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Relationship between genotype – technological environment and productive performances in Japanese quail (*Coturnix coturnix*)

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Abstract. The continuous growth of living standards and consumption capacity of human society, require raising the share of animal production by: increasing the number of animals, improving their productive potential, improving technology and the effective operation of all forage resources. In achieving these goals and in particular the improvement of the productive potential of animals, a profound knowledge of the laws and phenomena that lead to the formation, development and evolution of animal body is imperative. In studying these issues we should consider the following premise: the animal body, the whole complex of qualities morpho-physiological posed at a time, is the result of the interaction between hereditary factors and environmental conditions in which the organism develops. To sense the presence of the genotype - environment interaction and its estimation of the production character in Japanese quail eggs (*Coturnix coturnix*) we conducted an experiment using a random extracted sample of the population, in which we observed egg production according to the duration of the photoperiod. The experiment was organized according to an experimental plan which included repeated measurement blocks. This has the advantage that it does not have to produce genetically uniform biological material, because the same individual is subject to different treatments during successive periods of time. This fact requires a decrease in the influence of genetic structures on the experimental results, so that differences arising between experimental variations are due to experimental treatments applied alone. To determine the genotype – environment interaction for the Japanese quail egg production character, the experimental data was statistically processed by testing the differences between the average values of two samples (Student) and using the analysis of variance (Fisher test). From direct analysis of raw data and average values of the egg production in Japanese quail, it can be said that the influence of light is very strong, and this is why the duration and intensity of artificial lighting are very important for directing technological factors of production and reproduction of this species. Experiments on this species confirm the existence of the genotype – environment interaction for the learning factor levels we have analyzed and considered. The interaction was highlighted by the phenotypic correlation coefficients (0.87, 0.42, 0.39) and by the differences between mean values of three samples. These differences are statistically insured for the threshold of 0.1%, and nonetheless by the interaction variant, which is also statistically insured.
Key words: Japanese quail, *Coturnix*, animal production, genotype, technological environment.

Rezumat. Creşterea continuă a nivelului de trai şi a capacităţii de consum a societăţii umane, impun ridicarea ponderii producţiei animaliere prin: sporirea efectivelor de animale, îmbunătăţirea potenţialului productiv al acestora, perfecţionarea tehnologiilor de exploatare şi valorificarea eficientă a tuturor resurselor furajere. În realizarea acestor deziderate şi în special al aceluia privind îmbunătăţirea potenţialului productiv al animalelor, este necesară o profundă cunoaştere a legilor şi fenomenelor care duc la formarea, dezvoltarea şi evoluţia organismului animal. În studierea acestor aspecte trebuie avută în vedere următoarea premisă: organismul animal, cu întregul complex de însuşiri morfofiziologice pe care le prezintă la un moment dat, constituie rezultatul interacţiunii dintre patrimoniul ereditar şi factorii legaţi de condiţiile de mediu în care organismul se dezvoltă. Pentru a sesiza prezenţa interacţiunii genotip – mediu şi pentru estimarea acestuia privind caracterul producţie de ouă la prepeliţa japoneză (*Coturnix coturnix*) am efectuat o experienţă pe un eşantion extras randomizat din populaţie, la care am urmărit producţia de ouă în funcţie de durata iluminării. Experienţa a fost organizată în cadrul unui plan experimental în blocuri de măsurători repetate, plan care are avantajul că nu mai trebuie să producem material biologic uniform genetic, pentru că acelaşi individ este supus la tratamente diferite în perioade succesive de timp. Acest fapt face să fie diminuată influenţa structurilor genetice asupra rezultatelor experienţei, aşa că diferenţele care apar între variantele experimentale se datorează numai tratamentelor aplicate. În vederea stabilirii interacţiunii genotip – mediu pentru caracterul producţia de ouă la prepeliţa japoneză, datele experimentale au fost prelucrate statistic prin testul diferenţelor dintre valorile medii a două probe (Student) şi prin analiză

de varianţă (testul Fisher). Din analiza directă a datelor primare şi a valorilor medii în privinţa producţiei de ouă la prepeliţa japoneză, se poate spune că influenţa luminii este foarte mare, de aceea durata şi intensitatea iluminatului artificial sunt factori tehnologici foarte importanţi pentru dirijarea producţiei şi a reproducţiei la această specie. Experimentele pe această specie confirmă existenţa interacţiunii genotip – mediu pentru însuşirea analizată şi nivelele factorului luat în studiu. Interacţiunea a fost evidenţiată de nivelul coeficienţilor de corelaţie fenotipică (0,87; 0,42; 0,39), de diferenţele dintre valorile medii ale celor trei probe, diferenţe asigurate statistic pentru pragul de 0,1%, cât şi de varianta de interacţiune care şi ea este asigurată statistic.
Cuvinte cheie: prepeliţă, *Coturnix*, producţie animală, genotip, mediu tehnologic.

Introduction. A certain level of animal production is the result of a particular genotype response to the combined action of the environmental factors (Dickerson 1962; Frisch & Vercoe 1984; Carşai 2009; Dediu et al 2011). In different environmental conditions, the same genotype can generate different performances and also, the same performance can be achieved by different genotypes in different environmental conditions (Petre 1990; Cahaner 1990; Vlaic 2011).

The exploitation of animals was always intended to achieve one of the array of factors that ensure optimum production. In order to determine the interaction between genotype and environment, and the contribution of each of the two elements to the phenotypical exhibition, it must be ensured that both the genotype and the environment can be controlled. This possibility can be achieved by ensuring conditions and applying methods of homogenizing the studied animal organisms and the environment in which assessment is carried out. Aspects of how to homogenize the genetic structure of animal populations and environmental conditions are absolutely doable, especially in terms of practice. If the environment can be standardized to a large extent but not entirely, due to large constellation of factors included, setting up a uniform genetic structure, in turn, depends on the reproductive characteristics of the species.

The organisms that reproduce sexually, by fertilizing gametes from two individuals of the opposite sex, the genotype leveling must be led by practicing uniform genotypes mating between closely related individuals (inbred matings). After several generations of related pairings "inbred lines" are obtained, in which individuals exhibit a high degree of genetic uniformity.

An effective opportunity to obtain genetically uniform individuals is cloning, but the technology and economic costs do not allow yet this technique as a mass procedure that can be widely useful in common practice. This means that related pairings for several generations is the easiest method to obtain genetically uniform individuals. Using uniform individuals in terms of heredity, we can study one of the most important aspects of interaction between genotype and environment, namely - the reaction of the genotype - which represents the diversity of phenotypes resulting from the interaction of a given genotype and different backgrounds.

The possibility of knowing the field response of a genotype is limited by the number of huge environmental factors that affect individuals with similar genotypes (Petre 1990). In common practice methods it is very important to establish how certain genotypes will respond to certain existing environmental conditions. The same genotype can take different development paths and generate different phenotypes in different environmental conditions. Certain types of genotype reactions are relatively narrow in the sense that whatever the conditions the genotype performs in, phenotypic expression remains the same. However, different genotypes can occur in the form of identical phenotypes if their reaction spectra overlap (Drăgănescu 1979).

The animal's production potential is determined by its genotype, yet it can be affected by environmental factors that have acted until the animal continued to perform. Environmental conditions that influence the phenotypic expression of a character are very different and may be caused by internal and external environmental influences. Among many external environmental conditions we mention the most influential factors: temperature, humidity, light, nutrition etc. Considering the internal environment conditions, we can also mention a few: age, sex, physiological status, health etc. It is difficult to distinguish clearly between the influence of the external environment and internal manifestation of a genotype, because some external environmental conditions affect certain aspects of internal environment and vice versa.

Material and Method. There are statements that sustain that the animal or population with the best performance in an environment is also the best in another different environment, which leads to the idea that the environment would not influence the level of performance, in other words, there is an interaction between genotype and environment that determines a change in the phenotype of a character (Falconer 1990).

A statement of the same kind as the one mentioned above is not always valid. There are situations when an animal or a population that performs better than others in an environment for a character, can be less productive in another environment, therefore the hierarchy of animals depends on a particular environment. Environmental differences may have more influence on certain genotypes rather than on others (Falconer 1990). In some characters, depending on species, there is an interaction between genotypes and environment, with major effects on phenotype expression. This means that a character will be displayed at a certain degree in a certain environment and at another degree in a different environment.

Genotype - environment interaction in such cases should be considered in the effort of improving animal productive characteristics, because in such situations testing for parents intended to produce the next generation of individuals must be carried out under similar conditions to those their descendants will endure (Drăgănescu 1979). The extraordinary diversity of the animal technological environment requires the evaluation of the genotypical reaction limits in the populations.

Our study is intended to estimate the genotype – environment interaction using biological material represented by a population of Japanese quail (*Coturnix coturnix*). Quails used as biological material have been subjected for three periods of 20 days each, with a break of 10 days between periods, to a successive treatment in terms of daylight, while watching the evolution of egg production of each individual. The experience started with a twenty day period of 24 hour lighting, continued with the second period in which lighting was 12 hours/day, and during the third period, lighting lasted 8 hours daily. Other technological environmental conditions (feeding, temperature etc) remained identical throughout the experiment.

The experiment was held in a repeated measurement experimental blocks plan. In this experimental plan, each experimental unit, each quail in our case, forms an experimental block, while measurements on this experimental unit (the quail) at different distances of time forms the data block.

Using this type of experimental plan we can increase the sensitivity of the experiment assessment, and may be able to approach the existence of genotype – environment interactions, because in this type of experimental plan, the same individual (genotype) is subjected to different treatments (different environments).

As shown above, the use of such an experimental plan as "repeated measurement blocks" can spare us the labor and expense required for the production of biologically uniform material from a genetical point of view, because the treatments are applied at successive time periods on the same biological material. Data processing in production of eggs was made by variance analysis; variance significance was tested using variance test "F" (Fisher). We have also established the differences between treatments and their significance by "t" (Student) test and phenotypic correlation coefficients.

Results and Discussion. The data reffering to the number of eggs produced by each individual, subjected to three periods of 20 days each with a break of 10 days between periods, to a successive lighting treatment duration, presented in Table 1, reveal that this treatment strongly influences egg production (see also Woodart et al 1969). In the first 20 day period illumination lasted 24 hours, with the average production of quail eggs of the 15 individuals of 18.33, while in periods following average values, these were 15.33 and 11.73 eggs per quail. This demonstrates the importance of lighting on the egg production period. In order to estimate the interactions between genotype and environment for Japanese quail eggs production we have used for primary data processing the “t” test (testing the differences between mean values of two samples), the calculation of the phenotypic correlation coefficients (Table 2) and for the variance analysis study (Table 3).

Table 1

Experimental plan and results concerning the production of eggs obtained after periods of 20 days depending on the duration lighting

BLOCKS (quail)	*TREATMENT - light - (a)*			*TOTAL*
	a_1 24 h	a_2 12 h	a_3 8 h	
1	18	15	11	44
2	20	16	12	48
3	20	17	12	49
4	19	16	11	46
5	17	14	10	41
6	18	15	10	43
7	18	15	11	44
8	19	16	12	47
9	18	16	13	47
10	17	14	12	43
11	18	16	11	45
12	17	15	13	47
13	19	14	12	43
14	20	17	14	51
15	17	14	12	43
SX	275	230	176	681
$\bar{x}$	18.33	15.33	11.73	

Table 2

Statistical parameters, the differences and phenotypic correlations for egg production in quail subjected to different light treatments

Treatment	*n*	$\bar{x} \pm s\bar{x}$	*s*	*V%*	*t*	*d*	r_p
a_1	15	18.33 ± 0.28	1.11	6.06	7.60	3.00***	0.87
a_2	15	15.33 ± 0.27	1.04	6.82			
a_1	15	18.33 ± 0.28	1.11	6.06	16.33	6.61***	0.42
a_3	15	11.73 ± 0.28	1.10	9.73			
a_2	15	15.33 ± 0.27	1.04	6.82	9.81	3.60***	0.39
a_3	15	11.73 ± 0.28	1.10	9.37			

a_1 = 24 h light; a_2 = 12 h light; a_3 = 8 h light.

The presence of highly significant differences between mean values and the existence of correlation coefficients of medium to low intensity (0.87 to 0.39) which are estimated between the egg productions achieved by the same genotypes in the three different environmental conditions, show that the genotype – environment interaction is a source of influence for the the traced character.

Table 3

Table of analysis of variances

Source of variation	*Sum of squares of deviations Sx^2*	*Degrees of freedom GL*	*Average square*	*F*
Total	377.20	44	-	-
Between blocks	35.20	14	2.51	4.92*
Intrablocks	342.00	30	11.40	22.35***
- treatments	327.60	2	163.80	321.17***
- error	14.40	28	0.51	-

Variance analysis consists of disassembling the total variance components associated with different sources of variation. These components were statistically comparable to the Fisher test (F).

From the analysis of the data contained in Table 3 we can observe the following: the treatment (duration of illumination) very significantly affects egg production, confirming this way the existence of the genotype – environment interaction.

Conclusions. Not all individuals in a population respond equally to environmental differences, as there are clear differences between their performance differences due to the presence of the genotype – environment interaction, leading to changes in the classification order of the individuals in a population. The work for genetic improvement of animal populations should take into account the genotype – environment interaction. Regardless of this interaction, the relative response supposed to be achieved (in farm production) following the selection made in another environment (testing stations) may be substantially lower. Experiments on the species *C. coturnix* confirm the existence of the genotype – environment interaction for the character in view, which is highlighted by the phenotypic correlation coefficients (0.39, 0.42, 0.87) and by very significant differences between the mean values of the three options included in the Student test and the variation of interaction.

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