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Influence of synchronization techniques and dates of sowing on nicking in parental lines of pearl millet hybrid BPMH-3 seed production

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Abstract
The field experiment was carried out during *Kharif* 2016 at the Main Agricultural Research Station, to investigate the effect of staggered sowings and application of additional dose of nitrogen to late parent on synchronization of male and female parents of pearl millet hybrid BPMH-3. The field experiment comprised of twelve treatments with three replications in split plot design. The results revealed that staggered sowing of male parent nine days earlier than female (S_4) took less number of days for panicle initiation, flower initiation and 50 per cent flowering in male. On the other hand simultaneous sowing of female and male parent (S_1) recorded the lowest values for growth parameters and it took more number of days to panicle initiation, flower initiation and 50 per cent flowering. This revealed that sowing of male parent nine days earlier than the female parent and application of additional 10 kg N ha^{-1} to male parent at 35 days after sowing (S_4) was appropriate to achieve nicking between female and male parental lines of pearl millet hybrid, BPMH-3. Another experiment was conducted at Saidapur farm, University of Agricultural Sciences, Dharwad, to study the flowering behaviour of TPRT 111 (male) and ICMA 9277 (female) parents of pearl millet BPMH-3 in periodical date of sowing with fifteen days interval from first June, 2016 to Second fortnight of December, 2016. The results revealed that the female (ICMA 9277) and male (TPRT 111) parental lines took significantly more number of days 52.00 days and 64.00 days respectively when sown during first fortnight of June 2016. While, less number of days was recorded by female and male parental lines (46.00 days and 51.00 days respectively) when sown during second fortnight of December 2016. Progressive decline in days to fifty percent flowering was observed with the advancement in the sowing which narrow down the flowering gap between male and female parental line.

Keywords: Synchronization, dates of sowing, flowering.

Introduction
Pearl millet (*Pennisetum glaucum*) in India is known by several names in different languages, commonly called as bajra, cumbu, sajje etc and it is also called as cattle millet, bulrush millet or candle millet. It belongs to family gramineae (poaceae). Pearl millet seed contains 11.8g proteins, 4.8g fat, 2.3g fiber, 67g carbohydrate and minerals like calcium (16mg), iron (6mg), magnesium (228mg), phosphorous (570mg), sodium (10mg), zinc (3.4mg), potassium (390mg), copper (1.5mg) and manganese (33mg).

Area under pearl millet cultivation in Karnataka is 0.29 mha, production of 0.31m tons and productivity of 1080kgs/ha (Annon, 2014) [1]. Mainly pearl millet is grown on marginal lands under harsh condition with limited use of chemicals and fertilizers. Besides this, the quality seed of improved genotypes is another major constraint to enhance production, productivity, seed replacement rate and also loss of crop due to downy mildew disease. Though the yielding potential of pearl millet is good, there is a wide gap exists between potential yield and natural yield. Hence with the establishment of AICRIP in pearl millet in 1961 by ICAR, New Delhi, the exploitation of heterosis was initiated, as a result of this first hybrid of pearl millet (HB-1) was released by AICRIP in 1965.

Among the production factors, major barrier in hybrid seed production is to achieve proper nicking between female and male parental lines and the non-uniformity in flowering period of male and female parent results in poor seed set mainly due to non-availability of pollen at the time of stigma receptivity in female parent due to the protogyny. To achieve proper synchronization of flowering of male and female parents during hybrid seed production, the methods like staggered planting, chemical methods and cultural practices such as application of additional dose of nitrogen through soil, spraying of urea, gibberellic acid, ABA, hydro priming and controlled irrigation are followed.

The pearl millet hybrid BPMH-3 is a cross between ICMA 9277 ×TPRT 111.

The female parent (ICMA 9277) flowers earlier than male parent (TPRT 111). The period of staggered sowings in hybrid seed production of pearl millet can be reduced amicably by application of additional dose of nitrogen to late parent so that the late flowering parent meet synchrony and facilitate the simultaneous flowering which otherwise difficult under a longer period of staggered sowing. In the past, several methods have been adopted to overcome the problem of non-synchronization of flowering. When the difference in flowering between parental lines is more than the marginal, the only alternative is staggered planting which is not in practice in pearl millet hybrid. In staggered planting, the planting dates of parental lines of hybrid is adjusted to make them to flower at the same time but the success mainly depends on the information about the flowering behaviour of both the parents across the locations during different seasons, as inter planting of parental lines in definite row ratios is involved in pearl millet hybrid seed production. Since pearl millet is nitro positive crop, increase in the doses of nitrogen application has been practiced to hasten the flowering which also enables the parental lines to bridge the marginal gap in the flowering period. The flowering behaviour could also be manipulated by the use of different chemicals like gibberellic acid, foliar spray of nitrogen, phosphorus and presowing hydration, which hasten the flowering. Hence, in the present investigation efforts were made to achieve synchrony between parental flowering where flowering of male parent is 11 days later compared to the female parent.

Flowering behaviour in parental lines of pearl millet hybrid BPMH-3 revealed that, with the advancement in date of sowing at fortnightly interval from first fortnight of June, 2016 to second fortnight of December 2016, was observed decreasing trend in days to fifty per cent flowering in female (ICMA 9277) and male parent (TPRT 111).

Material and methods

The field experiment was conducted during *Kharif* 2016 at Main Agricultural Research Station (MARS), UAS Dharwad, which is situated at 15012' N latitude and 76034'E longitude with an altitude of 678m above mean sea level. The experimental site consisted of medium deep black soil. The field experiment was laid out in a split plot design with two factors, Factor - I: Staggered sowing (S), Factor - II: application of additional dose of nitrogen to male parent (N). Main factor consisting of sowing of male line at different dates i.e. S_1: Simultaneous sowing of both the parents, S_2: Staggered sowing of late parent (male) 3 days earlier to female, S_3: Staggered sowing of late parent (male) six days earlier to female and S_4: Staggered sowing of late parent (male) nine days earlier to female. While, sub plots of application of additional dose of nitrogen to male parent consisted of N_0: Recommended dose of fertilizer (100:60:25NPK, kg/ha), N_1: Additional 10kg/ha N application 30 days after sowing and N_2: Additional 10kg/ha N application 35days after sowing.

The Another field experiment was carried out at Saidapur farm, University of Agricultural Sciences, Dharwad, to study the flowering behaviour of TPRT 111 (male) and ICMA 9277 (female) parents of pearl millet BPMH-3. The field experiment was laid out under Randomized Block Design (RBD) with two replications and fourteen treatments of periodical date of sowing with fifteen days interval from first June, 2016 (T_1) to Second fortnight of December, 2016 (T_{14}).

The observations on days to panicle initiation, flower initiation and 50 per cent flowering were recorded at respective stages.

Results and discussion

The experimental results indicated that, delay in days to panicle initiation, flower initiation and fifty per cent flowering in S_4N_2 treatment combination (Table-1 and Table-2). Among the staggered sowings, S_4 recorded less number of days for panicle initiation, flower initiation and 50 per cent flowering. Significant differences were observed for days to panicle initiation, flower initiation and 50 per cent flowering due to staggered sowings irrespective of application of additional dose of nitrogen. However, the sowing of male parent 9 days before female parent (S_4) took relatively shorter period (56.33 days) for panicle initiation, 61.46 days for flower initiation and 66.33days for fifty per cent flowering as compared to sowing of female and male parent on same day (S_1:57.44 days) for panicle initiation, 62.67 days for flower initiation and 67.64 days for fifty per cent flowering and reduced the difference in fifty per cent flowering between female and male parent from 10.55 to 0.89 days. The results indicated significant effect on flowering parameters due to staggered sowings. These findings are also in conformity with the results of Biradar Patil (1984) [3] and Shivappa (1988) [11] in sorghum hybrid seed production, Tanwir Alam *et al*. (2007) [12] in maize hybrid and Dhedhi *et al*. (2007) in Bajra.

Irrespective of staggered sowings, application of additional dose of nitrogen revealed significant variation on flowering parameters. However, number of days taken to panicle initiation, flower initiation and 50 per cent flowering was relatively less (55.92days, 61.25days and 65.92days respectively) at 10kg N at 35 DAS. This may be due to increase in plant height and more number of leaves leading to faster growth of reproductive structures. Further, it was also related to greater availability and translocation of photosynthates at the metabolizing zone and it hastened flowering behaviour of the plants due to additional application of nitrogen levels at 35DAS. Similar findings were also reported by Pandusastry (1981) in CSH-5 and Shivappa (1988) [11] in DSH-1 sorghum hybrid, Dhedhi *et al*. (2006) [4] in bajra, Tanwir Alam *et al*. (2007) [12] in maize.

The interaction effect between staggered sowings and application of additional dose of nitrogen (SxN) showed significant variation for days to panicle initiation, flower initiation and 50 per cent flowering. However, the treatment combination of sowing of male parent 9 days before female sowing along with application of 10kg/ha additional nitrogen to late parent took relatively less number of days panicle initiation, flower initiation and 50 per cent flowering (55.33days, 61.00days and 65.00days respectively) as compared to the simultaneous sowing of male and female parents and application of recommended dose of fertilizer (S_1N_0) took 58.40, 63.10days and 68.33 days for panicle initiation, flower initiation and 50 per cent flowering respectively.

Closer synchronization of flowering between parents (ICMA 9277xTPRT 111) of hybrid pearl millet BPMH-3 could be obtained by sowing of male parent by 9 days earlier to female along with application of additional dose of nitrogen to late parent at 35DAS(Fig. 1). Further, this treatment resulted in better yield components, higher seed yield and better seed quality traits. These findings are in agreement with those of earlier researchers in sorghum hybrid seed production (Shivappa, 1988). Further, smaller differences in flowering between female and male parent resulted in good synchronization of flowering between parents on account of more availability of viable pollens. Hence, this resulted in the higher seed setting (78.10%) and increased hybrid seed yield

components as evident from the results of this study. Similar positive results of plant nutrients on hybrid seed yield components was also reported by Joshi (1976) [6] and Patil (1978) [8] in sorghum; Dhedhi *et al*. (2006) [4] and Bhanuje (2012) [2] in bajra and Varshney *et al*. (2006) [13] and Tanwir Alam *et al*. (2007) [12] in maize.

Table 1: Days to panicle initiation and flower initiation in female parent and male parent as influenced by staggered sowing and application of additional dose of nitrogen to late parent (restorer line).

Treatments	Days to panicle initiation (days)		Days to flower initiation (days)	
Main plot : Staggered sowings (S)	**Female parent (Seed parent)**	**Male parent (Restorer line)**	**Female parent (Seed parent)**	**Male parent (Restorer line)**
S_1: Simultaneous sowing of both the parents	48.01	57.44	51.44	62.67
S_2: Staggered sowing of late parent (male) three days earlier to female	47.86	57.22	51.37	62.28
S_3: Staggered sowing of late parent (male) six days earlier to female	48.08	57.33	51.42	62.00
S_4: Staggered sowing of late parent (male) nine days earlier to female	46.97	56.33	51.17	61.46
Mean	47.73	57.20	51.36	62.10
S.Em. ±	0.27	0.14	0.46	0.15
C.D. (P = 0.05)	NS	0.42	NS	0.46
Sub plot: Application of additional doses of nitrogen to late parent (N)				
N_0: Recommended dose of fertilizer (100:60:25 kg ha^{-1}) only	47.88	58.08	51.27	62.80
N_1: Application of additional N @ 10 kg ha^{-1} at 30 DAS	47.66	57.25	51.39	62.25
N_2: Application of additional N @ 10 kg ha^{-1} at 35 DAS	47.67	55.92	51.40	61.25
Mean	47.73	57.20	51.36	62.10
S.Em. ±	0.35	0.16	0.56	0.14
C.D. (P = 0.05)	NS	0.50	NS	0.44
Interactions (SXN)				
S_1N_0	47.83	58.40	51.33	63.17
S_1N_1	48.07	57.73	51.33	63.00
S_1N_2	48.13	56.40	51.67	61.83
S_2N_0	47.67	58.06	51.00	63.00
S_2N_1	47.83	57.76	51.45	62.67
S_2N_2	48.09	56.10	51.67	61.17
S_3N_0	48.09	58.46	51.33	63.00
S_3N_1	47.73	57.50	51.67	62.00
S_3N_2	48.43	56.43	51.25	61.00
S_4N_0	47.92	57.80	51.4	62.03
S_4N_1	47.00	56.40	51.11	61.33
S_4N_2	46.00	55.33	51.00	61.00
Mean	47.73	57.20	51.36	62.10
S.Em. ±	0.59	0.47	0.20	0.41
C.D. (P = 0.05)	NS	1.44	NS	1.24

NS: Non significant

Table 2: Days to 50 per cent flowering in Female parent (ICMA 9277) and male parent (TPRT 111) as influenced by staggered sowing and application of additional dose of nitrogen to late parent (restorer line).

Treatments	Days to 50 flowering (days)		
Main plot : Staggered sowings (S)	**Female parent (Seed parent)**	**Male parent (Restorer line)**	**Difference (days)**
S_1: Simultaneous sowing of both the parents	56.89	67.44	10.55
S_2: Staggered sowing of late parent (male) three days earlier to female	56.44	67.22 (-3)	7.78
S_3: Staggered sowing of late parent (male) six days earlier to female	57.00	67.33 (-6)	4.33
S_4: Staggered sowing of late parent (male) nine days earlier to female	56.44	66.33 (-9)	0.89
Mean	56.69	67.08	-
S.Em. ±	0.63	0.14	
C.D. (P = 0.05)	NS	0.42	
Sub plot: Application of additional doses of nitrogen to late parent (N)			
N_0: Recommended dose of fertilizer (100:60:25 kg ha^{-1}) only	57.17	68.08	10.91
N_1: Application of additional N @ 10 kg ha^{-1} at 30 DAS	56.83	67.25	10.42(-0.42)
N_2: Application of additional N @ 10 kg ha^{-1} at 35 DAS	56.08	65.92	9.84(-1.07)
Mean	56.69	67.08	-
S.Em. ±	1.39	0.16	
C.D. (P = 0.05)	NS	0.50	
Interactions (SXN)			
S_1N_0	57.33	68.33(-0)	11
S_1N_1	57.00	67.67(-0.49)	10.18
S_1N_2	56.33	66.33(-1.07)	8.93

S_2N_0	57.00	68.00 (-3)	8
S_2N_1	56.33	67.33 (-3.49)	7.51
S_2N_2	56.00	66.00 (-4.07)	5.93
S_3N_0	57.33	68.33 (-6)	5
S_3N_1	57.33	67.33 (-6.49)	3.51
S_3N_2	56.33	66.33 (-7.07)	2.93
S_4N_0	57.00	67.67 (-9)	1.67
S_4N_1	56.67	66.33 (-9.49)	0.17
S_4N_2	55.67	65.00 (-10.07)	-0.74
Mean	56.69	67.08	-
S.Em. ±	0.18	0.48	
C.D. (P = 0.05)	NS	1.47	

NS: Non significant

Fig. 1 : Days to 50 % flowering in Female parent (ICMA 9277) and male parent (TPRT 111) as influenced by staggeredsowing and application of additional of nitrogen

Among the different dates of sowing, the female (ICMA 9277) and male (TPRT 111) parental lines took significantly more number of days 52.00 days and 64.00 days respectively when sown during first fortnight of June 2016. While, less number of days was recorded by female and male parental lines (46.00 days and 51.00 days respectively) when sown during second fortnight of December 2016 indicated in Table 3 and depicted in figure 2. Progressive decline in days to fifty percent flowering was observed with the advancement in the sowing.

In the sowings, taken during the month of June, July, August and September months delayed the flowering due to rainy days, non-availability of better sun shine hours and due to prevailing photo period nature, as flowering requires particular day length and temperature and also pearl millet is photosensitive and short day plant Short day length induces early flowering. During the month of December, the day length is short this period favours early flowering. This was true with both the parents. The present results are in conformity with the findings of Quinby and Shertz (1970) in sorghum hybrid seed production. The early flowering in December second sowing might be due to low temperature and good sunshine hours during that period (Shirwal *et al.* 1974 and Ganachari, 2015).

From the above data it can be concluded that at all the dates of sowing, both the male and female parents found to be non synchronous in their flowering behaviour. Hence, none of the dates of sowing found suitable for synchronous flowering of male and female parental lines of pearl millet hybrid BPMH-3 seed production at Dharwad location.

Table 3: Influence of date of sowing on days to fifty per cent flowering in A-line (ICMA 9277) and R-line (TPRT 111)

Treatments	Days to fifty per cent flowering		
	A-line	R-line	Difference (days)
T_1: First fortnight of June, 2016	52	64	12
T_2: Second fortnight of June, 2016	51	62.5	11.5
T_3: First fortnight of July, 2016	50.5	62	11.5
T_4: Second fortnight of July, 2016	50	61	11
T_5: First fortnight of August, 2016	49.5	60	10.5
T_6: Second fortnight of August, 2016	48.5	58.5	10
T_7: First fortnight of September, 2016	49.5	59	9.5
T_8: Second fortnight of September, 2016	48	57	9
T_9: First fortnight of October, 2016	48	56.5	8.5
T_{10}: Second fortnight of October, 2016	47.5	55	7.5
T_{11}: First fortnight of November, 2016	47	54	7
T_{12}: Second fortnight of November, 2016	46.5	53	6.5
T_{13}: First fortnight of December, 2016	46.5	52	5.5
T_{14}: Second fortnight of December, 2016	46	51	5
Mean	48.60	57.53	-
S.Em. ±	1.93	2.93	-
C.D. (P = 0.05)	5.92	8.95	-

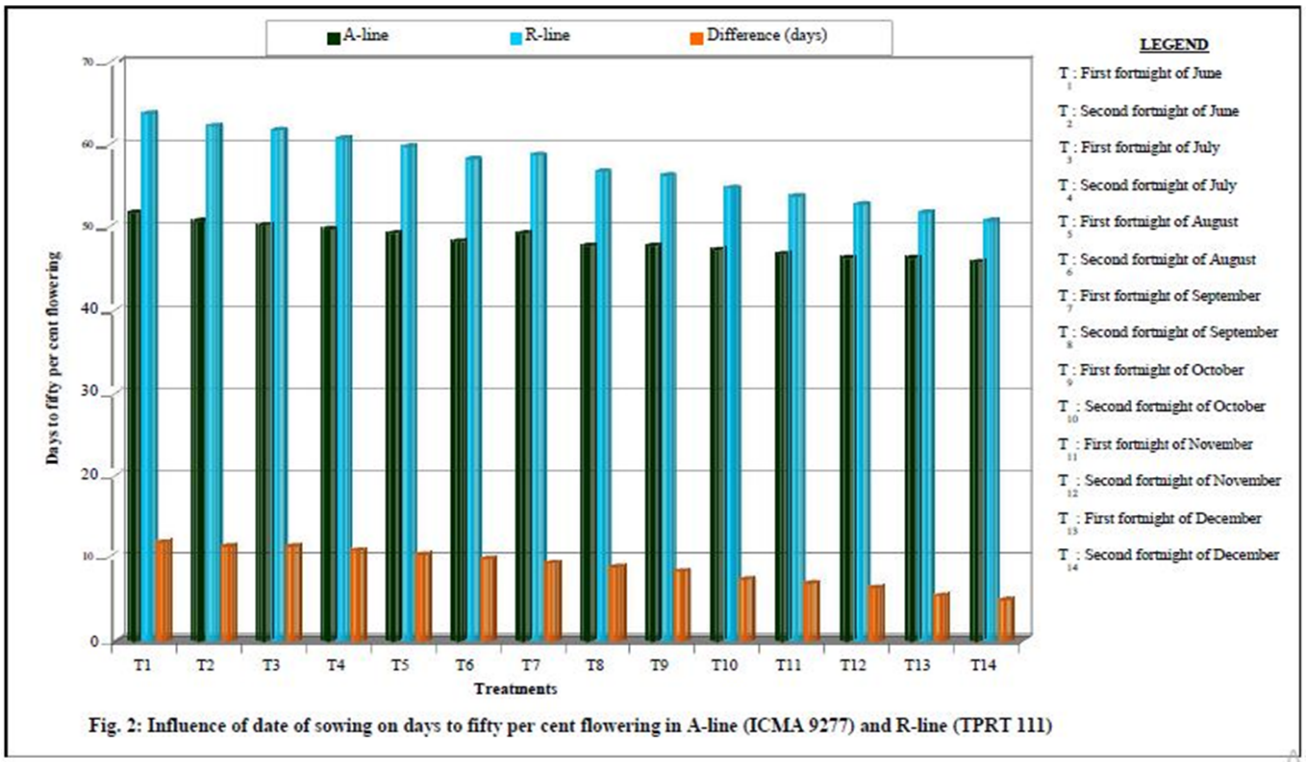

Fig. 2: Influence of date of sowing on days to fifty per cent flowering in A-line (ICMA 9277) and R-line (TPRT 111)

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