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# Effect of Different Dates of Sowing on Stigma Receptivity and Pollen Viability in Parental Lines of Sorghum Hybrids

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## A B S T R A C T

A field experiment to study the effect of different dates of sowing on Stigma receptivity in parental lines of sorghum hybrids was conducted during *Kharif.* Stigma receptivity was studied for four sterile 'A' lines viz. AKMS-14A, MS-27A, MS-70A and MS-296A of Sorghum hybrids at three different sowing dates. In all sowing dates Stigma of seed parent MS-27A remained receptive up to '6' day with highest receptivity on '0' day and lowest at 6$^{th}$ day of starvation period whereas it remained receptive up to '5' days in other seed parent as judged by seed setting percentage. Seed parents was significantly better upto 2 to 4 days of starvation after complete flowering in *Kharif* season. On an average stigma receptivity was significantly highest at '0'day starvation and subsequently reduced due to delay in pollination. Pollen viability was studied for restorer (R) lines AKR-150, C-43, ICSR-89058 and AKR-73 of sorghum hybrids at three different sowing dates. In all sowing dates pollen viability of seed parent AKR-150 was viable upto 6 hours and highest at 8 AM in $D_1$. Seed setting was highest at 8 AM for seed parent AKR-150, ICSR-89058 and AKR-73 except C-43, wherein, highest seed setting was observed at 9 AM.

**Key words:** CSH-14, CSH-16, SPH-388, SPH-840, Stigma receptivity, Pollen viability

Sorghum is the 5$^{th}$ major cereal crop in the agriculture scenario of the globe and also one of the world's most important source of food, animal field and biofuel, is considered a model crop for research because it has a high tolerance to drought, heat and high salt condition. Improper nicking of male sterile lines and restorer of hybrids is one of the reason for low seed yield of released hybrids during hybrid seed production. Hence, improved seed production technology will help to improve the present low level of seed yield and spread of hybrids. For better seed production of hybrids, it is essential that the male sterile (A) lines and restorer (R) should synchronize in flowering. Delayed or early flowering of any parent adversely affects the seed setting. Among the released hybrids serious synchronization problem is often and observed with the hybrid seed production of CSH-5 and CSH-9 (Singh and Nayeem 1980). Male sterile lines show differential flowering behaviour in different sowing dates because of environmental factors prevailing during primordial initiation to seed maturity. The stigma receptivity studies of male sterile lines will help in predicting proper planting time of male and female lines for maximum seed set. It also helps to find out the male sterile lines with longer stigma receptivity period. Longer period of stigma receptivity will help whenever the pollen parental line to be crossed blooms later than male sterile parent (Ross 1957). Synchronization, stigma receptivity and pollen viability which are the bottle necks in the hybrid seed production of sorghum and hence present study was undertaken in the parent of newly evolved sorghum hybrids like CSH-14, CSH-16, SPH-840 and SPH-388 during *Kharif* season to see performance of these hybrids for determining stigma receptivity period of 'A' lines as influenced by sowing dates, pollen viability studies are important for understanding the pollen sterility problems in crop plants and experimental work of hybridization. With the pollen viability studies proper time for pollination can be found during hybridization programme. Synchronization, stigma

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receptivity and pollen viability which are bottle necks in the hybrid seed production of sorghum, the studies were undertaken in the parents of newly evolved sorghum hybrids like CSH-14, CSH-16, SPH-840 & SPH-388 during *Kharif* to see performance of these hybrids for determining the pollen viability of 'R' lines.

# MATERIALS AND METHODS

The experiment was laid out during *Kharif*. Eight genotypes were studied at three planting dates in factorial randomized block design, replicated thrice. Sorghum hybrids CSH-14, CSH-16, SPH-840 and SPH-388 are sown at three different dates $D_1$ (25th June), $D_2$ (1st July) and $D_3$ (7th July) in a plot size of 4m × 2.7m area with spacing of 45 cm × 15 cm. All the cultural practices were followed as per the recommended package of practices for sorghum results were analyzed for randomized block design (factorial) by standard statistical procedure (Panse and Sukhatme 1981).

Five plants were randomly selected from middle of rows of each genotype in all sowing dates for recording observation.

*Stigma receptivity studies*

Four male sterile 'A' lines AKMS-14A, MS-27A, MS-70A and MS-296A were undertaken by growing the genotypes during *Kharif* season. After stigma protrudence pollens from respective restorer (R) lines were collected and male sterile 'A' lines were pollinated in $D_1$, $D_2$ and $D_3$ sowing dates respectively each day from 0 to 6 day between 8 to 10 AM by giving one day as a starvation period to the stigma of male sterile (A) lines.

*Pollen viability studies*

Four restorer 'R' lines AKR-150, C-43, ICSR-89058 and AKR-73 were used by sowing the genotypes. By giving one hour storage period interval to the pollens of restorers (R) lines the male sterile (A) lines were pollinated from 8.00 AM to 1.00 PM. Pollen viability studies was conducted on restorer (R) lines was judged by seed setting percentage on their respective seed parents after complete flowering and judged at 8 AM,9 AM,10 AM,11AM,12 noon and 1PM starvation period in $D_1$, $D_2$ and $D_3$ sowing date.

# RESULTS AND DISCUSSION

Stigma receptivity and pollen viability studies in parental lines of newly evolved sorghum hybrids were conducted by planting parental lines of CSH-14 (AKMS-14A × AKR150), CSH-16 (MS-27A × C-43), SPH-840 (MS-70A × ICSR-89058) and SPH-388 (MS-296A × AKR-73). Three rows of four male sterile lines and three rows of restorer lines were planted in replicated trials on three different sowing dates and observations were recorded on stigma receptivity of male sterile lines and pollen viability of restorer lines.

Table 1 Performance of male sterile 'A' lines for stigma receptivity studies in $D_1$ sowing date

| Genotypes ($F_2$) | Starvation period in days ($F_1$) | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | |
| AKMS-14A | 88.21 | 78.26 | 60.26 | 53.25 | 20.10 | 0.00 | 0.00 | 42.86 |
| MS-27A | 93.21 | 84.24 | 76.01 | 64.79 | 33.41 | 21.90 | 0.00 | 53.36 |
| MS-70A | 90.83 | 88.13 | 69.87 | 49.95 | 15.55 | 0.00 | 0.00 | 44.19 |
| MS-296A | 84.05 | 75.20 | 61.91 | 45.02 | 25.25 | 0.00 | 0.00 | 41.63 |
| Mean | 89.07 | 80.20 | 67.01 | 53.25 | 23.57 | 5.47 | 0.00 | |
| | | | F test | SE (m)± | | CD at 5% | | |
| Sowing date ($F_1$) | | | Sign. | 0.77 | | 1.55 | | |
| Genotype ($F_2$) | | | Sign. | 0.58 | | 1.17 | | |
| Interaction ($F_1 \times F_2$) | | | Sign. | 1.55 | | 3.11 | | |

Table 2 Performance of male sterile 'A' lines for stigma receptivity studies in $D_2$ sowing date

| Genotypes ($F_2$) | Starvation period in days ($F_1$) | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | |
| AKMS-14A | 85.92 | 77.30 | 56.22 | 48.18 | 18.34 | 0.00 | 0.00 | 40.85 |
| MS-27A | 89.24 | 81.31 | 68.12 | 58.28 | 28.39 | 18.56 | 0.00 | 49.12 |
| MS-70A | 87.56 | 75.10 | 65.75 | 42.16 | 12.48 | 0.00 | 0.00 | 40.43 |
| MS-296A | 87.43 | 76.17 | 67.72 | 40.23 | 20.41 | 0.00 | 0.00 | 41.75 |
| Mean | 87.53 | 77.47 | 64.45 | 47.28 | 19.90 | 4.64 | 0.00 | |
| | | | F test | SE (m)± | | CD at 5% | | |
| Sowing date ($F_1$) | | | Sign. | 0.62 | | 1.25 | | |
| Genotype ($F_2$) | | | Sign. | 0.47 | | 0.94 | | |
| Interaction ($F_1 \times F_2$) | | | Sign. | 1.24 | | 2.50 | | |

*Stigma receptivity*

It is observed from the data that on average stigma receptivity was significantly highest at '0' day starvation period in $D_1$, $D_2$, $D_3$ and subsequently reduced due to delayed pollination. Seed setting percentage in seed parents was significantly better up to 3 days of starvation period after complete flowering in all sowing dates. In $D_1$, $D_2$ and $D_3$ sowing dates stigma of seed parent MS-27A remained

receptive up to 5 days starvation period and highest receptivity on 0 day and lowest on 6 days of starvation period whereas stigma of other seed parents AKMS-14A, MS-296A remained receptive up to 5 days starvation period and subsequently reduced due to delay in pollination in male sterile lines in all sowing dates. On an average seed setting percentage in these male sterile (A) lines was better up to 2 to 3 Day's starvation period in all sowing dates. These observations corroborate with the findings of Shellar and Patil (1991).

Table 3 Performance of male sterile 'A' lines for stigma receptivity studies in $D_3$ sowing date

| Genotypes ($F_2$) | Starvation period in days ($F_1$) | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | |
| AKMS-14A | 86.21 | 80.45 | 60.13 | 45.28 | 15.27 | 0.00 | 0.00 | 41.04 |
| MS-27A | 84.21 | 78.00 | 64.18 | 54.46 | 27.26 | 15.19 | 0.00 | 46.24 |
| MS-70A | 85.34 | 71.15 | 66.78 | 41.41 | 10.36 | 0.00 | 0.00 | 39.29 |
| MS-296A | 81.27 | 75.88 | 58.19 | 38.33 | 17.27 | 0.00 | 0.00 | 38.70 |
| Mean | 84.35 | 76.37 | 62.32 | 44.87 | 17.54 | 3.79 | 0.00 | |
| | | | F test | SE (m)± | | CD at 5% | | |
| Sowing date ($F_1$) | | | Sign. | 0.80 | | 1.60 | | |
| Genotype ($F_2$) | | | Sign. | 0.60 | | 1.21 | | |
| Interaction ($F_1 \times F_2$) | | | Sign. | 1060 | | 3.20 | | |

Stigma receptivity was evaluated in the female parents AKMS-14 A, MS-27 A, MS-70 A and MS-296 A. Variation for stigma receptivity was significantly affected by starvation period, genotypes and interaction in $D_1$, $D_2$ and $D_3$ sowing dates. Stigma receptivity was studied after complete flowering and was counted as 0,1,2,3,4,5,6 days of starvation period in $D_1$, $D_2$ and $D_3$ sowing dates.

Stigma receptivity was highest at '0' days of starvation period in $D_1$, $D_2$ and $D_3$ and subsequently reduced due to delayed pollination. $D_1$ sowing date (89.07%) exhibited highest stigma receptively followed by $D_2$ (87.53%) and $D_3$ (84.35%) at '0' days starvation period. Seed setting percentage was significantly better up to 2 days of starvation period after complete flowering in all sowing dates. Seed parent MS-27A exhibited highest (53.36%) stigma receptivity in $D_1$, $D_2$ and $D_3$ sowing date followed by seed parent MS-70 A (44.19%) and AKMS-14 A (42.86%). Seed parent MS-296 A exhibited lowest (38.70%) stigma respectively in $D_3$ sowing date.

*Pollen viability*

Pollen viability studies in parental lines of newly evolved Sorghum hybrids were conducted by planting parental lines of CSH-14, CSH-16, SPH-840 and SPH-388. Three rows of restorer lines were planted in replicated trial on three different sowing dates and observation were recorded on pollen viability of restore lines. It was observed that in $D_1$ sowing date pollen of seed parent AKR-150 was viable up to 6 hours. Viability was highest at 8.00 AM where as in $D_2$ and $D_3$ viability was up to 5 hours for seed parents AKR-150, C-43, ICSR-8905 and AKR-73. Seed setting was highest at 8.00 am for seed parents AKR-150, ICSR-8905 and AKR-73 except C-43. Seed parent C-43 showed highest seed setting at 9.00AM. In general pollen viability was satisfactory up to 11.00 am (3 hours storage) under field condition in *Kharif*. These results are corroborated with the findings of Singh *et al*. (1985).

Early planting of seed crop and staggered sowing of early parent in *kharif* season under Vidharbha condition should be adopted to reduce synchronization problems. Variation due to storage of pollens, genotypes and interaction was statistically significant in $D_1$, $D_2$ and $D_3$ sowing dates. Pollen viability studies were conducted on restores (R) lines and judged by seed setting percentage on their respective seed parent in $D_1$, $D_2$ and $D_3$ sowing date. Pollen viability was maximum in $D_1$ (52.86%) and maximum in $D_3$ (46.49%) at 8.00 a.m. (0 hour storage) and percentage was better up to 10 A. M. (2 hours) storage in all sowing dates. Pollen parent AKR-150 exhibited highest (52.86%) pollen viability followed by ICSR-8958 (52.36%) in $D_1$ and C-43 exhibited best (46.49%) pollen viability in $D_3$ sowing date (Table 4-6).

Table 4 Performance of restorer (R) lines for pollen viability in $D_1$ sowing date

| Genotypes ($F_2$) | Starvation period in days ($F_1$) | | | | | | Mean |
|---|---|---|---|---|---|---|---|
| | 8.00 | 9.00 | 10.00 | 11.00 | 12.00 | 1.00 | |
| AKR-150 | 86.98 | 82.80 | 70.25 | 52.12 | 18.70 | 6.36 | 52.86 |
| C-43 | 60.00 | 91.65 | 80.70 | 46.00 | 25.27 | 0.00 | 50.60 |
| ICSR-89058 | 85.57 | 73.36 | 67.30 | 55.53 | 30.35 | 0.00 | 52.36 |
| AKR-73 | 84.29 | 71.63 | 61.21 | 46.46 | 24.50 | 0.00 | 48.01 |
| Mean | 87.53 | 77.47 | 64.45 | 47.28 | 19.90 | 4.64 | |
| | | | F test | SE (m)± | | CD at 5% | |
| Sowing date ($F_1$) | | | Sign. | 0.88 | | 1.77 | |
| Genotype ($F_2$) | | | Sign. | 0.71 | | 1.44 | |
| Interaction ($F_1 \times F_2$) | | | Sign. | 1.76 | | 3.84 | |

Table 5 Performance of restorer (R) lines for pollen viability in $D_2$ sowing date

| Genotypes ($F_2$) | Starvation period in days ($F_1$) | | | | | | Mean |
|---|---|---|---|---|---|---|---|
| | 8.00 | 9.00 | 10.00 | 11.00 | 12.00 | 1.00 | |
| AKR-150 | 87.18 | 76.29 | 62.21 | 41.46 | 21.23 | 0.00 | 48.06 |
| C-43 | 43.30 | 88.35 | 72.58 | 47.36 | 30.04 | 0.00 | 46.93 |
| ICSR-89058 | 82.48 | 77.30 | 69.19 | 50.56 | 25.40 | 0.00 | 50.82 |
| AKR-73 | 83.30 | 65.16 | 65.80 | 52.43 | 28.19 | 0.00 | 49.14 |
| Mean | 74.06 | 76.77 | 67.44 | 47.95 | 26.21 | 0.00 | |
| | | F test | | SE (m)± | CD at 5% | | |
| Sowing date ($F_1$) | | Sign. | | 0.71 | 1.43 | | |
| Genotype ($F_2$) | | Sign. | | 0.58 | 1.17 | | |
| Interaction ($F_1 \times F_2$) | | Sign. | | 1.42 | 2.87 | | |

Table 6 Performance of restorer (R) lines for pollen viability in $D_3$ sowing date

| Genotypes ($F_2$) | Starvation period in days ($F_1$) | | | | | | Mean |
|---|---|---|---|---|---|---|---|
| | 8.00 | 9.00 | 10.00 | 11.00 | 12.00 | 1.00 | |
| AKR-150 | 89.47 | 80.50 | 65.13 | 48.40 | 16.56 | 0.00 | 50.01 |
| C-43 | 37.66 | 88.14 | 81.56 | 50.30 | 21.29 | 0.00 | 46.49 |
| ICSR-89058 | 82.28 | 70.14 | 62.30 | 41.31 | 25.10 | 0.00 | 46.85 |
| AKR-73 | 85.40 | 78.28 | 65.73 | 45.56 | 23.26 | 0.00 | 49.70 |
| Mean | 73.70 | 79.26 | 68.68 | 46.39 | 21.55 | 0.00 | |
| | | F test | | SE (m)± | CD at 5% | | |
| Sowing date ($F_1$) | | Sign. | | 1.01 | 2.03 | | |
| Genotype ($F_2$) | | Sign. | | 0.82 | 1.66 | | |
| Interaction ($F_1 \times F_2$) | | Sign. | | 2.02 | 4.07 | | |

In $D_1$, $D_2$ and $D_3$ sowing dates ,stigma receptivity of seed parent MS-27A was receptive upto 6 days and highest receptivity on O day starvation period where as stigma of other seed parent AKMS-14A, MS-70A and MS-296A was receptive upto 5 days starvation periods and subsequently reduced due to delay in pollination in these male sterile A lines was better upto 2 to 3 days starvation periods in $D_1$, $D_2$ and $D_3$ sowing dates. In $D_2$ and $D_3$ sowing dates, pollen viability was upto 5 hours of pollen parents AKR-150, C-43, ICSR-89058 and AKR-73, where as in $D_1$ sowing date pollen viability in AKR-150 was upto 6 hours. Pollen viability was satisfactory upto 2 to 3 hours and 3 to 4 hours of storage under field condition. It is possible to take hybrid seed production of CSH-14, CSH-16, SPH-840 and SPH-388 in kharif. In case of SPH-388, simultaneous sowing of male and female parent can be under taken but in case of CSH-16 and CSH-14 minimum 4 days staggering needs to be followed.

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