Genotype x environment interactions in an exotic commercial egg strain and the local chicken of Nigeria

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Abstract

Six hatches of the Apollo, a commercial egg strain of chicken imported from the United Kingdom at day old and the Local chicken hatched from eggs collected all over Southwestern Nigeria were reared under modern brooding, feeding and management conditions to study genotype x environment interaction. Body weight, egg weight and egg production from first egg to eight months of production were recorded for each hen. Analyses of variance showed that there were significant breed x hatch interactions for age at sexual maturity, egg weight from the third month of production, and four and eight month egg production. Body weight at 12 and 20 weeks of age, weight of first egg and egg weight at first month of production did not show significant breed x hatch interaction effects. The results show that locally adapted breeds and strains are required, in view of large environmental differences between the temperate and tropical climates.

Introduction

Genotype x environment interactions are of major interests to breeders as it affects changes in relative level of performances of genotypes in different environments. Within the last two decades, several authors have discussed genotype x environment interaction in poultry. Gowe (1956) and Tindell **et al** (1967) reported significant strain x location and stock x location interaction on several body weight and egg production traits. Hill and Gowe (1962) reported significant sire family x farm interactions in one of two strains for egg and body weight measurements at sexual maturity, and strain x year interactions for body weight, egg weight and egg quality. Earlier, Gowe and Wakely (1954) found no sire x location interaction for hen housed and survivor egg production and Abplanalp (1956) reported generally low sire and dam family x hatching date interaction for winter egg production, March egg weight, egg production to 72 weeks and age at sexual maturity. There are no known reports dealing with studies on genetic stock x hatching date interaction effects in the tropical environment. This study was carried out to evaluate breed x hatch interactions for body weight, egg weight and egg production of chickens, using an exotic and a local chicken stock.

Materials and methods

The two genotypes were the Apollo, an exotic commercial egg strain of chicken imported at day old from the United Kingdom, and the Local

Chicken whose foundation stock was established from five hatches of eggs collected from villages in Southwestern Nigeria. The study included data from three hatches in each of two generations. The hatches were produced over eight to nine weeks in each generations, that is from September to November in the first generation and from February to April in the second. The first generation was produced from the foundation stock without selection of parents while the second generation was obtained from hens and cocks of the first generation that were selected for egg production on the basis of individual and sire family performance. Selection intensity was quite low as reflected in selection differentials of 0.97 and 0.80 respectively for the Apollo and the Local Chicken.

Chicks were reared under modern brooding, feeding and management conditions in the two generations. Chicks were weighed at 4, 12 and 20 weeks and individual egg production was recorded from first egg to eight months of production. The weight of the first egg as well as mean weight of eggs laid during the last three days of the first, third, fifth and seventh months of production for each hen, were recorded.

Analyses of variance to determine the significance of main effects (breed and hatch) and their interaction were carried out, separately for each generation and for hatches in both generations put together. The dependent variables considered were various body weight and egg weight measurements, age at sexual maturity and egg production to four and eight months of production, and the analyses were carried out as described by Steel and Torie (1960).

Results and discussion

Mean body weights at 4, 12 and 20 weeks, age at sexual maturity and results of statistical test of significance for the main effects and interaction are shown on Table 1. Table 2 shows mean egg weight at various stages of production, while Table 3 shows egg production to four and eight months of production, and record of laying house mortality.

Body weight and sexual maturity

Breed x hatch interaction was significant at 5% level on body weight at 4 weeks of age and at 1% level on age at sexual maturity, but was not significant for body weight at 12 and 20 weeks of age. The range in age at sexual maturity was 156.6 to 169.8 among the Apollo and 148.4 to 176.9 among the Local Chickens, and these differences could significantly affect the total number of eggs produced in the pullet year.

Osborne (1952) reported significant sire family x date of hatch interaction for age at sexual maturity. Abplanalp (1956) reported that sire x hatch and dam x hatch interaction did not significantly affect age at sexual maturity. Gowe (1956) observed a significant genotype x environment interaction for March body weight while Hill and Gowe (1962) found significant sire family x farm interactions for body weight at housing time and mature body weight, and significant stock x year interaction for body weight at 8 weeks and age at sexual maturity. Also Biswas and Craig (1970) reported significant hatch x sire family interaction for age at first egg, but the effect was not significant for body weight at 32 weeks

of age. The findings on age at sexual maturity agree with most of the above reports, and suggest that the attainment of sexual maturity for various genotypes will change in different environments. With respect to body weight, the low breed x hatch interaction effects observed in this study does not agree with most of the above reports. This is a reflection of the fact that breed effect was not significant at 12 weeks, and hatch effect was not significant at 12 and 20 weeks. It would thus appear that the genotypes were not significantly different with respect to body weight, and therefore reacted in a similar way to various hatching date environments.

TABLE 1. MEANS AND STANDARD ERRORS OF BODY WEIGHT AND AGE AT SEXUAL MATURITY FOR THE APOLLO AND LOCAL CHICKENS

	Body weight (g) at			Age at sexual maturity
	4 weeks	12 weeks	20weeks	
Apollo				
Hatches: 1	193.2 ± 11.8^{ac}	733.5 ± 33.9^{a}	1328.6 ± 104.4^{a}	169.8 ± 3.1^{a}
2	213.1 ± 13.5^{a}	669.0 ± 38.7^{a}	1233.9 ± 119.1^{a}	166.1 ± 3.5^{a}
3	175.4 ± 9.9^{bc}	607.8 ± 28.5^{a}	1186.6 ± 87.6^{a}	169.7 ± 2.6^{a}
4	162.1 ± 8.1^{b}	668.6 ± 23.1^{a}	1379.6 ± 71.2^{a}	156.6 ± 2.1^{b}
5	165.3 ± 10.5^{b}	665.6 ± 30.1^{a}	1279.4 ± 92.8^{a}	162.6 ± 2.7^{b}
6	160.7 ± 7.9^{b}	650.5 ± 22.7^{a}	1232.8 ± 69.9^{a}	166.4 ± 2.0^{ac}
Local Chicken				
Hatches: 1	204.8 ± 9.9^{a}	638.2 ± 28.5^{a}	1007.3 ± 87.6^{a}	172.3 ± 2.6^{a}
2	167.8 ± 11.8^{ab}	651.5 ± 33.9^{a}	1003.2 ± 104.4^{a}	176.9 ± 3.1^{a}
3	162.9 ± 10.1^{b}	640.3 ± 28.8^{a}	1115.2 ± 88.7^{a}	159.4 ± 2.6^{b}
4	166.5 ± 9.1^{b}	626.6 ± 26.1^{a}	1105.9 ± 80.3^{a}	148.4 ± 2.1^{c}
5	122.0 ± 7.9^{c}	632.5 ± 22.5^{a}	1171.9 ± 69.3^{a}	151.7 ± 2.0^{c}
6	129.4 ± 8.0^{c}	651.2 ± 22.9^{a}	1088.3 ± 70.5^{a}	161.7 ± 2.1^{b}
Breed differences	**	n.s	**	**
Hatch differences	**	n.s	n.s	**
Breed x Hatch interaction	*	n.s	n.s	**

*Significant at 5%
** Significant at 1% level
n.s = not significant

[1] means in the same column within breeds having no common superscript are significantly different at 1% level.

Egg weight.

There was no significant breed x hatch interaction for weight of first egg and egg weight in the first month of production, but the effect was highly significant for egg weight in the third, fifth and seventh month of production as well as for pullet year average egg weight. Gutteridge and

O'Neil (1942) found no significant strain x farm interaction for egg weight of Barred Rocks. Gowe (1956), Tindell **et al** (1967) and Biswas and Craig (1970) also did not find evidence for genotype x environment interaction for egg weight. The highly significant breed x hatch interaction for mature egg weight in this study disagrees with the above reports. The genotypes used in the study showed large differences (about 15g) in mean pullet year egg weight (Table 2). Also, hatch differences were highly significant. The genotypes used in earlier studies were either strains or sire and dam families within the same strain or breed, and these might not be genetically different with respect to the traits under consideration. The evidence here suggests that genotype x environment interaction effect could be expected where, as with the stock under investigation, the genotypes show real genetic differences.

TABLE 2. MEAN EGG WEIGHTS AND STANDARD ERRORS FOR THE APOLLO AND LOCAL CHICKENS AT VARIOUS STAGES OF EGG PRODUCTION

	Weight of egg at					*Average* egg weight
	First egg	1st month	3rd month	5th month	7th month	
Apollo						
Hatches: 1	42.0 ± 1.8^{a}	48.5 ± 2.1^{a}	50.6 ± 2.1^{a}	55.5 ± 2.1^{a}	53.7 ± 2.3^{a}	50.1 ± 0.8^{a}
2	44.6 ± 2.1^{a}	48.4 ± 2.4^{a}	50.2 ± 2.4^{a}	53.9 ± 2.4^{ab}	53.4 ± 2.6^{a}	50.1 ± 0.9^{a}
3	44.0 ± 1.9^{a}	47.0 ± 1.7^{a}	50.2 ± 1.8^{a}	51.2 ± 1.8^{b}	52.0 ± 1.9^{a}	48.9 ± 0.7^{ab}
4	40.8 ± 1.2^{b}	43.7 ± 1.4^{b}	49.6 ± 1.4^{b}	51.0 ± 1.4^{b}	50.2 ± 1.5^{a}	47.1 ± 0.6^{b}
5	41.8 ± 1.5^{b}	47.0 ± 1.9^{a}	56.1 ± 1.9^{c}	55.9 ± 1.9^{a}	48.1 ± 1.5^{b}	48.0 ± 0.5^{a}
6	42.8 ± 1.2^{a}	46.5 ± 1.4^{a}	51.2 ± 1.4^{ab}	51.2 ± 1.4^{b}	48.1 ± 1.5^{b}	48.0 ± 0.5^{a}
Local Chickens						
Hatches: 1.	26.4 ± 1.5^{b}	32.5 ± 1.7^{a}	35.7 ± 1.8^{a}	38.1 ± 1.8	40.4 ± 1.9^{a}	34.6 ± 0.7^{a}
2	28.9 + 1.8^{a}	32.1 + 2.1^{a}	35.2 ± 2.1^{a}	36.4 ± 2.1	36.7 ± 2.3^{c}	33.9 ± 0.8^{a}
3	28.9 ± 1.6^{a}	34.0 ± 1.8^{a}	35.7 ± 1.8^{a}	37.4 ± 1.8	39.1 ± 1.9^{a}	35.0 ± 0.7^{a}
4	28.3 ± 1.3^{a}	28.1 ± 1.4^{b}	28.6 ± 1.5^{b}	33.7 ± 1.5	34.2 ± 1.6^{b}	30.6 ± 0.6^{b}
5	28.1 ± 1.2^{a}	30.3 ± 1.4^{b}	32.8 ± 1.4^{b}	40.9 ± 1.4	29.7 ± 1.5^{c}	32.4 ± 0.5^{c}
6	29.3 ± 1.2^{ac}	29.7 ± 1.4^{b}	32.3 ± 1.4^{b}	29.4 ± 1.4	28.5 ± 1.5^{c}	29.8 ± 0.5^{bd}
Breed differences	**	**	**	**	**	**
Breed x Hatch interaction	n.s	n.s	**	**	**	**
Hatch differences	*	n.s	n.s	**	**	**

* *Significant at 5%*
** *Significant at 1% level*
n.s = not significant
1 means in the same column within breeds having no common superscript are significantly different at 1% level.

Egg production

There were highly significant breed x hatch interactions four four month and eight month hen housed egg production as well as eight

month survivor egg production (Table 3). There were large differences between hatches within breeds and also between breeds. This indicates that there are major differences among the genotypes and the environments. Cutteridge and O'Neil (1942) found no significant interaction between genotype and location for egg production in a test where three strains of Barred Rocks were tested on three farms. Also, Gowe and Wakely (1954) detected no sire x location interaction for hen housed and survivor egg production. However, Hill and Nordskog (1956) reported significant variety x year interaction for survivor egg production, when they tested seven single comb White Leghorns in laying batteries and floor pens. Proudfot and Gowe (1967) reported significant strain x light treatment interaction for hen housed and hen-day egg production and feed per 24 oz. of eggs; and significant strain x feed treatment interaction

TABLE 3. MEAN SURVIVOR AND HEN HOUSED EGG PRODUCTION AND PERCENT MORTALITY OF THE APOLLO AND LOCAL CHICKENS

	Egg production to			*Mortality* [%
	4 months h.h	8 months h.h	8 months sv.	to 8 months
Apollo				
Hatches: 1	53.7 ± 3.8^{ab}	107.4	144.1 ± 8.6^{a}	33.7
2	46.3 ± 4.4^{a}	85.8	127.0 ± 9.8^{a}	47.5
3	59.8 ± 3.2^{b}	98.6	141.1 ± 7.2^{a}	40.9
4	56.2 ± 3.4^{b}	88.5	108.3 ± 7.9^{b}	19.6
5	56.2 ± 3.4^{b}	98.2	108.3 ± 7.9^{b}	19.6
6	57.8 ± 2.6^{b}	104.7	108.5 ± 6.9^{b}	6.9
Local Chicken				
Hatches: 1	51.6 ± 3.2^{c}	92.2	102.7 ± 7.2^{a}	23.3
2	61.1 ± 3.8^{b}	93.0	100.4 ± 8.6^{a}	14.0
3	51.9 ± 3.2^{a}	88.7	95.7 ± 7.3^{a}	17.4
4	54.2 ± 2.6^{ad}	99.1	109.1 ± 6.0^{a}	21.6
5	59.1 ± 2.5^{bd}	119.0	121.0 ± 5.7^{b}	6.6
6	69.1 ± 2.6^{c}	125.1	130.5 ± 8.3^{b}	8.3
Breed differences	n.s	**	*	
Hatch differences	**	**	**	
Breed x Hatch interaction	**	**	**	

** *Significant at 1%*

1 means in the same column within breeds having no common superscript are significantly different at 1% level.

n.s = not significant

h.h = hen housed

sv. = survivor production

for egg production and feed efficiency in tests involving five legnorn strains. Biswas and Craig (1970) also reported highly significant strain x housing method interaction for hen-housed egg production when they tested chickens that had been subjected to two-way selection over several generations.

The above reports and the results obtained in this study suggest that genotype x environment interaction would occur where the genotypes involved were breeds rather than sire families or strains within the same breed, and environments were photoperiods, feed treatments or housing systems which have drastic effects on performances of different genotypes. Where genotype x environment interaction occurs, the correlation between the performance of a stock in one environment and its performance in another environment will be low, and this suggests that the performance of genotypes might not be the same over a range of environments.

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