## *Plant Production (Group Lotus)*

# Effect of Plant Density and Harvest Time on Cotton Seed Quality. Field Studies on Acid-delinted Cotton Seed

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## *Introduction*

Acid-delinted cotton seed is the highest improved seed quality approaches introduced in Egypt. In 1998, an experiment was carried out on the cultivar Giza 87 to investigate the effect of acid-delinted seed on the plant population and their influence on the productivity of cotton at Sakha, Kafr El-Sheikh, Egypt. The results discovered that the plant population could be reduced to 30-40 thousand plants per fed. without negative effects on yield from unit area in comparison to the traditional growing pattern, that recommend 60-70 $\times$ $10^3$ plants per fed. Also, the yield of the first harvest was improved (Abdel-Hafezand Homeyer;1999). Moreover, further studies were carried out on the cultivar Giza 89 in another location (Abdel-Hafez;2000). The results showed that, there were not significant differences between 64,000 plants/fed and 40,000 plants/fed. So, growing 40,000 plants/fed is shown to be enough for getting the best yield/fed. This was achieved by 75 cm ridging distance and 25 cm among hills. This facilitates the culture practicing, save seed and reduce shading to encourage generative growth (fruiting) and reduce flower and capsule shedding. Also, it provides the best land use and input use efficiencies. Consequently increases seed cotton yield.
Such results are not strange, thus the breeding processes and plant improvement resulted in modern cultivars with different branching patterns and earliness. In other words the present varieties are different in one or another way from the old ones and need more suitable culture practices, e.g. in terms of planting patterns.
On the other hand, germination of cotton seed in the field and emergence of seedlings is very important factor, for encouraging the cotton growers. High quality certified cotton seed is the most important factor to reach excellent germination as well as seedling emergence, especially in the early sowing during March, under the Egyptian conditions. The quality of seed depends on several factors, e.g. seed maturity, seed purity, seed health and seed viability. Seed maturity and storage have effects on other important criterion, i.e. free fatty acid (FFA) content in its oil. The presence of high ratios of FFA in the oil of seeds adversely affects or inhibit the metabolism and germination of seed. Also, immature seeds have a much higher FFA content and the presence of immature seeds within the mature seeds could raise the FFA content.
Therefore, the present investigation was planed to study the effect of plant population and harvest time on seed quality. The obtained information will provide information to improve the quality of cottonseed in seed production process.

## *Material and Methods*

An experiment was carried out in 1999 season at El-Magd village, Rahmania, El-Behira Governorate. The soil structure is mostly silt and the soil is highly fertile. The preceding crop was Berseem (two cuts) as early winter crop. The soil was operated and $P_2O_5$ fertilizer in form of monosuperphosphate 15.5% at the rate of 60 kg $P_2O_5$/fed incorporated in the soil before ridging and dividing. Also 50 kg Kalium sulfate (24 units and 18 units sulfur) was added. Three different ridge widths were used; 65 cm, 75 cm and 90 cm widths. Cotton was planted on one ridge-side in hills 20, 25 and 90 cm apart.

Planting date: April 1999:
Planting was done with special handy planter prepared for this experiment that allows only unique depth of 3 cm for the seeds.

The seeding rate:
3 different seed-numbers per hill were put. First, the control plots on ridges 65 cm wide had to ensure presence of $64 \times 10^3$ plants per fed and therefore, four seeds were put per hill and the seedlings were thinned to leave two plants per each hill. Second, the hills were spaced 25 cm on the 75cm wide ridges and spaced 30 cm on the 90 cm wide ridges. The number of seeds in each hill in the last two planting patterns; $75 \times 25$ cm and $90 \times 30$ cm; differed, from the control ($65 \times 20$ cm). Herein, only three seeds were planted in each hill and not more than two plants were left per hill after emergence. Theoretically, the number of plants per feddan within the three planting patterns was $64 \times 10^5$ ($60 \times 20$ cm $\times$ 2 plants), $40 \times 10^3$ ($75 \times 25$ cm $\times$ 1-2 plants) and $30 \times 10^3$ ($90 \times 3$ cm $\times$ 1-2 plants). The actual number of plants was almost 10% less than the former ones. The plants received the same normal growing culture practices.

Experimental design:
The treatments were arranged in a randomized complete block design (RCBD) with four replication. The plot size was $7 \times 9 m^2$ area in which the plot included the following number of ridges:
14 ridges for the planting pattern ($65 \times 20$ cm),
12 ridges for the planting pattern ($75 \times 25$ cm), and
10 ridges for the planting pattern ($90 \times 30$ cm).

The two outer rows were left as guard rows and
12 central ridges were used for evaluation of the ($65 \times 20$ cm) pattern,
3 replications were used for the determination of all the seed quality studies.

The following data were recorded on the seeds:

1- **Seed index first harvest**: Weight of 100 seeds in first harvest.
2- **Seed index second harvest:** Weight of 100 seeds in second harvest.
3- **Estimation of the mature/immature seed %:** An amount of 10 kg seeds from each population and harvest time were used to estimate the percentage of mature/immature seeds. The seeds were exposed to a seed blower. The airflow rate was adjusted to remove almost all the immature seeds and insect damaged seeds. However, some light mature seeds were also removed. The mature seeds were weighed

$$\text{Mature seed \%} = \frac{\text{Weight of mature seed g}}{\text{Weight of raw seed g}} \times 100$$

$$\text{Immature seed \%} = \frac{\text{Weight of immature seed g}}{\text{Weight of raw seed g}} \times 100$$

4- **Determination of free fatty acids (FAA) %:** The percent FFA was determined in the mature seeds after removing of the immature and insect damaged seeds obtained from the three plant populations and the two harvest times. The procedure of determination was carried out according to the quick method of the Association of official oil chemists as described by Dr. Bernhard Homeyer in the "Egyptian-German Acid Delinting for Cotton Seed Project". Bulletin. Three samples were taken from each oil stock to determine the FFA percent.

5- **Germination %:** Germination test of mature seeds was carried out in lab under controlled conditions. The germination test was carried out in sandy soil and in eight replications at 30°C. The seedlings were counted after five days were classified in normal seedlings and abnormal ones. Also, the not germinating seeds were assorted in dead/disease-infected seeds and not germinating seeds. Finally, the following traits were calculated.

$$\text{Germination \%} = \frac{\text{Mean No. of normal seedlings}}{\text{No. of sown seeds}} \times 100$$

$$\text{Abnormal seedling \%} = \frac{\text{Mean No. of abnormal seedlings}}{\text{No. of sown seeds}} \times 100$$

$$\text{Dead seed (infected)\%} = \frac{\text{Mean No. of dead seeds}}{\text{No. of sown seeds}} \times 100$$

$$\text{Not germinating seeds \%} = \frac{\text{Mean No. of not germinating seeds}}{\text{No. of sown seeds}} \times 100$$

Finally, the data were computed and the means were compared according to Duncan's Multiple Range Test. In some cases the data were transformed before subjecting it to statistical analyses.

## *Results*

### 1- Seed Index:

The seed index data (Table1) showed that the plant populations used herein did not effect the seed index strongly. But, this trait was strongly affected by the harvest time. The seeds produced from the first harvest were higher in weight than that of the second harvest. This means, that second harvest produce low quality seeds, that are not suitable for cultivation. The differences in seed index between the two harvests were highly significant.

**Table (1): Mean seed index (g) of Giza 89 cotton planted with acid-delinted seed in 1999.**

| Planting pattern cm | Plants/hill | Harvest (H) | | Means (p) | Difference |
|---|---|---|---|---|---|
| | | 1st | 2nd | | |
| 65/20 (control) | 2 | 9.058 a | 11.265 a | 10.162 a | -2.208** |
| 75/25 | 1-2 | 8.912 a | 11.308 a | 10.110 a | -2.396** |
| 90/30 | 1-2 | 9.187 a | 11.261 a | 10.224 a | -2.074** |
| **Mean** | | **9.052** | **11.278** | **10.165** | **-2.226**** |

** = Significant at 1% level.
ns = not significant.
In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

| Comparison | S.E.D. | LSD (5%) | LSD (1%) |
|---|---|---|---|
| 2-H*P means | 0.258 | 0.550 | 0.761 |
| 2-p means | 0.149 | 0.318 | 0.439 |

## 2- Lint percentage:

The lint percentage of the first harvest was highly significantly lower than that of the second harvest (Table 2). This is mainly caused due to the high seed index in the first harvest compared to that of the second one. However, these differences were only significant in both 65/20 cm (the control treatment) and 75/25 cm plant population patterns. But, the difference was highly significant in the 90/30 cm plant population pattern that produced high seed index besides its higher yields than the control in the first harvest.

**Table (2): Mean lint percentage of Giza 89 cotton planted by acid-delinted seed in 1999.**

| Planting pattern cm | Plants/hill | Harvest (H) | | Means (p) | Difference |
|---|---|---|---|---|---|
| | | 1st | 2nd | | |
| 65/20 (control) | 2 | 0.362 a | 0.396 a | 0.379 a | -0.034 * |
| 75/25 | 1-2 | 0.370 a | 0.404 a | 0.387 a | -0.034 * |
| 90/30 | 1-2 | 0.358 a | 0.399 a | 0.378 a | -0.041 ** |
| **Mean** | | **0.363** | **0.400** | **0.381** | **-0.036 **** |

** = Significant at 1% level.
ns = not significant.
In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

| Comparison | S.E.D. | LSD (5%) | LSD (1%) |
|---|---|---|---|
| 2-H*P means | 0.013 | 0.029 | 0.039 |
| 2-H means | 0.008 | 0.016 | 0.023 |

## 3- Mature seed %:

The mean percentage of mature seeds (Table 3) was less in the second harvest by 20.88% than that of the first harvest. Such reduction reached 25.06, 16.44 and 21.35% at the 65/20, 75/25 and 90/30 $cm^2$ plant population patterns, respectively. Also, the mature seed percentage was influenced with the plant population density/pattern x harvest time interaction. Thus the high population of 64,000 plant/fed produced the least percentage mature seeds in the second harvest. On the other hand, the 75/25 $cm^2$ planting pattern/population produced the highest mature seed percentage at each of first and second harvest compared with the other populations and their correspondent harvest time.

**Table (3): Mature seed percent as affected by the interaction of harvest time × plant population: means for mature seed % of Giza 89 cotton planted by acid-delinted seed in 1999.**

| Planting pattern cm | Plants/hill | Harvest (H) | | Means (p) | Difference |
|---|---|---|---|---|---|
| | | 1st | 2nd | | |
| 65/20 (control) | 2 | 77.917 c | 58.394 c | 68.155 | 19.524** |
| 75/25 | 1-2 | 81.412 a | 68.030 a | 74.721 | 13.383** |
| 90/30 | 1-2 | 80.357 b | 63.204 b | 71.781 | 17.153** |
| **Mean** | | **79.896** | **63.209** | **71.552** | **16.686** |

** = Significant at 1% level.
In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

## 4- Immature seed %:

Opposite to the mature seed %, the immature seed percentage (Table 4) was higher by 80.67 in the seeds derived from the second harvest than that obtained in the first harvest. In respect to the plant population, different relative values of mature seeds and immature seeds were produced in the first and second harvests. The highest plant population (64,400 plants/ fed) produced the highest relative immature seeds compared to the 40,000 and 30,000 plants/fed. The lightest plant population of 30,000 plants/fed produced more immature than the intermediate plant population of 40,000 plants/fed.

**Table (4): Immature seed percent as affected by the interaction of harvest time × plant population: means for mature seed % of Giza 89 cotton planted by acid-delinted seed in 1999.**

| Planting pattern cm | Plants/hill | Harvest (H) | | Means (p) | Difference |
|---|---|---|---|---|---|
| | | 1st | 2nd | | |
| 65/20 (control) | 2 | 22.562 a | 40.963 a | 31.762 | -18.402** |
| 75/25 | 1-2 | 18.555 c | 31.533 c | 25.044 | -12.977** |
| 90/30 | 1-2 | 19.396 b | 36.830 b | 28.113 | -17.434** |
| **Mean** | | **20.171** | **36.442** | **28.306** | **-16.271** |

** = Significant at 1% level.
In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

## 5- Free fatty acids%:

The percentage of free fatty acids in cotton seed oil of Egyptian cotton *Gossypium barbadense* seemed to be higher than that in the upland cotton *Gossypium hirsutum*. It was ranged from 2.98 to 4.88% in our experiment Table 5. The percentage of free fatty acids differed in cottonseed oil, depending on the source of the seeds. It was higher in seeds of second harvest (second pick) than that derived from the first harvest. The difference was very high and reached 76.35% increase free fatty acids in the second harvest seed. Also, such increase was existent irrespective of the plant population density ("Pflanzendichte") in field; 70.54% at 65 × 20 $cm^2$, 103.82% at 75 × 25$cm^2$ and 35.55 at 90 × 30 $cm^2$.

**Table (5): Free fatty acid % in cotton seed oil as affected by interaction between harvest time and plant population: means for mature seed % of Giza 89 cotton planted by acid-delinted seed in 1999.**

| Planting pattern cm | Plants/hill | Harvest (H) 1st | Harvest (H) 2nd | Means (p) | Difference |
|---|---|---|---|---|---|
| 65/20 (control) | 2 | 2.787 b | 4.753 a | 3.770 b | -1.966** |
| 75/25 | 1-2 | 2.254 b | 4.599 a | 3.426 b | -2.345** |
| 90/30 | 1-2 | 3.907 a | 5.296 a | 4.602 a | -1.389** |
| **Mean** | | **2.983** | **4.883** | **3.933** | **-1.900**** |

** = Significant at 1% level.
In a column, means followed by a common letter are not significantly different at the 5% level by DMR

## 6- Germination %:

When the mature seeds produced from the first harvest were subjected to germination test, in comparison to the mature seeds produced from the second harvest, the data in table 6 showed highly significant differences among the means of the two seeds. Seeds from the first harvest which represent two thirds of the total seed yield, as presented in yield data, showed highly significantly higher germination percentage than that of the second harvest. The difference was 4.332% at 64,000 plants/fed 0.338% at 40,000 plants/fed and 13.705% at 30,000 plants/fed.

**Table (6): Germination % as affected by interaction of harvest time x Plant population: means for mature seed % of Giza 89 cotton planted by acid-delinted seed in 1999.**

| Planting pattern cm | Plants/hill | Harvest (H) 1st | Harvest (H) 2nd | Means (p) | Difference |
|---|---|---|---|---|---|
| 65/20 (control) | 2 | 83.704 ab | 79.373 a | 81.538 | 4.332** |
| 75/25 | 1-2 | 82.007 b | 81.669 a | 81.838 | 0.338 ns |
| 90/30 | 1-2 | 85.373 a | 71.668 b | 78.520 | 13.705** |
| **Mean** | | **83.695** | **77.570** | **80.632** | **6.135** |

** = significant at 1% level. ns = not significant.
In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

## 7- Number of abnormal seedlings % :

There was no significant difference. In other words, there were no significant effects for plant population or harvest time on the number of abnormal seedlings in germination tests (Table 7).

**Table (7): Abnormal seedlings % as affected by interaction of harvest time × plant population: means for mature seed % of Giza 89 cotton planted by acid-delinted seed in 1999.**

| Planting pattern cm | Plants/hill | Harvest (H) 1st | Harvest (H) 2nd | Means (p) | Difference |
|---|---|---|---|---|---|
| 65/20 (control) | 2 | 5.9 a | 4.2 b | 5.0 a | 1.7 ns |
| 75/25 | 1-2 | 7.0 a | 5.7 ab | 6.3 a | 1.3 ns |
| 90/30 | 1-2 | 5.3 a | 7.7 a | 6.5 a | -2.3 ns |
| **Mean** | | **6.1** | **5.8** | **5.9** | **0.2 ns** |

Ns = not significant.
In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

**8- Dead seeds % and No. of non-germinating seeds:**

Dead seeds exhibited disease infection instead of germinating. The mean number of dead seeds was not significantly effected by plant population. However, it was shown significantly influenced (increased) in seeds derived from the second harvest compared to the first one. Also, it was influenced by the interaction between plant population density and harvest time. Yet, the first harvest at 64,000 and 40,000 plants population densities obtained relatively significant higher relative dead seeds than the second harvest, but the opposite was obtained at the 30,000 plant population density. Moreover, the second harvest seeds showed highly significantly higher relative dead seeds than that of the first harvest (Table 8).

**Table (8): Dead seeds % as affected by interaction of harvest time × plant population: means for mature seed % of Giza 89 cotton planted by acid-delinted seed in 1999.**

| Planting pattern cm | Plants/hill | Harvest (H) | | Means (p) | Difference |
|---|---|---|---|---|---|
| | | 1st | 2nd | | |
| 65/20 (control) | 2 | 4.655 ab | 6.610 ab | 5.632 | -1.955 ns |
| 75/25 | 1-2 | 6.667 a | 4.580 b | 5.624 | 2.086 ns |
| 90/30 | 1-2 | 2.645 b | 8.292 a | 5.468 | -5.647** |
| **Mean** | | **4.655** | **6.494** | **5.575** | **-1.839** |

** = significant at 1% level. Ns = not significant.
In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Also, data in Table 9 show that the relative number of non-germinating seeds was significantly or highly significantly higher for seeds derived from second harvest that derived from first harvest.

**Table (9): Non-germinating seeds % as affected by interaction of harvest time × plant population: means for mature seed % of Giza 89 cotton planted by acid-delinted seed in 1999.**

| Planting pattern cm | Plants/hill | Harvest (H) | | Means (p) | Difference |
|---|---|---|---|---|---|
| | | 1st | 2nd | | |
| 65/20 (control) | 2 | 4.624 a | 7.327 a | 5.975 a | -2.703* |
| 75/25 | 1-2 | 4.250 a | 7.584 a | 5.917 a | -3.334* |
| 90/30 | 1-2 | 2.645 a | 8.625 a | 5.635 a | -5.980** |
| **Mean** | | **3.839** | **7.845** | 5.842 | **-4.005**** |

** = significant at 1% level. * = significant at 5% level.
In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

## *Discussion*

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In comparison between seeds produced from the first and the second pick ("Pflücken"), seed index of seeds from the first pick was higher than that derived from the second pick. This means that seeds of the first pick are vigorous than these of the second one. Such difference was increased as the plant population was reduced. Consequently, the seeds from the first pick especially, that produced under lower plant population should be preferred for planting.

The percent of mature seed was strongly higher in seeds of first pick compared to the second one. This findings, demonstrates the importance of reserving the seeds of the

first pick for seed production as they are the better quality seeds. Also, this idea can save a lot of time and costs in seed processing to separate the immature seeds from the raw seeds. On the other side, the second pick produces higher percentages of immature seeds than the first pick, and needs more time and costs in seed processing, transportation, packages, handling, storage etc., and lastly produce less amount of mature seeds for certification. Furthermore, seeds of the second pick proved to contain higher amounts of free fatty acids in their oil, compared to the seeds derived from the first pick.

The seeds of the second pick contained 76.35% more FFA in cotton seed oil, than that oil from the seed derived from the first pick. The presence of such sizeable increase in FFA is very effective in deterioration of the viability of the seed obtained from the second pick.

Therefore, it is wise to use seeds derived from the first pick alone to be processed and certified to grow cotton. This findings is strongly supported by the fact that our results clearly demonstrated that the germination percent of seeds from the first pick was highly significantly higher than that of seeds derived from the second pick. Moreover, the last seeds derived from the second pick contained more dead and disease infected seeds as well as non-germinating seeds than the that from the first pick. Finally, it will be possible to cultivate the unit area *feddan* with *less than twenty kg* of the acid-delinted seed of first pick.

## *Conclusion*

Seeds produced from the first harvest have less content of free fatty acids and can have longer viability life in storage.

Seeds produced from first harvest have higher seed index, better germination ratios and are preferred to produce better quality seed with less total costs.

On the other hand, seeds from second harvest have less germination percentage, contain higher free fatty acids and could hardly keep good viability during storage. Therefore, it should be avoided as source of seed.

Seeds derived from the first pick are representing up to 2/3 of the seed yield per unit area and would be enough to produce high quality seed. Some financial promotion, for seed producing cotton growers could encourage them pick the fast yield at proper time.

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## *References:*

**1. Abdel-Hafez,Abdel-Aziz Galal. and B. Homeyer (1999).** Response of yield to plant population density in Giza 87 cotton**. In:** proceed.3rd Egyptian National Seed Conference May 10-12,1999, CASC-MALR, Cairo Egypt:128-136.

**2. Abdel-Hafez, Abdel-Aziz Galal (2000).** Field Studies on Acid-delinted Cotton Seed 1. Yield in relation to plant density**. In:** Proceed.1st Intern .Symp." Sustainable Agriculture and Rural Development in Egypt, Experiences of Egyptian Graduates from German Unversities.GEAR,November1999, Cairo, Egypt: 61-70.