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IMPROVING SOME PRODUCTIVE TRAITSOF NORFA CHICKENS USING SELECTION INDEX

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ABSTRACT: The recent experiment was carried out at the Poultry research farm of the Faculty of Agriculture, Menoufia University, Shebin El-Kom, Egypt, during the period from 2019 to 2022 for two generations aiming to improve some egg production traits by using selection indices in Norfa chickens. Data on 1078 Norfa hens including age at sexual maturity (ASM). body weight at sexual maturity (BWSM). egg weight at sexual maturity (EWSM) and egg number during the first 90 days of laying (EN**90**) were individually recorded. Data computerized and selection applied by selection index method helping appropriate statistical and genetic analysis software programs.

Results showed that, in the second generation of the study sexually matured earlier than the first by 12.17 days. In addition, either body weight or egg weight in the second and the first generation didn't differ significantly in second and first generation. Application of selection index method resulted in improving average EN90 in the second generation compared with first generation by 2.5995 eggs (with high statistical importance). The highest value of h2 (heritability) recorded by body weight (0.231 and 0.197 for BWSM and BWM, respectively). Moreover, the lowest heritability estimates detected for EN90 (0.130) and EWM (0.117) in studied flock of Norfa chickens. Moderate to high estimates (0.255, 0.186 and 0.368) of h2 were observed for EN90, EWSM and ASM, respectively, in current study.

Results showed that using general index in selection for one generation resulted in improving egg production traits under investigation. The actual genetic gains for ASM, BWSM, BWM, EN90, EWSM, EWM and EN42 were -11.724 days, +52.88 g, +11.177 g, +2.5951 eggs, -1.1244 g, -0.391 g and +6.4637 eggs, respectively. It can be concluded that applying selection indices including the main egg-laying traits (i.e., EN42, EWM and BWM) leads to improve laying performance of Norfa hens regardless of the negative correlations detected between some traits at a multi-trait selection method.

Key word: Laying performance, Chickens, Selection index.

INTRODUCTION

Local chicken breeds and strains are considered one of the most important parts in Egyptian agricultural resources, there are many advantages of the local chickens such as adaptation with the Egyptian environment conditions as well as the unique and favorable taste of their meat and eggs. In addition, local Egyptian strains produce high-quality eggs, but egg production still needs to be improved. So, we should take the responsibility to improve the productivity of the local chicken breeds by applying effective breeding plans.

The Norfa chicken is a synthetic, white layer strain developed at the Faculty of Agriculture, Menoufia University, Egypt, by crossing exotic breeds with local egg breeds (White Leghorn, Fayoumi and Baladi) and kept as a closed flock. The birds have white feathers, single comb, white eggs, and are adaptable to harsh environments and resistant to diseases.

Improving the laying performance of chickens is considered very essential topic to help developing countries meet the nutritional needs of their growing populations. The aggregate genotype value of a layer hen relies mainly on many traits which that must be considered when building a breeding plan, such as body weight, number of eggs produced and weight of egg. It is

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already indicated previously by many workers that, when improving multiple traits is desired, the selection index is considered as the efficient method to evaluate the total breeding values of candidates (Devi *et al.,* 2011; Oleforuh-Okoleh, 2013 and Elnoomany 2015). Various selection indices (i.e. general, reduced, restricted, multi-source and two-stage indices) were applied (Ben Naser, 2007; AbouElewa, 2010; Elnoomany, 2015) in Norfa strain using multiple economic traits, and the results of previous studies were auspicious. The current study's main goal is to genetically evaluate some economically important egg production traits, and to improve the production performance of Norfa chicken by applying a selection index.

MATERIAL AND METHODS

The present investigation has been carried out at the poultry farm of the Faculty of Agriculture, Menoufia University, Shebin El-Kom, Egypt, from 2019 to 2022 for two generations to investigate the possibility of genetic improvement of some egg production traits in chickens

Mating System: In the current study, Norfa chickens (local strain) were used. Artificial insemination was applied as a mating system during the experimental period. The semen was collected from cocks and inseminated fresh and undiluted into dams. Each sire artificially inseminated three dams in each line each generation. Relative mating was avoided. Insemination started one week before collecting hatching eggs, each dam was inseminated twice a week. Fertile eggs were collected daily for two weeks and stored in a prepared storage room, where the storage temperature was 55°F and the relative humidity was 85 - 90%.

Management procedures: The stored fertile eggs were moved to the hatching room one day night before incubation and then they were set in a full-automatic force draft incubator. After 18 days of incubation, the eggs transferred to the hatching compartment. At hatching, all chicks were wing-banded and pedigreed. Chicks were brooded in floor brooder watered continuously and fed *ad libitum* during the brooding period a starting diet containing 19.43 % crude protein and 2916 kcal ME/kg., then at 16 weeks the ration was changed by a layer ration containing 17.1% crude protein and 2760 kcal ME/kg.. The compositions of the two rations are given in Table 1.

Table (1): Compositions and calculated analysis of the experimental at layer and starter diet.

Ingredients	Starter ,%	Layer ,%
Ground yellow corn (8.9%)	62.35	61.31
Soybean meal (44%)	20.25	15.02
Gluten yellow (55%)	7.89	8.01
Wheat bran (11%)	5.82	5.18
Limestone, ground	1.80	7.85
Di-calcium phosphate	1.14	1.93
Vitamin and mineral premix(1)	0.31	0.30
L. lysine	0.10	0.06
Sodium chloride (salt)	0.34	0.34
Total	100	100
Calculated Value(2):		
Crude protein,%	19.43	17.10
Metabolizable energy(Kcal/Kg)	2916	2760
C/P ratio	150	161
Calcium,%	0.99	3.46
Available Phosphorus,%	0.50	0.50

(1) Vitamin and Mineral mixture: at 0.30% of the diet supplies the following / of the diet:Vitamin A,1200 IU; V.D3, 2500 IU; V.E, 10mg; VK3, 3mg; V.B1, 1mg; V.B2; 4mg; Biotin, 0.05 mg; Niacin, 40 mg, VB6, 3mg; VB12, 20mg; Choline Chloride, 400; Mn, 62 mg; Fe, 62mg; Zn, 56 mg; Cu, 5mg and Se, 0.01 mg.(2) Calculated according to NRC (1994).

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Cockerels were separated from pullets in the brooding house at the 8th week of age and at the 14thweek cockerels were moved to individual cages in cocks' house while pullets were moved to individual cages in the laying house at the 16th week of age. A "step down-step up" lighting program was used during brooding, rearing and production periods. The photoperiod was 24 h/d during the first week, which decreased to 19 h/d during the second week. Thereafter, the photoperiod was decreased by half an hour per a week until the 15th week of age. Starting from the 16th week of age, the photoperiod was increased by 20 minutes per week up to 14 - 16 h/d.

Studied traits: Age at sexualmaturity (ASM); body weight at sexual maturity (BWSM); egg weight at sexual maturity (EWSM): The first 5 eggs after maturity were weighed individually and the mean of egg weight at sexual maturity was calculated for every laying hen; weighed individually and the mean of egg weight at maturity will calculated for every laying hen; egg number in first 90 days (EN90) were recorded individually.

Statistical analysis: The statistical analysis was performed using general linear models procedure of the IBM-SPSS (IBM- Statistical Package for Social Science) program version 21 (2012). Different models were assumed according to the traits studied. Duncan's new multiple-range tests were used to compare every two means of different traits studied (Duncan, 1955). The following two models were utilized:

Model (1):

$$Y_{ij} = \mu + L_i + e_{ij}$$

Where:

Y_{ij} : Observation of j^{th} hen;

μ : General mean;

L_i : Fixed effect of i^{th} line (i = selected and control);

e_{ij} : Residual effect.

Model (2):

$$Y_{ijk} = \mu + L_i + G_j + (L \times G)_{ij} + e_{ijk}$$

Where:

Y_{ijk} : Observation of k^{th} hen;

μ : General mean;

L_i : Fixed effect of i^{th} line (i = selected, control);

G_j : Fixed effect of j^{th} generation (j = first, second, third);

$(L\times G)_{ij}$: Effect of interaction $(L\times G)_{ij}$;

e_{ijk} : Residual effect.

The least squares and maximum likelihood general purpose program-mixed model LSMLMW (Harvey, 1990) was used to estimate the values of heritability, phenotypic and genetic correlations for the studied flock of Norfa Strain. The general random model (2) utilized by (LSMLMW) was as follow:

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

Where:

Y_{ijk} = Observation of the K^{th} progeny of the i^{th} sire and j^{th} dam.

μ = Common mean

S_i = Random effect of i^{th} sire

D_{ij} = random effect of j^{th} dam within i^{th} sire.

e_{ijk} = Random error assumed to be normally distributed with zero mean and variance $\sigma^2 e$.

General selection index (I_G): The general index was obtained in terms of heritability, phenotypic and genetic correlations among the studied traits by solving the following equations given in matrix expression according to Cunningham (1969):

$$Pb = Gv \quad \text{to give} \quad b = P^{-1}Gv$$

Where:

P = Phenotypic variances and covariances matrix.

G = Genetic variances and covariances matrix.

V = Economic weights column vector.

b = Weighting factors column vector, which is going to be solved.

Furthermore, according to Cunningham (1969) the other different properties of the selection index were calculated as follows:

The standard deviation of the index $= \sigma_I = \sqrt{b'Pb}$

The standard deviation of aggregate genotype = $\sigma_T = \sqrt{v'Gv}$

The correlation between the index and the aggregate genotype =

$$(r_{TI}) = {}^{\sigma_I}/_{\sigma_T} = \sqrt{{}^{b'Pb}/_{v'Gv}}$$

value of each trait in the index =

$$V_T = 100 - \sqrt{\frac{b'pb - b_i^2/W_{ii}}{b'pb}} \times 100$$

Where,

W_{ii} is a diagonal element of p^{-1}

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Expected and actual genetic gain

- The expected genetic change (Δ_G) in each trait after one generation of selection on the index (i = 1) was obtained by solving the following equation:

$$\Delta_{Gi} = b_{GiI} i \sigma_I$$

Where

i = Selection differential in standard deviation units.

σ_{Gi} = Genetic standard deviation of the trait.

b_{GiI}= Regression of the trait on the index.

σ_I = Standard deviation of the index.

- Actual geneticgain and correlated responses were calculated as deviation from the control line performance by equation given by Hill (1972) as follows: $\Delta G = (S_t - C_t)$

Where: S and C are the means of selected and control lines in generation number (t).

The relative economic values (v): The economic values were calculated by estimating the change of the difference between cost and income per unit change in the trait according to the Egyptian market (Kolstad, 1975). According to the Egyptian market quotations in 2018 the relative economic values were: - 0.008, 1.110 and 1.000 for -1 gram in body weight at maturity, +1 gram in egg weight at maturity and + 1 egg in egg number till 42 weeks of age.

RESULTS AND DISCUSSION

Means of studied traits

Results represented in Table 2 showed the means ± S.E of different studied traits from current research. After one generation of selection using the selection index method differed significantly (P≤0.01) with an average of 177.55 days of ASM compared to the first generation (189.2754 days). It is common that selection to improve egg production traits leads to a decrease in the ASM (Elnoomany, 2015). However, earlier ASM have been detected in Norfa chickens (170.9d) by many authors (Abdou and Enab 1994); 154 d (Zatter, 1994) and more recently by AbouSada 2019 (162.5 d). On the other hand, Norfa chickens sexually matured later than in the current study as noticed by Abdou *et al.*, 2017 (201.2 d at the third generation of their experiment).

Body weight at sexual maturity (BWSM): After one generation of selection using the selection index method selected line didn't differed significantly (P=0.062) with an average of 1116.1565 g of BWSM compared to the first generation (1063.2754 g) as shown in Table 2. According to the reviewed literature body weight at sexual maturity of Norfa bullets fluctuated between 919.2 g (Enab*et al.*, 2015) and 1496.7 g (El-Weshahy, 2010). Results of current experiment fall within the range previously reported and fully agreed with those noticed by many authors (El-Wardany, 1987; El-Wardany *et al.*, 1992 and more recently Enab, *et al.*, 2012 and AbouSada, 2019).

Body weight at maturity (BWM): At the third experimental generation second generation (1222.51 g) didn't differed significantly (P=0.41) comparing to first generation (1211.333 g) Table 2. At the last generation of the study average of BWM in second was heavier than first generatin by 11.177 g. Current study results of Norfa mature body weight are in good agreement with those found by researchers over-time. From the reviewed articles, Norfa chickens body weight at maturity ranged from 1007.8 g (El-Wardany *et al.*, 1992) and 1549.0 g (Abou El-Ghar, 2003).

Egg weight sexual maturity (EWSM): At the final experimental generation (36.4627 g) didn't differed significantly (P=0.842) comparing to first genration (37.587 g) as shown in Table 2. Egg weight at sexual maturity had been investigated for different local Egyptian chicken strains, it is very common that egg weight positively correlated to body weight, so, the heavier strain laid the heavier eggs and vise versa. Regarding Norfa chickens, EWSM ranged between 30.7 g (Enab, 1991; in control line) to 44.2 g (El-Weshahy, 2010; in selected line for body weight). Results from the recent work are consistent with previous findings by Ben Naser (2007), Abou-Elewa (2010), Enab *et al.* (2015) and AbouSada (2019) for the base populations of Norfa hens. Slightly higher or lower estimates of EWSM had been recorded by many authors according to the experimental conditions for each reviewed study.

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Table (2): Means of different studied traits as affected by generation($\bar{X} \pm S.E.$).

Generation		ASM	BWSM	BWM	EN90	EWSM	EWM	EN42
First	N	414	414	414	414	414	414	414
	Mean	189.2754	1063.2754	1211.3333	42.0580	37.5871	46.7365	51.6473
	S.E.	1.34630	7.06983	6.07932	0.33572	0.18150	0.17458	0.67905
Second	N	441	441	441	441	441	441	441
	Mean	177.5510	1116.1565	1222.5102	44.6531	36.4627	46.3454	58.1111
	S.E.	0.77757	6.45148	7.11797	0.64661	0.13651	0.14161	0.89838
Total	N	855	855	855	855	855	855	855
	Mean	183.2281	1090.5509	1217.0982	43.3965	37.0072	46.5348	54.9813
	S.E.	0.79076	4.85622	4.70692	0.37346	0.11417	0.11185	0.57851

Egg number during the first 90 days of laying (EN90): At the end of experiment (third generation), EN90 in selected line (44.653 eggs) differed significantly (P≤ 0.01) comparing to first generation (42.058 eggs) as shown in Table 2. Higher average number of eggs were produced during the first 90 days of production cycle according to El-Weshahy, 2010 (70.6 eggs), Enab, 1991 (62.7 eggs) and Sherif, 1991 (57.8 – 61.3 eggs) (62.0 – 64.8 eggs) than those found in current study. Moreover, lower average of EN90 were observed by many authors (Enab *et al.*, 2000; AbouSada, 2007; Ben Naser, 2007 and AbouSada, 2019).

Phenotypic and Genetic Parameters

Heritability: Heritability estimates (calculated from both maternal and paternal components of variance) for the studied traits are shown in Table 3. Results showed that estimated values of heritabilities for different characteristics in recent research fall in the normal biological rang (0.00 to 1.00). The highest value of h2 (heritability) recorded by body weight (0.231 and 0.197 for BWSM and BWM, respectively). Moreover, the lowest heritability estimates detected for EN90 (0.130) and EWM (0.117) in studied flock of Norfa chickens.

Estimates of h2 from the studied flock for all traits are agreed with the observed values by previous workers (Abou-Elewa, 2010; Elnoomany, 2015 and AbouSada, 2019).

It is widely accepted that heritability estimates for different characters of selfsame strain and/or breed might bear no resemblance due to the variation of the genetic making, selection plans applied and history of it, accordingly values of h2 among reviewed literature in addition to current study exhibit different values for the same trait (Elnoomany, 2015 and AbouSada, 2019).It is widely accepted that heritability estimates for different characters of selfsame strain and/or breed might bear no resemblance due to the variation of the genetic making, selection plans applied and history of it, accordingly values of h^2among reviewed literature in addition to current study exhibit different values for the same trait (Elnoomany, 2015 and AbouSada, 2019).

Phenotypic and genetic correlations: Trustworthy evaluation of phenotypic and genetic relations (correlations) is essential to conduct different genetic improvement plans of the productivity of chickens especially that needs to construct selection indices (Hazel, 1943 and Enab, 1991). These correlations lead to cause changes in traits that correlated phenotypically or genetically to the selected trait (in either positive or negative direction). Consequently, all types of relations (phenotypic and genetic) between the studied traits that included in improvement plans have to recognized and considered to evade the unfavorable changes in some productive traits when applying selection plans for particular trait/traits.

Results recorded in Table 3 represent the estimated values of phenotypic and genetic correlations between different studied traits Moderate to high phenotypic correlations either

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positive or negative were noticed between EN42 and other traits under investigation. Phenotypically, EN42 positively correlated with EN90 and EWM, however, this relation was negative with other studied traits (i.e., ASM, BWSM, BWM and EWSM). The same trend was observed regarding the genetic correlation between EN42 and traits under investigation in current study.

L INDEX (I_G):

Regarding egg production type of chickens, body weight, egg number and egg weight must be taken into consideration when constructing section index. General selection index (I_G) considered as the fundamental index because of its attributes, general index assumed to include all traits under selection without any reduction or restriction. In current study, general selection index (I_G) was constructed for Norfa layers according to the formal method according to Cunningham (1969), the weighting factors acquired by solving the equation (b =P^{-1} GV) in matrix expression. Results in Table 4 shows the elements of P-, G-, P^{-1}- matrices which used to construct the general index. Weighting factors, values of traits in the index and genetic gain were recorded in Table 5. The equation of general index was:

I_G = 0.1335 EN90 + 0.1273 EWSM + 0.0044 BWSM

The variance of this index was (1.4265) and its correlation with the aggregate genotype was (0.5302).The expected genetic change which would be gained by applying this index were + 1.0118 egg, + 0.4794 g, and + 36.2811g for EN90, EWSM and BWSM Table 5. These results were in good agreement with those found by Abdou and Enab (1994), Barwal *et al.* (1994), Ben Naser (2007), El-Gazar (2012) and Elnoomany (2015).

Table (3): Heritability (on diagonal), genetic (above diagonal) and phenotypic (below diagonal) correlations between traits:

	ASM	BWSM	BWM	EN90	EWSM	EWM	EN42
ASM	0.368	0.208	0.096	-0.546	0.614	-0.401	-0.869
BWSM	-0.038	0.231	0.697	-0.028	0.421	0.217	-0.156
BWM	-0.109	0.030	0.197	0.077	0.276	0.272	-0.025
EN90	-1.109	0.528	0.487	0.130	-0.288	0.260	0.796
EWSM	0.535	0.559	0.000	-0.062	0.186	-0.004	-0.526
EWM	-0.754	0.520	0.477	1.559	-0.077	0.117	0.353
EN42	-1.038	0.181	0.212	0.890	-0.457	0.959	0.255

Table (4): P-, G- and P^{-1} matrices elements were used to construct the applied selection indices in current experiment:

Matrix elements		**Matrices in second generation**		
J	K	P	G	P-1
1	1	46.6626	6.180	0.0236
1	2	-27.5139	94.073	-0.000127
1	3	-7.2653	-0.2458	0.014681
2	2	20692.82	5136.445	0.000059
2	3	223.651	63.900	-0.001042
3	3	13.638	2.544	0.098235

Table (5): Weighing factors, value of each trait and the expected genetic changes of general index.

Variate	**General Index (I_G)**

	B	V_T	ΔG
EN_{90}	0.1335	31.3540	1.0118
EW_{sm}	0.1273	5.9582	0.4794
BW_{sm}	0.0044	12.2006	36.281

EN_{90} = egg number up to 90 day ;EWs_M = the average weight of 5 eggs ; BWs_M = body weight at 26 weeks of age, b = economic weighing factor, V_T = value of the trait, ΔG = expected genetic gain.

Results indicated in the current study are in good agreement with those previously recorded by much research works on selection indices to improve laying performance in chickens. Expected genetic gains were 2.595 eggs (EN), -1.124 g (EW) and -52.88 g (BW) after one generation of selection as noticed by Abdou and Kolstad (1979). By construction of an index including EN, EW and BW in White Leghorn chickens, Das *et al.* (1982) found that after one generation of selection the genetic change was 9.99 eggs, 0.27 g and 99.4 g in egg number, egg weight and body weight, respectively. Moreover, Ben Naser (2007) reported that actual applying selection indices (26-indices in his study) leads to improve EWM and EN42 more than expected (in the second generation of his study) in two lines (light and heavy) of Norfa chickens. It can be concluded that applying selection indices including the main egg laying traits (i.e., EN42, EWM and BWM) leads to improve laying performance of Norfa hens regardless of the negative correlations detected between some traits at a multi-trait selection method.

Actual genetic gain from general selection index: Data represented in Table 6 show the actual genetic gain and correlated responses that realized in secend generation by applying selection using general selection index equation obtained previously in recent study. Results showed that using general index in selection for one generation resulted in improving egg production traits under investigation. The actual genetic gains for ASM, BWSM, BWM, EN90, EWSM, EWM and EN42 were -11.724 days, +52.88 g, +11.177 g, +2.5951 eggs, -1.1244 g, -0.391g and +6.4637 eggs, respectively.

Table (6): Selection differential and actual genetic gains for different traits in current study achieved by applying general selection index

	ASM	BWSM	BWM	EN90	EWSM	EWM	EN42
Genetic Gain	-11.724	52.88	11.177	2.5951	-1.1244	-0.391	6.4637

Generally, results from recent work revealed that applying general index (I_G) including three traits in Norfa chickens was effective in improving laying performance of Norfa chickens.

Conclusion

It can be concluded that applying selection indices including the main egg laying traits (i.e., EN90, EWSM and BWSM) leads to improve laying performance of Norfa hens regardless of the negative correlations detected between some traits at a multi-trait selection method.

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تحسين بعض الصفات الإنتاجية لدجاج النورفا باستخدام الدليل الإنتخابى

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الملخص العربي

أجريت هذه الدراسة في مزرعة الدواجن البحثية بكلية الزراعة جامعة المنوفية بشبين الكوم -جمهورية مصر العربية- خلال الفترة ما بين ٢٠١٩ حتى ٢٠٢٢ ولمدة جيلين متتالين وذلك بهدف تحسين بعض صفات إنتاج البيض بإستخدام الدليل الإنتخابي في سلالة النورفا. تم جمع بيانات عدد ١٠٧٨ دجاجة نورفا بصورة فردية تشمل العمر عند النضج الجنسي، وزن الجسم عند النضج الجنسي و وزن البيضة عند النضج الجنسي، عدد البيض المنتج خلال ال٩٠ يوم الأولي من الإنتاج، جميع البيانات تم تسجيلها على الحاسب وتم تحليلها إحصائيا ووراثيا وتم تطبيق الإنتخاب بإستخدام طريقة الدليل الانتخابي.

أظهرت النتائج أنه في الجيل الثاني من الدراسة ينضج جنسيا مبكرا عن الجيل الأول بمقدار ١٢,١٧ يوم بالإضافة لم يختلف وزن الجسم ووزن البيضة في الجيل الثاني عن الجيل الأول بشكل ملحوظ . تطبيق الدليل الإنتخابي نتج عنه تحسن في عدد البيض المنتج خلال ٩٠ يوم الأولى مقارنة بالجيل الأول وذلك بما يعادل +٢,٥٩٥ بيضة (وكانت الفروق بين الخطين عالية المعنوية). سُجّلت أعلى قيمة للمكافئ الوراثي لصفة وزن الجسم عند النضج الجنسي ووزن الجسم عند النضج التام على التوالي (٠,٢٣١ و ٠,١٩٧). هذا علاوة على أن أقل قيمة للمكافئ الوراثي سُجّلت لصفات إنتاج البيض خلال ال٩٠ يوم الأولى من الإنتاج (٠,١٣٠) ولصفة وزن البيضة عند النضج (٠,١١٧) في القطيع تحت الدراسة من دجاج النورفا. لوحظت قيم متوسطة إلى مرتفعة للمكافئ الوراثي (٠,٢٥٥، ٠,١٨٦ و ٠,٣٦٨) في صفات إنتاج البيض حتى ٩٠ يوم من الإنتاج، وزن البيضة عند النضج الجنسي و العمر عند النضج الجنسى، على التوالي في الدراسة الحالية.

أظهرت نتائج هذه الدراسة أن استخدام الدليل العام في إجراء الإنتخاب لمدة جيل واحد حسن صفات إنتاج البيض المختلفة تحت الدراسة. وكان العائد الوراثي الفعلي (المحقق) لصفات العمر عند النضج الجنسي، وزن الجسم عند النضج الجنسي، وزن الجسم عند النضج التام، إنتاج البيض خلال الـ ٩٠ يوم الأولى من الإنتاج، وزن البيضة عند النضج الجنسي، ووزن البيضة عند النضج التام وأخيراً إنتاج البيض حتى عمر ٤٢ أسبوع يساوى – ١١,٧٢٤ يوم، + ٥٢,٨٨ جم، + g١١,١٧٧ جم، + ٢,٥٩٥١ بيضة، + ١,١٢٤٤ جم، -٠,٣٩١ جم و+ ٦,٤٦٣٧ بيضة على التوالى.

من نتائج الدراسة يمكن استنتاج أنه بتطبيق الأدلة الإنتخابية التى تشتمل على الثلاث صفات الأساسية فى إنتاج البيض (عدد البيض حتى عمر ٤٢ أسبوع، وزن البيضة عند النضج التام ووزن الجسم عند النضج الجنسي) أدى إلى تحسين أداء إنتاج البيض فى دجاج النورفا بغض النظر عن العلاقات السالبة والتى تم ملاحظتها بين بعض الصفات.