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Optimization of seed production techniques in a single cross maize hybrid

K.S. VINUTHA*, S. RAJENDRA PRASAD[1], RAME GOWDA[2], P. RAVISHANKAR[2], S.P. JEEVAN KUMAR[1] AND J. SHANTHALA[2]
Department of Seed Science and Technology, UAS, Bangalore-560065, Karnataka
vinuthaks.mysore@gmail.com

ABSTRACT Synchronization of parental lines is a basic need for hybrid seed production technology to improve seed setting. To optimize the seed production techniques staggered sowing, planting ratios and subtending cob leaf clipping were performed in single cross maize hybrid Hema with NAI-137, female and MAI-105, male parent during *kharif* 2011. The results implicates that the synchronization of flowering was attained by sowing male parent (MAI-105) three days earlier to female parent (NAI-137) with a planting ratio of 6:2 resulted 50% female silking in 56.83 days with concomitant higher seed yield (130.86 g/plant). However, clipping had no effect on seed yield of single cross maize hybrid Hema.

Keywords: Staggered sowing, planting ratio, subtending cob leaf clipping, shelling percentage and seed setting

Maize (*Zea mays* L.; 2n = 20) is an important cereal crop, next to wheat and rice. Being a C_4 plant, it is physiologically more efficient, higher yield potential and wider adaptability over a range of environmental conditions. Synchronization in flowering between parental lines is a crucial factor in achieving higher hybrid seed yield. The knowledge on flowering days of parental lines is essential for adjusting sowing dates of parent. Often the problem of non-synchrony due to differential behaviour of the parental lines under different environmental conditions are prevalent. The optimum planting ratio developed for one hybrid may not be suitable for another hybrid of the same crop. To improve pollen deposition on silk, clipping of subtending cob leaf was performed at silk initiation stage. An attempt was made to determine the staggered planting of parents and optimum planting ratio with clipping of subtending cob leaf in hybrid seed production to enhance seed set and yield in maize hybrid Hema.

MATERIALS AND METHODS

The experiment was conducted with factorial RCBD in three replicates, at the experimental block of National Seed Project, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore, during *Kharif* 2011 on single cross maize hybrid Hema (NAH-1137) by using female parent NAI-137 and male parent MAI-105. The clipping of subtending cob leaf was carried out at silk initiation stage as shown in Fig. 1. The observations on flowering behavior, seed set, seed recovery and yield parameters were recorded. There were 18 treatment combinations and the respective treatment details are as follows:

Factors: S-Staggered sowing

S1: Sowing male (MAI-105) seeds and female (NAI-137) seeds on the same day

S2: Sowing male (MAI-105) 3 days earlier to female (NAI-137) seeds

S3: Sowing hydro-primed male (MAI-105) seeds and female (NAI-137) seeds on the same day

*Corresponding author
[1]ICAR-Directorate of Seed Research, Mau-275103
[2]University of Agricultural Sciences, Bangalore -560 065, Karnataka, India

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No clipping Clipping

Fig. 1. Clipping of subtending cob leaf in maize hybrid Hema.

P- Planting ratio - Female (NAI-137): Male (MAI-105)

P_1: 4:2 P_2: 5:2 P_3: 6:2

C- Subtending cob leaf clipping

C_1: without clipping C_2: with clipping

RESULTS AND DISCUSSION

Effect of staggered sowing, planting ratios and subtending cob leaf clipping on tasseling and silking

Tasseling in male plants showed significant difference for staggered sowing. The treatment S_3 (hydro-priming of male line) has showed lesser number of days to 50 percent tasseling (55.95 days) due to increase in speed of germination by hydro-priming, whereas S_1 (sowing male and female seeds on the same day) required more number of days (57.31 days) for tasseling (Table 1).The interactions S_1xP_3 and S_3xP_1 recorded 59.75 and 57.42 days for 50 percent tasseling respectively and differed significantly over the other treatments. For SxC interactions, S_1xC_1 showed higher number of days (59.69 days) and less in S_3xC_1 (57.22 days) to 100 percent tasseling.

Similar to days for 50 percent tasseling, the 100 tasseling was advanced by three-and-half-days in hydro-priming at a planting ratio of 4:2 with subtending cob leaf clipping (56.25 days) against no staggering with planting ratio of 6:2 without subtending cob leaf clipping (59.98 days). The treatment of hydro-priming enhance germination in field by increasing the biochemical activities and effect of hydro-priming persisted only till vegetative stage as reported by [1] and [2-3] in maize and sorghum.

The silking in female line has showed significant difference for staggered sowing (Table 1) while it was insignificant for planting ratio and subtending cob leaf clipping in days for both 50 and 100 percent silking. Among the different staggered sowing, S_3 (hydro-priming of male lines) showed 55.21 days when compared with S_2 (sowing of male 3 days earlier to female) 56.83 days to 50 percent silking in female.

Significant differences were observed among the interactions of SxP and SxC. The interaction of S_2xP_1 has taken more number of days to 50 percent silking in female (57.00 days) in comparison to S_1xP_3 which resulted 55.00 days that is less than the former. More number of days to 50 percent silking in female was recorded in S_2xC_1 (57.33 days), while it was less in S_3xC_1 (55.08 days). Similar trend was observed with respect to 100 percent flowering in all the treatment combinations. The 100 percent silking was completed by additional three to three-and- half days from 50 percent silking (Table 1).

In three way interactions both 50 and 100 percent silking was significant with the staggered sowing of male 3 days earlier with planting ratio of 4:2 without subtending cob leaf clipping recorded 58.00 days for 50 percent and 61.32 days for 100 percent ($S_2xP_1xC_1$), whereas in $S_1xP_3xC_2$ 54.67 days for 50 percent and 57.61 days for 100 percent silking. The differential staggering of male parent (early flowering parent) for 3 days has delayed flowering of female parental line and thus improved synchrony and is in accordance with studies of [4-5] in sorghum.

Table 1. Influence of staggered sowing, planting ratio and subtending cob leaf clipping on female silking and male tasseling in single cross maize hybrid Hema

Treatment		Female silking (NAI-137)						Male tasseling (MAI-105)					
		50 % female silking			100 % female silking			50 % male tasseling			100 % male tasseling		
		C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
S_1	P_1	55.07	55.33	55.20	57.61	58.32	58.00	57.17	56.67	56.92	59.58	58.92	59.24
	P_2	55.33	55.67	55.50	58.35	58.67	58.00	57.50	57.17	57.33	59.92	59.25	59.52
	P_3	55.33	54.67	55.00	58.39	57.61	58.01	58.00	57.33	57.67	59.98	59.56	59.75
S_2	P_1	58.00	56.00	57.00	61.32	59.33	60.31	57.67	57.27	57.47	59.32	59.52	59.58
	P_2	57.67	56.00	56.83	60.00	60.39	60.17	57.67	56.60	57.13	59.52	59.25	59.56
	P_3	56.33	57.00	56.67	59.31	60.68	60.00	57.00	56.33	56.67	58.12	58.54	58.75
S_3	P_1	55.17	55.50	55.33	59.00	58.63	58.83	55.60	55.93	55.77	56.25	58.58	57.42
	P_2	55.00	55.43	55.22	58.38	59.08	58.67	56.00	56.50	56.25	57.58	57.57	57.58
	P_3	55.07	55.10	55.08	59.77	59.10	59.13	55.67	56.00	55.83	57.92	57.92	57.92
SXC Mean		55.88	55.63		59.05	59.07		56.92	56.64		58.83	58.80	
S_1		55.24	55.22	55.23	58.10	58.24	58.16	57.56	57.06	57.31	59.69	59.25	59.47
S_2		57.33	56.33	56.83	60.29	60.15	60.27	57.44	56.73	57.09	59.58	59.14	59.36
S_3		55.08	55.34	55.21	59.00	58.83	58.94	55.76	56.14	55.95	57.22	58.03	57.64
PXC					PXC			PXC			PXC		
P_1		56.08	55.61	55.84	59.35	58.78	59.06	56.81	56.62	56.72	58.48	59.03	58.81
P_2		56.00	55.70	55.85	58.86	59.31	59.13	57.06	56.76	56.91	59.14	58.6	58.92
P_3		55.58	55.59	55.58	59.18	59.15	59.18	56.89	56.56	56.72	58.81	58.69	58.75
Mean		55.89	55.63	55.76	59.11	59.07	59.09	56.92	56.64	56.78	58.84	58.81	58.82
		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		0.20	0.58	1.55	0.28	0.81	2.02	0.12	0.34	1.89	0.16	0.46	1.15
P		0.20	NS		0.28	NS		0.12	NS		0.16	NS	
C		0.17	NS		0.23	NS		0.10	NS		0.13	NS	
SXP		0.35	1.01		0.49	1.40		0.21	0.60		0.28	0.79	
SXC		0.29	0.83		0.40	1.15		0.17	0.49		0.23	0.65	
PXC		0.29	NS		0.40	NS		0.17	NS		0.23	NS	
SXPXC		0.5	1.43		0.69	1.98		0.29	0.84		0.39	1.12	

NS: Non Significant S_1: Sowing male (MAI-105) and female(NAI-137) seeds on the same day, S_2: Sowing of male (MAI-105) 3 days earlier to female (NAI-137), S_3: Hydro priming of male (MAI-105) line P_1: 4:2 (female: male), P_2: 5:2 (female: male), P_3: 6:2 (female: male) and C_1: No clipping, C_2: Clipping of subtending leaf of cob at silk initiation stage

Effect of staggered sowing, planting ratios and subtending cob leaf clipping on shelling and seed recovery percentage

The shelling percent was significantly differed for staggered sowing and planting ratio, with high shelling percent (85.33) in S_2 (sowing male 3 days earlier to female) (85.04) in P_1 (4:2) (Table 2) and lower (82.68) shelling percent in P_3 (6:2). The higher shelling percent was observed in planting ratio P_1 (4:2) due to availability of pollen to cover the required number of female rows. Increase in female rows reported in pollen shortage and thus inferior seed setting and development. The seed setting observed in planting ratio of P_1 (4:2) is better due to more pollen to the female

Table 2. Effect of staggered sowing, planting ratio and subtending cob leaf clipping on shelling and seed recovery in single cross maize hybrid Hema

Treatment		Shelling (%)			Seed recovery (%)		
		C_1	C_2	Mean	C_1	C_2	Mean
S_1	P_1	84.96	85.97	85.46	87.09	80.28	83.68
	P_2	82.49	83.68	83.08	85.79	80.70	83.25
	P_3	79.88	82.68	81.28	85.04	80.52	82.78
S_2	P_1	88.02	83.81	85.92	91.09	87.63	89.36
	P_2	86.61	85.91	86.26	91.95	86.29	89.12
	P_3	81.64	85.97	83.8	89.41	88.18	88.80
S_3	P_1	84.62	82.84	83.73	87.95	86.73	87.34
	P_2	82.52	82.30	82.41	86.45	84.19	85.32
	P_3	82.77	83.17	82.97	86.35	82.53	84.44
SXC							
S_1		82.44	84.11	83.28	85.97	80.50	83.24
S_2		85.42	85.23	85.33	90.81	87.37	89.09
S_3		83.30	82.77	83.04	86.92	84.48	85.70
PXC							
P_1		85.86	84.21	85.04	88.71	84.88	86.80
P_2		83.87	83.97	83.92	88.06	83.72	85.89
P_3		81.43	83.94	82.68	86.93	83.74	85.34
Mean		83.72	84.04	83.88	87.90	84.12	86.01
		S.Em±	CD (p=0.05)	CV %	S.Em±	CD (p=0.05)	CV %
S		0.43	1.25	2.2	1.37	3.94	6.75
P		0.43	1.25		1.37	NS	
C		0.36	NS		1.12	3.21	
SXP		0.75	2.17		2.37	NS	
SXC		0.62	1.77		1.94	5.57	
PXC		0.62	1.77		1.94	NS	
SXPXC		1.07	3.06		3.35	9.64	

NS: Non Significant S_1: Sowing male (MAI-105) and female(NAI-137) seeds on the same day, S_2: Sowing of male (MAI-105) 3 days earlier to female (NAI-137), S_3: Hydro priming of male (MAI-105) line P_1: 4:2 (female: male), P_2: 5:2 (female: male), P_3: 6:2 (female: male) and C_1: No clipping, C_2: Clipping of subtending leaf of cob at silk initiation stage

rows. But seed yield per plot and seed yield per hectare was more in P_3 (6:2) due to more number of female rows. This result is in confirmation with [5] in sorghum and bajra [6]. All the two way interactions were significant for shelling percentage. The S_2xP_2 recorded higher (86.26) shelling percent, 85.42 in S_2xC_1 and 85.86 in P_1xC_1 while lower shelling percent in S_1xP_3 with 81.28, S_1xC_1 with 82.44 and P_3xC_1 with 81.43. Significantly higher (88.02) shelling percent was recorded in treatment combination of staggered sowing of male by three days earlier to female with the planting ratio of 4:2 without clipping of subtending cob leaf at silk initiation stage ($S_2xP_1xC_1$) due to better seed setting. Seed

Table 3. Effect of staggered sowing, planting ratio and subtending cob leaf clipping on seed yield in single cross maize hybrid Hema

Treatment		Seed yield per plant (g)			Seed yield per hectare (q)		
		C_1	C_2	Mean	C_1	C_2	Mean
S_1	P_1	117.55	104.40	110.98	31.96	27.09	29.53
	P_2	114.15	103.04	108.60	37.03	32.62	34.83
	P_3	112.76	102.69	107.73	40.47	36.28	38.38
S_2	P_1	142.55	126.25	134.40	41.22	35.19	38.20
	P_2	138.25	122.32	130.29	46.60	40.27	43.43
	P_3	130.78	125.02	127.90	47.98	45.58	46.78
S_3	P_1	131.74	124.02	127.88	37.22	34.36	35.79
	P_2	124.83	114.38	119.61	41.27	37.12	39.20
	P_3	122.28	111.06	116.67	44.44	39.76	42.10
SXC					SXC		
S_1		114.82	103.38	109.10	36.49	32.00	34.24
S_2		137.19	124.53	130.86	45.27	40.35	42.81
S_3		126.29	116.49	121.39	40.98	37.08	39.03
PXC					PXC		
P_1		130.61	118.22	124.42	36.80	32.21	34.51
P_2		125.75	113.25	119.50	41.63	36.67	39.15
P_3		121.94	112.93	117.43	44.30	40.54	42.42
Mean		126.10	114.80	120.45	40.91	36.48	38.69
		S.Em±	CD (p=0.05)	CV %	S.Em±	CD (p=0.05)	CV %
S		3.05	8.76	10.74	1.18	3.40	12.98
P		3.05	NS	1.18	3.40		
C		2.49	7.15	0.97	2.78		
SXP		5.28	15.18	2.05	5.89		
SXC		4.31	12.39	1.67	4.81		
PXC		4.31	12.39	1.67	4.81		
SXPXC		7.47	21.46	2.90	8.33		

NS: Non Significant S1: Sowing male (MAI-105) and female(NAI-137) seeds on the same day, S2: Sowing of male (MAI-105) 3 days earlier to female (NAI-137), S3: Hydro priming of male (MAI-105) line P1: 4:2 (female: male), P2: 5:2 (female: male), P3: 6:2 (female: male) and C1: No clipping, C2: Clipping of subtending leaf of cob at silk initiation stage

recovery was significantly differed for staggered sowing and cob leaf clipping with high seed recovery (89.09 %) in S_2 (sowing of male 3 days earlier to female) (Table 2), while in S_1 (sowing male and female seeds on the same day) (83.24 %) was observed due to poor seed setting and non-synchrony of flowering. The cob leaf clipping have reduced to 84.12 percent seed recovery from 87.9 percent indicating reduction in photosynthates leads to poor seed filling. Among the interactions the higher (90.81 %) seed recovery was recorded in S_2xC_1 and lower (80.50 %) in S_1xC_2. In three way interactions, higher (91.95%) seed recovery was observed in $S_2xP_2xC_1$, while lower (80.28%) in $S_1xP_1xC_2$.

Effect of staggered sowing, planting ratios and subtending cob leaf clipping on seed yield

The seed yield per plant was significantly differed for staggered sowing with high seed yield of 130.86 g/plant in S_2 (sowing of male 3 days earlier to female), in contrast S_1 (sowing male and female seeds on the same day) showed low seed yield of 109.10 g/plant due to non-synchrony of flowering between male and female. The clipping of subtending leaves of cobs at silk initiation stage have recorded low (114.80 g/plant) seed yield.

The interactions of staggered sowing with planting ratio (SxP), staggered sowing with subtending cob leaf clipping (SxC) and planting ratio with subtending cob leaf clipping (PxC) recorded significant values. The S_2xP_1 recorded higher seed yield per plant of 134.40 g, 137.19 g in S_2xC_1 and 130.61 g in P_1xC_1. There was a significant difference in seed yield per hectare due to staggered sowing with high seed yield of 47.98 q/ha was recorded in S_2 (sowing of male 3 days earlier to female), on the other hand, S_1 (sowing male and female seeds on the same day) resulted low seed yield of 36.49 q/ha. Among the planting ratio high seed yield (44.30 q/ha) was recorded in P_3 (6:2) and low seed yield (36.80 q/ha) in P_1 (4:2). The leaf clipping recorded significantly lower (36.48 q/ha) seed yield per hectare than in C_1 (no clipping) (40.91 q/ha). The S_2xP_3 and S_2xC_1 recorded higher seed yield of 46.78 q/ha and 45.27 q/ha respectively. The combination of staggered sowing of male lines three days earlier to female line with plating ratio of 6:2 without leaf clipping has significantly recorded higher (47.98 q/ha). The results are in confirmation with [4, 7-9] in sorghum hybrid, as synchrony between parental lines has improved seed set.

CONCLUSION

In single cross maize hybrid seed production the synchronization between male and female parents with proper planting ratio is very critical. In the present study staggered sowing of male parent (MAI-105) three days earlier to female parent (NAI-137) with a planting ratio of 6:2 was found to be optimum for higher seed set and seed yield in single cross maize hybrid Hema. However, the clipping of subtending cob leaf at silk initial stage has no effect on either seed set or seed yield.

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