

Effect of Staggered Sowing and Micronutrient Application on Floral Synchronization, Seed Yield in Maize (*Zea mays* L.)

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Abstract

This study evaluated the effects of staggered sowing and micronutrient applications on two single-cross maize hybrids, NAH-2049 and NAH-1137, across two field locations: NSP, GKVK and ZARS, V. C. Farm, Mandya. Experimental results revealed significant variations among hybrids, staggered sowing and micronutrient application. Sowing of male parent by two days late than female parent in NAH-2049 (34.20 and 36.30q/ha) and 2 days early sowing of male parent in NAH-1137 (59.97 and 59.96q/ha) showed significantly higher seed yields at GKVK and Mandya, respectively. Overall, hybrid NAH-1137 consistently outperformed NAH-2049. Among micronutrient application, soil application of 10 kg ZnSO₄ + 10 kg FeSO₄ per hectare significantly enhanced seed yield parameters compared to individual applications. These findings demonstrate that adjusting parental sowing combined with balanced zinc and iron fertilization effectively synchronizes flowering, leading to maximized hybrid seed yields in maize.

Key words: Staggered sowing, Micronutrient, Synchronization, Parental lines, Seed yield

Maize or corn (*Zea mays* L. 2n=20) belongs to the tribe Maydeae of grass family *Poaceae*. “*Zea*” (zela) was derived from an old Greek name for a fodder grass. The genus *Zea* consists of four species of which *Zea mays* L. is economically important. The Centre of origin for *Zea mays* has been established as the Mesoamerican region, now Mexico and Central America [12]. It is an important cereal crop used as a raw material for food and feed processing and recently worldwide as bio-fuel. The major maize production areas are located in temperate regions of the globe. In many countries, it is the basic staple food and an important ingredient in the diet of people. Worldwide, it has been estimated that approximately 17 per cent of the total grain produced is consumed as food. India ranked as the 5th largest producer of Maize in the world in 2024, with a production of 43.41million tonnes from an area of 12.09 million hectares and productivity of 3.59 tonnes per ha [1]. It is the third most important cereal in India after wheat and rice.

The major maize growing states are Madhya Pradesh, Karnataka, Bihar, Maharashtra, Telangana, West Bengal, Rajasthan, Tamil Nadu, Andhra Pradesh and Uttar Pradesh jointly accounting for over 95 per cent of the national maize production. The maize production in 2024-25 was 6.19 million tonnes from an area of 1.91 million hectares with an average productivity of 3.23 tonnes per hectare [1]. Though, the area under maize has shown an increasing trend, with maize emerging as a competitive crop, the level of production has substantially risen to meet the growing demand for supply of quality seed. Seed yield is the most important and complex trait. The salient components of maize seed yield are number of ears,

seed rows, seeds per row, test-weight and shelling percentage. Efforts have also been made to undertake breeding of high yielding corn hybrids which are stable across locations for both wet (*kharif*) and dry (*rabi*) seasons. In the hybrid seed production, seed yield and quality attributes can be increased through proper synchronization of flowering of parental lines. Synchronization in flowering between the parents in hybrid seed production is indispensable to encourage optimum seed setting and desired seed yield. Under such situation, the flowering time of the parental lines need to be manipulated. When the difference in flowering of parents is more than trivial, the only alternative is to adopt staggered planting. This has been in practice since the release of hybrids [5]. Staggered planting, is being practiced widely by the farmers in many hybrids of different crop plants to achieve proper synchronization of flowering of male and female parents. Keeping these points in view, an investigation was carried out with an objective to know the Effect of staggered sowing and micronutrient application on floral synchronization and seed yield in maize (*Zea mays* L.).

MATERIALS AND METHODS

The experiment was conducted at the experimental blocks of National Seed Project, Gandhi Krishi Vigyan Kendra, University of Agricultural Sciences, Bengaluru and G block of Zonal Agricultural Research Station, V. C. Farm, Mandya. The experiment consisted of eighteen treatment combinations with three factors *viz.* Hybrid (H): H₁: NAH-2049 and H₂: NAH-1137, Staggered sowing (S):S₁: Sowing female and male parent simultaneously, S₂:Sowing of 40 % male parent seeds 2 days

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after sowing of 100 % female + 60 % male parent in NAH-2049 and sowing of 40 % male parent seeds 2 days before sowing of 100 % female + 60 % male parent in NAH-1137, S₃: Sowing of 50 % male parent seeds 4 days after sowing of 100 % female + 50 % male parent in NAH-2049 and sowing of 50 % male parent seeds 4 days before sowing of 100 % female + 50 % male parent in NAH-1137 and Micronutrient (M): M₁:RDF (150:75:40 NPK kg/ha) + ZnSO₄ 10 kg/ha, M₂:RDF (150:75:40 NPK kg/ha) + FeSO₄ 10 kg/ha, M₃: RDF (150:75:40 NPK kg/ha) + 10kg ZnSO₄ + FeSO₄ 10kg/ha. The recommended fertilizer dose (RDF) of 150:75:40 kg NPK per ha were applied to the crop. Out of this, 75 kg N and entire P and K along with micronutrients as per the treatments were applied as basal dose at the time of sowing and the remaining quantity of N was applied at grand growth stage. The observations were recorded on growth and seed yield parameters such as days to 50 per cent tasseling, days to 50 per cent silking, number of seeds per row, number of seed rows per cob, seed yield per plant, seed yield per hectare, shelling percentage, seed recovery percentage. The data collected from experiments were analyzed statistically by the procedure prescribed by Sundarajan *et al.* [7]. Critical difference was calculated at 5 per cent level wherever 'F' test was significant. The data on percentage of germination was transferred into Arc Sine values and transferred data was used for statistical analysis.

RESULTS AND DISCUSSION

Plant growth parameter

Significant differences were observed for days to 50 per cent flowering due to staggered sowings irrespective of soil application of micronutrients (Table 1). Among staggered

sowings, S₃ (4 days staggered sowing) took more number of days to 50 per cent tasseling (59.22) and less number of days to 50 per cent tasseling (57.00) were noticed in S₁ (Sowing female and male parent simultaneously) at Mandya. However, at GKVK, it was found non-significant difference. Amongst the staggered sowings, sowing female and male parent same day (S₁) took less number of days to 50 per cent female silking (58.94) and more number of days to 50 per cent female silking (61.00) at Mandya, which was recorded in S₃ (4 days staggered sowing). The differential staggering of male parent (late flowering parent) for three days has delayed flowering and thus improved synchrony and is in accordance with studies of Vinutha (2014) in maize [11]. Between the hybrids, H₁ (NAH-2049) was recorded with the more number of days to 50 per cent silking (58.93) and less number of days to 50 per cent (57.85) female silking was recorded in H₂ (NAH-1137) at GKVK. Whereas, at the Mandya location, a non-significant difference was observed in 50 per cent female silking. Among the interactions, S₃ × H₂ (sowing of 40% male parent seeds 4 days before the sowing of 100% female + 60% male parent in NAH-1137) recorded more number of days to 50 per cent male tasseling (60.33) and less number of days to 50 per cent male tasseling (56.67) were recorded for S₁ × H₂ (Sowing female and male parent simultaneously in NAH-1137 hybrid) at Mandya. While at GKVK it was non-significant. Among the interactions, S₁ × H₂ (Sowing female and male parent simultaneously in NAH-1137 hybrid) recorded less number of days to 50 per cent silking (56.11 and 57.56) at GKVK and Mandya, respectively. More number of days to 50 per cent silking (59.22 and 62.56) was recorded for S₃ × H₂ (sowing of 40% male parent seeds 4 days before the sowing of 100% female + 60% male parent in NAH-1137) at GKVK and Mandya, respectively.

Table 1 Effect of staggered sowing and micronutrient application on days to 50 per cent male and female tasseling of single cross maize hybrids

Cross maize hybrids																	
Treatment		Days to 50% male tasseling								Days to 50% female silking							
		GKVK				Mandya				GKVK				Mandya			
		M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	H ₁	57.00	57.33	56.67	57.00	57.67	56.33	58.00	57.33	58.33	60.00	58.67	59.00	60.00	60.33	60.67	60.33
	H ₂	56.33	57.67	56.33	56.78	56.67	56.67	56.67	56.67	56.00	56.00	56.33	56.11	57.33	57.00	58.33	57.56
S ₂	H ₁	57.67	58.00	57.67	57.78	57.67	57.33	57.00	57.33	58.00	59.67	58.33	58.67	60.00	60.33	60.00	60.11
	H ₂	57.00	58.33	57.67	57.67	55.67	58.00	57.33	57.00	58.00	58.33	58.33	58.22	60.67	59.67	59.33	59.89
S ₃	H ₁	56.67	58.00	57.33	57.33	57.67	58.00	58.67	58.11	59.33	59.33	58.67	59.11	59.67	59.33	59.33	59.44
	H ₂	57.33	59.00	58.00	58.11	59.33	61.00	60.67	60.33	59.00	59.67	59.00	59.22	61.67	61.67	64.33	62.56
S × M		S × M				S × M				S × M				S × M			
S ₁		56.67	57.50	56.50	56.89	57.17	56.50	57.33	57.00	57.17	58.00	57.50	57.56	58.67	58.67	59.50	58.94
S ₂		57.33	58.17	57.67	57.72	56.67	57.67	57.17	57.17	58.00	59.00	58.33	58.44	60.33	60.00	59.67	60.00
S ₃		57.00	58.50	57.67	57.72	58.50	59.50	59.67	59.22	59.17	59.50	58.83	59.17	60.67	60.50	61.83	61.00
H × M		H × M				H × M				H × M				H × M			
H ₁		57.11	57.78	57.22	57.37	57.67	57.22	57.89	57.59	58.56	59.67	58.56	58.93	59.89	60.00	60.00	59.96
H ₂		56.89	58.33	57.33	57.52	57.22	58.56	58.22	58.00	57.67	58.00	57.89	57.85	59.89	59.44	60.67	60.00
Mean		57.00	58.06	57.28	57.44	57.44	57.89	58.06	57.80	58.11	58.83	58.22	58.39	59.89	59.72	60.33	59.98
S.Em±		CD (P=0.05)		CV (%)	S.Em±	CD (P=0.05)		CV (%)	S.Em±	CD (P=0.05)		CV (%)	S.Em±	CD (P=0.05)		CV (%)	
S		0.67	NS		0.14	0.55			0.38	NS			0.13	0.53			
H		0.41	NS		0.24	NS			0.16	0.57			0.26	NS			
M		0.57	NS		0.44	NS			0.60	NS			0.52	NS			
S × H		0.71	NS		4.20	0.41	1.42	3.21	0.28	0.98		4.34	0.46	1.59	3.67		
S × M		0.99	NS			0.76	NS			1.04	NS			0.90	NS		
H × M		0.81	NS			0.62	NS			0.85	NS			0.73	NS		
S × H × M		1.39	NS			1.07	NS			1.46	NS			1.27	NS		

S₁ : Sowing female and male parent simultaneously
S₂ : Sowing of 40% male parent seeds 2 days after the sowing of 100% female+60% male parent in NAH-2049 and sowing of 40% male parent seeds 2 days before the sowing of 100% female+60% male parent in NAH-1137
S₃ : Sowing of 50% male parent seeds 4 days after the sowing of 100% female+50% male parent in NAH-2049 and sowing of 50% male parent seeds 4 days before the sowing of 100% female+50% male parent in NAH-1137

H₁ : NAH-2049
H₂ : NAH-1137
NS : Non-Significant
M₁ : RDF + ZnSO₄ 10 kg/ha
M₂ : RDF + FeSO₄ 10 kg/ha
M₃ : RDF + ZnSO₄ 10 kg + FeSO₄ 10 kg/ha

Table 2 Effect of staggered sowing and micronutrient application on number of seeds per row and number of seeds per cob of single cross maize hybrids

Treatment		Number of seeds per row								Number of seeds per cob							
		GKVK				Mandya				GKVK				Mandya			
		M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	H ₁	23.00	22.27	23.53	22.93	21.20	20.07	21.80	21.02	239.20	222.67	241.41	234.43	219.11	207.80	242.62	223.18
	H ₂	32.53	28.80	33.80	31.71	34.60	31.13	33.27	33.00	424.56	387.71	441.79	418.02	445.16	427.24	443.59	438.67
S ₂	H ₁	26.07	25.27	27.47	26.27	23.60	23.87	24.87	24.11	274.51	262.67	303.87	280.35	258.48	244.95	290.70	264.71
	H ₂	34.00	33.00	35.27	34.09	34.40	32.67	34.73	33.93	439.20	417.60	474.48	443.76	476.48	443.77	471.82	464.02
S ₃	H ₁	25.40	25.40	27.20	26.00	24.47	24.40	25.13	24.67	264.05	260.88	297.92	274.28	264.73	246.78	279.52	263.68
	H ₂	32.47	32.20	33.87	32.84	37.20	35.13	37.47	36.60	408.00	430.16	439.28	425.81	490.25	467.16	517.28	491.56
S × M		S × M				S × M				S × M				S × M			
S ₁		27.77	25.53	28.67	27.32	27.90	25.60	27.53	27.01	331.88	305.19	341.60	326.22	332.14	317.52	343.11	330.92
S ₂		30.03	29.13	31.37	30.18	29.00	28.27	29.80	29.02	356.85	340.13	389.17	362.05	367.48	344.36	381.26	364.37
S ₃		28.93	28.80	30.53	29.42	30.83	29.77	31.30	30.63	336.03	345.52	368.60	350.05	377.49	356.97	398.40	377.62
H × M		H × M				H × M				H × M				H × M			
H ₁		24.82	24.31	26.07	25.07	23.09	22.78	23.93	23.27	259.25	248.74	281.07	263.02	247.44	233.18	270.95	250.52
H ₂		33.00	31.33	34.31	32.88	35.40	32.98	35.16	34.51	423.92	411.82	451.85	429.20	470.63	446.06	477.56	464.75
Mean		28.91	27.82	30.19	28.97	29.24	27.88	29.54	28.89	341.59	330.28	366.46	346.11	359.04	339.62	374.26	357.64
		S.Em±	CD (P=0.05)	CV (%)	S.Em±	CD (P=0.05)	CV (%)	S.Em±	CD (P=0.05)	CV (%)	S.Em±	CD (P=0.05)	CV (%)	S.Em±	CD (P=0.05)	CV (%)	
S		0.41	1.59		0.48	1.90		3.14	12.34		7.75	30.45					
H		0.37	1.27		0.36	1.26		6.03	20.87		4.80	16.61					
M		0.64	1.86		0.51	NS		8.52	24.87		4.44	12.95					
S × H		0.64	NS	9.34	0.63	NS	7.55	10.44	NS	10.45	8.32	NS	5.26				
S × M		1.11	NS		0.89	NS		14.76	NS		7.68	NS					
H × M		0.90	NS		0.73	NS		12.05	NS		6.27	NS					
S × H × M		1.56	NS		1.26	NS		20.87	NS		10.87	NS					

S₁ : Sowing female and male parent simultaneously
S₂ : Sowing of 40% male parent seeds 2 days after the sowing of 100% female+60% male parent in NAH-2049 and sowing of 40% male parent seeds 2 days before the sowing of 100% female+60% male parent in NAH-1137
S₃ : Sowing of 50% male parent seeds 4 days after the sowing of 100% female+50% male parent in NAH-2049 and sowing of 50% male parent seeds 4 days before the sowing of 100% female+50% male parent in NAH-1137

H₁ : NAH-2049
H₂ : NAH-1137
NS : Non-Significant

M₁ : RDF + ZnSO₄ 10 kg/ha
M₂ : RDF + FeSO₄ 10 kg/ha
M₃ : RDF + ZnSO₄ 10 kg + FeSO₄ 10 kg/ha

Table 3 Effect of staggered sowing and micronutrient application on seed yield per plant (g) and Seed yield (q/ha) of single cross maize hybrids

Treatment		Seed yield (g/plant)								Seed yield (q/ha)							
		GKVK				Mandya				GKVK				Mandya			
		M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	H ₁	79.47	74.93	80.00	78.13	77.00	85.93	80.53	81.16	30.68	27.40	30.73	29.60	31.08	33.20	29.78	31.35
	H ₂	133.68	121.20	128.47	127.78	109.60	120.27	112.20	114.02	51.19	46.33	49.27	48.93	43.67	45.60	44.06	44.44
S ₂	H ₁	89.27	78.73	90.93	86.31	78.33	104.47	91.87	91.56	34.76	33.28	34.55	34.20	32.12	40.10	36.67	36.30
	H ₂	150.13	140.77	157.47	149.46	164.13	142.93	136.93	148.00	59.25	57.48	63.18	59.97	66.87	60.86	52.15	59.96
S ₃	H ₁	88.27	86.20	94.40	89.62	95.07	95.53	85.67	92.09	32.44	33.14	36.29	33.96	33.40	35.25	31.83	33.49
	H ₂	125.27	119.60	120.00	121.62	135.80	131.80	171.27	146.29	49.76	49.57	49.52	49.62	53.67	50.31	72.57	58.85
S × M		S × M				S × M				S × M				S × M			
S ₁		106.58	98.07	104.23	102.96	93.30	103.10	96.37	97.59	40.93	36.87	40.00	39.27	37.38	39.40	36.92	37.90
S ₂		119.70	109.75	124.20	117.88	121.23	123.70	114.40	119.78	47.01	45.38	48.86	47.08	49.49	50.48	44.41	48.13
S ₃		106.77	102.90	107.20	105.62	115.43	113.67	128.47	119.19	41.10	41.35	42.91	41.79	43.54	42.78	52.20	46.17
H × M		H × M				H × M				H × M				H × M			
H ₁		85.67	79.96	88.44	84.69	83.47	95.31	86.02	88.27	32.63	31.27	33.86	32.59	32.20	36.18	32.76	33.71
H ₂		136.36	127.19	135.31	132.95	136.51	131.67	140.13	136.10	53.40	51.13	53.99	52.84	54.74	52.26	56.26	54.42
Mean		111.01	103.57	111.88	108.82	109.99	113.49	113.08	112.19	43.01	41.20	43.92	42.71	43.47	44.22	44.51	44.07
		S.Em±	CD (P=0.05)	CV (%)	S.Em±	CD (P=0.05)	CV (%)	S.Em±	CD (P=0.05)	CV (%)	S.Em±	CD (P=0.05)	CV (%)	S.Em±	CD (P=0.05)	CV (%)	
S		2.73	10.71		2.54	9.96		1.51	5.94		1.72	6.74					
H		2.78	9.63		3.60	12.45		1.55	5.35		2.12	7.35					
M		2.82	NS		3.28	NS		1.38	NS		1.65	NS					
S × H		4.82	16.68	11.01	6.23	NS	12.41	2.68	NS	13.76	3.68	NS	15.92				
S × M		4.89	NS		5.68	NS		2.40	NS		2.86	NS					
H × M		4.00	NS		4.64	NS		1.96	NS		2.34	NS					
S × H × M		6.92	NS		8.04	23.46		3.39	NS		4.05	11.82					

S₁ : Sowing female and male parent simultaneously
S₂ : Sowing of 40% male parent seeds 2 days after the sowing of 100% female+60% male parent in NAH-2049 and sowing of 40% male parent seeds 2 days before the sowing of 100% female+60% male parent in NAH-1137
S₃ : Sowing of 50% male parent seeds 4 days after the sowing of 100% female+50% male parent in NAH-2049 and sowing of 50% male parent seeds 4 days before the sowing of 100% female+50% male parent in NAH-1137

H₁ : NAH-2049
H₂ : NAH-1137
NS : Non-Significant

M₁ : RDF + ZnSO₄ 10 kg/ha
M₂ : RDF + FeSO₄ 10 kg/ha
M₃ : RDF + ZnSO₄ 10 kg + FeSO₄ 10 kg/ha

Seed yield parameters

Amongst the staggered sowings, S₂ recorded more number of seeds per row (30.18) at GKVK. While at Mandya more number of seeds per row (30.63) was observed in S₃ compared to S₁, which was recorded less number of seeds per row (27.32 and 27.01) at GKVK and Mandya, respectively. Amongst the staggered sowings, S₂ recorded more number of seeds per cob (362.05) at GKVK but at Mandya, S₃ recorded more number of seeds per cob (377.62) compared to S₁, which recorded less number of seeds per cob (326.22 and 330.92) at GKVK and Mandya, respectively (Table 2). Amongst the staggered sowings S₂ was recorded with higher shelling (84.27%), seed yield per plant (117.88 and 119.78), seed yield per hectare (47.08 and 48.13 q) compared to S₁, which was recorded with lower shelling (81.84%), seed yield per plant (102.96 and 97.59 g), seed yield per hectare (39.27 and 37.90 q) at GKVK and Mandya, respectively. Amongst the staggered sowings, S₁ recorded higher seed recovery (95.12%) followed by S₃ (91.72%) and low seed recovery of (91.16%) was observed in S₂ at GKVK (Table 3-4). The better synchrony in male and female parents is due to sowing of 40 per cent male parent seeds two days after the sowing of female parent in NAH-2049 and sowing of 40 per cent male parent seeds two days before the sowing of female parent in NAH-1137 and may be the main cause of increased seed yield. The better synchronization in flowering of parents of maize hybrid with two to three days staggered sowing of male parent (2 days late sowing of male parent than female) [7], [10]] and male parent three days earlier to get synchrony as reported by Vinutha [11]. Similar results reported in sorghum crop by Bommegowda and

Umashankar [2], Shekar *et al.* [6], Kumar *et al.* in sorghum [4] and Dhedhi *et al.* [3], Tejjagouda Bhanuje *et al.* in pearl millet [9]. Amongst the interaction of staggered sowings in hybrids, S₂ × H₂ (2 days staggered sowing in NAH-1137) was recorded higher shelling (86.51%) and lower shelling (78.35%) was recorded in S₁ × H₁ (Sowing female and male parent simultaneously in NAH-2049 hybrid) at Mandya. Amongst the interaction of staggered sowing in hybrids, S₃ × H₂ (4 days staggered sowing in NAH-1137) were recorded more, seed yield per plant (149.46 g) and less seed yield per plant of 78.13 g was recorded in S₁ × H₁ (Sowing female and male parent simultaneously in NAH-2049 hybrid) at GKVK and similar observations were found at Mandya location but it was non-significant. Amongst the interactions of staggered sowing, hybrid and micronutrient application, higher seed yield per plant (171.27 g) and seed yield per hectare (72.57 q) were recorded in S₃ × H₂ × M₃ (4 days staggered sowing in NAH-1137 + 10 kg ZnSO₄ + 10 kg FeSO₄) and lesser seed yield per plant of 77.00 g and seed yield per hectare (31.08 q) were recorded in S₁ × H₁ × M₁ (Sowing female and male parent simultaneously in NAH-2049 + 10 kg ZnSO₄) at Mandya [13-14]. Whereas at GKVK interactions were non-significant (Table 3-4).

The present study reports staggered sowing delays male flowering, which directly improving nicking and significantly increases yield components compared to simultaneous sowing. NAH-1137 consistently produced superior seed yield compared to NAH-2049. Soil application of combined micronutrients significantly improved seed yields over single micronutrient applications [15].

Table 4 Effect of staggered sowing and micronutrient application on shelling (%) and seed recovery (%) of single cross maize hybrids

Treatment		Shelling (%)								Seed recovery (%)							
		GKVK				Mandya				GKVK				Mandya			
		M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean	M ₁	M ₂	M ₃	Mean
S ₁	H ₁	84.13	83.84	85.82	84.60	86.70	85.09	84.20	85.33	96.12	93.24	94.29	94.55	101.39	93.24	85.51	93.38
	H ₂	77.81	77.74	82.45	79.33	78.79	77.84	78.42	78.35	96.16	97.37	93.53	95.69	81.25	94.32	88.94	88.17
S ₂	H ₁	70.57	77.96	81.38	76.64	86.44	87.20	85.90	86.51	93.54	97.24	87.13	92.64	93.63	84.12	92.01	89.92
	H ₂	77.93	75.92	82.66	78.84	83.29	82.13	80.68	82.03	93.24	93.83	81.96	89.67	81.38	87.85	92.64	87.29
S ₃	H ₁	76.59	79.77	84.12	80.16	86.16	86.79	84.40	85.79	92.85	90.12	84.73	89.23	84.68	88.31	94.64	89.21
	H ₂	73.70	77.15	78.82	76.56	81.03	82.72	83.28	82.34	94.24	96.58	91.78	94.20	85.21	104.23	77.34	88.93
S × M		S × M				S × M				S × M				S × M			
	S ₁	80.97	80.79	84.13	81.97	82.74	81.47	81.31	81.84	96.14	95.30	93.91	95.12	91.32	93.78	87.23	90.78
	S ₂	74.25	76.94	82.02	77.74	84.86	84.66	83.29	84.27	93.39	95.53	84.55	91.16	87.51	85.98	92.32	88.60
	S ₃	75.15	78.46	81.47	78.36	83.60	84.75	83.84	84.06	93.54	93.35	88.26	91.72	84.95	96.27	85.99	89.07
H × M		H × M				H × M				H × M				H × M			
	H ₁	77.10	80.53	83.78	80.47	86.43	86.36	84.83	85.88	94.17	93.53	88.72	92.14	93.24	88.56	90.72	90.84
	H ₂	76.48	76.94	81.31	78.24	81.04	80.90	80.79	80.91	94.55	95.93	89.09	93.19	82.61	95.46	86.30	88.13
	Mean	76.79	78.73	82.54	79.35	83.73	83.63	82.81	83.39	94.36	94.73	88.90	92.66	87.93	92.01	88.51	89.48
		S.Em±		CD (P=0.05)	CV (%)	S.Em±		CD (P=0.05)	CV (%)	S.Em±		CD (P=0.05)	CV (%)	S.Em±		CD (P=0.05)	CV (%)
	S	1.08	NS			0.21	0.81			0.41	1.62			1.86	NS		
	H	1.79	NS			0.22	0.75			1.43	NS			2.01	NS		
	M	1.74	NS			0.42	NS			1.31	3.83			2.53	NS		
	S × H	3.10	NS	9.33		0.38	1.31	2.14		2.48	NS	6.00		3.49	NS	12.01	
	S × M	3.02	NS			0.73	NS			2.27	NS			4.39	NS		
	H × M	2.47	NS			0.59	NS			1.85	NS			3.58	NS		
	S × H × M	4.27	NS			1.03	NS			3.21	NS			6.20	NS		

- S₁ : Sowing female and male parent simultaneously
S₂ : Sowing of 40% male parent seeds 2 days after the sowing of 100% female+60% male parent in NAH-2049 and sowing of 40% male parent seeds 2 days before the sowing of 100% female+60% male parent in NAH-1137
S₃ : Sowing of 50% male parent seeds 4 days after the sowing of 100% female+50% male parent in NAH-2049 and sowing of 50% male parent seeds 4 days before the sowing of 100% female+50% male parent in NAH-1137
- H₁ : NAH-2049
H₂ : NAH-1137
NS : Non-Significant
- M₁ : RDF + ZnSO₄ 10 kg/ha
M₂ : RDF + FeSO₄ 10 kg/ha
M₃ : RDF + ZnSO₄ 10 kg + FeSO₄ 10 kg/ha

CONCLUSION

The present study demonstrated that staggered sowing of male and female parents significantly influenced flowering synchronization and seed yield of maize hybrids, with the magnitude of response varying between locations and hybrids. Staggering the male parent by two to four days improved flowering synchrony (nicking) between the parental lines, thereby enhancing seed set and yield attributes. Among the staggered sowing treatments, S₂ generally recorded superior seed yield, shelling percentage and yield components, while S₃ was particularly effective in NAH-1137 under specific

treatment combinations. The hybrid NAH-1137 (H₂) consistently exhibited better seed yield performance than NAH-2049 (H₁). The combined soil application of ZnSO₄ and FeSO₄ further improved seed production, with the highest seed yield of 72.57 q ha⁻¹ recorded under S₃ × H₂ × M₃ at Mandya. Overall, appropriate staggered sowing of the male parent, particularly in combination with suitable micronutrient application, proved effective in improving flowering synchrony, seed set and hybrid seed yield. Therefore, adoption of an optimized staggered sowing schedule along with combined Zn and Fe application can enhance the efficiency and productivity of hybrid maize seed production.

LITERATURE CITED

1. Anonymous. 2025. Available from: www.upag.gov.in/.
2. Bommegowda A, Umashankar M. 1983. Hybrid seed production studies in CSH-5. *Sorghum Newsletter* 26: 7-8.
3. Dhedhi KK, Dangaria CJ, Prasanna GJ, Joshi AK. 2007. Synchronization of flowering in parental lines of bajra hybrid GHB-558. *Agricultural Science Digest* 27(2): 1582-1583.
4. Kumar RN, Mohammad S, Lawrence M. 2000. Influence of time and method of sowing of parental lines and nitrogen dose on the phenology of flowering, seed set and yield of 'CSH-14' sorghum hybrid. *Indian Journal of Agricultural Sciences* 70(11): 781-783.
5. Quinby AS, Niango MBA, Binso-Dabire CL, Pittendrigh BR. 2010. Effectiveness of Spinosad (Naturalytes) in controlling the cowpea storage pest, *Callosobruchus maculatus* (Coleoptera: Bruchidae). *Journal of Economic Entomology* 103(1): 203-210.
6. Shekar VB, Jilani PS, Shinde PB, Mulik. 1985. Synchronization of flowering studies on parental lines of some popular hybrids. *Punjabrao Krishi Vidyapeeth Research Journal* 9: 62-64.
7. Sundarrajan N, Nagaraju S, Venkataramana S, Jaganath MK. 1972. *Design and Analysis of Field Experiments*. University of Agricultural Sciences, Hebbal, Bangalore.
8. Tanwir Alam, Prasad SK, Varshney SK. 2007. Studies on synchronization of flowering in parental lines of Shaktiman-1 maize hybrid. *Seed Research* 35(1): 99-101.
9. Tejagouda Bhanuje, Jolli RB, Vyakaranahal BS, Gurumurthy R, Guggari AK, Sajjanar GM. 2014. Effect of staggered sowing and split application of nitrogen in seed production of pearl millet hybrid MH-946. *Karnataka Journal of Agricultural Sciences* 27(1): 9-13.
10. Varshney SK, Tanwir Alam, Prasad SK, Singh B. 2006. Lack of synchrony of flowering: Barrier in seed production of Shaktiman-1 maize hybrid. XII National Seed Seminar, 24-26 February, ANGRAU, Hyderabad. pp 52.
11. Vinutha KS, Rajendra Prasad S, Rame Gowda, Ravishankar P, Jeevan Kumar SP, Shanthala J. 2014. Optimization of seed production techniques in single cross maize hybrid. *Seed Research* 42(2): 210-216.
12. Watson L, Dallwitz MJ. 1992. *Grass Genera of the World: Descriptions, Illustrations, Identification and Information Retrieval; Including Synonyms, Morphology, Anatomy, Physiology, Phytochemistry, Cytology, Classification, Pathogens, World and Local Distribution*. pp 1038.
13. Anil Kumar GS, Ramanappa TM, Siddaraju R. 2019. Influence of staggered sowing on growth, seed yield and quality of single cross hybrid maize: MAH 14-5 (*Zea mays* L.). *Mysore Journal of Agricultural Sciences* 53(3): 59-63.
14. Vinutha KS, Rajendra Prasad S, Ramegowda, Ravishakar P, Parshivamurthy, Jeevan Kumar SP. 2012. Influence of staggered sowing, planting ratio and subtending cob leaf clipping on seed quality parameters of maize. *Seed Research* 42(1): 91-97.
15. Kugashiya KG, Chaudhari PR, Viradiya YA, Patel DK, Desai TA, Vaghela PO, Chaudhari BK. 2022. Effect of staggered sowings on crop growth, flowering parameters and hybrid seed yield on castor hybrid cv. GCH 8. *The Pharma Innovation Journal* 11(9): 2149-2152.