*J. Agric. Sci. Mansoura Univ., 25 (6): 3187 - 3195, 2000*

# GENETIC STUDY OF EGG LAYING PERFORMANCE IN FOUR LOCALLY DEVELOPED STRAINS OF CHICKENS

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## ABSTRACT

A total number of 364 pedigreed pullets at sexual maturity was used randomly which contained 90 Mandarah (MN), 84 Golden Montazah (GM), 96 Silver Montazah (SM) and 94 Matrouh (MT) to study the genetic parameters of egg laying performance in four consecutive months in each strain. Results obtained are summarized as follows:

1- Matrouh pullets reached age at sexual maturity earlier than other strains, hence, they had lighter average body weight compared to other strains at this age. Moreover, Matrouh excelled other strains with respect to average weight of first egg and number of days in which the first 10 eggs were laid.

2- Matrouh strain surpassed other strains in average total egg mass, total egg number and rate of laying .

3- Percentages of variance components showed that maternal and sex-linked effects are considered important factors in determining traits of egg laying performance in these strains.

4- In general, traits of laying performance had relatively higher heritability estimates, which suggest that rapid improvement of egg production in these strains could be reached by within family selection.

5- Genetic and phenotypic correlations among total egg number and each of age at sexual maturity, body weight at sexual maturity, weight of first eggs and number of days in which the first 10 eggs were laid in all strains indicated that, when the pullet reached its sexual maturity at an early, it could have the ability to produce more number of eggs. Moreover, first egg weight and number of days in which the first 10 eggs were laid would be decreased.

6- Genetic correlations among total egg number and average egg mass indicated that genes which affect total egg number may, also, affect egg mass.

**Key words**: Strains, variance components, heritability, correlations

## INTRODUCTION

Egg production in chickens is a complex metric trait showing many variations during the period of production of the pullets. The study of egg production and its related traits such as age and body weight at sexual maturity attraction of several investigators who found that there were wide variations in these traits between the different breeds and varieties of chickens (Abdel Gawad, 1981 in Mandarah; Kosba *et al*. 1981 in Gimmazah, Alexandria, Silver Montazah and Bandarah; El-labban *et al*. 1991 in Dokki-4; Hassan, 1997 in Silver Montazah and Matrouh; Ali *et al*. 1999 in Gimmazah and Mamourah and El-Soudany, 2000 in Golden Montazah and Matrouh ).

Partial recording of egg production in pullets of chickens is used to enhance and to increase the efficiency of genetic selection as well as to shorten the generation interval. Results of many investigators showed that more genetic gain could be obtained in egg production when using partial recording ( Ayyagari and Mohapatra, 1983; Ezzeldin and Mostageer, 1984; Hanafi and El-labban, 1984; Muir, 1990 and El-labban *et al*. 1991 ).

Genetic study of egg production traits (heritability, genetic and phenotypic correlations) in different breeds were cited by many investigators, who found that there were many variations in the estimates of heritability and correlations according to the differences of the genetic make-up (Al-Rawi, 1980; Atalla *et al*., 1983; Chaudhary *et al*., 1988; Singh *et al*., 1988; Haggere, 1989 and El-labban *et al*. 1991).

The objectives of this study are to study the genetic parameters of laying performance in four locally developed strains as well as to give more information about the possibility of using these strains as parents to improve the egg production in local chickens.

## MATERIALS AND METHODS

This work was carried out at Inshas Poultry Breeding Research Station, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture.

**Strains of chickens and plan of mating:**

Four locally developed strains namely Mandarah (MN), Golden Montazah (GM), Silver Montazah (SM) and Matrouh (MT) were used. A total number of 364 pedigreed pullets at sexual maturity was used at random which contained 90 Mandarah (progeny of 10 sires mated with 30 dams), 84 Golden Montazah (progeny of 9 sires mated with 28 dams), 96 Silver Montazah (progeny of 10 sires mated with 31 dams) and 94 Matrouh (progeny of 10 sires mated with 31 dams) to study the genetic parameters of the laying performance for each pullet in four consecutive months in each strains starting from June 1994.

All pullets housed in breeding pens 3mx2m and were fed on ration containing 16.07 % crude protein and 2752 k cal / kg. Metabolizable energy. The pullets were exposed to light for 16 hours / day and all pullets of each strain were treated and medicated similarly through out the experimental period.

**Measurements:**

The following traits were studied:

1- Age at sexual maturity in days (ASM).
2- Body weight at sexual maturity in grams (BWSM).
3- Weight of first egg in grams (EW1).
4- Egg mass at first 10 eggs in grams (EM10).
5- Days in which the first 10 eggs were laid (DF10).
6- Egg mass at first, second, third and fourth months and total egg mass in grams (EM1, EM2, EM3, EM4 and TEM).
7- Total egg number in eggs (TEN).
8- Rate of laying (RL%).

**Statistical analysis:**

Least squares was carried out according to SAS (1996). Estimates of analysis of variance and covariance components (needed for the calculation of heritabilities and correlations among traits) were computed according to the following model (Harvey, 1990).

$$X_{ijk} = \mu + S_i + D_{ij} + e_{ijk}$$

Where $X_{ijk}$ = The observation

$\mu$ = an effect of common all observation.

$S_i$ = an effect of the $i^{th}$ sire,

$D_{ij}$ = an effect of the $j^{th}$ dam mated to the $i^{th}$ sire and

$e_{ijk}$ = the random effect due to the $k^{th}$ pullet of the $j^{th}$ dam and $i^{th}$ sire.

Genetic parameters (heritabilities and correlations) were estimated based on the sum of the sire plus dam components of variance, because combined estimates are more precise, although they may be biased by dominance and maternal effect (Miur, 1990).

## RESULTS AND DISCUSSION

**Least squares means:**

Least squares means (± SE) for traits of egg production in different strains are presented in Table 1.

From Table1, it seems that Matrouh pullets reached age at sexual maturity at about 171 days with body weight at sexual maturity of about 1550 grams, weight of the first egg of 38.98 grams, egg mass at first 10 eggs of about 437 grams and days in which first 10 eggs were laid of about 15 days. While the other strains characterized with higher estimates. It is clear that Matrouh pullets were early sexual maturity and light body weight at sexual maturity and consequently weight of first egg and days in which first 10 eggs were laid decreased. Otherwise, the pullets of other strains were late age at sexual maturity and heavy body weight, therefore, weight of first egg and days in which first 10 eggs were laid increased.

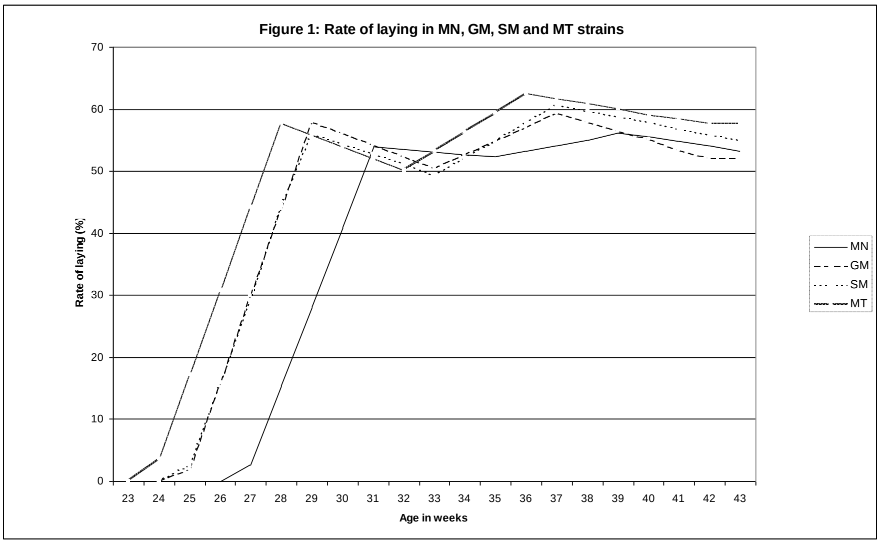
Results in Table 1, also, showed that in first month, pullets of each of Golden Montazah and Matrouh strains had heavier egg mass (about 809 and 789 grams) than pullets of each of Mandarah (about 721 grams) and Silver Montazah (about 739 grams). While third and fourth months were nearly equal in all strains. Total egg number (about 69 eggs) and total egg mass (about 3365 grams) in Matrouh strains surpassed those of the other strains. The respective values for the same traits in Mandarah were about 65 eggs and about 3136 grams, in Golden Montazah were about 66 eggs and about 3304 grams and in Silver Montazah were about 67 eggs and about 3185 grams, respectively.

**Table 1: Least squares means ± SE for traits of egg laying performance in MN, GM, SM, and MT strains. ***

| Traits | MN | GM | SM | MT |
|---|---|---|---|---|
| NO | 90 | 84 | 96 | 94 |
| ASM | 186.17 ± 1.05 c | 175.05 ± 1.09 b | 171.93 ± 1.04 a | 170.77 ± 1.03 a |
| BWSM | 1905.11 ±13.89 a | 1860.00 ± 15.83 b | 1762.08 ± 14.71 c | 1549.79 ± 12.67 d |
| EW1 | 39.68 ± 0.55 b | 41.68 ± 0.63 a | 39.17 ± 0.55 b | 38.98 ± 0.53 b |
| EM10 | 425.02 ± 4.16 c | 453.44 ± 4.02 a | 428.07 ± 4.52 c | 437.49 ± 4.08 b |
| DF10 | 16.90 ± 0.32 b | 16.85 ± 0.46 b | 16.06 ± 0.52 b | 15.09 ± 0.32 a |
| EM1 | 720.77 ± 15.70 b | 808.57 ± 13.82 a | 739.27 ± 13.59 b | 788.77 ± 13.47a |
| EM2 | 799.81 ± 32.59 a | 748.41 ± 28.70 ab | 698.90 ± 28.20 b | 725.63 ± 27.95 ab |
| EM3 | 926.27 ± 65.31 a | 972.04 ± 57.52 a | 895.25 ± 56.53 a | 940.01 ± 56.03 a |
| EM4 | 824.22 ± 67.47 b | 835.02 ± 59.41 b | 1004.05 ± 58.39 a | 913.90 ± 57.88 ab |
| TEM | 3135.92 ± 32.45 b | 3304.48 ± 57.32 a | 3185.45 ± 37.11 b | 3365.35 ± 37.03 a |
| TEN | 64.71 ± 0.67 b | 66.31 ± 1.14 b | 66.80 ± 0.75 ab | 68.78 ± 0.75 a |

*** Means within a row followed by different letters differ significantly from each other ($P < 0.05$)**

Figure 1, shows the rate of laying during four months of production in MN, GM, SM and MT strains. MT strain was of the highest rate of laying (about 63 %) and reached the peak of production at about 36 weeks of age. While MN, GM and SM strains were about 56 %, 59 % and 61 %, respectively and their age of peak of production was about 39, 37 and 37 weeks, respectively. The drop in egg production, which occurred during 32-33 weeks of age, might be due to the irregularity of light during this period.




From these results, it is shown that MT strain exceed by 4.07, 2.47 and 1.98 eggs in egg number, 229.43, 60.87 and 179.61 grams in egg mass and 6.3 %, 3.2 % and 1.9 % in rate of laying for peak than each of MN, GM and SM strains. It is logic to conclude that MT pullets were reached their sexual maturity early and, therefore, higher rate of egg production was obtained and consequently MT pullets may be more persistency than other strains. Shower *et al*. (1981) with five strains (Alexandria, Golden Montazah, Matrouh and White Leghorn) found the averages of age and body weight at sexual maturity and egg number in the first ninety days of laying ranged from 155.0 to 202.9 days, from 1613.0 to 2005.8 grams and from 29.3 to 40.0 eggs, respectively. While El-labban *et al*. (1991) reported that age and body weight at sexual maturity, egg number in the first ninety days of laying and number of days in which first 10 eggs were laid were 172.8 days, 1524.9 grams, 56.0 eggs and 15.8 days in Dokki-4, respectively.

**Components of variance:**

Results in Table 2 indicated that there were significant differences among sires and among dams in many traits of egg laying performance. These results indicated that these strains had not been subjected to any intensive selection for a long time. Therefore, high genetic variabilities in egg production traits for these strains were expected. The percentages of variance due to sire versus due to dam for ASM, BWSM and EW1were 23.2 % vs 37.4 %, 24.1 % vs 26.5 % and 45.3 % vs 3.7 % in MN, 14.9 % vs 28.8 %11.5% vs 8.1 % and 18.8 % vs 28.4 % in GM, 35.5 % vs 17.3 %, 30.9 % Vs 13.1 % and 42.5 % vs 0.0 % in SM and 9.7 % vs 37.4 %, 16.8 % vs 31.2 % and 20.4 % vs 30.9 % in MT, respectively. From these results, it is appeared that dams contributed more genetic variabilities than sires for some traits in some strains. While, sires contributed more genetic varibilities than dams for other traits in other strains. Therefore, maternal and sex-linked effects should be considered as important factors in determining these traits.

The percentages of variance due to sires were higher than due to dams in each of average egg mass and total egg number in all strains (Table 2). The percentages of variance components due to sires versus due to dams for these traits were 15.6 % vs 7.1 % and 4.4 % vs 0.0 % in MN, 18.4 % vs 9.8 % and 2.0 % vs 8.3 % in GM, 27.4 % vs 3.9 % and 16.2 % vs 4.5 % in SM and 33.2 % vs 4.0 % and 14.0 % vs 0.0 % in MT strains. Therefore, sex-linked effects were important for these traits in all strains. Similar results were obtained by Hanafi and El-labban (1984), Hagger (1989) and El-labban *et al*. (1991).

**Heritability estimates:**

Heritability estimates along with their standard errors for traits of egg performance in different strains are presented in Table 3. The estimates of heritabilities for ASM, BWSM, EW1, DF10, average egg mass and TEN were 1.212, 1.012, 0.980, 0.211, 0.455 and 0.088 in MN, 0.874, 0.392. 0.944, 0.984, 0.564 and 0.206 in GM, 1.056, 0.880, 0.850, 0.914, 0.626 and 0.414 in SM and 0.942, 0.960, 1.026, 0.586, 0.734 and 0.280 in MT, respectively. In general, these traits of laying performance are shown to be relatively highly heritable traits, which suggest that rapid improvement of egg production in these strains could be reached by genetic selection utilizing the additive effect. This is one of the criteria of the highly heritable traits. These results agree with Atalla *et al*. (1983); Singh *et al*. (1988); Muir (1990) and El-labban *et al*. (1991).

**Table 3: Herieability estimates ($\overline{X}$±SE) for traits of egg laying performance in MN, GM, SM and MT strains.**

| Traits | MN | GM | SM | MT |
|---|---|---|---|---|
| ASM | 1.212 ±0.224 | 0.874 ± o.267 | 1.056 ± 0.237 | 0.942 ± 0.248 |
| BWSM | 1.012 ± 0.248 | 0.392 ± 0.249 | 0.880 ± 0.249 | 0.960 ± 0.247 |
| EW1 | 0.980 ± 0.252 | 0.944 ± 0.263 | 0.850 ± 0.250 | 1.026 ± 0.242 |
| EM10 | 1.537 ± 0.156 | 1.432 ± 0.189 | 1.536 ± 0.152 | 1.072 ± 0.238 |
| DF10 | 0.211 ± 0.215 | 0.984 ± 0.260 | 0.914 ± 0.248 | 0.586 ± 0.251 |
| EM1 | 0.659 ± 0.259 | 0.828 ± 0.269 | 0.900 ± 0.248 | 0.874 ± 0.252 |
| EM2 | 0.130 ± 0.199 | 0.810 ± 0.269 | 0.486 ± 0.242 | 0.898 ± 0.251 |
| EM3 | 0.000 ± 0.000 | 0.016 ± 0.180 | 0.538 ± 0.245 | 0.478 ± 0.243 |
| EM4 | 0.344 ± 0.234 | 0.140 ± 0.208 | 0.024 ± 0.169 | 0.678 ± 0.255 |
| TEM | 0.060 ± 0.184 | 0.156 ± 0.211 | 0.272 ± 0.216 | 0.406 ± 0.236 |
| TEN | 0.088 ± 0.190 | 0.206 ± 0.221 | 0.414 ± 0.235 | 0.280 ± 0.279 |

## Correlations:

Genetic and phenotypic correlation coefficients among TEN and different traits of laying performance in different strains are presented in Table 4. Estimates of genetic correlations among TEN and each of ASM, BWSM, EW1 and DF10 in each of MN (-1.038, -0.591, -0.624 and -0.591), GM (-1.215, -1.887, -1.562 and –0.663), SM (-0.736, -0.206, -0.755 and - 0.903) and MT (-0.550, 0.323, -0.387 and –0.680) were, in general, negative and high which means that when the pullet reached its sexual maturity at an early age, it has the ability to produce more number of eggs and consequently, weight of first egg and number of days in which the first 10 eggs were laid are decreased. The same trend was obtained for phenotypic correlations for the same traits.

With respect to the associations between TEN and average egg mass (Table 4), the average estimate of genetic correlations for MN, GM, SM and MT strains (-0.486, 0.152, 0.112 and 0.231) and phenotypic correlations (0.332, 0.440, 0.347 and 0.454) were positive and generally moderate. These correlations indicate that genes which affect TEN may, also, affect egg mass.

**Table 4: Genetic and phenotypic correlations (± SE) among total egg number and other different traits in MN, GM, SM and MT strains.**

| Traits | MN | | GM | | SM | | MT | |
|---|---|---|---|---|---|---|---|---|
| | $r_G$ | $r_P$ | $r_G$ | $r_P$ | $r_G$ | $r_P$ | $r_G$ | $r_P$ |
| ASM | - 1.038 ± 1.315 | 0.439 ± 0.085 | - 1.215 ± 0.723 | - 0.375 ± 0.015 | - 0.736 ± 0.357 | - 0.261 ± 0.109 | - 0.550 ± 0.504 | - 0.452 ± 0.124 |
| BWSM | - 0.591 ± 0.842 | - 0.013 ± 0.105 | - 1.887 ± 1.019 | - 0.156 ± 0.112 | - 0.206 ± 0.384 | - 0.093 ± 0.103 | 0.323 ± 0.434 | - 0.094 ± 0.104 |
| EW1 | - 0.624 ± 0.940 | 0.940 ± 0.012 | - 1.562 ± 0.737 | - 0.194 ± 0.113 | - 0.755 ± 0.355 | - 0.153 ± 0.105 | - 0.387 ± 0.434 | - 0.143 ± 0.105 |
| EM10 | - 1.167 ± 1.257 | - 0.202 ± 0.110 | - 1.015 ± 0.576 | - 0.264 ± 0.117 | - 0.603 ± 0.335 | - 0.244 ± 0.108 | 0.024 ± 0.426 | - 0.131 ± 0.105 |
| DF10 | - 0.591 ± 1.497 | - 0.327 ± 0.106 | - 0.663 ± 0.616 | - 0.377 ± 0.125 | - 0.903 ± 0.406 | - 0.440 ± 0.122 | - 0.680 ± 0.524 | - 0.249 ± 0.110 |
| EM1 | - 0.160 ± 0.721 | 0.418 ± 0.087 | 0.635 ± 0.336 | 0.614 ± 0.068 | 0.694 ± 0.245 | 0.423 ± 0.084 | 0.588 ± 0.297 | 0.579 ± 0.069 |
| EM2 | 0.000 ± 0.000 | 0.177 ± 0.102 | 0.518 ± 0.375 | 0.633 ± 0.065 | - 0.179 ± 0.422 | 0.422 ± 0.084 | - 0.034 ± 0.442 | 0.376 ± 0.089 |
| EM3 | 0.000 ± 0.000 | 0.085 ± 0.105 | 0.000 ± 0.000 | 0.095 ± 0.108 | 0.216 ± 0.402 | 0.501 ± 0.076 | - 0.045 ± 0.517 | 0.423 ± 0.085 |
| EM4 | - 1.009 ± 0.659 | 0.586 ± 0.069 | - 0.033 ± 0.998 | 0.587 ± 0.072 | 0.000 ± 0.000 | 0.087 ± 0.101 | 0.351 ± 0.385 | 0.590 ± 0.067 |
| TEM | - 0.577 ± 1.057 | 0.925 ± 0.015 | 0.806 ± 0.243 | 0.972 ± 0.006 | 0.543 ± 0.330 | 0.893 ± 0.021 | 0.500 ± 0.359 | 0.888 ± 0.022 |

Atalla *et al*. (1983); Ezzeldin and Mostageer (1984); Hanafi and El-labban (1984); Chaudhary *et al.* (1988) and El-labban *et al*. (1991) gave evidence for these results.

From above results, it could be pointed out that these strains had not been subjected to any intensive selection for a long time, therefore, rapid improvement of egg production in these strain could be reached by genetic selection utilizing the additive effect. In addition, partial recording could be considered as a good indicator for the future egg production of the pullet and therefore, selecting and/ or culling of pullets could be carried out at early stage, i.e. generation interval would decrease.

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## دراسة وراثية لأداء وضع البيض في أربعة سلالات مستنبطة محليا من الدجاج

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آجري هذا البحث على 364 دجاجة آخذت عشوائيا حيث احتوت على 90 مندرة و 84 منتزه ذهبى و 96 منتزه فضى و 94 مطروح ، و ذلك لدراسة المعايير الوراثية لأداء وضع البيض في أربعة شهور متتالية في كل سلالة و النتائج المتحصل عليها أمكن تلخيصها كما يلي:

1- دجاج مطروح كان مبكرا في عمر النضج الجنسي عن السلالات الأخرى و لذلك كانت هذه السلالات أعلى في وزن الجسم في هذا العمر. و تفوقت سلالة مطروح عن السلالات الأخرى في وزن أول بيضة و في عدد الأيام التى وضعت فيها العشر بيضات الأولى.
2- تفوق دجاج مطروح على السلالات الأخرى فى كل من كتلة البيض الكلية و عدد البيض الكلى و معدل وضع البيض.
3- النسبة المئوية لمكونات التباين أوضحت آن تأثيرات الاموره و الارتباط بالجنس عوامل هامة في تحديد صفات لأداء وضع البيض فى هذه السلالات .
4- بوجه عام ، كانت صفات أداء وضع البيض عالية التوريث نسبيا و قد اقترح آن الانتخاب الوراثي يمكن أن تؤدى إلى التحسين السريع فى إنتاج البيض فى هذه السلالات.
5- أوضح الارتباط الوراثي و المظهرى بين عدد البيض الكلى و كل من عمر و وزن النضج الجنسي و وزن أول بيضة و عدد الأيام التى وضعت فيها العشر بيضات الأولى فى كل السلالات انه وصول الدجاجة إلى عمر النضج الجنسي مبكرا يعطى لها القدرة على إنتاج عدد اكثر و بالتالي فأن وزن أول بيضة و عدد الأيام التى توضع فيها العشر بيضات الأولى سوف ينقصان .
6- الارتباط الوراثي بين العدد الكلى للبيض و متوسط كتلة البيض يشير إلى أن الجينات التى تؤثر على عدد البيض الكلى ربما تؤثر أيضا على كتلة البيض.

*J. Agric. Sci. Mansoura Univ., 25 (6): 3187 - 3195, 2000*

**Table 2: Percentages of variance components for traits of egg laying performance in MN, GM, SM and MT strains***

| Traits | MN | | | GM | | | SM | | | MT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\sigma^2_s$ | $\sigma^2_d$ | $\sigma^2_e$ | $\sigma^2_s$ | $\sigma^2_d$ | $\sigma^2_e$ | $\sigma^2_s$ | $\sigma^2_d$ | $\sigma^2_e$ | $\sigma^2_s$ | $\sigma^2_d$ | $\sigma^2_e$ |
| df | 9 | 20 | 60 | 8 | 19 | 56 | 9 | 22 | 64 | 9 | 21 | 63 |
| ASM | 23.2 * | 37.4 ** | 39.4 | 14.9 | 28.8 ** | 56.2 | 35.5 ** | 17.3 ** | 47.1 | 9.7 | 37.4 ** | 52.8 |
| BWSM | 24.1 ** | 26.5 ** | 49.4 | 11.5 * | 8.1 | 80.3 | 30.9 ** | 13.1 * | 56.0 | 16.8 * | 31.2 ** | 52.0 |
| EW1 | 45.3 ** | 3.7 | 51.0 | 18.8 ** | 28.4 ** | 52.8 | 42.5 ** | 0.0 | 57.5 | 20.4 * | 30.9 ** | 48.7 |
| EM10 | 57.6 ** | 19.2 ** | 23.2 | 54.0 ** | 17.6 ** | 28.3 | 70.2 ** | 6.6 * | 23.1 | 47.4 ** | 6.2 | 46.4 |
| DF10 | 2.1 | 8.4 | 89.5 | 28.4 ** | 20.8 ** | 50.8 | 18.6 * | 27.1 ** | 54.3 | 22.2 ** | 7.1 | 70.7 |
| EM1 | 16.0 ** | 17.0 * | 67.0 | 11.1 | 30.3 ** | 58.5 | 39.2 ** | 5.8 | 55.0 | 43.7 ** | 0.0 | 56.3 |
| EM2 | 0.0 | 6.5 | 93.5 | 33.4 ** | 7.1 | 59.5 | 24.3 ** | 0.0 | 75.7 | 42.9 ** | 2.1 | 55.0 |
| EM3 | 0.0 | 0.0 | 100.0 | 0.0 | 0.8 | 99.2 | 19.9 ** | 7.0 | 73.1 | 10.5 | 13.4 * | 76.1 |
| EM4 | 17.2 ** | 0.0 | 82.8 | 7.0 | 0.0 | 93.0 | 0.2 | 1.0 | 98.8 | 34.4 ** | 2.0 | 63.6 |
| TEM | 3.0 | 0.0 | 97.0 | 4.7 | 3.1 | 92.2 | 10.8 * | 2.8 | 86.4 | 20.3 ** | 0.0 | 79.7 |
| TEN | 4.4 | 0.0 | 95.6 | 2.0 | 8.3 | 89.7 | 16.2 ** | 4.5 | 79.2 | 14.0 ** | 0.0 | 86.0 |

**+ Negative estimates considered zero**
*** Significant at P < 0.05**
**** Significant at P < 0.01**