

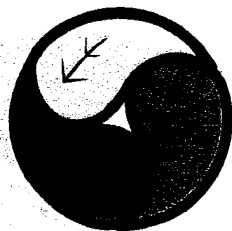
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**ГОДИШЕН ЗБОРНИК
ЗЕМЈОДЕЛСКИ ФАКУЛТЕТ
YEARBOOK
FACULTY OF AGRICULTURE**

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Original research paper
Оригинален научен труд

MALE STERILITY IN COTTON AND POSSIBILITIES FOR ITS UTILIZATION

Ana Stoilova*, Vladimir Rusev*, Dragica Spasova**

Abstract

Five male sterile lines were crossed to the *G. hirsutum* male parents under the natural field conditions to produce hybrid plants. At the flowering time in different days and hours, observations were made on pollen sterility. The trials were carried in 2005 and 2006. Results obtained showed that the available sterile lines were not completely sterile, there was no pollen in the early hours (from 9 a.m. to 2 p.m.) or in case of presence it was highly sterile. The absence of pollen in the early hours of day during the flowering will permit to solve the problem with the hand emasculation by its reduction in the hybrid cotton seed production. At these lines some viable pollen was developed in the later hours or at the end of flowering and normal seeds were produced by self-pollination, and it is not necessary to restore fertility or to maintain sterility by the use of maintainer lines. The hybrid plants based on male sterility produced under the free cross pollination were insufficient for commercial seed production. The highest percent was found to be 67.8 at the line A-21 in 2006. As the very early № 433 (brown cotton) was used as a pollinator high percent of hybrid plants was also realized.

Key words: *G. hirsutum*, pollen sterility, hybrid plants, out-crossing

МАШКА СТЕРИЛНОСТ КАЈ ПАМУКОТ И МОЖНОСТИ ЗА НЕГОВА УПОТРЕБА

Ана Стоилова*, Владимир Русев*, Драгица Спасова**

Краток извадок

Пет машки стерилни линии беа вкрстени со татковците на *G. hirsutum* во

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природни полски услови за да се добијат хибридни растенија. Во времето на цветање беше набљудувана поленовата стерилност во различни часови и денови. Опитите беа правени во 2005 и 2006 година. Добиените резултати покажаа дека добиените линии се целосно стерилни, бидејќи немаа полен во раните утрински часови (од 9 до 14 часот). Отсуството на поленот во раните часови од денот во текот на цветањето ќе дозволи да се реши проблемот со рачно кастрирање, преку негова редукција во производството на хибридно семе од памук. Кај тие линии беше развиен нестерилен полен во доцните часови или кон крајот од цветањето при што се разви нормално семе преку самоопрашување и не е потребно да се враќа фертилноста или да се одржи стерилноста со користење на одржливи линии. Хибридните растенија со машка стерилност произведени при слободно самоопрашување беа недоволни за комерцијално производство на семе. Највисок процент се доби од линијата *A-21* (67,8%) во 2006 година. Како полинатор беше користена рана сорта памук № 433 од кој беше добиен висок процент хибридни растенија.

Клучни зборови: *G. hirsutum*, поленова стерилност, хибридни растенија, надворешно вкрстување

1 Introduction

The heterosis in cotton is of great importance for increasing the yields. There are some practical difficulties in its exploiting concerning hybrid seed production. In India only hybrid cottons are planted on large acreages. Chaudry (1997) indicated that almost all of India's hybrids are produced by hand emasculation and pollination. Different male sterility systems have been studied and used to exploit heterosis in the USA, China, India and other countries. Meridith (1999) reported the obvious disadvantage of using cytoplasmic male sterility (CMS) until now there is no efficient practical pollination system available to use heterosis. Pollination is the major unsolved problem, which prevents the development of hybrid cotton on a large scale. Many of the CMSs are temperature and environmentally sensitive (Sarvella, 1966; Meyer, 1970).

Our investigation is on development of cotton hybrids based on cytoplasmic male sterility:

- a) Pollen sterility/viability of five cytoplasmic male sterile lines;
- b) Percentage of hybrid plants produced through cross pollination of cytoplasmic male sterile lines under the natural field conditions.

2. Material and methods

Five cytoplasmic male sterile lines *107*, *108*, *A-1*, *A-21* and *A-65* were included in this study. At the mass flowering (the second half of July and the

beginning of August), in different days and hours, observations on pollen sterility/viability were made for all male sterile lines as well for the check variety Chirpan-539 on squash slices using acetocarmin under a light microscope.

In a field trial three of male sterile lines in 2005 and all five in 2006 were sown in three rows long 25 m. The *G. hirsutum* varieties used as pollinators were sown at the two sides of each male sterility line also in three rows, to produce hybrid plants on CMS base, under the condition of natural pollination. One hundred bolls were harvested from each MS line, separately from the neighbouring rows – 1st-3rd and from the middle – 2nd row. The seeds were sown the next year when the hybrid plants were counted.

3. Results and discussion

At the time of mass flowering there was no pollen until 2 p. m. in most cases, single pollen grains only were observed (tables 1 and 2). There was sterile and viable pollen at the line A-21 as in early as well in later hours of the day. At the end of the flowering pollen was recorded at the lines 107, 108 and A-65 in the later hours. There was a limited quantity of viable pollen in the flowers isolated on the previous day, with the exception of line A-21 having a larger quantity of viable pollen (table 2). At the check variety Chirpan-539 in the days with normal temperatures the pollen was ready to pollinate at about 9-10 a. m. and kept its viability to the next day. Under binocular the anthers of this variety were strewn with pollen after 9-10 a. m., while at the lines the anthers did not open to 1-2 p. m. and they seemed very smooth. The time most favorable to pollinate is 9-11 a.m. and the behavior of male sterile lines will permit to solve the problem with the hand emasculation by its reduction in the hybrid cotton seed production.

All these lines were not completely sterile, some viable pollen was developed in the later hours or at the end of flowering, and some normal seeds were produced by self-pollination. At these lines it is not necessary to restore fertility or to maintain sterility by the use of maintainer lines.

In the *G. hirsutum*, expression of male sterility is high at 32 °C and complete at 38 °C (Meyer and Meyer, 1965). All environmental factors are effective during 3 weeks before anthesis, as they primarily impair anther differentiation and development. The maximum temperatures in this period were not above 33-35 °C and probably affected the male sterility of lines.

Detailed studies on the MS lines showed, that some 3-5 % of plants were completely fertile, probably due to physical or genetic contamination as result of natural pollination by bees. The plants not typical for the sterile lines were also observed, but their flowers had high percentage of sterile pollen and their leaves were of lancet type shape, probably naturally pollinated with the pollen of Turkish variety Adana-98.

Cotton is self-pollinated but often it is cross-pollinated. The data for the hybrid plants, produced by cross pollination of male sterile lines under the natural field conditions, are presented in table 3. The results obtained showed that the percentage of hybrid plants was low – average 18.3 % in 2005 and 45.7 % in 2006 and was insufficient for hybrid seed production. This percentage was lower when *G. barbadense* L. was used – average 15 %. The line A-I was worse receptive to the foreign pollen and the hybrid plants at this line were 10.5 % in the first year and 35.9 % in the second year. The line A-21 seems to be the most receptive to the foreign pollen. The hybrid plants at that line were accounted to be 67.8 %. The range for the individual pollinators was from 54.8 to 78.3 % (average from 1+3+2 rows). The remaining lines did not differ significantly in their receptiveness to the foreign pollen, the hybrid plants at these lines were 20.0-21.9 % in 2005 and 35.9-42.0 % in 2006. The rows near the male sterile lines (1st and 3rd) and the middle row (2nd) did not differ significantly in the percentage of hybrid plants. The percentage of produced hybrid plants was two-three times higher in the second year. There were bee-hives with bees near trial and probably they assisted natural cross pollination.

Coloured cotton was used as an indicator for identification of hybrid plants. Using brown cotton the hybrid plants achieved 90.0 % at the line A-21 pollinated by № 433 (2nd row). High level of hybrid plants were also accounted at the lines 108 – 61.1 % (2nd row) and A-I – 63.6 % (1st row). Using the № 433 as a pollinator, the hybrid plants were three to four times higher compared with the Koyu Deve. These two brown cottons differed strongly in their earliness, the № 433 was very early, whereas the Koyu Deve was very late.

Hybrid plants were accounted on the basis of morphological traits of flowers. The male sterile lines were characterized by significant reduction in flower characters. The hybrids had intermediate flowers. The number and size of anthers were inherited also intermediately. The flowers of hybrid plants were more similar to those of male sterile lines and they were accounted with difficulty. In 2005 in hybridization with the male sterile lines the Turkish variety Adana-98 with lancet type leaf shape was included. This type shape of leaves is inherited dominantly and could serve as a marker character.



4. Conclusion

- The studied male sterility lines were not completely sterile and it is not necessary to restore their fertility or to maintain their sterility by the use of maintainer lines.
- There was no pollen in the early hours (from 9 a.m. to 2 p.m.) or in case of presence it was highly sterile which is of great importance for producing hybrid cotton seeds without hand emasculation.
- The hybrid plants based on outcrossing of the male sterile lines under the natural field conditions were insufficient for commercial cotton seed production.
- The highest percent of hybrid plants was found to be 67.8 at the line A-21, but it needs to be confirmed in future work.
- Of the pollinators high percent of hybrid plants was realized with the very early brown cotton № 433.

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Tab. 1 Pollen sterility in the male sterile lines in 2005

Таб. 1 Поленова стерилност кај машките стерилни линии во 2005 год.

| Date | Hour | Ch.-539 | | 107 | | 108 | | A - 1 | | A - 21 | | A - 65 | |
|--------|------------|---------|----|-----|-----|-----|----|-------|---|--------|-----|--------|----|
| | | v* | s* | v | s | v | s | v | s | v | s | v | s |
| 22.07. | 9-10 a.m. | 102 | 10 | 0 | 0 | 0 | 62 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11-12 a.m. | 123 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13-14 p.m. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23.07. | 9-10 a.m. | 186 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 |
| | 11-12 a.m. | 361 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13-14 p.m. | 628 | 3 | 323 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24.07. | 9-10 a.m. | 360 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 87 | 0 | 0 |
| | 11-12 a.m. | 630 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 63 | 0 | 0 |
| | 13-14 p.m. | 896 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 38 | 0 | 0 |
| 30.07. | 9-10 a.m. | 658 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11-12 a.m. | 645 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13-14 p.m. | 564 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 42 | 0 | 0 |
| 31.07. | 9-10 a.m. | 450 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 84 | 67 | 0 | 0 |
| | 11-12 a.m. | 986 | 11 | 56 | 168 | 0 | 0 | 0 | 0 | 128 | 84 | 0 | 0 |
| | 13-14 a.m. | 756 | 3 | 73 | 28 | 0 | 0 | 0 | 0 | 38 | 8 | 0 | 0 |
| 01.08. | 9-10 a.m. | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11-12 a.m. | 871 | 0 | 245 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 78 | 63 |
| | 13-14 a.m. | 432 | 0 | 385 | 30 | 0 | 0 | 0 | 0 | 86 | 120 | 0 | 0 |

v* - viable-number; s* - sterile-number; Ch. – Chirpan – check variety
v* - фертилен број; s* - стерилен број; Ch – чирпан



Tab. 2 Pollen sterility/viability in the male sterile lines and check variety in 2006
Таб. 2 Поленова стерилност/фертилноста кај машките стерилни линии и контролната сорта во 2006 год.

| Date | hour | Ch.-539 | | 107 | | 108 | | A - I | | A - 21 | | A - 65 | |
|---|------------|---------|-----|-----|---|-----|----|-------|---|--------|-----|--------|---|
| | | v* | s* | v | s | v | s | v | s | v | s | v | S |
| 20.07. | 9-10 a.m. | 460 | 10 | 1 | 0 | 9 | 2 | 0 | 0 | 13 | 265 | 7 | 0 |
| | 11-12 a.m. | 380 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13-14 p.m. | 480 | 37 | 86 | 4 | 507 | 21 | 3 | 0 | 0 | 0 | 0 | 0 |
| 21.07. | 9-10 a.m. | 483 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11-12 a.m. | 966 | 143 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13-14 p.m. | 628 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24.07. | 9-10 a.m. | 360 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11-12 a.m. | 583 | 40 | 1 | 0 | 0 | 0 | 1 | 0 | 169 | 319 | 0 | 0 |
| | 13-14 p.m. | 632 | 0 | 75 | 2 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 0 |
| 27.07. | 9-10 a.m. | 658 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11-12 a.m. | 645 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13-14 p.m. | 716 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | 0 | 0 | 0 |
| 9.08. | 9-10 a.m. | 450 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 11-12 a.m. | 986 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13-14 p.m. | 862 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Flowers isolated on 9.08. (on the previous day) / Изолирани цветови на 9.08 (претходен ден) | | | | | | | | | | | | | |
| 10.08. | 9-10 a.m. | 871 | 0 | 8 | 0 | 4 | 0 | 0 | 0 | 980 | 0 | 2 | 0 |

v* - viable-number; s* - sterile-number; Ch. – Chirpan – check variety
v* - фертилен број; s* - стерилен број; Ch – чирпан

Tab. 3 Hybrid plants produced on male sterile base under free cross pollination
Таб. 3 Хибридни растенија произведени од машка стерилна база во услови на слободно опрашување

| Crosses Вкрстувања | Rows Редови | 2005 г. | | | 2006 г. | | | Average | | |
|--------------------------------|----------------|---------------------------------------|--|------|---------------------------------------|--|------|---------------------------------------|--|------|
| | | Obs plants Прегледани растенија | Hybrid plants Хибридни растенија | | Obs plants Прегледани растенија | Hybrid plants Хибридни растенија | | Obs plants Прегледани растенија | Hybrid plants Хибридни растенија | |
| | | | Nos. | % | | Nos. | % | | Nos. | % |
| 107 x Chirpan 539 | 1+3 | 100 | 34 | 34.0 | 40 | 18 | 45.0 | 140 | 52 | 37.1 |
| | 2 | - | - | - | 36 | 15 | 41.7 | - | - | - |
| 107 x L. 361 | 1+3 | 100 | 23 | 23.0 | 36 | 13 | 36.1 | 136 | 36 | 26.5 |
| | 2 | 100 | 20 | 20.0 | 39 | 18 | 46.1 | 139 | 38 | 28.1 |
| 107 x L. 5 | 1+3 | 80 | 16 | 20.0 | - | - | - | - | - | - |
| | 2 | 80 | 17 | 21.3 | - | - | - | - | - | - |
| 107 x L. 713 | 1+3 | 60 | 13 | 21.7 | 27 | 14 | 51.9 | 87 | 27 | 31.0 |
| | 2 | 50 | 9 | 18.0 | 31 | 20 | 64.5 | 81 | 29 | 35.8 |
| 107 x T-3 | 1+3 | 100 | 25 | 25.0 | 25 | 10 | 40.0 | 125 | 35 | 28.0 |
| | 2 | 100 | 21 | 21.0 | 26 | 10 | 38.5 | 126 | 31 | 24.6 |
| 107 x Millenium | 1+3 | 50 | 13 | 21.7 | 33 | 9 | 27.3 | 88 | 22 | 25.0 |
| | 2 | 80 | 18 | 22.5 | 30 | 12 | 40.0 | 110 | 30 | 27.3 |
| 107 x Giza 77 G. barbadense | 1+3 | 50 | 9 | 18.0 | - | - | - | - | - | - |
| | 2 | 50 | 8 | 16.0 | - | - | - | - | - | - |
| 107 x KoyuDeve Brown cotton | 1+3 | 50 | 9 | 18.0 | - | - | - | - | - | - |
| | 2 | 80 | 15 | 18.7 | - | - | - | - | - | - |
| 107 x № 433 Brown cotton | 1+3 | - | - | - | 26 | 8 | 30.8 | - | - | - |
| | 2 | - | - | - | 39 | 16 | 41.0 | - | - | - |
| 107 Average: | 1+3 | 600 | 142 | 23.7 | 187 | 72 | 38.5 | 576 | 172 | 29.9 |
| | 2 | 540 | 108 | 20.0 | 201 | 91 | 45.3 | 456 | 128 | 28.1 |
| | 1+3+2 | 1140 | 250 | 21.9 | 388 | 163 | 42.0 | 1032 | 300 | 29.1 |
| 108 x Chirpan- 539 | 1+3 | 50 | 8 | 16.0 | 25 | 8 | 32.0 | 75 | 16 | 21.3 |
| | 2 | 60 | 14 | 23.3 | 40 | 12 | 30.0 | 100 | 26 | 26.0 |
| 108 x L. 361 | 1+3 | 50 | 10 | 20.0 | 22 | 5 | 22.7 | 77 | 15 | 19.5 |
| | 2 | 80 | 16 | 20.0 | 28 | 14 | 50.0 | 108 | 30 | 27.7 |
| 108 x L. 5 | 1+3 | 50 | 7 | 14.0 | - | - | - | - | - | - |
| | 2 | 100 | 24 | 24.0 | - | - | - | - | - | - |
| 108 x L. 713 | 1+3 | 100 | 27 | 27.0 | 20 | 12 | 60.0 | 120 | 39 | 32.5 |
| | 2 | 80 | 16 | 20.0 | 26 | 13 | 50.0 | 106 | 29 | 27.3 |
| 108 x T-3 | 1+3 | 60 | 14 | 23.3 | 30 | 14 | 46.7 | 90 | 28 | 31.1 |
| | 2 | 50 | 10 | 20.0 | 38 | 18 | 47.4 | 88 | 28 | 31.8 |



| | | | | | | | | | | |
|-------------------------|--------------|-------------|------------|-------------|------------|------------|-------------|------------|------------|-------------|
| 108 x Millenium | 1+3 | 60 | 13 | 21.7 | 30 | 8 | 26.7 | 90 | 21 | 23.3 |
| | 2 | 100 | 21 | 21.0 | 28 | 11 | 39.3 | 128 | 32 | 25.0 |
| 108 x Giza 77 | 1+3 | 50 | 5 | 10.0 | - | - | - | - | - | - |
| G. barbadense | 2 | 50 | 8 | 16.0 | - | - | - | - | - | - |
| 108 x KoyuDeve | 1+3 | 50 | 10 | 20.0 | - | - | - | - | - | - |
| Brown cotton | 2 | 50 | 5 | 10.0 | - | - | - | - | - | - |
| 108 x № 433 | 1+3 | - | - | - | 24 | 10 | 41.7 | - | - | - |
| Brown cotton | 2 | - | - | - | 18 | 11 | 61.1 | - | - | - |
| 108 Average: | 1+3 | 470 | 94 | 20.0 | 151 | 57 | 37.7 | 452 | 119 | 26.3 |
| | 2 | 570 | 114 | 20.0 | 178 | 79 | 44.4 | 530 | 145 | 27.3 |
| | 1+3+2 | 1040 | 208 | 20.0 | 329 | 136 | 41.3 | 982 | 264 | 26.9 |
| A-1 x Chirpan - 539 | 1+3 | 50 | 2 | 4.0 | 28 | 12 | 42.9 | 78 | 30 | 38.5 |
| | 2 | 50 | 2 | 4.0 | 31 | 12 | 38.7 | 81 | 14 | 17.3 |
| A-1 x L. 361 | 1+3 | - | - | - | 44 | 19 | 43.2 | - | - | - |
| | 2 | - | - | - | 29 | 10 | 34.5 | - | - | - |
| A-1 x L. 5 | 1+3 | 50 | 5 | 10.0 | - | - | - | - | - | - |
| | 2 | 50 | 2 | 4.0 | - | - | - | - | - | - |
| A-1 x L. 713 | 1+3 | 50 | 3 | 6.0 | 30 | 5 | 16.7 | 80 | 8 | 10.0 |
| | 2 | - | - | - | 39 | 14 | 40 | - | - | - |
| A-1 x T-3 | 1+3 | 50 | 1 | 2.0 | 32 | 12 | 37.5 | 82 | 13 | 15.9 |
| | 2 | 50 | 1 | 2.0 | 38 | 13 | 34.2 | 88 | 14 | 15.9 |
| A-1 x Millenium | 1+3 | 50 | 1 | 2.0 | 32 | 9 | 28.1 | 82 | 10 | 12.2 |
| | 2 | 50 | 3 | 6.0 | 34 | 14 | 41.2 | 84 | 17 | 20.3 |
| A-1 x KoyuDeve | 1+3 | 100 | 27 | 27.0 | - | - | - | - | - | - |
| Brown cotton | 2 | 100 | 21 | 21.0 | - | - | - | - | - | - |
| A-1 x № 433 | 1+3 | - | - | - | 33 | 11 | 33.3 | - | - | - |
| Brown cotton | 2 | - | - | - | 28 | 12 | 42.9 | - | - | - |
| A-1 Average: | 1+3 | 350 | 39 | 11.1 | 199 | 68 | 34.2 | 322 | 45 | 14.0 |
| | 2 | 300 | 29 | 9.7 | 199 | 75 | 37.7 | 253 | 45 | 17.8 |
| | 1+3+2 | 650 | 68 | 10.5 | 398 | 143 | 35.9 | 575 | 90 | 15.7 |
| A-21 x Chirpan - 539 | 1+3 | - | - | - | 33 | 26 | 78.8 | - | - | - |
| | 2 | - | - | - | 45 | 31 | 68.9 | - | - | - |
| A-21 x L. 361 | 1+3 | - | - | - | 28 | 22 | 78.6 | - | - | - |
| | 2 | - | - | - | 34 | 12 | 35.3 | - | - | - |
| A-21 x L. 713 | 1+3 | - | - | - | 40 | 27 | 67.5 | - | - | - |
| | 2 | - | - | - | 39 | 25 | 64.1 | - | - | - |
| A-21 x T-3 | 1+3 | - | - | - | 36 | 23 | 63.9 | - | - | - |
| | 2 | - | - | - | 25 | 12 | 48.0 | - | - | - |
| A-21 x Millenium | 1+3 | - | - | - | 22 | 19 | 86.4 | - | - | - |
| | 2 | - | - | - | 39 | 28 | 71.8 | - | - | - |
| A-21 x № 433 | 1+3 | - | - | - | 30 | 20 | 66.7 | - | - | - |
| Brown cotton | 2 | - | - | - | 30 | 27 | 90.0 | - | - | - |

| | | | | | | | | | | |
|---|--------------|-------------|------------|-------------|-------------|------------|-------------|-------------|------------|-------------|
| A-21 Average: | 1+3 | - | - | - | 189 | 137 | 72.5 | - | - | - |
| | 2 | - | - | - | 212 | 135 | 63.7 | - | - | - |
| | 1+3+2 | - | - | - | 401 | 272 | 67.8 | - | - | - |
| <i>A-65 x</i> <i>Chirpan – 539</i> | 1+3 | - | - | - | 24 | 21 | 87.5 | - | - | - |
| | 2 | - | - | - | 29 | 15 | 51.7 | - | - | - |
| <i>A-65 x L. 361</i> | 1+3 | - | - | - | 20 | 6 | 30.0 | - | - | - |
| | 2 | - | - | - | 19 | 7 | 36.8 | - | - | - |
| <i>A-65 x L. 713</i> | 1+3 | - | - | - | 32 | 11 | 34.4 | - | - | - |
| | 2 | - | - | - | 23 | 5 | 21.7 | - | - | - |
| <i>A-65 x T-3</i> | 1+3 | - | - | - | 8 | 1 | 12.5 | - | - | - |
| | 2 | - | - | - | 32 | 10 | 31.3 | - | - | - |
| <i>A-65 x Millenium</i> | 1+3 | - | - | - | 28 | 10 | 35.7 | - | - | - |
| | 2 | - | - | - | 51 | 19 | 37.3 | - | - | - |
| <i>A-65 x A® 433</i> <i>Brown cotton</i> | 1+3 | - | - | - | 18 | 9 | 50.0 | - | - | - |
| | 2 | - | - | - | 39 | 13 | 33.3 | - | - | - |
| A-65 Average: | 1+3 | - | - | - | 130 | 58 | 44.6 | - | - | - |
| | 2 | - | - | - | 193 | 68 | 35.2 | - | - | - |
| | 1+3+2 | - | - | - | 323 | 126 | 39.3 | - | - | - |
| Average: | 1+3 | 1420 | 275 | 19.4 | 856 | 392 | 47.0 | 1350 | 336 | 24.9 |
| | 2 | 1410 | 251 | 17.8 | 983 | 448 | 44.6 | 1239 | 318 | 25.7 |
| | 1+3+2 | 2870 | 526 | 18.3 | 1839 | 840 | 45.7 | 2589 | 654 | 25.3 |