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Khair ANRegional Research Station,
Anand Agricultural University,
Anand, Gujarat, India**Bhanvadia A**Regional Research Station,
Anand Agricultural University,
Anand, Gujarat, India**Kalyanrao Patil**Department of Seed Science and
Technology, Anand Agricultural
University, Anand, Gujarat,
India

Effect of staggered sowing and foliar spray of fertilizer on seed yield and quality of pearl millet (*Pennisetum glaucum* L.) hybrid GHB 905

Khair AN, Bhanvadia A and Kalyanrao Patil

Abstract

A field experiment was conducted during summer seasons of 2018 on loamy sand soil at Regional Research Station Farm, Anand Agricultural University, Anand, Gujarat to study the effect of staggered sowing and foliar spray of fertilizer on seed yield and quality of pearl millet (*Pennisetum glaucum* L.) hybrid GHB 905. The experiment was laid out in split plot design with nine treatment combinations and four replications. The results revealed that sowing of male parent by four days earlier to female and foliar spray of urea @ 2% on male parent at 25 DAS recorded less number of days to 50% flowering in male (49.25 days) and it also recorded significantly higher ear head length (25.44 cm), ear head girth (9.03 cm), number of seeds per ear head (2048), ear head weight (25.80 g), seed weight per ear head (18.28 g), test weight (7.88 g) and hybrid seed yield (2172 kg/ha). Higher seed quality traits viz., seed germination (84.25%), seedling root length (14.75 cm), seedling shoot length (3.95 cm), seedling dry weight (38.62 mg), seedling vigour index I (1575) and seedling vigour index II (3254) with higher net returns of ₹ 106020/ha and BCR of 4.70 were also reported under same treatment combination.

Keywords: Staggered sowing, foliar spray of fertilizer, synchronization, hybrid seed yield, seed quality and net return

Introduction

Pearl millet (*Pennisetum glaucum* L.) is one of the important major millet, belongs to family Poaceae. It is a major warm-season coarse grain cereal grown on 26 million hectares in semi-arid tropical environments of Asia and Africa with a production of 29 million tonnes (Anon., 2017a) [4]. India is the largest producer, both in terms of area (7.47 million hectares) and production (9.80 million tonnes), with average productivity of 1312 kg/ha (Anon., 2017b) [2]. The major pearl millet growing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana, which account for more than 90% of pearl millet acreage in the country. Pearl millet cultivation is mainly during *Kharif* across the country. It is also grown to a lesser extent during the summer season in Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. Summer pearl millet cultivation is popular in Gujarat because of higher productivity and excellent grain quality in this season. In Gujarat, pearl millet growing area was 0.39 million hectares and production was 0.96 million tonnes with average productivity of 2430 kg/ha (Anon., 2019) [3].

Seed is the key input in determining crop establishment and yield in agriculture unlike the commercial grain production, the process of hybrid seed production is a difficult task. Hybrid seed yield in any crop depends on synchronization of parental lines, proper planting ratio and yielding ability of female parent. Among the production factors, major barrier in hybrid seed production is to get perfect synchronization of flowering between female and male parental lines; non-uniformity in flowering period of male and female parent causes a poor seed set due to non-availability of pollen at the time of stigma receptivity in female parent (Bhanuje, 2012) [7].

Synchronization of flowering in parents can be achieved through simple agronomic manipulations like staggered sowing and cultural practices viz., application of nitrogenous fertilizer through soil or foliar spray, spray of gibberellic acid and controlled irrigation are being followed in hybrid seed production programme. In staggered sowing method, the male and female parents are sown at different dates depending on the differences in their flowering

Corresponding Author:**Khair AN**Regional Research Station,
Anand Agricultural University,
Anand, Gujarat, India

days to coincide the flowering of male parent with that of female parent (Kumar and Merwade, 2012)^[11]. The previous concept ascertained by Tisdale and Nelson (1966)^[17] that nitrogen fertilization delays the maturity of crops. However, it is not invariably true, delaying maturity is determined by the nature of the crop, nitrogen deficiency, quantity and time of nitrogen application. Therefore, only such agronomic practices should be advocated that induce early maturity and make multiple cropping a success. Hence, nitrogen application is likely to enhance the maturity (Shrivastava and Singh, 1969)^[16]. Pearl millet is nitro positive crop; increase in the doses of nitrogen application has been in practice to hasten the flowering, which also enables the parental lines to bridge the marginal gap in the flowering duration (Bhanuje *et al.*, 2014)^[6].

The pearl millet hybrid GHB 905 is a cross between ICMA 04999 × J 2454. The female parent (ICMA 04999) flowers seven to eight days earlier to male parent (J 2454). Therefore, synchronization is a serious issue in the seed production of this hybrid. For better flowering synchrony, eight to ten days early sowing of male line is possible solution but in the field all the time land may not free. So, days of sowing of male and female need to reduce by other tools *i.e.*, spraying of both urea and DAP as to the late flowering parent (male parent) to meet synchrony and facilitate the simultaneous flowering. Seed producers facing problem of non-synchronization of flowering that cause poor seed set in seed production of pearl millet hybrid GHB 905. In view of the paucity of adequate, research on “Effect of staggered sowing and foliar spray of fertilizer on seed yield and quality of pearl millet (*Pennisetum glaucum* L.) hybrid GHB 905” was carried out at Regional Research Station Farm, AAU, during summer season of 2018.

Materials and Methods

A study was conducted at Regional Research Station Farm, Anand Agricultural University, Anand to find out the “Effect of staggered sowing and foliar spray of fertilizer on seed yield and quality of pearl millet (*Pennisetum glaucum* L.) hybrid GHB 905” during summer season of 2018. The soil of experimental plot was loamy sand which was low in available N (172.50 kg/ha), medium in available P₂O₅ (48.83 kg/ha) and K₂O (233.72 kg/ha). Nine treatment combination comprising three levels of staggered sowing (M₁-simultaneous sowing of male and female parent, M₂-sowing of male parent by four days earlier to female and M₃-sowing of male parent by eight days earlier to female) and three levels of foliar spray of fertilizer (S₁-water spray, S₂-2% urea spray and S₃-2% DAP spray) were included in the experiment. Three staggered sowing treatments were allotted to main plot while three foliar spray of fertilizer levels were embedded as sub plot in Split Plot Design with four replications. All the treatments of foliar spray of fertilizer were applied at 25 DAS to male parent only. The foundation seed of female (ICMA 04999) and male (J 2454) parent of pearl millet hybrid GHB 905 were obtained from the Pearl millet Research Station, Jamnagar, Junagadh Agricultural University, Gujarat. Seed quality parameters were tested as per ISTA rules and vigour index was determined according to Abdul-Baki and Anderson (1973)^[1]. The economics was worked out on current market price basis. The variances of different sources of variation in ANOVA were tested by “F-test” and compared with the value of Table-F at 5% level of significance.

Results and Discussion

Growth parameters

Staggered sowing did not exhibit marked variations on growth parameters of both the parents (Table 1). Foliar spray of fertilizer significantly influenced the plant height of male parent only. Foliar spray of urea @ 2% at 25 DAS to male parent recorded significantly higher plant height at harvest (118.94 cm) followed by foliar spray of DAP @ 2% at 25 DAS to male parent (116.57 cm). It may be attributed to readily available nutrients in the source (nitrogenous fertilizers) that modified morpho-physiological characteristics of plant thus enhanced the source availability to the developing sinks. Basavaraju and Bommegowda (1982)^[5], Yadav and Singh (2000)^[18], Bhanuje (2012)^[7] and Kumar *et al.* (2012)^[10], also reported similar beneficial effect of fertilizer application on plant height. The interaction was found non-significant for growth parameters of both the parents.

Flowering parameters

Days to 50% flowering did not significantly affected by staggered sowing (Table 1). Foliar spray of fertilizer showed significant variation in flowering parameters of male parent only. Significantly lower days to 50% flowering was recorded under foliar spray of urea @ 2% at 25 DAS to male parent (51.17 days) and it remained at par with foliar spray of DAP @ 2% at 25 DAS to male parent (52.25 days). Water sprayed plants took more days to 50% flowering (54.08 days). Pearl millet is nitro-positive crop; foliar spray of nitrogenous fertilizer at initiation of boot leaf stage may increase 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 of the plants. It favors to begin flowering within 2-3 days after emergence of spike. The results collaborate the findings of Reddy and Husain (1967)^[14], Patil and Kulkarni (1989)^[12], Yadav and Singh (2000)^[18], Kannababu and Rana (2003)^[9], Dhedhi *et al.* (2007)^[8], Bhanuje (2012)^[7], Kumar *et al.* (2012)^[10] and Priyanka *et al.* (2017)^[13].

Interaction effect showed significant influence on days to 50% flowering of male parent while result was non-significant in female parent (Table 1). Sowing of male parent by four days earlier to female and foliar spray of urea @ 2% at 25 DAS to male parent recorded significantly lower days to 50% flowering. Which was remained at par with sowing of male parent by four days earlier to female and foliar spray of DAP @ 2% at 25 DAS to male parent. Staggered sowing helped to reduce flowering gap of both parents, which also narrowed by foliar spray of fertilizers. So, closer flowering synchronization was observed under sowing of male parent by four days earlier to female and foliar spray of urea @ 2% at 25 DAS to male parent. In addition, pollen viability of male and stigma receptivity of female parent played major role in seed setting as well as in development of seeds. The results agreed with the findings of Basavaraju and Bommegowda (1982)^[5], Bhanuje *et al.* (2014)^[6] and Priyanka *et al.* (2017)^[13].

Yield attributes and yield

The results revealed that yield attributes and yield were significantly influenced by staggered sowing treatments (Table 1). Significantly the highest ear head girth (8.44 cm), number of seeds per ear head (1933), ear head weight (23.05 g), seed weight per ear head (16.71 g), test weight (7.21 g)

and hybrid seed yield (1973 kg/ha) were recorded under sowing of male parent by four days earlier to female. Foliar spray of fertilizer did not significantly alter yield attributes and hybrid seed yield.

Sowing of male parent by four days earlier to female and foliar spray of urea @ 2% at 25 DAS to male parent recorded significantly higher values of yield attributes viz., ear head length (25.44 cm), ear head girth (9.03 cm), number of seeds per ear head (2048), ear head weight (25.82 g), seed weight per ear head (18.28 g), test weight (7.88 g) and hybrid seed

yield (2172 kg/ha). However, it was at par with sowing of male parent by four days earlier to female and foliar spray of DAP @ 2% at 25 DAS to male parent. Closer nicking in flowering favored higher seed setting in female parent so resulted yield attributes and hybrid seed yield were recorded significantly higher under applied treatment. The results are in accordance with the result reported by Basavaraju and Bommegowda (1982) [5], Bhanuje *et al.* (2014) [6] and Priyanka *et al.* (2017) [13].

Table 1: Effect of staggered sowing and foliar spray of fertilizer on growth parameter, yield attributes and hybrid seed yield

Treatments	Plant height at harvest (cm)		Days to 50% flowering		Ear head length of female (cm)	Ear head girth of female (cm)	Number of seeds per ear head of female	Ear head weight of female (g)	Seed weight per ear head of female (g)	Test weight (g)	Hybrid seed yield (kg/ha)
	Female	Male	Female	Male							
Staggered sowing (M)											
M ₁	84.61	112.90	47.00	53.25	21.00	7.35	1468	18.54	13.42	5.54	1523
M ₂	83.35	117.56	46.17	51.42	23.13	8.44	1933	23.05	16.71	7.21	1973
M ₃	81.82	115.27	47.50	52.83	21.23	7.66	1670	20.89	14.70	6.43	1755
S. Em. ±	2.41	3.35	0.60	0.86	0.62	0.19	40.3	0.61	0.56	0.21	58.33
CD at 5%	NS	NS	NS	NS	NS	0.67	139.3	2.12	1.92	0.74	201.85
CV%	10.02	10.06	4.40	5.68	9.86	8.63	8.2	10.18	12.87	11.64	11.54
Fertilizer Foliar Spray (S)											
S ₁	83.15	110.22	47.33	54.08	21.07	7.62	1633	19.94	14.37	6.16	1653
S ₂	83.96	118.94	46.33	51.17	22.61	8.11	1744	21.62	15.89	6.70	1826
S ₃	82.67	116.57	47.00	52.25	21.67	7.73	1694	20.92	14.57	6.33	1772
S. Em. ±	2.00	1.88	0.49	0.46	0.47	0.14	32.2	0.55	0.46	0.16	52.74
CD at 5%	NS	5.59	NS	1.38	NS	NS	NS	NS	NS	NS	NS
Interaction M×S											
M ₁ S ₁	82.65	104.95	47.50	54.75	20.87	6.86	1393	17.86	11.57	4.90	1283
M ₁ S ₂	85.63	116.90	46.50	51.75	21.22	7.76	1605	19.28	14.44	6.16	1665
M ₁ S ₃	85.55	116.85	47.00	53.25	20.90	7.45	1407	18.50	14.24	5.57	1619
M ₂ S ₁	84.35	112.20	46.25	54.50	20.73	7.93	1846	20.45	15.80	6.63	1841
M ₂ S ₂	83.65	122.33	46.00	49.25	25.44	9.03	2048	25.82	18.28	7.88	2172
M ₂ S ₃	82.05	118.15	46.25	50.50	23.24	8.35	1905	22.86	16.06	7.13	1907
M ₃ S ₁	82.45	113.50	48.25	53.00	21.62	8.06	1660	21.52	15.73	6.94	1834
M ₃ S ₂	82.60	117.60	46.50	52.50	21.17	7.53	1580	19.76	14.94	6.04	1642
M ₃ S ₃	80.40	114.70	47.75	53.00	20.88	7.38	1770	21.39	13.41	6.31	1790
S. Em. ±	3.47	3.26	0.84	0.80	0.81	0.24	55.7	0.96	0.80	0.28	91.36
CD at 5%	NS	NS	NS	2.39	2.40	0.71	165.5	2.84	2.37	0.84	271.45
CV%	8.33	5.65	3.60	3.06	7.42	6.19	6.6	9.17	10.70	8.85	10.44

Seed quality parameters

Data of seed quality parameters were recorded after seed germination test and analyzed data are presented in Table 2. Results showed that sowing of male parent by four days earlier to female was recorded significantly higher values of seed quality parameters viz., germination percentage (81.25%), seedling root length (13.34 cm), seedling shoot length (3.65 cm), seedling dry weight (36.63 mg), seedling vigour index I (1383) and seedling vigour index II (2982). Urea spray @ 2% at 25 DAS to male parent was found to record higher value of seedling vigour index I (1256) and II (2727) than water spray and it was statistically comparable with DAP spray @ 2% at 25 DAS to male parent.

Interaction was found significant for seed quality traits. Seed germination percentage (84.25%), seedling root length (14.75

cm), seedling shoot length (3.95 cm), seedling dry weight (38.62 mg), seedling vigour index I (1575) and seedling vigour index II (3254) were noticed significantly higher under sowing of male parent by four days earlier to female and foliar spray of urea @ 2% at 25 DAS to male parent compared to simultaneous sowing of both the parents and water spray at 25 DAS to male parent. Flowering synchrony at reproductive stage between parental lines increased the availability of viable pollen to the receptive stigma thus prompt higher out crossing. These phenomena helped to getting seeds having higher viability and vigour over other treatment combinations. Bhanuje (2012) [7] and Sharnkumar (2012) [15] were recorded similar findings.

Table 2: Effect of staggered sowing and foliar spray of fertilizer on seed quality parameters of pearl millet hybrid GHB 905

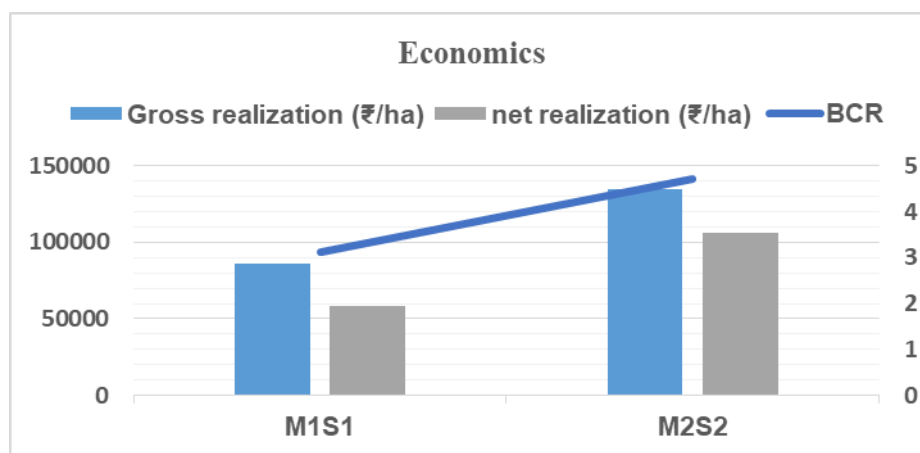
Treatments	Germination%	Seedling root length (cm)	Seedling shoot length (cm)	Dry weight of seedling (mg)	Seedling vigour Index I	Seedling vigour Index II
Staggered Sowing (M)						
M ₁	76.33	10.73	3.01	31.34	1049	2392
M ₂	81.25	13.34	3.65	36.63	1383	2982
M ₃	78.17	11.76	3.17	32.49	1165	2540
S. Em. ±	0.91	0.26	0.05	0.52	18.42	42.16
CD at 5%	3.15	0.91	0.19	1.80	63.74	145.90
CV%	4.01	7.61	5.74	5.37	5.31	5.54
Fertilizer Foliar Spray (S)						
S ₁	77.08	11.58	3.16	32.74	1136	2525
S ₂	79.75	12.35	3.33	34.07	1256	2727
S ₃	78.92	11.91	3.34	33.65	1204	2663
S. Em. ±	0.73	0.22	0.05	0.37	22.11	30.43
CD at 5%	NS	NS	NS	NS	65.72	90.40
Interaction M×S						
M ₁ S ₁	75.00	10.37	3.02	30.45	1004	2281
M ₁ S ₂	78.75	11.40	3.04	33.20	1136	2610
M ₁ S ₃	75.25	10.41	2.61	30.38	1007	2286
M ₂ S ₁	78.25	11.75	3.31	32.48	1177	2539
M ₂ S ₂	84.25	14.75	3.95	38.62	1575	3254
M ₂ S ₃	81.25	13.52	3.70	38.78	1396	3152
M ₃ S ₁	78.00	12.61	3.15	35.29	1227	2754
M ₃ S ₂	76.25	10.89	3.03	30.38	1059	2316
M ₃ S ₃	80.25	11.78	3.34	31.80	1209	2551
S. Em. ±	1.27	0.38	0.09	0.64	38.31	52.70
CD at 5%	3.76	1.13	0.28	1.90	113.83	156.58
CV%	3.22	6.36	5.67	3.83	6.38	4.00

M₁ : Simultaneous sowing of male and female parentsM₂ : Sowing of male parent by four days earlier to female parentM₃ : Sowing of male parent by eight days earlier to female parentS₁ : Water spray at 25 DAS to male parentS₂ : 2 per cent urea spray at 25 DAS to male parentS₃ : 2 per cent DAP spray at 25 DAS to male parent

Economics

Sowing of male parent by four days earlier to female and foliar spray of urea @ 2% at 25 DAS to male parent accrued maximum values of gross realization (₹ 134711/ha), net realization (₹ 106020/ha) and 4.70 of BCR. While, lower

values of gross realization (₹ 85829/ha), net realization (₹ 58312/ha) and 3.12 of BCR were obtained in simultaneous sowing of both parents and water spray at 25 DAS to male parent (Fig. 1).

**Fig 1:** Effect of treatments on economics of pearl millet hybrid (GHB 905) seed production



M₁S₁: Simultaneous sowing of both parents and foliar water spray at 25 DAS only to male parent



M₂S₂: Sowing of male parent by four days earlier to female and 2% urea spray at 25 DAS only to male parent

Plate 1: Treatments wise plot view at flowering stage



M₂S₂: Sowing of male parent by four days earlier to female and 2% urea spray at 25 DAS only to male parent



M₁S₁: Simultaneous sowing of both parents and foliar water spray at 25 DAS only to male parent

Plate 2: Germinated seedling at 7th day (BP method)



M₂S₂: Sowing of male parent by four days earlier to female and 2% urea spray at 25 DAS only to male parent



M₁S₁: Simultaneous sowing of both parents and foliar water spray at 25 DAS only to male parent

Plate 3: Seedling root and shoot length at 7th day (BP method)

Conclusion

From this investigation, it is concluded that closer synchronization of flowering between parents (ICMA 04999 × J 2454) of pearl millet hybrid GHB 905 could be obtained by sowing of male parent by four days earlier to female and foliar spray of urea @ 2% at 25 DAS to male parent for getting 69.29% higher hybrid seed yield with better quality seed traits and securing 81.81% higher net return over simultaneous sowing of both parent and water spray at 25 DAS to male parent.

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