

Influence of staggered sowing, planting ratio and subtending cob leaf clipping on seed quality parameters of maize

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ABSTRACT To know the quality of seed produced by different agronomic practices viz., staggered sowing, planting ratio and subtending cob leaf clipping in single cross maize hybrid Hema was carried out. Seeds harvested from staggered sowing S₂ (sowing of male 3 days earlier to female) resulted in significantly higher 100 seed weight (31.39 g), seedling length (35.86 cm), seedling dry weight (86.93 mg), total dehydrogenase activity of seed (1.43, A_{iso}), seedling vigour index-I (3165) and seedling vigour index-II (7711). However, the germination percentage, electrical conductivity of seed leachate, pH of seed leachate and seed health was found insignificant for planting ratio and subtending cob leaf clipping and their interaction. It is clearly illustrated that the seeds from sowing of male 3 days earlier to female (S₂) has showed better seed quality in hybrid Hema may be due to the timely seed setting and maturity.

Keywords: Maize, staggered sowing, planting ratio, subtending cob leaf clipping, seed quality

Maize (*Zea mays* L.) is known as "queen of cereals" in view of its several uses. Maize is one of the world's most widely grown cereals, having great significance as human food, animal feed and raw material for large number of industrial products. In India, Andhra Pradesh, Karnataka and Maharashtra are the major maize producing states [1]. The hybrid technology available particularly in rice and maize can be extended suitably to cover larger areas to meet targets of food grain production of future (2030). Quality seed production and making them available to farmers at right time coupled with technologies which tackle climate change shall play a decisive role. To acquire maximum seed yield and good quality seed factors such as staggered sowing, planting ratios, planting date, plant density and optimum harvesting time are indispensable [2]. While developing a technology for higher seed yield there is a need to ensure the quality of seed. Synchrony of parents is a basic need for hybrid seed production technology to improve seed setting and quality. In the

present study, an attempt was made to know the effect of staggered planting of parents, planting ratios and subtending cob leaf clipping on seed quality attributes of single cross maize hybrid Hema.

MATERIALS AND METHODS

The experiment was conducted at Seed Technology Research laboratory, National Seed Project, University of Agricultural Sciences, Bangalore, during July- December, 2011 with factorial CRBD with three replicates. The seed produced from staggered planting of parents, planting ratios and subtending cob leaf clipping were collected and recorded different seed quality attributes in Hema maize hybrid.

Staggered planting of parents on quality of seed yield

Synchronization of flowering between two parental lines is an important parameter which influences the quality of seed. In order to attain synchronization staggered sowing was performed in three different treatments. The first treatment involves sowing of male and

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female seeds on the same day (S₁), second treatment consists of sowing of male 3 days earlier to female (S₂) and the last treatment was carried out with hydro-priming of male line. The seed quality parameters of the respective treatment were recorded.

Planting ratio on quality of seed yield

Planting ratio of lines was carried out at a ratio of P₁- (female: male) 4:2, P₂-5:2 and P₃-6:2. The effect of different planting ratio was studied with the help of seed quality parameters.

Subtending cob leaf clipping on quality of seed yield

Effect of clipping of subtending leaves of cobs on seed quality were studied by varying the conditions with no clipping (C₁) and clipping of subtending leaves of cobs at silk initiation stage (C₂).

Assessment of seed quality parameters

Determination of functional role of all the above mentioned parameters were studied by conducting the seed quality parameters such as germination percentage, seedling length, seedling dry weight, vigour index-I, vigour index-II, seed health, electrical conductivity (EC) of seed leachate, pH of seed leachate, TDH of seed 100 seed weight respectively. Germination test was conducted using between paper (BP) methods as per [3]. The seedling vigour indices were calculated as per the formula given by [4]. The total dehydrogenase activity (TDH) was expressed in terms of absorbance value (480nm) as given by [5]. Seed health was detected using top paper method as prescribed in [3].

RESULTS AND DISCUSSION

Effect of parameters and interactions on quality of seed yield

Seeds harvested from S₂ (sowing of male 3 days earlier to female) has resulted highest 100 seed weight with 31.39 g (Table-1), whereas in hydro-priming of male line (S₃)

yielded 29.39 g which is lowest than the other treatments. Between the interaction of staggered sowing (S) and planting ratio (P), obtained 33.00 g of 100 seed weight which is highest in sowing of male 3 days earlier to female with planting ratio of 4:2 (S₂xP₁). Interactions of staggered sowing (S) and subtending cob leaf clipping (C) the treatment sowing of male 3 days earlier to female without clipping (S₂xC₁) has recorded highest 100 seed weight 32.22 g. In contrary, S₁xC₁ (sowing of male and female seeds on the same day without clipping of subtending cob leaf recorded 29.11 g of 100 seed weight that is lower than the latter. Between the interaction of staggered sowing, planting ratio and clipping, the treatment S₂xP₁xC₁ (sowing of male 3 days earlier to female with planting ratio of 4:2 and without clipping of subtending leaves of cobs at silk initiation stage) resulted higher 33.67g of 100 seed weight, whereas S₃xP₂xC₂ (sowing hydro-primed male line in 5:2 planting ratio and clipping of subtending leaves of cobs at silk initiation stage) obtained lowest 100 seed weight (27.67 g).

Sowing of male 3 days earlier to female (S₂) has recorded highest seedling length (35.86 cm), seedling dry weight (86.93 mg) seedling vigour index-I (3165) and seedling vigour index-II (7711), whereas S₁ (sowing male and female seeds on the same day) showed lowest seedling length (32.57 cm), seedling dry weight (80.52 mg), seedling vigour index-I (2896) and seedling vigour index-II (7151). The interactions of treatment (Table -2) sowing of male 3 days earlier to female with planting ratio of 6:2 (S₂xP₃) has recorded highest seedling length (36.55 cm), seedling dry weight (89.77 mg), seedling vigour index-I (3164) and seedling vigour index-II (7957).

In contrary, S₁xP₁ (sowing male and female seeds on the same day with planting ratio of 4:2) resulted lower seedling length (30.87 cm), seedling dry weight (78.43 mg),

Table 1. Effect of staggered sowing, planting ratio and subtending cob leaf clipping on 100 seed weight and germination in single cross maize hybrid Hema

Treatment	100 seed weight (g)				Germination (%)				
	C ₁	C ₂	Mean	C ₁	C ₂	Mean	C ₁	C ₂	Mean
S ₁	P ₁	29.67	29.00	29.33	90.33 (71.86)	90.00 (71.55)	90.17 (71.71)		
	P ₂	30.33	29.67	30.00	88.33 (70.05)	88.67 (70.37)	88.5 (70.21)		
	P ₃	30.33	28.67	29.50	88.00 (69.73)	88.33 (70.07)	88.17 (69.90)		
S ₂	P ₁	33.67	32.33	33.00	88.33 (70.01)	88.33 (70.07)	88.33 (70.04)		
	P ₂	30.67	28.67	29.67	88.67 (70.37)	89.67 (71.24)	89.17 (70.81)		
	P ₃	32.33	30.67	31.50	88.67 (70.37)	88.67 (70.37)	88.67 (70.37)		
S ₃	P ₁	30.00	30.67	30.33	88.67 (70.37)	88.67 (70.37)	88.67 (70.37)		
	P ₂	28.33	27.67	28.00	89.33 (70.94)	88.67 (70.37)	89.00 (70.66)		
	P ₃	30.33	29.33	29.83	89.33 (70.94)	90.33 (71.88)	89.83 (71.41)		
SXC									
S1		30.11	29.11	29.61	88.89 (70.55)	89.00 (70.66)	88.94 (70.61)		
	S2	32.22	30.56	31.39	88.56 (70.25)	88.89 (70.56)	88.72 (70.41)		
	S3	29.56	29.22	29.39	89.11 (70.75)	89.22 (70.87)	89.17 (70.81)		
PXC									
P1		31.11	30.67	30.89	89.11 (70.75)	89.00 (70.66)	89.06 (70.71)		
	P2	29.78	28.67	29.22	88.78 (70.45)	89.00 (70.66)	88.89 (70.56)		
	P3	31.00	29.56	30.28	88.67 (70.35)	89.11 (70.77)	88.89 (70.56)		
Mean	30.63	29.63	30.13	88.85 (70.52)	89.04 (70.70)	88.94 (70.61)			
	S _i Em±	CD (p=0.05)	CV %	S _i Em±	CD (p=0.05)	CV %			
S	0.59	1.70		0.42			NS		
P	0.59	NS		0.42			NS		
C	0.48	NS		0.34			NS		
SXP	1.02	2.94	8.33	0.72			NS	2.50	
SXC	0.84	2.40		0.59			NS		
PXC	0.84	2.40		0.59			NS		
SXPXC	1.45	4.16		1.02			NS		

NS: Non Significant, (*) figures in parenthesis is arc sine transformed values

S₁: Sowing male and female seeds on the same day, S₂: Sowing of male 3 days earlier to female, S₃: Hydro priming of male lineP₁: 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

Table 2. Effect of staggered sowing, planting ratio and subtending cob leaf clipping on seedling length, seedling dry weight, SVI-I and SVI-II in single cross maize hybrid Hema

Treatment	Seedling length (cm)			Seedling dry weight (mg)			SVI-I			SVI-II			
	C ₁	C ₂	Mean	C ₁	C ₂	Mean	C ₁	C ₂	Mean	C ₁	C ₂	Mean	
S ₁	P ₁	31.47	30.27	30.87	81.63	75.23	78.43	2842	2724	2783	7308	6766	7037
	P ₂	33.40	31.90	32.65	83.47	81.53	82.50	2949	2829	2889	7379	7224	7301
	P ₃	34.27	34.13	34.20	80.60	80.67	80.63	3017	3016	3017	7093	7136	7114
S ₂	P ₁	35.00	35.67	35.33	82.67	89.20	85.93	3092	3150	3121	7301	7873	7587
	P ₂	36.07	35.33	35.70	85.53	84.67	85.10	3254	3167	3210	7575	7602	7588
	P ₃	37.00	36.10	36.55	93.87	85.67	89.77	3217	3111	3164	8323	7591	7957
S ₃	P ₁	33.50	34.47	33.98	82.10	74.97	78.53	2970	3059	3014	7279	6993	7136
	P ₂	34.00	33.33	33.67	84.80	82.33	83.57	3036	2956	2996	7576	7295	7435
	P ₃	33.00	34.53	33.77	86.03	88.83	87.43	2945	3118	3032	7683	8022	7852
SXC	SXC			SXC			SXC			SXC			
S1	33.04	32.10	32.57	81.90	79.14	80.52	2936	2857	2896	7260	7042	7151	
S2	36.02	35.70	35.86	87.36	86.51	86.93	3187	3143	3165	7733	7689	7711	
S3	33.50	34.11	33.81	84.31	82.04	83.18	2984	3044	3014	7513	7436	7475	
PXC	PXC			PXC			PXC			PXC			
P1	33.32	33.47	33.39	82.13	79.80	80.97	2968	2978	2973	7296	7211	7253	
P2	34.49	33.52	34.01	84.60	82.84	83.72	3080	2984	3032	7510	7373	7442	
P3	34.76	34.92	34.84	86.83	85.06	85.94	3060	3082	3071	7700	7583	7641	
Mean	34.19	33.97	34.08	84.52	82.57	83.54	3036	3014	3025	7502	7389	7445	
	S.Em±	CD	CV %	S.Em±	CD	CV %	S.Em±	CD	CV %	S.Em±	CD	CV %	
	(p=0.05)			(p=0.05)			(p=0.05)			(p=0.05)			
S	0.51	1.45		1.54	4.42		44.57	128.08		136.37	391.93		
P	0.51	NS		1.54	NS		44.57	NS		136.37	NS		
C	0.41	NS		1.25	NS		36.39	NS		111.34	NS		
SXP	0.87	2.51	6.29	2.66	7.65	7.8	77.19	221.85	6.25	236.2	678.84	7.77	
SXC	0.71	2.05		2.17	6.25		63.03	181.14		192.85	554.27		
PXC	0.71	NS		2.17	NS		63.03	NS		192.85	NS		
SXPXC	1.24	3.56		3.76	10.82		109.16	313.74		334.03	960.02		

NS: Non Significant

S₁: Sowing male and female seeds on the same day, S₂: Sowing of male 3 days earlier to female, S₃: Hydro priming of male lineP₁: 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

seedling vigour index-I (2783) and seedling vigour index-II (7037).

The probable reason for high rate of seed germination is attributed to increased metabolic activities in the hydroprimed seeds. The same observation was found in maize and sorghum [1, 6 - 8]. Moreover, the primed seeds can rapidly imbibe water and revive the seed metabolism, enhancing germination rate and uniformity [9]. It is envisaged that the higher rate of seed germination can lead to the production of large and uniform seedlings.

Between the interaction of staggered sowing and clipping, the treatment sowing of male 3 days earlier to female without clipping (S2xC1) has recorded highest seedling length (36.88 cm), seedling dry weight (87.77 mg), seedling vigour index-I (3164) and seedling vigour index-II (7957). On the other hand, the treatment with sowing of male and female seeds on the same day without clipping of subtending cob leaf (S1xC1) showed lower seedling length (32.10 cm), seedling dry weight (79.14 mg), seedling vigour index-I (2857) and seedling vigour index-II (7042) as shown in Table-2. These findings are in confirmation with the report of [10] and [11] in pearl millet.

The seed quality parameters recorded significantly higher values in S2xP3xC1 (with sowing of male 3 days earlier to female with planting ratio of 6:2 and clipping of subtending leaves of cobs at silk initiation stage) for seedling length (37.00 cm), seedling dry weight (93.87 mg), seedling vigour index-I (3217) and seedling vigour index-II (8323). Conversely, sowing of male and female seeds on the same day with planting ratio of 4:2 with clipping of subtending leaf of cob at silk initiation stage (S1xP1xC2) obtained lowest seedling length (30.27 cm), seedling dry weight (75.23 mg), seedling vigour index-I (2724) and seedling vigour index-II (6766). These results corroborates with reports of [12] and [13] in the sorghum hybrid.

The higher TDH of seed (1.43) was recorded in S2 (sowing of male 3 days earlier to female), whereas lower TDH of seed (1.25) was observed in S1 (sowing male and female seeds on the same day). From the interactions relation to total dehydrogenase activity, S2xP3 (sowing of male 3 days earlier to female with planting ratio of 6:2) showed higher TDH of seed, with 1.54 whereas, S1xP1 (sowing male and female seeds on the same day with planting ratio of 4:2) resulted lower TDH of seed with 1.20 as shown in (Table-3). Similarly from the interactions of staggered sowing and clipping the treatment sowing of male line 3 days earlier to female with clipping (S2xC2) has recorded highest TDH of seed (1.53), on the other hand, sowing of male and female seeds on the same day with clipping of subtending cob leaf (S1xC2) resulted lower TDH of seed (1.23). The seed quality parameters recorded significantly higher values) for TDH of seed (1.71) in S2xP3xC1 (with sowing of male 3 days earlier to female with planting ratio of 6:2 and clipping of subtending leaves of cobs at silk initiation stage. Conversely, sowing of male and female seeds on the same day with planting ratio 4:2 with clipping of subtending leaf cob at silk initiation stage (S1xP1xC2) has showed lowest TDH of seed (1.12). The germination percentage, EC of seed leachate and pH of seed leachate was found insignificant for staggered sowing, planting ratio and subtending cob leaf clipping. These results are in coherence with the reports on sorghum hybrid [14] and [13].

CONCLUSION

Among the different seed production techniques studied, seeds obtained from staggered sowing of female line 3 days later than male line with the planting ratio of 6:2 was found to be better quality seed in terms of 100 seed weight, seedling length, seedling dry weight, seedling vigour index-I & II and higher total dehydrogenase activity.

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

Treatment	Electrical conductivity (dSm-1)				pH				TDH (A 480nm)			
	C ₁	C ₂	Mean	C ₁	C ₂	Mean	C ₁	C ₂	Mean	C ₁	C ₂	Mean
S ₁	P ₁	58.14	61.29	4.59	4.68	4.64	1.27	1.12	1.20			
	P ₂	63.04	64.22	4.68	4.49	4.58	1.20	1.29	1.25			
	P ₃	70.41	68.67	4.62	4.67	4.65	1.34	1.27	1.30			
S ₂	P ₁	52.43	57.39	4.70	4.63	4.66	1.29	1.95	1.62			
	P ₂	54.57	60.84	4.56	4.70	4.63	1.47	1.27	1.37			
	P ₃	74.54	63.75	4.66	4.54	4.60	1.18	1.38	1.28			
S ₃	P ₁	66.55	62.04	4.54	4.49	4.52	1.34	1.31	1.32			
	P ₂	52.99	53.03	4.62	4.61	4.62	1.26	1.24	1.25			
	P ₃	57.27	62.70	4.59	4.59	4.59	1.37	1.30	1.34			
		SXC		SXC		SXC		SXC				
S ₁	65.59	63.86	64.73	4.63	4.61	4.62	1.27	1.23	1.25			
S ₂	60.80	60.51	60.66	4.64	4.62	4.63	1.31	1.53	1.42			
S ₃	59.57	58.94	59.26	4.58	4.57	4.58	1.32	1.28	1.30			
		PXC		PXC		PXC		PXC				
P ₁	61.44	59.04	60.24	4.61	4.60	4.61	1.30	1.46	1.38			
P ₂	61.86	56.87	59.37	4.62	4.60	4.61	1.31	1.27	1.29			
P ₃	62.67	67.41	65.04	4.63	4.60	4.61	1.29	1.32	1.31			
Mean	61.99	61.10	61.55	4.62	4.60	4.61	1.30	1.35	1.32			
S.Em±		CD (p=0.05)	CV %	S.Em±	CD (p=0.05)	CV %	S.Em±	CD (p=0.05)	CV %			
S	2.22	NS		0.03	NS		0.04	0.12				
P	2.22	NS		0.03	NS		0.04	NS				
C	1.81	NS		0.03	NS		0.04	NS				
SXP	3.85	NS	15.31	0.06	NS	3.04	0.07	0.21	13.81			
SXC	3.14	NS		0.05	NS		0.06	0.18				
PXC	3.14	NS		0.05	NS		0.06	NS				
SXPXC	5.44	15.64		0.08	0.23		0.11	0.30				

NS: Non Significant S₁: Sowing male and female seeds on the same day, S₂: Sowing of male 3 days earlier to female, S₃: Hydro priming of male 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

However, some seed quality parameters such as germination percentage, EC of seed leachate and pH of seed leachate was found insignificant for staggered sowing, planting ratio and subtending cob leaf clipping in single cross maize hybrid Hema .

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