morphological traits *viz* plant height at 30, 60 and 90 Days after sowing (DAS), Days to 50 percent male tassel initiation and Days to 50 percent female silk initiation. The observations recorded from the growth parameters like plant height at 30, 60 and 90 DAS (days after sowing) did not differ significantly due to the effect of planting ratios. The application of micronutrients like zinc alone or in combination with iron initially at crop growth stage increased growth which is attributed to internode elongation and higher growth rate of stem that ultimately played a major role in increasing the plant height. Non-significant differences on male tasseling due to planting ratio and hybrid were recorded at both the locations, however, the interactions were found to differ significantly. The observations recorded on number of days to female silking in female lines showed significant difference with respect to hybrids and their interaction with planting ratios and application of micronutrients at both the locations.

**Keywords:** Planting, ratios, micronutrients, morphological, cross maize

## Introduction
Maize (*Zea mays* L., 2n=20) belongs to family *Poaceae*. The term "maize" seems to be derived from the word "mahiz" of Taino language, which became "maiz" in Spanish (Oxford dictionary 2015). Based on this Linnaeus included it as species in botanical classification of *Zea*. Among the four species of genus *Zea*, economically important species is *Zea mays* L. Maize has a very high yield potential than any other cereal and thus is popularly known as the 'queen of cereals' (Singh, 2002) [10]. The centre of origin has been entrenched as Mesoamerica, now Mexico and Central America (Watson and Dallwitz, 1992) [12]. It is an important bio-fuel and cereal crop used as a raw material for feed processing and food worldwide. Temperate regions are major maize producing areas across globe. It's important for diet of people and staple food in major countries. It possesses more than 32,000 genes, a genomic size of 2.3 gigabase and a somatic chromosome number of 20 (Schnable *et al.* 2009) [11]. It has a global importance owing to its uses as food, feed and industrial crop after wheat and rice. It is extensively grown in tropics, sub-tropics and temperate regions up to $50^0$N and S from the equator to more than 3000m above sea level under irrigated to semi-arid conditions. The maize production in world was 1147.6 million tonnes from an area of 193.73 million hectares whereas the production in India was 27.82 million tonnes from an area of 9.2 million hectares (FOA, 2018) [6]. The major maize growing states are Uttar Pradesh, West Bengal, Rajasthan, Karnataka, Andhra Pradesh, Bihar, Madhya Pradesh, Punjab, Himachal Pradesh, Jammu & Kashmir, jointly accounting for about 95% of maize production nationally. In Jammu & Kashmir maize production was 52.7 lakh quintals from an area of 3.1 lakh hectares (Anonymous, 2018) [1]. Over the years, maize has witnessed a remarkable growth with respect

to production, productivity and area. This is associated to the cultivation of stress free and high yielding single cross hybrids. In comparison to three way or double cross hybrids, synthetics or composite varieties, single cross maize hybrids have proved itself in the significant alleviation of productivity (Dass *et al*., 2009) [4]. The nutrient requirement for maize is very high as it is considered to be the exhaustive feeder of nutrients. Moreover, as compared to other nutrients, the demand of nitrogen fertilizer is considered to be greater. The deficiency of nitrogen occurring at tasseling and silking stages may significantly affect crop failure. The application of amount of nitrogen to be applied for maize plant depends upon maize variety, location, crop fertility status, soil type, and yield. Previous studies reported that days to 50% silking increased with increasing the plant population. Moreover, the date of silking was delayed as plant density increased from 55000 to 85000 plants/ha. Further it was also noticed that the time interval between anthesis and silking increased with increasing plant density. This study was also carried out to determine the effect of various levels of micronutrient application on the crop phenology.

## Materials and Method

The present study was under taken during Kharif 2019, Rabi 2019-20, Kharif 2020 and Rabi 2020-21 at Dry Land Agriculture Research Station (DARS) Srinagar, Faculty of Agriculture Wadura and Winter Nursery Centre Hyderabad. Experimental materials comprised of two early maturing single cross maize hybrids *viz* SMH-3 (Shalimar Maize Hybrid-3) and SMH-5 (Shalimar Maize Hybrid-5). These single cross hybrids where pipelines and then got released in 2022. SMH-3 (H-100) is a cross combination of KDM 116× KDM 125. It is disease resistant, semi dent, hybrid suitable for low to medium ecologies. SMH-5 or DMRH-1417 is a cross combination of IML 187× BML6. It is an early maturing abiotic stress resilient hybrid with high yield potential, and outcome of SKUAST-IIMR collaboration. The experiment was carried out by maintaining the minimum isolation distance in a Split plot design with three replications as per the plan where main plot includes different planting ratios and sub plot includes different planting dates. The seed parents of single cross hybrids SMH-3 (Shalimar Maize Hybrid-3) and SMH-5 (Shalimar Maize Hybrid-5) were sown at a spacing of 60×30 cm in female and male ratios. Three treatment combinations *viz*. M1: RDF (150:75:40 NPK kg/ha) + ZnSO4 10 kg/ha, M2: RDF (150:75:40 NPK kg/ha) + FeSO4 10 kg/ha and M3: RDF (150:75:40 NPK kg/ha) + 10 kg ZnSO4 + FeSO4 10 kg/ha with two maize in breds which were allotted in main plots are female and male inbred for four planting ratios *viz*: P1: 4:1 (Female: Male), P2: 4:2 (Female: Male), P3: 5:1 (Female: Male)and P4: 6:2 (Female: Male). Five plants were tagged at random for recording various parameters *viz* plant height at 30, 60 and 90 Days after sowing (DAS), Days to 50 percent male tassel initiation and Days to 50 percent female silk initiation.

## Results

The observations recorded for growth parameters in parental lines of single cross maize hybrids (SMH-3 and SMH-5) as influenced by planting ratios, hybrid and micronutrient application at FoA, Wadura and DARS, Rangreth locations during Kharif 2019, Rabi 2019-20, Kharif 2020 and Rabi 2020-21 are presented as:

### Growth parameters

### Plant Height

Observations recorded on plant height (cm) of parental lines of single cross maize hybrid (SMH-3) and (SMH-5) at 30, 60 and 90 days after sowing (DAS) as influenced by micronutrient application, hybrid and planting ratios are presented in Table 1, 2 and 3.

The effect of planting ratios, micronutrient application, interactions of planting ratios with hybrids (P x H), interaction of planting ratios in hybrids with micronutrient application (P x H x M) and planting ratios with micronutrient application (P x M) did not show any significant difference for plant height at 30, 60 and 90 DAS. However, the interaction of hybrids and their interaction with micronutrient application (P x M) on plant height were found to differ significantly. Among the hybrids, H2 (SMH-5) recorded the higher mean value for plant height (37.35, 138.61 and 144.13 cm) at DARS Rangeth as compared to H1 (SMH-3) (28.06, 125.16 and 121.91 cm) FoA Wadura at 30, 60 and 90 DAS, respectively.

Among the interaction of hybrids with micronutrients lower plant height was observed in H1 x M1 (SMH-3 with 20 kg $ZnSO_4$) (27.22, 124.33 and 127.47 cm) FoA at 30, 60 and 90 DAS, respectively. Whereas the interaction of hybrids with micronutrient application, H2 x M3 (SMH-5 with 10 kg ZnSO4 + 10 kg FeSO4) recorded higher plant height (40.39, 143.60 and 144.20 cm) at DARS

**Table 1:** Influence of planting ratios and micronutrients on plant height (cm) at 30 days after sowing in single cross maize hybrids (SMH-3 and SMH-5)

| Plant Height (cm) at 30 DAS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Locations** | | **FoA, Wadura** | | | | **DARS, Rangreth** | | | |
| **Micronutrients Hybrids** | | **M1** | **M2** | **M3** | **Mean** | **M1** | **M2** | **M3** | **Mean** |
| P1 | H1 | 27.91 | 29.44 | 30.04 | 29.12 | 32.51 | 35.27 | 35.73 | 34.50 |
| | H2 | 32.97 | 33.95 | 34.58 | 33.83 | 34.81 | 35.79 | 38.72 | 36.44 |
| Sub Mean | | 30.44 | 31.70 | 32.31 | 31.48 | 33.66 | 35.53 | 37.23 | 35.47 |
| P2 | H1 | 27.68 | 27.97 | 29.21 | 28.29 | 29.21 | 29.21 | 28.14 | 28.85 |
| | H2 | 31.32 | 32.76 | 34.12 | 32.73 | 33.11 | 32.56 | 34.56 | 33.41 |
| Sub Mean | | 29.50 | 30.37 | 31.67 | 30.51 | 31.16 | 30.89 | 31.35 | 31.13 |
| P3 | H1 | 27.22 | 28.2 | 28.75 | 28.06 | 29.75 | 32.05 | 32.27 | 31.36 |
| | H2 | 34.27 | 35.99 | 37.17 | 35.81 | 37.03 | 38.41 | 38.72 | 38.05 |
| Sub Mean | | 30.75 | 32.10 | 32.96 | 31.94 | 33.39 | 35.23 | 35.50 | 34.71 |
| P4 | H1 | 31.20 | 30.87 | 33.56 | 31.87 | 34.23 | 35.10 | 35.39 | 34.90 |
| | H2 | 34.41 | 34.87 | 35.99 | 35.10 | 38.87 | 40.1 | 40.39 | 39.79 |
| Sub Mean | | 32.81 | 32.87 | 34.78 | 33.49 | 36.55 | 37.60 | 37.89 | 37.35 |
| Factor Means | Micronutrients | 30.87 | 31.76 | 32.93 | | 33.69 | 34.81 | 35.49 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Hybrids | 29.34 | 34.37 | | 32.40 | 36.92 | |
| | | SE (d) | | CD (5%) | SE (d) | | CD (5%) |
| P | | 0.86 | | NS | 0.98 | | NS |
| H | | 0.63 | | 1.83 | 0.49 | | 1.42 |
| M | | 0.57 | | NS | 0.73 | | NS |
| P×H | | 1.00 | | NS | 1.26 | | NS |
| P×M | | 1.13 | | NS | 1.46 | | 4.24 |
| H×M | | 0.80 | | NS | 1.03 | | NS |
| P×H×M | | 1.61 | | NS | 2.07 | | NS |

| **Planting ratios (P)** | **Hybrids (H)** | **Micronutrients (M)** | NS: Non-Significant |
|---|---|---|---|
| P1: 4:1 P3: 5:1 | H1: SMH-3 | M1: $ZnSO_4$ 20 kg/ha + RDF | |
| P2: 4:2 P4:6:2 | H2: SMH-5 | M2: $FeSO_4$ 20 kg/ha + RDF | |
| | | M3: $ZnSO_4$ 20 kg/ha + $FeSO_4$20 kg/ha + RDF | |

**Table 2:** Influence of planting ratios and micronutrients on plant height (cm) at 60 days after sowing in single cross maize hybrids (SMH-3 and SMH-5)

| **Plant Height (cm) at 60 DAS** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Locations** | | **FoA, Wadura** | | | | **DARS, Rangreth** | | | |
| **Micronutrients Hybrids** | | **M1** | **M2** | **M3** | **Mean** | **M1** | **M2** | **M3** | **Mean** |
| P1 | H1 | 124.67 | 125.73 | 126.07 | 125.87 | 125.67 | 125.87 | 128.20 | 126.20 |
| | H2 | 135.80 | 137.47 | 137.60 | 136.96 | 134.47 | 137.47 | 141.07 | 137.73 |
| Sub Mean | | 130.23 | 131.60 | 131.83 | 131.41 | 130.07 | 131.67 | 134.63 | 131.96 |
| P2 | H1 | 124.33 | 124.40 | 125.60 | 125.16 | 124.87 | 125.27 | 126.73 | 125.24 |
| | H2 | 132.23 | 134.43 | 135.40 | 134.02 | 133.24 | 133.89 | 135.90 | 134.34 |
| Sub Mean | | 128.33 | 129.41 | 130.50 | 129.59 | 129.05 | 129.58 | 131.31 | 129.79 |
| P3 | H1 | 128.07 | 128.80 | 129.00 | 128.52 | 130.73 | 131.47 | 132.80 | 131.67 |
| | H2 | 139.53 | 141.20 | 141.47 | 140.73 | 142.80 | 143.47 | 143.60 | 143.29 |
| Sub Mean | | 133.80 | 135.00 | 135.23 | 134.62 | 136.76 | 137.47 | 138.20 | 137.48 |
| P4 | H1 | 132.43 | 130.70 | 133.00 | 132.04 | 134.09 | 134.35 | 135.89 | 134.77 |
| | H2 | 139.73 | 140.40 | 141.47 | 140.53 | 141.73 | 142.47 | 143.20 | 142.46 |
| Sub Mean | | 136.08 | 135.55 | 137.23 | 136.28 | 137.91 | 138.41 | 139.54 | 138.61 |
| Factor Means | Micronutrients | 132.11 | 132.89 | 133.70 | | 133.44 | 134.28 | 135.92 | |
| | Hybrids | 127.89 | 138.06 | | | 129.47 | 139.45 | | |
| | | SE (d) | | CD (5%) | | SE (d) | | CD (5%) | |
| P | | 0.88 | | NS | | 1.41 | | NS | |
| H | | 0.88 | | 2.57 | | 1.37 | | 3.98 | |
| M | | 1.25 | | NS | | 1.45 | | 4.23 | |
| P×H | | 1.73 | | NS | | 2.72 | | NS | |
| P×M | | 2.48 | | NS | | 2.88 | | NS | |
| H×M | | 1.76 | | 5.13 | | 2.04 | | NS | |
| P×H×M | | 3.5 | | NS | | 4.07 | | NS | |

| **Planting ratios (P)** | **Hybrids (H)** | **Micronutrients (M)** | **NS:** Non-Significant |
|---|---|---|---|
| P1: 4:1 P3: 5:1 | H1: SMH-3 | M1: $ZnSO_4$ 20 kg/ha + RDF | |
| P2: 4:2 P4:6:2 | H2: SMH-5 | M2: $FeSO_4$ 20 kg/ha + RDF | |
| | | M3: $ZnSO_4$ 20 kg/ha + $FeSO_4$20 kg/ha + RDF | |

**Table 3:** Influence of planting ratios and micronutrients on plant height (cm) at 90 days after sowing in single cross maize hybrids (SMH-3 and SMH-5)

| **Plant Height (cm) at 90 DAS** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Locations** | | **FoA, Wadura** | | | | **DARS, Rangreth** | | | |
| **Micronutrients Hybrids** | | **M1** | **M2** | **M3** | **Mean** | **M1** | **M2** | **M3** | **Mean** |
| P1 | H1 | 127.47 | 128.00 | 128.27 | 121.91 | 127.2 | 128.13 | 132.53 | 129.29 |
| | H2 | 137.13 | 138.8 | 139.4 | 138.44 | 138 | 135.47 | 141.87 | 138.44 |
| Sub Mean | | 132.29 | 133.40 | 133.98 | 130.17 | 132.60 | 131.80 | 137.20 | 133.86 |
| P2 | H1 | 127.6 | 127.6 | 127.87 | 127.69 | 127.3 | 128.8 | 129.8 | 128.6 |
| | H2 | 136.78 | 136.90 | 137.67 | 137.11 | 137.09 | 138.56 | 140.09 | 138.58 |
| Sub Mean | | 132.19 | 132.25 | 132.77 | 132.40 | 132.19 | 133.68 | 134.94 | 133.59 |
| P3 | H1 | 129.87 | 130.07 | 130.07 | 130.00 | 131.47 | 132.33 | 133.67 | 132.49 |
| | H2 | 141.07 | 142.73 | 142.67 | 142.16 | 146.13 | 143.27 | 143.00 | 144.13 |
| Sub Mean | | 135.47 | 136.40 | 136.37 | 136.08 | 138.80 | 137.80 | 138.33 | 138.31 |
| P4 | H1 | 133.20 | 135.67 | 135.89 | 134.92 | 136.45 | 136.09 | 137.67 | 136.73 |
| | H2 | 140.87 | 141.93 | 142.6 | 141.8 | 143.73 | 143.27 | 144.2 | 143.73 |
| Sub Mean | | 137.03 | 138.80 | 139.24 | 138.36 | 140.09 | 139.68 | 140.93 | 140.23 |
| Factor Means | Micronutrients | 134.24 | 135.21 | 135.56 | | 135.92 | 135.74 | 137.85 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Hybrids | 129.38 | 139.87 | | | 131.77 | 141.22 | | |
| | | SE (d) | | CD (5%) | | SE (d) | | CD (5%) | |
| P | | 0.90 | | NS | | 1.28 | | NS | |
| H | | 0.70 | | 2.03 | | 1.42 | | 4.13 | |
| M | | 1.15 | | NS | | 1.37 | | 3.98 | |
| P×H | | 1.36 | | NS | | 2.82 | | NS | |
| P×M | | 2.27 | | NS | | 2.72 | | 7.94 | |
| H×M | | 1.61 | | 4.68 | | 1.93 | | NS | |
| P×H×M | | 3.19 | | NS | | 3.82 | | NS | |

| **Planting ratios (P)** | **Hybrids (H)** | **Micronutrients (M)** | NS: Non-Significant |
|---|---|---|---|
| P1: 4:1 P3: 5:1 | H1: SMH-3 | M1: $ZnSO_4$ 20 kg/ha+RDF | |
| P2: 4:2 P4:6:2 | H2: SMH-5 | M2: $FeSO_4$ 20 kg/ha+RDF | |
| | | M3: $ZnSO_4$ 20 kg/ha + $FeSO_4$20 kg/ha+RDF | |

**Days to 50 percent male tassel initiation**

The results on Days to 50 percent male tassel initiation of parental lines of single cross maize hybrid (SMH-3) and (SMH-5) as influenced by planting ratio, hybrid and micronutrient application are presented in Table 4

Observations recorded on 50 percent male tassel initiation were found to be non-significant for planting ratios at both locations however significant difference were observed with respect to interaction. The effect of planting ratios, micronutrient application, interactions of planting ratios with micronutrient application (P x M) and planting ratios with hybrids (P x H) differed significantly for Days to 50 percent male tassel initiation. Whereas, among hybrids and their interaction with micronutrient application (P x M) on days to 50 percent male tassel initiation didnot show significant differences. Between the hybrids, H2 (SMH-5) recorded the higher mean value for days to 50 percent male tassel initiation (70.55 days) at DARS Rangeth as compared to H1 (SMH-3) (66.66 days) at FoA Wadura.

Among the interaction of hybrids with micronutrient application, lowest value was observed in H1 x M1 (SMH-3 with 20 kg $ZnSO_4$) (66.00 days) FoA whereas, H2 x M3 (SMH-5 with 10 kg $ZnSO_4$ + 10 kg $FeSO_4$) recorded highest days to 50 percent male tassel initiation (71.33 days) at DARS.

**Table 4:** Influence of planting ratios and micronutrients on 50% male tassel initiation in single cross maize hybrids (SMH-3 and SMH-5)

| **Days to 50 percent male tassel initiation** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Locations** | | **FoA, Wadura** | | | | **DARS, Rangreth** | | | |
| **Micronutrients Hybrids** | | **M1** | **M2** | **M3** | **Mean** | **M1** | **M2** | **M3** | **Mean** |
| P1 | H1 | 67.00 | 67.00 | 68.00 | 67.33 | 67.00 | 69.00 | 70.00 | 68.66 |
| | H2 | 65.00 | 68.00 | 68.00 | 67.00 | 69.00 | 70.00 | 70.00 | 69.66 |
| Sub Mean | | 66.00 | 67.50 | 68.00 | 67.16 | 68.00 | 69.50 | 70.00 | 69.16 |
| P2 | H1 | 66.00 | 67.00 | 67.00 | 66.66 | 68.00 | 68.00 | 69.00 | 68.33 |
| | H2 | 67.33 | 67.00 | 68.00 | 67.44 | 69.00 | 69.00 | 69.00 | 69.00 |
| Sub Mean | | 66.66 | 67.00 | 67.50 | 67.05 | 68.50 | 68.50 | 69.00 | 68.66 |
| P3 | H1 | 66.00 | 67.00 | 67.00 | 66.66 | 68.00 | 69.00 | 69.00 | 68.66 |
| | H2 | 67.00 | 67.00 | 67.00 | 67.00 | 70.00 | 70.00 | 71.00 | 70.33 |
| Sub Mean | | 66.50 | 67.00 | 67.00 | 66.83 | 69.00 | 69.50 | 70.00 | 69.49 |
| P4 | H1 | 66.00 | 67.00 | 67.00 | 66.66 | 70.00 | 71.00 | 70.00 | 70.33 |
| | H2 | 67.33 | 68.00 | 68.00 | 67.77 | 69.33 | 71.00 | 71.33 | 70.55 |
| Sub Mean | | 66.66 | 67.50 | 67.60 | 67.21 | 69.66 | 71.00 | 70.66 | 70.44 |
| Factor Means | Micronutrients | 66.45 | 67.25 | 67.50 | | 68.79 | 69.62 | 69.91 | |
| | Hybrids | 66.82 | 67.30 | | | 68.99 | 69.88 | | |
| | | SE (d) | | CD (5%) | | SE (d) | | CD (5%) | |
| P | | 0.48 | | 1.40 | | 0.26 | | NS | |
| H | | 0.45 | | NS | | 0.09 | | NS | |
| M | | 0.28 | | NS | | 0.24 | | NS | |
| P×H | | 0.63 | | NS | | 0.19 | | 0.55 | |
| P×M | | 0.55 | | NS | | 0.46 | | 1.33 | |
| H×M | | 0.38 | | NS | | 0.33 | | NS | |
| P×H×M | | 0.74 | | NS | | 0.86 | | NS | |

| **Planting ratios (P)** | **Hybrids (H)** | **Micronutrients (M)** | NS: Non-Significant |
|---|---|---|---|
| P1: 4:1 P3: 5:1 | H1: SMH-3 | M1: $ZnSO_4$ 20 kg/ha+RDF | |
| P2: 4:2 P4:6:2 | H2: SMH-5 | M2: $FeSO_4$ 20 kg/ha+RDF | |
| | | M3: $ZnSO_4$ 20 kg/ha + $FeSO_4$20 kg/ha+RDF | |

**Days to 50 percent female silk initiation**

The results on Days to 50 percent female silk initiation of parental lines of single cross maize hybrid (SMH-3) and (SMH-5) as influenced by micronutrient application, planting ratio and hybrid are presented in Table 5

Observations recorded on 50 percent female silk initiation showed significant difference due to hybrids and interaction of planting ratios and micronutrient application at both the

locations. However, non-significant difference was found on female silking with respect to planting ratios at both the locations. Between the hybrids, H2 (SMH-5) recorded the higher mean value for days to 50 percent female silk initiation (73.63 days) at DARS Rangeth as compared to H1 (SMH-3) (66.66 days) at FoA Wadura.

Among the interaction of hybrids with micronutrient application, lowest value was observed in H1 x M1 (SMH-3 with 20 kg $ZnSO_4$) (66.00 days) FoA. As compared to H2 x M3 (SMH-5 with 10 kg $ZnSO_4$ + 10 kg $FeSO_4$) that recorded highest days to 50 percent female silk initiation (73.00 days) at DARS.

**Table 5:** Influence of planting ratios and micronutrients on 50% female silk initiation in single cross maize hybrids (SMH-3 and SMH-5).

| Days to 50 percent female silk initiation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Locations** | | **FoA, Wadura** | | | | **DARS, Rangreth** | | | |
| **Micronutrients Hybrids** | | **M1** | M2 | M3 | Mean | M1 | M2 | M3 | Mean |
| P1 | H1 | 66.00 | 67.00 | 67.00 | 66.66 | 68.00 | 69.00 | 68.00 | 68.33 |
| | H2 | 70.00 | 71.00 | 70.00 | 70.33 | 70.00 | 71.00 | 70.00 | 70.33 |
| Sub Mean | | 68.00 | 69.00 | 68.50 | 68.49 | 69.00 | 70.00 | 69.00 | 69.33 |
| P2 | H1 | 69.00 | 69.00 | 70.00 | 69.33 | 69.00 | 68.00 | 69.00 | 68.66 |
| | H2 | 67.00 | 68.33 | 67.33 | 67.55 | 70.00 | 69.00 | 71.00 | 69.66 |
| Sub Mean | | 68.00 | 68.66 | 68.66 | 68.44 | 69.50 | 68.50 | 70.00 | 69.16 |
| P3 | H1 | 70.00 | 70.00 | 71.00 | 70.33 | 68.00 | 70.00 | 69.00 | 69.00 |
| | H2 | 71.00 | 71.00 | 71.00 | 71.00 | 70.00 | 71.00 | 71.00 | 70.66 |
| Sub Mean | | 70.50 | 70.50 | 71.00 | 70.66 | 69.00 | 70.50 | 70.00 | 69.83 |
| P4 | H1 | 70.13 | 70.76 | 69.89 | 70.26 | 71.90 | 70.00 | 71.00 | 70.96 |
| | H2 | 72.67 | 73.67 | 72.67 | 73.00 | 74.90 | 73.00 | 73.00 | 73.63 |
| Sub Mean | | 71.40 | 72.21 | 71.28 | 71.63 | 73.40 | 71.50 | 72.00 | 72.29 |
| Factor Means | Micronutrients | 69.47 | 70.09 | 69.86 | | 70.22 | 70.12 | 70.25 | |
| | Hybrids | 69.14 | 70.47 | | | 69.23 | 71.07 | | |
| | | SE (d) | | CD (5%) | | SE (d) | | CD (5%) | |
| P | | 0.12 | | NS | | 0.44 | | NS | |
| H | | 0.18 | | NS | | 0.53 | | 1.54 | |
| M | | 0.22 | | NS | | 0.27 | | NS | |
| P×H | | 0.33 | | NS | | 1.03 | | NS | |
| P×M | | 0.38 | | NS | | 0.49 | | 1.43 | |
| H×M | | 0.28 | | NS | | 0.38 | | NS | |
| P×H×M | | 0.52 | | NS | | 0.69 | | NS | |

| **Planting ratios (P)** | **Hybrids (H)** | **Micronutrients (M)** | NS: Non-Significant |
|---|---|---|---|
| P1: 4:1 P3: 5:1 | H1: SMH-3 | M1: $ZnSO_4$ 20 kg/ha + RDF | |
| P2: 4:2 P4:6:2 | H2: SMH-5 | M2: $FeSO_4$ 20 kg/ha + RDF | |
| | | M3: $ZnSO_4$ 20 kg/ha + $FeSO_4$20 kg/ha + RDF | |

## Discussion

The recorded observations from the growth parameters like plant height at 30, 60 and 90 DAS (days after sowing) did not differ significantly due to the effect of planting ratios as no treatment can affect the genetic characters of a crop as reported in sorghum by Veeranagoudar (1999) [13]. The application of micronutrients like zinc alone or in combination with iron initially at crop growth stage increased growth which is attributed to internode elongation and higher growth rate of stem that ultimately played a major role in increasing the plant height. Whereas the difference in plant height between parental lines can be attributed to influence of genetic factor due to growing conditions., Similar results were reported by Ravi *et al.*, 2008 [9] in safflower, Gajendra Khidrapure, 2012 [5] in maize; Patil, 1979 [8]; Anon., 1986; Arya and Singh, 2000 [3] who recorded the increase in plant height was found due to combined application of micronutrients. Non-significant differences on male tasseling due to planting ratio and hybrid were recorded at both the locations, however, the interactions were found to differ significantly. The observations recorded on number of days to female silking in female lines showed significant difference with respect to hybrids and their interaction with planting ratios and application of micronutrients at both the locations.

The genotypic variation and their interaction with the environment is considered to be responsible for the variation in days to 50 percent silking and tasseling between the female and male parental lines. The genotypic difference in flowering may further be due to the difference in flower initiation which is in turn is affected by environmental factors like photoperiod, relative humidity, temperature, and interaction between them. Moreover, the variation in the days to 50 percent flowering between the female and male parents was also reported in PVK hy-5 (Anon., 2001) and by Krishnadoss *et al.* (1994) [7] in TCHB-213 hybrid cotton.

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