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**USING RECIPROCAL
RECURRENT SELECTION ON
TWO HYBRID STRAINS OF
CHICKENS.**

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By

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INTRODUCTION

Demand for certain kinds of human food, particularly those of animal origin, has been increasing during the last few decades. Poultry meat is one of the most popular kinds of human food. Yet, it could be produced under varying environmental conditions. On the other hand, it is well established that chickens can convert feed stuff to meat more efficiently than all the other classes of farm animals. Thus, the poultry industry is regarded now a days as being the most promising source for producing animal protein required for human supply. To meet this challenge various attempts has been undertaken to produce improved germplasm in chicken. Thus, the utilization of hybrid chicken, as a mean for capturing the existing, hybrid vigour has been of prime importance to poultry breeders.

The aim of the present study was to get information as regarding the use of reciprocal recurrent selection (R.R.S.) method for testing the crossing ability of two strains of chickens developed at the Baitoon Agriculture Experiment Station with the aim of investigating the possibility of producing strain

crosses for broiler production. The general and specific combining abilities and maternal and sex-linked effects were estimated from the results of this experiment. R.R.S. was described as a breeding method for exploiting both additive and non-additive genetic variance, without being faced by the serious disadvantages that would be incurred in developing inbred lines to be used in crosses.

REVIEW OF LITERATURE

Heterosis

Although the economic advantages of hybrid vigour have become obvious since mule was first produced, it is only during the present century that deliberate attempts have been made to exploit this "extra vigour" in plant and animal production.

The word "heterosis" was proposed by Shull (1914), for this increase in vigour following the union of dissimilar gametes. He objected to the term negative heterosis when applied to a decrease in size, vigour,... etc. Dobzhansky (1950, 1952, 1955) put the term "euheterosis" as applied to increase fitness and "luxuriance" for the cases at which may not alter or may even decrease fitness.

Some theories were put to explain the phenomenon of hybrid vigour. Shull (1908, 1911) and East (1908) believed that the increase in vigour by crossing such species was due to the genetic differences in the two germ plasma which would increase with the amount of difference between them. A return to the exploitation of this theory has been advocated by Rasmuson (1939) and East (1936). Hybrid vigour according to this view depends on the

existence of a number of loci in which the heterozygote is a superior to either homozygotes, and vigour then increases with the proportion of heterozygosis. Some findings have been made in barley by Gustafsson (1946) who has emphasized the importance of factors which may produce beneficial effects as heterozygotes and highly deleterious as homozygotes. Hull (1945) has postulated the existence of "overdominance" to explain the results of his regression analysis of corn yields and this is essentially the same idea.

An alternative concept called "dominance hypothesis" first stated explicitly by Bruce (1910) and Keeble and Fellow (1910) has come to be widely accepted. This idea depends on the observation that there is a positive correlation between recessiveness and detrimental effect (or dominance and beneficial effect). According to this hypothesis some of the detrimental recessiveness brought into the hybrid zygote by one parent are rendered ineffective by their dominant alleles received from the other. The result is an increase in vigour of the hybrid as compared with the parent stock.

Bruce (1910) proved mathematically that there are fewer homozygous recessives at a particular locus in the F_1 population than in the mean number of the two parent

stocks. Assuming, without evidence, that dominance was positively related to fitness, he concluded that the cross of two pure breeds produces a mean vigour greater than the collective mean vigour of the parents. Richey and Sprague (1931) provided evidence that at least some of the improvement in vigour on crossing inbred lines is due to increase in the number of dominance rather than to increase in heterozygosity.

Jones (1917) pointed out two criticisms raised against "Keeble and Pellew's dominance theory". Firstly, if heterosis were ascribable to dominance of factors it should be possible to recombine in a homozygous condition, a generations subsequent to the F_2 , all of the dominant characters in some individuals and all of the recessive in others. The dominant homozygotes should have equal vigour to the hybrids, and when inbred should not exhibit any decline in vigour. It had not proved possible to produce such individuals. Secondly, it was considered that if dominance were the correct explanation, the F_2 explanation would show an asymmetrical distribution. The same investigator showed that with linkage and Collins (1921) showed that with a large number of factors, even in the presence of linkage, the consequences of the dominance hypothesis and the stimulation of heterozygosity of East

and Shall were very similar and could not be distinguished in practice. Crow (1948,1952) has shown theoretically that if all the deleterious recessives were replaced by their dominance alleles the selective advantage and yield characteristics of an equilibrium population would rise by 5% at a maximum. So, some other mechanism must therefore be operating to account for the other increase of vigour more than 5%.

On the other hand, Reeve and Robertson (1952) reported a theory that the hybrid is better and more adaptable because it has a greater biochemical versatility, i.e. having more kinds of genes, it has more different kinds of enzyme systems. This theory had some direct support from the discovery of "hybrid substances" (Haldane, 1955) and indirect support from the increasing evidence showing that hybrids are more adaptable than inbreds (Lewis, 1955).

Bowman (1959) concluded that it seems highly probable that there is no single genetical explanation of heterosis but that dominance, whether partial or complete, and all types of genetic interaction combined in different populations in different situation result in heterosis. He added that two conclusions may be drawn which are

Lush (1948), Basilio and Sprague (1952) and Moto and Nordskog (1959) reported that general combining ability is a consequence of additive genetic effects while specific combining ability is a consequence of non-additive genetic effects (dominance, overdominance and epistasis). Lush added that the differences in specific combining ability can include also differences due to Mendelian segregation and another differences caused by uncontrolled variation in the environment. Also, Basilio and Sprague (1952) cited that it may include a considerable portion of the genotype-environment interaction.

Sprague and Tatum (1942) have demonstrated the importance of specific combining ability as a source of variation among single crosses of corn. Moreover, Basilio and Sprague (1952) reported that specific combining was consistently greater than general combining ability variance, while the latter will commonly be more efficient in prediction than the other. The variance of specific combining ability includes not only the non-additive deviations due to dominance and epistasis but also a considerable portion of the genotype-environment interaction.

Hazel and Lamaureux (1947), and Goto and Nordskog (1959), using Leghorn breed of chicken suggested that picking was not of major importance.

Hale and Clyton (1965) investigating the same concept in Leghorn breed and its crosses showed that genetic interactions were unimportant. Eisen et al (1966-b) worked an eight by eight diallel cross experiment among four light and four heavy-type inbred lines of poultry over three year period. The results showed that general combining ability variance was the most important type of genetic variability for the majority of the traits studied. Specific combining ability variance was low in magnitude for most traits, indicating that dominance and epistatic was of little importance.

Although Hill and Nordskog (1958) showed the importance of general combining ability over specific combining ability, they concluded that for lines that might previously have been selected for general combining ability, the relative importance of specific combining ability would probably increase as was found by Sprague and Tatum (1942) in corn. Also Can et al (1959) in a study on the Leghorns, New Hampshire and

their reciprocal crosses, found that non-additive gene effects were of considerable importance in contributing to the variation in shank length, keel length and body depth, whereas, they were of questionable significance to their contribution to the variation in gain in weight from 4 to 9 weeks but appeared to have little or no effect on body weight at either 4 or 9 weeks of age. Eardon et al (1964) in a full diallel crossing experiment using 3 White Leghorn and 3 Rhode Island Red "closed-flock" strains suggested that general combining ability was much more important than specific combining ability for five- and ten-month body weights. Contrarily, specific combining ability was estimated to be of more importance for sexual maturity, hen-day and hen-housed egg production to 260 and 470 days.

Maternal and Sex Linked Effects

Many workers showed the importance of maternal and sex-linked genetic effects in many of economic traits. Goto and Nordskog (1959) demonstrated that important maternal and reciprocal cross effects were present for some of the economic traits studied. Almova (1960) using Russian Whites, Zagorsk Whites and their crosses, concluded that the dam influence incubating

characters and body weight, while the sire influences maturity and egg production. The same results were found by Penionzhkevich (1963). Dobrynina (1958) using Leghorn, Moscow breeds and their reciprocal crosses, Kawahara and Ichikawa (1959) using White Leghorn and Barred Plymouth Rock breeds and their crosses, Beilharz (1960), Mehner and Torges (1963) using White Leghorns and White Rocks, Cock and Morton (1963) using two inbred lines of White Leghorn and their crosses, Kuit (1965) using White Leghorns and Rhode Island Reds, Potemkowska and Swierczewska (1965) using two lines of Polpers, Ragab et al (1967) using Fayoumi, Balady, Rhode Island Red breeds and their crosses and Erasmus et al (1968), all demonstrated the importance of sex-linked and reciprocal effects in all economic traits studied in chickens. Also, investigating the same phenomenon, Kawahara (1961) on White Leghorn and Barred Plymouth Rock breeds, King et al (1963) in White Leghorns, Wearden et al (1964, 1967) on White Leghorns and Rhode Island Reds, and Dinu and Turcu (1965) showed the significance of maternal effects in all the economic traits studied in chickens.

On the other hand, Hazel and Lamaureux (1947) using White Leghorns reported that maternal effects

are estimated to account for about five per cent of the variation in body weight, but no influence on sexual maturity could be demonstrated. Also, Muchowski et al (1963) using four breeds of chickens and Friars et al (1963) demonstrated the non significant effect of sex-linked and reciprocal effects in some characters.

Recurrent and Reciprocal Recurrent Selection

The use of inbred lines for hybridization in animals is faced by some difficulties. The cost of developing and maintaining the pure lines needed to produce the F1 hybrids and the "double crosses" of F1 hybrids is still rather expensive.

Donald's (1955) data illustrate that the reduction of litter size of swine on inbreeding is such that one pig would be lost before weaning for every twenty per cent increase in inbreeding. Even if a homozygous inbred was produced, it would usually die before reaching maturity or prove to be infertile, since Donald's data also showed that his inbreds were only about half as good as crossbreds in these respects. Donald, in his work showed a total of 9.4 % and 4.4 % abnormalities for inbred and outbred litters, respectively. The results of inbred hybrids in animals differ