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Published by
OSU Rabbit Research Center
Oregon State University
Corvallis, Oregon 97331
FACTORS AFFECTING REPRODUCTIVE PERFORMANCE OF FEMALE RABBITS

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Abstract

Data on reproductive performance of 288 doe rabbits were analyzed to study the effects of month and year of kindling, parity, mating buck and does within buck. Measurements of reproductive performance were: number of services per conception (NSC), gestation length (GL), litter size and weight at birth and at weaning (BLT, BLWT, WLS and WENT, respectively) and mortality (WM) and sex ratio at weaning (WSR). The repeatability of these traits was estimated by mixed model analysis.

Parity had no significant effect on the traits studied except for GL and NSC where the effect was significant. Most of the reproductive traits were significantly affected by year and month of kindling. Mating buck was found to be an important source of variation for NSC, BLWT, WENT, GL and WLS.

Due to low repeatabilities, with estimates ranging from 0.0 to 0.12, all reproductive traits should be considered when evaluating doe records for selection purposes.

Introduction

In the last few years, there has been a continuous increase in the demand for animal protein in Egypt as well as in many other countries. Local meat production has failed to satisfy increased consumption needs. If the need for meat consumption is to be met, much of the increase in production will have to come from short cycle animals, especially from animals kept by small scale farmers (Lebas, 1983). Rabbits are characterized by small body size, short generation interval, high reproductive potential, rapid growth rate, genetic diversity and the ability to utilize forages and by-products as major diet components, making them suitable as meat-producing animals in developing countries (Cheeke, 1986).

Planning a breeding program involves selection for high producing individuals within and between generations. It is essential to evaluate the non-genetic factors that contribute to the total phenotypic variation of the traits concerned before such a selection program is implemented.

Doe fertility and viability of kits at weaning are among the most important traits in determining profitability of commercial herds. Because of the economic importance of these reproductive traits for the rabbit industry, buck and/or doe effects on such traits have been subjected to extensive study (Rouvier et al., 1973; Vrillon et al., 1979; Kadry and Affifi, 1983).

The present study reports on the effect of month and year of kindling along with parity, mating buck and doe within buck on some doe reproductive measurements in Bauscat and Giza White rabbits. Repeatabilities of all traits studied were also estimated to better understand the effectiveness of possible selection for doe lifetime production.

Materials and Methods

Records on 495 litters of Bauscat and 336 litters of Giza White rabbits were collected from the Experimental Rabbitry of Zagazig University at Moshtohor in the period from October, 1975, to September, 1983. Young does were first mated at the age of 8 months. At the beginning of each breeding season (October), females within each breed were classified at random into groups ranging from 3 to 5 does. A buck from the same breed was assigned at random to each group of does except for the restriction of avoiding full-sib, half-sib and sire daughter matings. Each buck was allowed to produce all its litters from the same females. Further details on breeding plan, management and feeding procedures were described by Khali et al. (1987).

Each breed was analyzed separately for eight measurements of reproductive efficiency. The eight measurements were:

1) number of services per conception (NSC),
2) gestation length (GL),
3) birth litter size (BLS),
4) birth litter weight (BLWT),
5) pre-weaning mortality (WM),
6) weaning litter size (WLS),
7) weaning litter weight (WENT) and
8) sex ratio at weaning (WSR) as percentage of males relative to all males and females.

Data were available on 288 does mated to 73 bucks in the two breeds. Mixed model analysis of variance techniques were employed to estimate fixed effects of year and month of kindling and parity and variance components for random effects of mating buck and doe within mating buck. Repeatability estimates were computed from the ratio of doe variance component to the sum of mating buck, doe within buck and the residual variance components. The approximate standard errors for repeatabilities were computed according to Swiger et al. (1964). The Harvey's (1977) Mixed Model Computer Program was utilized in analyzing the data.
Table 1. Least-squares means (x), standard errors(S.E.) and tests of significance of factors affecting litter traits in Bauscat rabbits.

<table>
<thead>
<tr>
<th>Independent variables of records</th>
<th>NSC</th>
<th>GL (days)</th>
<th>BLS (young)</th>
<th>BLWT (grams)</th>
<th>WM (%)</th>
<th>WLS (young)</th>
<th>WETT (grams)</th>
<th>WSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of kindling:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975/76</td>
<td>79</td>
<td>2.58±0.61</td>
<td>31.5±0.2</td>
<td>6.44±0.02</td>
<td>348±11</td>
<td>21.0</td>
<td>73</td>
<td>4.89±0.23</td>
</tr>
<tr>
<td>1976/77</td>
<td>97</td>
<td>1.99±0.20</td>
<td>31.2±0.1</td>
<td>6.02±0.19</td>
<td>322±11</td>
<td>40.6</td>
<td>86</td>
<td>4.06±0.23</td>
</tr>
<tr>
<td>1977/78</td>
<td>74</td>
<td>3.53±0.22</td>
<td>31.1±0.1</td>
<td>6.24±0.21</td>
<td>326±12</td>
<td>23.5</td>
<td>67</td>
<td>5.11±0.24</td>
</tr>
<tr>
<td>1978/79</td>
<td>24</td>
<td>2.06±0.37</td>
<td>31.4±0.3</td>
<td>6.40±0.35</td>
<td>365±20</td>
<td>18.4</td>
<td>29</td>
<td>4.94±0.36</td>
</tr>
<tr>
<td>1979/80</td>
<td>24</td>
<td>1.58±0.37</td>
<td>31.3±0.3</td>
<td>7.06±0.36</td>
<td>344±20</td>
<td>37.9</td>
<td>20</td>
<td>4.33±0.42</td>
</tr>
<tr>
<td>1980/81</td>
<td>55</td>
<td>3.87±0.26</td>
<td>31.1±0.2</td>
<td>5.93±0.25</td>
<td>293±14</td>
<td>38.0</td>
<td>42</td>
<td>4.41±0.31</td>
</tr>
<tr>
<td>1981/82</td>
<td>91</td>
<td>2.47±0.19</td>
<td>30.5±0.1</td>
<td>6.75±0.19</td>
<td>308±10</td>
<td>16.0</td>
<td>89</td>
<td>5.44±0.21</td>
</tr>
<tr>
<td>1982/83</td>
<td>58</td>
<td>2.14±0.24</td>
<td>31.3±0.2</td>
<td>6.71±0.23</td>
<td>352±13</td>
<td>31.9</td>
<td>45</td>
<td>5.86±0.28</td>
</tr>
<tr>
<td>Month of kindling:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct.-Nov.</td>
<td>75</td>
<td>1.24±0.26</td>
<td>31.4±0.2</td>
<td>5.01±0.28</td>
<td>252±13</td>
<td>34.7</td>
<td>66</td>
<td>3.28±0.30</td>
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<tr>
<td>Dec.</td>
<td>54</td>
<td>3.14±0.29</td>
<td>31.0±0.2</td>
<td>5.64±0.32</td>
<td>297±15</td>
<td>16.3</td>
<td>46</td>
<td>5.20±0.33</td>
</tr>
<tr>
<td>Jan.</td>
<td>85</td>
<td>4.38±0.24</td>
<td>31.4±0.1</td>
<td>6.12±0.26</td>
<td>334±12</td>
<td>20.3</td>
<td>75</td>
<td>4.98±0.27</td>
</tr>
<tr>
<td>Feb.</td>
<td>82</td>
<td>3.28±0.24</td>
<td>30.9±0.1</td>
<td>7.11±0.25</td>
<td>361±12</td>
<td>18.5</td>
<td>69</td>
<td>5.76±0.27</td>
</tr>
<tr>
<td>March</td>
<td>63</td>
<td>2.45±0.27</td>
<td>31.2±0.2</td>
<td>7.60±0.28</td>
<td>376±14</td>
<td>20.5</td>
<td>55</td>
<td>5.95±0.30</td>
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<tr>
<td>April-May</td>
<td>136</td>
<td>2.48±0.23</td>
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<td>7.15±0.23</td>
<td>345±11</td>
<td>46.5</td>
<td>103</td>
<td>4.68±0.26</td>
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<td>Parity:</td>
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<td></td>
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<tr>
<td>1st</td>
<td>90</td>
<td>2.47±0.31</td>
<td>30.9±0.2</td>
<td>6.61±0.34</td>
<td>331±16</td>
<td>14.5</td>
<td>76</td>
<td>5.18±0.36</td>
</tr>
<tr>
<td>2nd</td>
<td>90</td>
<td>2.65±0.26</td>
<td>30.9±0.2</td>
<td>6.92±0.28</td>
<td>362±14</td>
<td>18.3</td>
<td>79</td>
<td>4.86±0.30</td>
</tr>
<tr>
<td>3rd</td>
<td>96</td>
<td>2.93±0.23</td>
<td>31.1±0.1</td>
<td>6.51±0.24</td>
<td>335±12</td>
<td>31.1</td>
<td>75</td>
<td>4.75±0.27</td>
</tr>
<tr>
<td>4th</td>
<td>84</td>
<td>3.28±0.23</td>
<td>31.3±0.1</td>
<td>6.23±0.24</td>
<td>319±12</td>
<td>34.9</td>
<td>71</td>
<td>4.88±0.26</td>
</tr>
<tr>
<td>5th</td>
<td>63</td>
<td>3.04±0.28</td>
<td>31.6±0.2</td>
<td>6.18±0.31</td>
<td>316±15</td>
<td>31.1</td>
<td>58</td>
<td>4.78±0.31</td>
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<tr>
<td>&gt;6th</td>
<td>72</td>
<td>2.61±0.37</td>
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<td>302±19</td>
<td>27.5</td>
<td>55</td>
<td>5.41±0.45</td>
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</tbody>
</table>

* The arc-sine transformed values were decoded to the original scale.
ns = nonsignificant, * = p<0.05 and ** = p<0.01.
Table 2. Least-Squares means (X), standard errors (S.E.) and tests of significance of factors affecting litter traits in Giza White rabbits.

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>No of records</th>
<th>NSC (days) X±S.E.</th>
<th>BLS (young) X±S.E.</th>
<th>BLWT (grams) X±S.E.</th>
<th>WM (%) X±S.E.</th>
<th>WLS (young) X±S.E.</th>
<th>WEMT (grams) X±S.E.</th>
<th>WSR (%) X±S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of kindling:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975/76</td>
<td>68</td>
<td>2.69±0.24</td>
<td>31.3±0.2</td>
<td>6.81±0.23</td>
<td>324±11</td>
<td>31.0±62</td>
<td>4.78±0.33</td>
<td>1852±156</td>
</tr>
<tr>
<td>1976/77</td>
<td>70</td>
<td>1.97±0.25</td>
<td>30.9±0.2</td>
<td>6.45±0.25</td>
<td>339±12</td>
<td>31.5±63</td>
<td>4.44±0.33</td>
<td>1610±149</td>
</tr>
<tr>
<td>1977/78</td>
<td>59</td>
<td>3.86±0.26</td>
<td>31.2±0.2</td>
<td>6.42±0.25</td>
<td>359±12</td>
<td>24.4±56</td>
<td>4.67±0.35</td>
<td>1951±168</td>
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<td>1978/79</td>
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<td>31.2±0.3</td>
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<td>356±18</td>
<td>31.6±24</td>
<td>4.44±0.50</td>
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<tr>
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<td>20</td>
<td>2.37±0.40</td>
<td>31.3±0.3</td>
<td>5.79±0.41</td>
<td>319±19</td>
<td>39.1±17</td>
<td>4.04±0.49</td>
<td>2042±210</td>
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<tr>
<td>1980/81</td>
<td>39</td>
<td>4.09±0.32</td>
<td>31.1±0.2</td>
<td>5.64±0.31</td>
<td>265±15</td>
<td>36.2±32</td>
<td>3.75±0.44</td>
<td>1565±202</td>
</tr>
<tr>
<td>1981/82</td>
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<td>2.92±0.34</td>
<td>31.0±0.2</td>
<td>5.71±0.34</td>
<td>247±16</td>
<td>10.9±30</td>
<td>4.59±0.42</td>
<td>2184±194</td>
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<td>1982/83</td>
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<td>31.3±0.2</td>
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<td>367±13</td>
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<td>5.98±0.38</td>
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<td>Month of kindling:</td>
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<tr>
<td>Oct.-Nov.</td>
<td>41</td>
<td>0.66±0.37</td>
<td>31.3±0.3</td>
<td>4.79±0.39</td>
<td>253±18</td>
<td>37.6±36</td>
<td>2.58±0.41</td>
<td>1126±176</td>
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<td>6.07±0.40</td>
<td>310±18</td>
<td>22.8±36</td>
<td>4.49±0.40</td>
<td>1899±175</td>
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<tr>
<td>Jan.</td>
<td>48</td>
<td>4.07±0.32</td>
<td>31.7±0.2</td>
<td>6.23±0.33</td>
<td>341±16</td>
<td>15.2±47</td>
<td>4.58±0.32</td>
<td>1988±149</td>
</tr>
<tr>
<td>Feb.</td>
<td>68</td>
<td>3.71±0.28</td>
<td>31.1±0.2</td>
<td>6.40±0.28</td>
<td>335±14</td>
<td>16.3±62</td>
<td>5.23±0.28</td>
<td>2483±136</td>
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<td>March</td>
<td>47</td>
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<td>359±17</td>
<td>12.4±44</td>
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<tr>
<td>April-May</td>
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<td>31.3±0.2</td>
<td>6.69±0.30</td>
<td>335±15</td>
<td>54.7±71</td>
<td>4.33±0.32</td>
<td>2262±150</td>
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<tr>
<td>Parity:</td>
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</tr>
<tr>
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<td>13.7±51</td>
<td>5.09±0.52</td>
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<td>2.77±0.37</td>
<td>31.3±0.3</td>
<td>6.51±0.39</td>
<td>319±18</td>
<td>26.1±52</td>
<td>5.19±0.43</td>
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<tr>
<td>3rd</td>
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<td>3.67±0.31</td>
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<td>326±15</td>
<td>30.3±55</td>
<td>4.56±0.33</td>
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<tr>
<td>4th</td>
<td>51</td>
<td>3.32±0.31</td>
<td>31.7±0.2</td>
<td>6.19±0.32</td>
<td>330±15</td>
<td>22.2±49</td>
<td>4.40±0.31</td>
<td>1775±147</td>
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<tr>
<td>5th</td>
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<td>5.94±0.45</td>
<td>319±20</td>
<td>31.1±31</td>
<td>3.84±0.46</td>
<td>1808±194</td>
</tr>
<tr>
<td>&gt;6th</td>
<td>67</td>
<td>1.65±0.54</td>
<td>31.1±0.4</td>
<td>6.47±0.60</td>
<td>357±27</td>
<td>30.5±58</td>
<td>4.06±0.62</td>
<td>1965±249</td>
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</tbody>
</table>

* The arc-sin transformed values were transformed to the original coding.
ns = nonsignificant, * = p<0.05 and ** = p<0.01.
Table 3. Estimates ($\sigma^2$) and proportions (V%) of random components of variance and repeatability estimates ($t$) for litter traits in Bauscat and Giza White rabbits.

<table>
<thead>
<tr>
<th>Traits</th>
<th>$\sigma_B^2$</th>
<th>V%</th>
<th>$\sigma_{D:B}^2$</th>
<th>V%</th>
<th>$\sigma_E^2$</th>
<th>V%</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bauscat</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>NSC</td>
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<td>8.4</td>
<td>0.27</td>
<td>8.5</td>
<td>2.70</td>
<td>83.1</td>
<td>0.09±0.05</td>
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<tr>
<td>GL</td>
<td>0.11</td>
<td>7.9</td>
<td>0.15</td>
<td>11.6</td>
<td>1.08</td>
<td>80.5</td>
<td>0.12±0.05</td>
</tr>
<tr>
<td>BLS</td>
<td>a</td>
<td>0.0</td>
<td>0.28</td>
<td>7.2</td>
<td>3.62</td>
<td>92.8</td>
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</tr>
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<td>BLWT</td>
<td>515</td>
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<td>306</td>
<td>3.7</td>
<td>7553</td>
<td>90.2</td>
<td>0.04±0.05</td>
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<td>WM</td>
<td>11.05</td>
<td>1.4</td>
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<td>806</td>
<td>98.6</td>
<td>a</td>
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<tr>
<td>WLS</td>
<td>0.06</td>
<td>1.7</td>
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<td>7.8</td>
<td>3.22</td>
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<td>0.08±0.06</td>
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<td>119327</td>
<td>18.3</td>
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<td>0.12±0.06</td>
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<tr>
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<td>a</td>
<td>0.0</td>
<td>470</td>
<td>99.4</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>Giza White</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSC</td>
<td>0.63</td>
<td>19.1</td>
<td>0.07</td>
<td>2.1</td>
<td>2.62</td>
<td>78.8</td>
<td>0.02±0.06</td>
</tr>
<tr>
<td>GL</td>
<td>a</td>
<td>0.0</td>
<td>0.09</td>
<td>5.8</td>
<td>1.53</td>
<td>94.2</td>
<td>0.06±0.06</td>
</tr>
<tr>
<td>BLS</td>
<td>0.18</td>
<td>4.8</td>
<td>0.13</td>
<td>3.6</td>
<td>3.45</td>
<td>91.6</td>
<td>0.04±0.06</td>
</tr>
<tr>
<td>BLWT</td>
<td>1756</td>
<td>21.6</td>
<td>65.71</td>
<td>0.8</td>
<td>6296</td>
<td>77.6</td>
<td>0.01±0.06</td>
</tr>
<tr>
<td>WM</td>
<td>a</td>
<td>0.0</td>
<td>38.17</td>
<td>5.6</td>
<td>640</td>
<td>94.4</td>
<td>0.05±0.06</td>
</tr>
<tr>
<td>WLS</td>
<td>0.45</td>
<td>13.8</td>
<td>0.08</td>
<td>2.4</td>
<td>2.73</td>
<td>83.8</td>
<td>0.02±0.07</td>
</tr>
<tr>
<td>WWT</td>
<td>255403</td>
<td>37.6</td>
<td>42818</td>
<td>6.3</td>
<td>381229</td>
<td>56.1</td>
<td>0.06±0.07</td>
</tr>
<tr>
<td>WSR</td>
<td>15.87</td>
<td>3.9</td>
<td>21.26</td>
<td>5.2</td>
<td>369</td>
<td>90.9</td>
<td>0.05±0.07</td>
</tr>
</tbody>
</table>

a Negative variance component estimates set to zero.
* = P < 0.05 and ** = P < 0.01.
Results and Discussion

Non-genetic factors:
In both breeds, BLS, BLWT, WLS and WEWT tended to be low when kidding took place in the early months of the year of production and to increase with the advance of month of kidding and to decrease again at the end of year of production during April and May (Tables 1 and 2). On the contrary, no consistent trend for month of kidding effect on NSC, GL and WM was observed (Tables 1 and 2). Month of kidding had a nonsignificant effect on WSR in the two breeds. The significant differences in reproductive traits with change in month of kidding were due to changes in the availability of good quality green fodder during the breeding season and to the changes in weather conditions.

Reproductive traits studied varied with respect to the significance of the effect of year of kidding. In Bauscat does it was significant for BLS (p < 0.05), BLWT, WM, NSC, GL, WLS and WEWT (p < 0.01) and nonsignificant for WSR, while in Giza White it was significant for WLS (p < 0.05), NSC, BLWT and WEWT (p < 0.01) and nonsignificant for GL, WM and WSR. These results are in close agreement with others reported in Egypt (Affifi et al., 1976a, b; Affifi et al., 1982a, b; Affifi and Emara, 1983; Affifi and Emara, 1986a, b; Khalil and Affifi, 1986; Khalil et al., 1987).

Parity, in general, had nonsignificant effects on reproductive measurements in both breeds with the exception of GL (in Bauscat) and NSC (in Giza White) (Tables 1 and 2). These results are in agreement with findings reported by other Egyptian investigators (Affifi et al., 1982a, b; Kadry and Affifi, 1982; Affifi and Emara, 1983; Affifi and Emara, 1986a, b).

Random effects
Estimates of variance components of mating buck and doe within buck are presented in Table 3. These results showed that mating buck contributed significantly (p < 0.01) to the total variance of NSC and GL (in Bauscat), WLS (in Giza White), BLWT and WEWT (in both breeds). Mating buck had little or no effect on BLS, WM and WSR. The highly significant effect of mating buck on NSC could be considered as evidence for the importance of evaluating buck semen quality before mating season. Also, mating buck affects doe reproductive performance through its direct genetic effect on progeny growth and survival during prenatal and post-natal periods.

Different trends for the service-sire effects on reproductive performance of doe rabbits have been cited in the literature. Rouvier et al. (1973) stated that service-sire had little or no effect on total number born and litter size, litter weight and mortality rate at 21 and 56 days of age. Similarly, Kadry and Affifi (1983) found nonsignificant mating buck effects on the number of services per conception and litter size at birth in Bauscat rabbits. On the other hand, Vrillon et al. (1979) pointed out that mating buck had a significant effect on litter size (born and weaned).

Differences in most of the reproduction traits due to doe effects were nonsignificant with the exception of NSC (VZ = 8.5), GL (VZ = 11.6), WLS (VZ = 7.8) and WEWT (VZ = 12.1) in Bauscat (Table 3). This might suggest the existence of a negative covariance between adjacent litters. Contrary to the present results, the investigators (Vrillon et al., 1979; Garcia et al., 1980; Blasco et al., 1982; Garcia et al., 1982b; Lukefahr et al., 1983) have reported that the phenotypic value of doe reproductive traits is due not to gene transmission but to maternal environment.

In conclusion, percentages of total variance attributed to mating buck were generally higher in Giza White than in Bauscat, while variation percentages due to doe effects in Bauscat were larger than the corresponding percentages in Giza White. Therefore, selection of mating bucks from Giza White and does from Bauscat rabbits could be more effective in a stratification system for commercial production.

Repeatability
Repeatability estimates for different measurements of reproductive efficiency were low in the two breeds studied (Table 3). In addition, most of the estimates cannot be relied upon because of a general lack of precision, i.e. their high standard errors. However, the estimates in this study agree, in general, with the corresponding estimates reported in the literature (Rouvier et al., 1973; Garcia et al., 1982a, b; Lukefahr et al., 1983; Lahiri, 1984; Lukefahr et al., 1984; Khalil and Affifi, 1986).

Culling of does for reproductive traits based on a single production record, as commonly practised in commercial rabbitry operations, would not be efficient from a genetic standpoint and, consequently, assessment of several records are required before selecting does for such traits.

References


