37

Seed Res., Vol. 40(2): 145-149 December 2012

Optimum planting ratio and staggered sowing of male parent for DHB-290 (*inter-specific*) cotton hybrid seed production

S.R. DODDAGOUDAR, M. SHEKHARGOUDA, B.M. KHADI, M.R. ESHANNA, N.K. BIRADARPATIL AND S.N. VASUDEVAN

Department of Seed Science and Technology and Agricultural Research Station, Dharwad Farm University of Agricultural Sciences, Dharwad 580 005
srdsst@gmail.com

ABSTRACT Continuous pollen availability and synchronous flowering determines the success of cotton hybrid seed production. The planting ratio of 2:1 (Female: male) and staggered sowing of male (25% each) one week before, along with one and two weeks after female parent sowing was found to be optimum to get better synchronization in female and male parents by efficient utilization of male flowers and to obtain higher hybrid seed yield with better quality.

Key words: Hybrid seed production, male parent, staggered sowing, synchronization of flowering, seed yield

The optimum planting ratio of female and male parents and synchronization in flowering between parental lines are most important factors for hybrid seed production. The cotton hybrid seed is generally produced by planting both female and male parents in two separate blocks in a definite planting proportion [1]. This planting proportion of blocks decides, the amount of hybrid seed produced and is affected by factors such as vigour of female parent and pollen production ability of male parent. The synchornizaiton in flowering of parental lines assumes more significance as the seed setting of female parent depends on pollen supplied from male parent during the entire flowering period. Considering these factors, an experiment was conducted during two *kharif* seasons to find out optimum planting ratio between female and male, and proper staggered sowing of male parent so that synchrony of parents is achieved to get higher hybrid seed yield in DHB-90 hybrid cotton seed production.

MATERIALS AND METHODS

The experiment was laid out in a split plot design with four replications, two planting ratios: P_1 (2:1) and P_2 (3:1) of female and male parent, and three staggered sowing of male parent *viz.* S_1-sowing of male (50% each) along with and one week after female, S_2-sowing of male (50% each) one week before and along with female and S_3-sowing of male (50% each) one and two weeks after female. The net plot area consisted of four rows of female parent spaced at 120 cm x 100 cm. During next year, experiment was modified with three planting, ratios *viz.* P_1 (1:1), P_2 (2:1) and P_3 (3:2) with three staggered sowing of male parent: S_1-sowing of male (25% each) one week before, along with one and two weeks after female sowing; S_2-sowing of 10% male one week before and 30% each along with, one and two weeks after female sowing; S_3-sowing of male (20% each) one week before, along with, one, two and three weeks after female sowing; S_4-sowing of male (10% each) one week before, 20% along with, 30, 30 and 10% after one, two and three weeks of female sowing, respectively and S_5-sowing of male (10% each) one week before, 20% along with, 20, 20, 20 and 10% after one, two, three and four weeks of female sowing, respectively. The net plot area consisted of four rows of female parent spaced at 120 cm 60 cm. Based on different

Received : April 2012 Revised : November 2012 Accepted : December 2012

planting ratios and percentage of staggered sowing for different staggering; number of male plants required for each treatment were worked out and sown in a separate block with an isolation of 5 m from female block. The spacing of 120 cm between rows and 30 cm between plants was maintained. One flower of male parent was used to pollinate three flowers of female parent for enhanced boll setting to obtain good number of seeds per boll [2]. The observations on number of female flowers, male flowers produced, female flowers crossed/ plant, female to male ratio, number of crossed bolls/plant, boll weight, seed weight/boll, seed index and hybrid seed yield were recorded. Statistical analysis of the data was done by Fishers Analysis of Variance technique [3].

RESULTS AND DISCUSSION

The first year data indicated that number of flowers crossed, number of crossed bolls and hybrid seed yield in different planting ratios showed significant differences among the treatments irrespective of staggered sowing. The female: male flower ratio was more than three 3:1 planting ratio irrespective of staggered sowing. Similarly, in all the staggered sowings mean female: male flower ratio was also more than three, which was not optimum. However, 2:1 planting ratio was found to be optimum, as the ratio was near to 3.0, which is on a par with normal requirement of female flower to male flower [4]. Decrease in boll setting, crossed seeds-boll and seed index has been reported in Varalaxmi hybrid seed production, if a single male flower was used to pollinate more than three female flowers [2]. Further, it was observed that, female: male flower ratio was more than three during third, fourth and fifth fortnights in a 3:1 ratio, whereas it was during fourth, fifth and sixth fortnights irrespective of staggered sowing in a 2:1 planting ratio which indicated shortage of male flowers during those particular fortnights. So, due to timely non-availability of male flowers, number of crossed flowers, number of crossed bolls and hybrid seed yield varied significantly. Hence, based on shortage of male flowers in a 3:1 ratio and non-synchronization of male and female, experiment was suitably modified during second *Kharif*.

The number of male flowers produced plant were significantly higher (83.29) in P_1 (1:1) planting ratio compared to P_3 (3:2) (59.09) and P_2 (2:1) (44.75) due to more number of male plants per female in P_1 (1:1) planting compared to either P_3 (3:2) or P_2 (2:1) during second year (Table 1). However, number of female flowers produced, crossed and crossed bolls/plant did not show any significant difference among planting ratios. This indicated that male flowers produced even in P_2 (2:1) planting ratio (44.75) were sufficient to cross as much as the female flowers that were crossed in P_1 (1:1) planting ratio and thereby retained almost the same number of crossed bolls as in P_1 (1:1) planting ratio. Thus, optimum female: male ratio of 3.55 was recorded in P_2 (2:1) planting ratio compared to either P_3 (3:2) (2.67) or P_1 (1:1) (1.71) which indicated excess of male flowers in P_3 (3:2) and P_1 (1:1) plating ratio than that was required for crossing the available female flowers. For enhanced boll setting and to obtain good number of seeds/boll, one flower of male parent is sufficient to pollinate three flowers of female parent [2]. Similarly, in DHB 105 and DHH 11 [5] and LAHH 33 [6] hybrid seed production, the 2:1 planting ratio was found to be optimum.

The yield-contributing characters such as boll weight (3.96 g), seed weight boll (2.56 g) and seed index (10.61 g) were significantly higher in P_2 (2:1) planting ratio compared to P_1 (1:1) ratio (3.67 g, 2.43 g and 10.19 g, respectively). This may be due to the fact that as the number of bolls on a plant increases, plants ability to feed new bolls decrease and the available photosynthesis would equally be distributed among all bolls on the plant. The plant with lower boll load would get more photosynthates due to less competition among bolls and develop more properly. This assumption was supported by earlier studies in which canopy photosynthesis were greatly reduced during season [7].

The hybrid seed yield did not show any significant differences among the planting ratios. This indicated that among all planting ratios of P_1 (1:1), P_2 (2:1) and P_3 (3:1), male flowers produced in P_2 (2:1) planting were sufficient for crossing as much female flowers that were crossed in P_1 (1:1) and P_3 (3:2). It also recorded more number of crossed bolls/plant which ultimately accounted for higher hybrid seed yield. Similarly, in DDH-2 hybrid seed production, 2:1 planting ratio recorded

Table 1. Effect of planting ratio and staggered sowing of male parent on seed yield and its attributing characters in DHB-290 cotton hybrid seed production

Treatment	No. of female flowers/ plant	No. of male flowers/ plant	No. of female flowers crossed/ plant	Female: male ratio	No. of crossed bolls/ plant	Boll weight (g)	Seed weight/ boll (g)	Seed index (g)	Seed yield (kg/ha)
Planting ratio (P)									
P_1	147.13	83.29	132.18	1.71	44.07	3.67	2.43	10.19	1367
P_2	149.57	44.75	121.38	3.55	40.09	3.96	2.56	10.61	1327
P_3	150.91	59.09	127.35	2.67	41.98	3.83	2.49	10.40	1333
Mean	149.20	62.37	126.97	2.64	42.05	3.82	2.49	10.40	1342
SEm+	3.46	2.56	4.55	0.09	1.49	0.06	0.03	0.08	72
CD at 5%	NS	10.05	NS	0.34	NS	0.22	0.10	0.30	NS
Staggered sowing (S)									
S_1	153.57	66.16	136.49	2.46	46.10	3.62	2.43	10.21	1441
S_2	145.72	58.92	118.36	2.78	38.03	4.01	2.56	10.59	1241
S_3	149.81	64.50	131.56	2.42	44.21	3.71	2.43	10.29	1380
S_4	147.56	59.40	119.68	2.89	39.16	3.96	2.54	10.52	1277
S_5	149.36	62.87	128.77	2.68	42.74	3.79	2.50	10.39	1373
Mean	149.20	62.37	126.97	2.64	42.05	3.82	2.49	10.40	1342
SEm+	3.95	2.38	4.55	0.13	1.75	0.06	0.03	0.98	46
CD at 5%	NS	6.96	13.29	0.39	5.11	ti.17	0.09	0.26	134
Interactions									
P_1S_1	151.27	88.90	140.33	1.60	47.47	3.50	2.37	10.00	1438
P_1S_2	143.43	76.60	125.00	1.83	40.43	3.87	2.47	10.37	1278
P_1S_3	148.00	87.37	136.30	1.63	46.00	3.53	2.37	10.10	1392
P_1S_4	145.23	78.70	126.27	1.80	41.87	3.77	2.50	10.33	1336
P_1S_5	147.70	84.87	133.00	1.67	44.60	3.67	2.43	10.17	1393
P_2S_1	155.10	46.40	133.07	3.43	44.90	3.73	2.50	10.40	1450
P_2S_2	145.53	45.03	111.70	3.57	35.73	4.13	2.63	10.83	1219
P_2S_3	149.63	45.30	126.17	3.10	42.17	3.87	2.50	10.47	1366
P_2S_4	148.50	43.23	113.43	3.97	37.13	4.13	2.60	10.73	1248
P_2S_5	149.10	43.77	122.53	3.70	40.53	3.93	2.57	10.60	1349
P_3S_1	154.33	63.17	136.07	2.33	45.93	3.63	2.43	10.23	1434
P_3S_2	148.20	55.13	118.37	2.93	37.93	4.03	2.57	10.57	1227
P_3S_3	151.80	60.83	132.20	2.53	44.47	3.73	2.43	10.30	1382
P_3S_4	148.93	56.27	119.33	2.90	38.47	3.97	2.53	10.50	1248
P_3S_5	151.27	59.97	130.77	2.67	43.10	3.77	2.50	10.40	1377
Mean	149.20	62.37	126.97	2.64	42.05	3.82	2.49	10.40	1342
SEm±	7.03	4.49	8.40	0.26	3.03	0.10	0.06	0.15	79
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS: Non-significant

P: Planting ratio (female to male)
P_1-1:1 P_2-2:1 P_3-3:2

S: Staggered sowing
S_1 : Sowing of male (25% each) one week before along with, one and two weeks later from female sowing
S_2 : Sowing of male one week before and 30 percent each along with, one and two weeks later from female sowing
S_3 : Sowing of male (20% each) one week before, along with, one, two and three weeks later from female sowing
S_4 : Sowing of male (10% each) one week before, 20% along with, 30, 30 and 10% respectively one, two and three weeks later from female sowing
S_4: Sowing of male (10% each) one week before, 20% along with, 20, 20, 20 and 10% respectively one, two, three and four weeks later from female sowing

the same hybrid seed yield as that of 1:1 ratio [4].

The number of male flowers (66.16) produced (Table 1) and female flowers crossed (136.49) per plant significantly higher in S_1 staggering (59.40 and 147.56, respectively) (Table 1). The higher number of crossed flowers in S_1 staggering may be due to supply of required number of male flowers during entire crossing period of female parent from initiation of flowering to the end of crossing. Similarly, better syncrhonization in flowering between male and female parents in seed production of hybrid, Varalaxmi and Jayalaxmi, was observed by sowing 10% of male seeds along with female, and remaining 90% of male sowing in three equal parts *i.e.* 30% each at one week interval from female sowing [8].

The S_1 staggering recorded significantly higher (46.10) number of crossed bolls/plant (Table 1) as compared to S_2 (38.03) ad S_4 (39.16). This may be due to significantly higher number of flowers crossed (136.49) at S_1 staggering. These results were in agreement with the findings in DHBB 105 hybrid seed production [9].

The hybrid seed yield (1441 kg/ha) was significantly higher in S_1 staggering compared to S_2 (1,241 kg/ha) which may be due to higher number of crossed bolls/plant. These result conform with the findings in DDH 2 hybrid seed production [4] and PKVhy 4 and PKVhy 5 [6], where higher hybrid seed cotton yield and hybrid seed yield were recorded due to staggered sowing of male parent.

The number of flowers crossed and crossed bolls plant (Table 1) were higher in P_1S_1 (140.33 and 47.47), followed by P_1S_3 (136.30 and 46.00) and P_3S_1 (136.07 ad 45.93). Due to availability of sufficient number of male flowers throughout the crossing period, number of flowers crossed and crossed bolls retained were higher in these combinations.

With regard to female: male flower ratio (3 and nearer), P_2S_2 combination recorded optimum ratio of 3.10, which was followed by P_2S_1 (3.43) and P_3S_2 (2.93). This ratio of female:male seems to be optimum which is around 3.0 throughout the crossing period (Table 1). The female:male ratio in P_1 (1:1) and P_3 (3:2) planting ratios was lesser than 3.0 at all the three staggered sowings which indicated excess of male flowers than required for crossing. Similarly, Khadi *et al.* [4] observed excess of male flowers in combination of 1:1, 1:2 and 3:2 planting ratios with different staggered sowings. The optimum female:male flower ratio was recorded in 2:1 planting ratio with staggered sowings.

The hybrid seed yield (1,450 kg/ha) was higher in combination of P_2S_1 (Table 1), followed in P_1S_1 (1,438 kg/ha) and P_3S_1 (1,434 kg/ha). The higher seed cotton and hybrid seed yield in these combinations is due to more number of crossed bolls/plant. Further, it showed that P_2 (2:1) planting ratio in combination with S_1 staggering was able to produce the same hybrid seed yield that was produced by either P_1 (1:1) or P_3 (3:2) planting ratios. This clearly indicated that S_1 staggering with P_2 (2:1) planting ratio was able to produce male flowers in sufficient number for crossing as much female flowers that were crossed in P_1S_1 and P_3S_1 combinations, thereby retaining more number of crossed bolls/plant which ultimately accounted for higher hybrid seed yield. These results were in line with the findings of [4] in DDH 2 hybrid seed production. Further, better synchronization in flowering between male and female parents in Varalaxmi and Jayalaxmi hybrid seed production was observed by sowing 10% of male seeds along with female and remaining 90% of male seeds in three equal parts of 30% each at an interval of one week from female sowing [8]. Thus, considering the efficient utilization of male flowers, better synchronization in female and male flowering and crossed hybrid seed yield, planting ratio of 2:1 (Female: male) and sowing of male (25% each) one week before, along with, one and two weeks later from female sowing can be recommended for seed production, of cotton hybrid DHB 290.

REFERENCES

1. SINGH P (1996). *Essentials of Plant Breeding*. Kalyani Publishers, New Delhi

2. RAO DV, JAGADESWARA K AND REDDY BMM (1979). Studies on different practices of hybrid seed production in Varalaxmi cotton. *Seed and Farms* 31-33

3. PANSE VG AND SUKHATME PV (1967). *Statistical Methods and Agricultural Workers*. ICAR, New Delhi, India

4. KHADI, BM, JANAGOUDAR, BS, RAO PRAKASH, YENJERAPPA, ST AND ESHANNA, MR (1995). Study on planting techniques for synchronization of flowering in desi hybrid seed production. *J Indian Society Cott Imp* **20**(2): 120-23

5. ANONYMOUS (1999). *Annual Report*. University of Agricultural Sciences, Dharwad. Seed production technology for newly released hybrids DHB-105 and DHH-11. Promotion of Research and Development Efforts on Hybrids in Selected Crops-Cotton.

6. AICNSP (Crops), New Delhi (2001). *Annual Report*, All India Co-ordinated National Seed Project (Crops). Project Co-ordinator Unit, National Seed Project (Crops), Indian Agricultural Research Institute, New Delhi

7. PENG S AND KRIEG DR (1991). Single leaf and canopy photosynthesis response to plant age in cotton. *Agron J* **83**: 704-08

8. KHADI BM, JANAGOUDAR BS, ESHANNA MR AND KATAGERI IS (1996). *Hybrid Cotton Seed Production Technology* (Kannada). University of Agricultural Sciences, Dharwad

9. ANONYMOUS (1995). *Annual Report*, University of Agricultural Sciences, Dharwad. Hybrid seed production technology in DHB-105 interspecific hybrid. Promotion of Research and Development Efforts on Hybrids in Selected Crops-Cotton.