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Identification of suitable synchronization technique in pearl millet [*Pennisetum glaucum* (L.) R. Br.] hybrid VPMH-7

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Abstract

The present investigation was carried out to study the influence of staggered sowing of male parent along with additional nitrogen dose of 10 kg/ha to male parent on synchronization of flowering. The results of the experiment revealed that male parent flowered late by 6.41 days than the female parent with simultaneous sowing (V₁). Among the different techniques to achieve synchronization of flowering, sowing of male parent (CPRT-112) by six days earlier to female (V₃) along with additional nitrogen dose of 10 kg/ha at 25 DAS to male parent (N₂) resulted in better synchronization of flowering (0.53 days). This treatment also hastened the days to panicle initiation in male parent (43.53 days), days to 50% flowering in male parent (52.75 days), increased the ear head weight (34.27 g), number of seeds per ear head (1853.00), seed weight per ear head (19.46 g), seed set (88.13%), highest seed yield (2701.96 kg/ha) and 1000 seed weight (10.76 g) as compared to other treatments.

Keywords: Staggered sowing, synchronization, nitrogen, panicle initiation and 50% flowering

Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is widely grown in Sahelian region. Sahel zone of West Africa is the centre of diversity, wherein it is suggested to be domesticated 5000 year ago (Andrews and Kumar, 1992) [1]. It was introduced to Indian subcontinent about 3000 years ago. Now, it is one of the important commercial crops which were earlier under subsistence farming only. This crop perform well under harsh environmental conditions with the annual rainfall being very low about less than 250 mm and the temperature required is very high about 30 °C in loamy soils (Anon., 1996) [3].

India is one among the major pearl millet growing countries. Out of total pearl millet growing area of the world 43.3% is shared by India. In India, about 6.70 mha of area is under pearl millet cultivation with production of 9.62 mt and productivity of 1,436 kg/ha (Anon., 2023) [2]. Rajasthan is the major pearl millet growing state with 3.74 mha under cultivation with the production of 3.75 mt and 1004 kg/ha productivity followed by Uttar Pradesh, Haryana, Gujarat, Madhya Pradesh and Maharashtra in terms of area under cultivation and production. Madhya Pradesh tops in terms of productivity of 2,533 kg/ha which is followed by Gujarat, Haryana, Uttar Pradesh, Karnataka and Rajasthan. In Karnataka, it is one of the major *kharif* crops grown over 0.15 mha, with production of 0.17 mt and productivity of 1161 kg/ha (Anon., 2023) [2].

Pearl millet plant takes about 4-6 days for panicle emergence from the sheath (Bhatnagar and Kumar, 1960) [5]. Only after the completion of panicle emergence out of boot, the flowering starts but it is also seen that in some genotypes before end of panicle emergence, the style exertion begins. In the central upper part of the panicle, the stylar exertion starts and then progresses downward as well as upward of the panicle. On third day of flowering, the maximum exertion of style is seen. Pearl millet shows protogynous flowering behaviour, wherein the stigma emerges before the anthers. For the period of 12-16 hours, the stigma remains receptive in pearl millet. Depending on genotypes and environment, varying degree of protogyny is expressed in pearl millet (Rachie and Majumdar, 1980) [11]. Throughout the day and night,

anthesis occurs and remains peak between the 8.00 pm to 2.00 pm (Sundararaj and Thulasidas, 1980) ^[13].

The non-uniformity in flowering period between the seed parent and the pollen parent is the reason for poor seed set and it is primarily due to non-availability of pollen when the stigma is receptive in seed parent. This problem is generally tackled by adjusting planting date of parental lines in seed production plot. However, when staggered sowing alone is not feasible, differential application of nitrogenous fertilizer to late parent is practiced (Dhedhi *et al.*, 2007) ^[7]. Pearl millet is a nitro positive crop, so in order to hasten flowering, the practice of using nitrogen dosage to reduce the gap in the flowering time between the parents is widely carried out.

The pearl millet hybrid VPMH-7 is a cross between ICMA-94555 and CPRT-112. The male parent CPRT-112 was found to be late in blooming than the female parent ICMA-94555. This gap between the flowering times could be minimized by giving additional nitrogen to late flowering parent along with staggered sowing, wherein the late parent is sown earlier than the other parent. The nitrogen doses could help to overcome the longer staggered sowings by hastening the flowering and thus, facilitating simultaneous flowering of both the parents.

Material and Methods

The field experiment was conducted at Agricultural Research Station, Arabhavi, UAS, Dharwad. It was laid out in a split plot design with two factors *i.e.*, Factor - I: Staggered sowing (V), Factor II: Application of additional dose of nitrogen to male parent (N). Main factor consisted of sowing of male line at different dates *i.e.*, V₁: Simultaneous sowing of both the parents, V₂: Staggered sowing of late parent (male) four days earlier to female, V₃: Staggered sowing of late parent (male) six days earlier to female, V₄: Staggered sowing of late parent (male) eight days earlier to female and V₅: Staggered sowing of late parent (male) ten days earlier to female, while sub plots of application of additional dose of nitrogen to male parent consisted of N₁: Additional N dose of 10 kg/ha at 20 days after sowing, N₂: Additional N dose of 10 kg/ha at 25 days after sowing, N₃: Additional N dose of 10 kg/ha at 30 days after sowing and N₄: Additional N dose of 10 kg/ha at 35 days after sowing.

Results and Discussion

Among the staggered sowings, V₃ treatment recorded less number of days for panicle initiation and days to 50% flowering. Significant differences were observed for days to panicle initiation and 50% flowering due to staggered sowings irrespective of application of additional dose of nitrogen (Table 1). However, the sowing of male parent six days before the female parent (V₃) took relatively shorter period (44.56 days) for panicle initiation and 50% flowering (54.30 days) as compared to sowing of female and male parent on same day (V₁) for

panicle initiation (48.88 days) and 50% flowering (59.62 days). The results indicated significant effect on flowering parameters due to staggered sowings. These findings are also in conformity with the results of BiradarPatil (1984) ^[6] and Shivappa (1988) ^[12] in sorghum hybrid seed production, Tanwir *et al.* (2007) ^[14] in maize hybrid and Dhedhi *et al.* (2007) ^[7] in pearl millet.

Irrespective of staggered sowings, application of additional dose of nitrogen revealed significant variation on flowering parameters. However, number of days taken to panicle initiation and 50% flowering was relatively less (45.60 days and 55.46 days, respectively) at 10 kg N at 25 DAS (N₂). 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 25 DAS. Similar findings were also reported by Pandusastry (1981) ^[9] in CSH-5 and Shivappa (1988) ^[12] in DSH-1 sorghum, Dhedhi *et al.* (2007) ^[7] in bajra and Tanwir *et al.* (2007) ^[14] in maize.

The interaction effect between staggered sowings and application of additional dose of nitrogen (V × N) showed significant variation for days to panicle initiation and 50% flowering. However, the treatment combination of sowing of male parent six days before the female parent sowing along with application of 10 kg/ha additional nitrogen to late parent at 25 DAS (V₃N₂) took relatively less number of days panicle initiation and 50 per cent flowering (43.53 days and 52.75 days respectively) as compared to the simultaneous sowing of male and female parents and application of 10 kg/ha additional nitrogen to late parent at 20 DAS (V₁N₁) took 49.00 days and 59.77 days for panicle initiation and 50% flowering, respectively. Closer synchronization of flowering between parents (ICMA-94555 × CPRT-112) of hybrid pearl millet VPMH-7 could be obtained by sowing of male parent by six days earlier to female along with application of 10 kg/ha additional dose of nitrogen to late parent at 25 DAS. 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. 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 increased the ear head weight (34.27 g), number of seeds per ear head (1853.00), seed weight per ear head (19.46 g), seed set (88.13%), highest seed yield (2701.96 kg/ha) and 1000 seed weight (10.76 g) as compared to other treatments (Table 2). Similar positive results of plant nutrients on hybrid seed yield components was also reported by Joshi (1976) ^[8] and, Patil and Goud (1980) ^[10] in sorghum; Dhedhi *et al.* (2007) ^[7] and Bhanuje *et al.* (2014) ^[4] in bajra, Varshney *et al.* (2006) ^[15] and Tanwir *et al.* (2007) ^[14] in maize.

Table 1: Influence of staggered sowing and application of additional nitrogen dose to male parent on days to panicle initiation and 50% flowering in parental lines of pearl millet hybrid VPMH-7

Treatment	Days to panicle initiation			Days to 50% flowering		
	Female parent (ICMA-94555)	Male parent (CPRT-112)	Difference	Female parent (ICMA-94555)	Male parent (CPRT-112)	Difference
Main plot (V): Staggered sowings						
V1: Simultaneous sowing of male and female parent	42.72	48.88	6.16	53.20	59.62	6.41
V2: Sowing of male parent 4 days earlier to female parent	41.51	47.68	6.17	49.97	56.85	2.88
V3: Sowing of male parent 6 days earlier to female parent	40.20	44.56	4.37	47.77	54.30	0.54
V4: Sowing of male parent 8 days earlier to female parent	41.12	45.63	4.51	49.57	55.65	-1.91
V5: Sowing of male parent 10 days earlier to female parent	41.21	45.72	4.51	49.86	56.02	-3.83
S. Em±	0.50	0.63		1.94	0.90	
CD (5%)	NS	2.07		6.32	2.92	
Sub plot (N): Additional nitrogen dose to late parent						
N1: Additional N dose of 10kg/ha at 20 days after sowing	42.06	46.59	4.53	50.42	57.11	6.68
N2: Additional N dose of 10kg/ha at 25 days after sowing	40.37	45.60	5.23	49.14	55.46	6.32 (-0.36)
N3: Additional N dose of 10kg/ha at 30 days after sowing	41.52	45.98	4.46	49.76	56.15	6.39 (-0.29)
N4: Additional N dose of 10kg/ha at 35 days after sowing	41.45	47.80	6.35	50.96	57.24	6.28 (-0.41)
S. Em±	0.42	0.42		1.66	0.34	
CD (5%)	NS	1.21		4.80	0.99	
Interactions (V × N)						
V ₁ N ₁	44.00	49.00	5.00	54.50	59.77 (-0)	5.27
V ₁ N ₂	39.98	48.60	8.62	53.18	59.11 (-0.36)	5.57
V ₁ N ₃	43.51	48.08	4.58	53.53	59.87 (-0.29)	6.05
V ₁ N ₄	43.39	49.83	6.44	51.60	59.71 (-0.41)	7.70
V ₂ N ₁	44.26	47.57	3.31	50.32	58.69 (-4)	4.37
V ₂ N ₂	40.67	46.48	5.81	49.71	55.29 (-4.36)	1.22
V ₂ N ₃	40.07	47.57	7.50	50.16	55.62 (-4.29)	1.17
V ₂ N ₄	41.02	49.07	8.06	49.71	57.82 (-4.41)	3.70
V ₃ N ₁	40.37	44.76	4.39	48.12	55.22 (-6)	1.09
V ₃ N ₂	39.46	43.53	4.06	45.85	52.75 (-6.36)	0.53
V ₃ N ₃	40.33	44.81	4.48	46.81	54.44 (-6.29)	1.34
V ₃ N ₄	40.62	45.16	4.54	50.28	54.81 (-6.41)	-1.87
V ₄ N ₁	40.40	45.44	5.04	49.90	57.29 (-8)	-0.61
V ₄ N ₂	41.25	44.89	3.64	49.72	54.99 (-8.36)	-3.09
V ₄ N ₃	42.27	46.93	4.67	48.35	55.07 (-8.29)	-1.57
V ₄ N ₄	40.56	45.24	4.67	50.29	55.26 (-8.41)	-3.44
V ₅ N ₁	41.27	46.18	4.92	49.28	54.56 (-10)	-4.72
V ₅ N ₂	40.51	44.51	4.01	47.25	55.18 (-10.36)	-2.43
V ₅ N ₃	41.40	42.50	1.10	49.97	55.77 (-10.29)	-4.49
V ₅ N ₄	41.67	49.69	8.02	52.92	58.58 (-10.41)	-4.75
Mean	41.35	46.49		50.07	56.49	
S.Em±	0.96	1.03		3.76	1.11	
CD (5%)	NS	3.12		11.22	3.49	

Table 2: Influence of staggered sowing and application of additional nitrogen dose to male parent on seed yield and its attributes in pearl millet hybrid VPMH-7

Treatment	Ear head weight (g)	Thousand seed weight (g)	Number of seeds per ear	Seed weight per ear (g)	Seed set percentage	Seed yield (kg/ha)
Main plot (V): Staggered sowings						
V1: Simultaneous sowing of male and female parent	21.56	10.09	495.42	4.90	15.22 (22.95)	453.47
V2: Sowing of male parent 4 days earlier to female parent	29.15	9.92	1700.33	16.86	77.45 (61.65)	2522.81
V3: Sowing of male parent 6 days earlier to female parent	33.53	9.72	1819.83	17.68	87.07 (68.92)	2651.84
V4: Sowing of male parent 8 days earlier to female parent	33.07	10.19	1744.67	17.86	85.59 (67.68)	2443.45
V5: Sowing of male parent 10 days	31.61	9.93	1715.17	17.18	84.64 (66.92)	2390.75

earlier to female parent						
S. Em±	0.35	0.08	11.74	0.20	0.35	37.79
CD (5%)	1.14	0.25	38.28	0.64	1.16	123.25
Sub plot (N): Additional nitrogen dose to late parent						
N ₁ : Additional N dose of 10kg/ha at 20 days after sowing	29.02	9.68	1492.80	14.44	69.28 (56.99)	2079.64
N ₂ : Additional N dose of 10kg/ha at 25 days after sowing	30.70	10.17	1522.33	15.37	70.87 (58.31)	2180.62
N ₃ : Additional N dose of 10kg/ha at 30 days after sowing	30.04	9.94	1478.87	14.58	69.94 (57.64)	2044.77
N ₄ : Additional N dose of 10kg/ha at 35 days after sowing	29.37	10.09	1486.33	15.20	69.89 (57.55)	2064.83
S. Em±	0.21	0.09	10.21	0.18	0.21	35.24
CD (5%)	0.61	0.27	29.50	0.53	0.62	101.78
Interactions (V × N)						
V ₁ N ₁	20.93	9.83	463.33	4.70	14.77 (22.59)	400.67
V ₁ N ₂	22.90	10.23	517.67	4.80	15.37 (23.07)	445.89
V ₁ N ₃	21.70	10.27	497.33	4.97	15.53 (23.20)	547.33
V ₁ N ₄	20.70	10.03	503.33	5.13	15.20 (22.93)	420.00
V ₂ N ₁	27.51	9.33	1728.33	16.13	79.81 (63.29)	2353.09
V ₂ N ₂	29.72	10.10	1726.67	17.45	78.33 (62.24)	2589.70
V ₂ N ₃	29.70	10.20	1683.33	17.17	75.00 (59.98)	2611.54
V ₂ N ₄	29.67	10.03	1663.00	16.68	76.67 (61.11)	2536.90
V ₃ N ₁	33.80	9.67	1793.33	17.34	85.68 (67.75)	2637.38
V ₃ N ₂	34.27	9.87	1828.67	18.04	88.13 (69.82)	2701.96
V ₃ N ₃	33.22	9.50	1804.00	17.13	87.46 (69.25)	2604.97
V ₃ N ₄	32.84	9.83	1853.33	18.23	87.03 (68.87)	2663.03
V ₄ N ₁	32.71	9.70	1767.00	17.15	83.68 (66.14)	2558.26
V ₄ N ₂	33.42	10.63	1830.00	19.46	86.89 (68.75)	2589.33
V ₄ N ₃	33.22	9.67	1703.33	16.47	86.28 (68.24)	2236.33
V ₄ N ₄	32.93	10.76	1678.33	18.38	85.50 (67.60)	2389.87
V ₅ N ₁	30.15	9.87	1712.00	16.88	82.44 (65.20)	2448.79
V ₅ N ₂	33.18	10.00	1708.67	17.09	85.61 (67.69)	2576.20
V ₅ N ₃	32.36	10.07	1706.33	17.18	85.43 (67.55)	2223.67
V ₅ N ₄	30.74	9.80	1733.67	17.57	85.07 (67.25)	2314.33
Mean	29.78	9.97	1495.08	14.90	69.99 (57.63)	2092.46
S. Em±	0.54	0.19	23.00	0.41	0.55	78.01
CD (5%)	1.65	0.57	68.66	1.21	1.66	232.13

Conclusion

Closer synchronization of flowering between parents (ICMA-94555 × CPRT-112) of hybrid pearl millet VPMH-7 could be obtained by taking up sowing of male parent (CPRT-112) by six days earlier to female parent followed by application of additional dose of nitrogen @ 10 kg/ha at 25 DAS to male parent. Further, this treatment resulted in better yield components and higher seed yield.

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