PERFORMANCE OF CERTAIN PUREBREDS AND CROSSBREDS FOR BROILER TRAITS

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "PERFORMANCE OF CERTAIN PUREBREDS AND CROSSBREDS FOR BROILER TRAITS" is a bonafide record of research work done by me during the course of my research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Mannuthy,

31.12.1979.

Signature of the candidate:

Name of the candidate: LEO JOSEPH

CERTIFICATE

Certified that this thesis entitled "PERFORMANCE OF CERTAIN PUREBREDS AND CROSSBREDS FOR BROILER TRAITS" is a record of research work done independently by Shri. Leo Joseph under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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LEO JOSEPH

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INTRODUCTION

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Broiler production is a fast developing phase of commercial poultry farming in India today. The demand for broilers is increasing every year. The production of broilers in India was four millions in 1972, while in 1975 the same was ten millions (Anon, 1976). National Commission on Agriculture (NCA) in their report have projected that the number of broiler birds would be 17.2 millions in 1985 and 71.8 millions in 2000 A.D. They have also stated that in 1985, the share of broiler meat in the total poultry meat production will be 11.1 per cent (17200 tonnes out of 1,50,000 tonnes). NCA has also estimated that between 1971 and 1985, while the production of poultry meat will increase at the rate of four per cent per year, broiler production would increase by not less than 25 per cent per annum. (Report of National Commission on Agriculture, 1976).

Profit is the aim of every commercial enterprise. In broiler production, main factors affecting the producer's margin are prevalent market price for chicks and feed, quality of chicks, feed and managemental practices. Cost of chicks and feed is beyond the control of the producer. Therefore, he has to concentrate on the quality of chick and feed and sound managemental practices to keep the business viable. Good quality chicks give better returns. The ideal qualities of broiler chicks are fast growth, high feed efficiency, good conformation and high livability.

Several breeding methods can be used for producing superior broiler chicks. The broiler stocks used for commercial production of chicks can be classified as purebreds or crossbreds. The present day commercial broilers are all crossbreds. Crossing may be between strains of the same breed, strains of different breeds, inbred lines of the same breed or different breeds. Heterosis is found to be important for body weight at eight to ten weeks of age and therefore, crosses between different lines or breeds usually give better performance (Kaushal <u>et al</u>., 1973). Another reason for crossbreeding is related to the economics of producing commercial chicks. Continued selection for larger body weights as in the case of pure line selection results in lower egg number. As a result cost of producing commercial chick increases.

Diallel crossing is a good method to compare the performance of different strains and breeds in cross combination. In this method, all the possible combinations between a set of lines are taken. Thus purebreds, crossbreds and the reciprocals are compared to identify the best combination.

University Poultry Farm, Mannuthy is maintaining White Plymouth Rocks (WPR), Australorps (ALP) and Rhode Island Reds (RIR). It is not known whether these genetic stocks could be utilized for the production of broiler chicks. A study was, therefore, undertaken to evaluate these breeds and their crosses for broiler traits using a full diallel mating system.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Diallel Cross

Diallel cross is a method of experimental breeding which has been used in plants for a long time. In animal species, it is extensively employed in poultry and pigs. This method enables genetic variation to be split into different components: general and specific combining abilities. Diallel crossing is one in which a set of 'P' lines is taken and single crosses among them are taken in all possible combinations. The progeny is dividable into 3 groups: (1) a set of 'P' lines (2) $\frac{1}{2}$ P (P-1) F_1s and (3) $\frac{1}{2}$ P (P-1) reciprocals. In experimentation either all crosses can be taken or only F_1s and reciprocals, or one set of F_1s and parental lines or one set of F_1s only (Griffing, 1956).

In animal experiments, a full diallel - one which includes all the possible crosses - is needed to determine whether crossing is useful in increasing productivity. As there is evidence for sex-linked and reciprocal effects a knowledge of them is important in deciding upon lines for use as sires and dams.

Griffing (1956) has discussed the analysis of a diallel cross data. He gave an orthogonal partition of the variance into general and specific combining abilities and reciprocal effects. The computation procedures were also given by him.

Combining Abilities

The performance of a line in cross combination can be best evaluated in terms of General Combining Ability (GCA) and Specific Combining Ability (SCA). The average performance of a line in hybrid combination is called GCA. The term specific combining ability is used to designate those crosses in which certain combinations do relatively better or worse than would be expected on the basis of the average performance of the lines involved. Henderson (1952) defined GCA as the average merit with respect to some trait or weighted combinations of traits of an indefenitely large number of progeny of an individual or line when mated with a random sample from some specified set of environmental circumstances. SCA on the other hand, was explained as the deviation of the average of an indefenitely large number of progeny of two individuals or lines from the values which would be expected on the basis of the known GCA of these two individuals or lines and the maternal ability of the female parent.

Reciprocal Effect

The primary sources of reciprocal differences in animal breeding experiments are sex linked and maternal effects. The presence of reciprocal effects are important in deciding upon the use of either the sire or dam line in a cross. Maternal effect was defined by Henderson (1952) as the average differences between a line used as a sire versus the same line used as a dam.

Body Weight

Body weight at marketing is the most important trait in broilers. Higher body weight is associated with higher growth rate. Higher growth rate in turn reduces the cost of production and thereby increasing the profit margin. Body weight is the mostly used criteria for measuring the growth.

Hatch weight.

Dinu and Vermesanu (1966) reported that day old chick weight in Rocks, Cornish and Cornish x Rock was 41.2, 42.3 and 43.1 g respectively.

Grosman and Lucinjs (1966) after comparing day old chicks of White Plymouth Rock (WPR), Cornish, Sussex and New Hampshire breeds reported that WPR and Cornish chicks were heavier than the latter two breeds.

Capulong and Agcanas (1967) observed a chick weight of 42 and 43 g respectively in males and females of White Plymouth Rock at day old age.

Ghany et al.(1967) compared hatch weights of WPR, New Hampshire (NH), Cornish x WPR and WPR x NH chicks. At hatching the two breeds and the two crosses weighed 36, 38, 37 and 34 g respectively.

Halaj and Uhrin (1969) observed a day old weight of 39.5 and 37.1 g for male and female chicks of White Plymouth Rock breed.

Litko (1969) reported that the progeny of Cornish x WPR, Cornish x Rhode Island Red (RIR) and Cornish x (WPR x RIR) matings had a day old weight of 36.0, 34.5 and 35.4 g respectively.

Latif and Salam (1970) found that in RIR, New Hampshire, WPR x RIR and RIR x NH chicks, weight at hatching averaged 35.4, 36.8, 39.5 and 36.6 g respectively.

Aggarwal et al.(1971) compared RIR, Desi breeds and their reciprocal crosses for chick weight at hatching. At hatching RIR, Desi, RIR x Desi and Desi x RIR chicks averaged 36.9, 33.0, 32.9 and 37.7 g respectively.

Chhabra and Sapra (1972) reported a day old chick weight of 36.80, 36.75 and 35.06 in WPR, NH and White Cornish (WC) breeds of fowl. He observed that variations in weights were significantly affected by breed and hatch.

Sapra et al.(1972) conducted a 3 x 3 diallel cross involving White Rock, New Hampshire and White Cornish breeds.

He observed that differences between genetic groups were significant for the hatch weight.

Chhabra and Sapra (1973) reported an average day old weight of 35.6 g in RIR chicks.

Khar et al. (1976) after conducting a 4 x 4 diallel cross involving White Rock, White Cornish, New Hampshire and Australorp reported that significant differences existed for hatch weight in the different genetic groups.

Body weight at ten and twelve weeks.

Meat yields from different breeds and their crosses have been investigated by many workers. Jaap et al. (1950) conducted comparative trials with Rhode Island Red (RIR), White Plymouth Rock (WPR), New Hampshire (NH) Barred Plymouth Rock (BPR) and White Leghorn (WL) breeds and their crosses. In the above breeds, body weight at 12 weeks averaged 3.2, 3.1, 3.18, 3.22 and 2.63 lbs respectively. In BPR x RIR, RIR x BPR, WPR x RIR and WPR x NH the weights were 2.98, 3.02, 3.45 and 3.33 lbs respectively.

Essary et al. (1951) compared strains of New Hampshire (NH) developed for egg production and for broilers and also their crosses with Barred Rocks (BR). BR x NH (Broiler strains) was found to be superior in body weight at 12 weeks, males averaging 34.5 lbs and females 3.4 lbs. NH (broiler strain) was found to give superior results in several respects to the NH (egg strain).

Nordskog and Ghostley (1954) conducted experiments with two strains for each of four breeds namely, New Hampshire, Rhode Island Reds, Barred Plymouth Rocks and Australorps. Two strains from each breed were also crossed in all combinations (the offsprings being pure strains, strain crosses or breed crosses). The strain cross and crossbred pullets averaged four per cent and seven per cent heavier than pure strains. They found that fastest growing crosses contained the New Hampshire breed.

Brunson et al. (1956) conducted two series of diallel matings among New Hampshires and Silver Oklabars and reciprocal crosses between these breeds. They found that breed crosses had mean body weights significantly higher than the combined parental mean.

Badreldin et al.(1961) conducted growth studies using reciprocal crosses of Fayoumis with White Leghorn and Rhode Island Red. They reported that highest body weight at 12 week was seen in the Fayoumi x RIR cross. The purebreds were inferior. Kamar and Mostageer (1963) based on similar experiments also found that a cross of Fayoumi x RIR to have better growth rate.

Derlugjan (1963) compared all possible crosses amongst Rhode Island Red, Australorp, and Russian Whites. He found that average daily gains were the greatest and feed consumption lowest for Australorp x RIR crossbred followed by the reciprocal cross.

Kusner and Heija (1963) compared growth rate to 90 days of age in Kuchin Anniversary chicks and their reciprocal crosses with White Plymouth Rocks, New Hampshires, Leghorns, Australorps and in purebred Leghorns. The average body weight in majority of crossbred groups exceeded that of the purebreds. The crossbreds produced more meat as well.

Tanabe et al. (1964) conducted trials with White Leghorns (WL), Barred Plymouth Rock (BPR) and White Rock (WR) and their crosses for growth upto ten weeks of age. Average 10th week body weight was 995, 973 and 1505 g for WL, BPR and WR and those for WL x BPR, BPR x WL, WL x WR and WR x WL, it was 1023, 939, 1211 and 1118 g respectively.

Masic and Khalifah (1965) compared seven groups of chicks representing New Hampshire, White Rock and Delaware purebreds, crosses between these breeds and Cornish x WR. They found that among the purebreds, WR was the most suitable for broiler production. Cornish x WR was the best among the crossbred groups and the best overall group.

Sakaida and Nishida (1966) carried out investigation in White Leghorns, Barred Plymouth Rocks, White Cornish and White Rock males and crossbred males produced by mating WC males with the other breeds. They observed that the 10th week body weight of WC and WR averaged 1586 and

1528 g respectively which were greater than that of the other two purebreds and crossbreds.

Buvanendran (1967) observed heterosis in the WC x WPR cross when comparing WC and WPR breeds and their reciprocal crosses. But the reciprocal cross did not show heterosis.

Negrutiu (1968) comparing body weight of chicks at eight weeks of age in White Leghorns (WL), Rhode Island Red, White Plymouth Rock (WPR) and White Cornish (WC) breeds, observed that WC and WPR had greater weight gain and body weight at all ages. It was the least for WL.

Litko (1969) carried out crossbreeding experiments in which females of WPR, RIR and WPR x RIR were mated to cornish males. At ten weeks of age the three groups had a body weight of 1592, 1478 and 1559 g respectively.

Latif and Salam (1970) conducted comparative studies of growth rates utilising RIR and NH breeds and their reciprocal crosses. They reported body weight at weight weeks was 0.9, 0.9, 1.36 and 10.6 kg and at twelve weeks it was 1.56, 1.60, 2.22 and 1.80 kg respectively in RIR, NH, WPR x RIR and RIR x NH chicks.

Aggarwal et al. (1971) after conducting growth studies involving RIR and Desi birds reported a 12 week body weight of 621 g in RIR, and 521 g in Desi birds.

Chandra Pho et al.(1971) compared White Rock and New Hampshire breeds and their crosses for broiler production. He observed significant differences among the genetic groups for 12 week body weight. The crossbreds in general showed superiority over the purebreds.

Ramappa and Deve Gowda (1971) conducted diallel crossing involving ALP, WPR, NH and WC. Body weight at ten weeks was highest in WC x ALP, purebred WC and WPR x WC birds with males averaging above 1100 g and females above 900 g.

Chhabra and Sapra (1972) studying body weight in three broiler breeds of chicken viz., WPR, NH and WC reported a 10th week body weight of 567.7, 523.0 and 518.6 g respectively in the above three breeds. The differences between breeds were significant.

Chhabra et al.(1972) after conducting a diallel cross involving WR, WC and NH breeds reported that at ten weeks NH x WC cross excelled all others in live weight (827.4 g). Corresponding weights of NHxWR and WR x WR chicks were 740 and 722 g respectively.

Sapra et al.(1972) reported that in a diallel cross involving WPR, NH and WC breeds, the difference in body weight was not significant among genetic groups at ten weeks of age. Cross breds in general were found to be not superior when compared with their pure bred parents. NH x WR cross excelled all other crosses at ten weeks (599.5 g).

Kaushal *et al.* (1973) conducted a diallel cross experiment involving three broiler breeds namely, WC, WPR and NH. At ten weeks of age, body weight differences were significant among the genetic groups. NH x WC cross was significantly heavier than the other cross breds and pure breds. All the crossbred groups except WC x WR were significantly better than purebred groups of NH and WC. The differences between purebreds were found to be non significant.

Pati *et al.* (1975) conducted a complete diallel involving four strains - two from cornish and two from Rock - and the different genetic groups were compared. They observed significant differences for body weights among genetic groups at eight and ten weeks of age.

A diallel cross involving three broiler breeds namely, White Cornish, White Rock and New Hampshire was performed by Patro *et al.* (1975) to study their combining abilities. They observed a body weight of 868 g, 993 g, 985 g in WR x WR, WR x WC and WR x NH crosses respectively in males and 755 g, 813 g and 744 g respectively in females at ten weeks of age.

Amrit Lal and Chhabra (1976) conducted diallel cross experiments with Australorp, New Hampshire and White Cornish breeds of chicken. At 12 weeks of age, they observed that in ALP x ALP, ALP x NH, ALP x WC the body weights were 809 g, 769 g and 882 g respectively.

Hanumaiah _et al._ (1976) after performing crossbreeding experiments with White Leghorn and Rhode Island Red breeds reported absence of heterosis for 10th week body weight. In WL, WL x RIR and RIR chicks the body weight at ten weeks were 612 g, 662 g and 753 g respectively.

Khar _et al._ (1976) reported from a diallel experiment involving WR, WC, NH and ALP breeds that body weight differences were significant in different genetic groups at ten and twelve weeks of age.

Prasad _et al._ (1977) utilised WR, WC, NH and a local strain of broiler in a crossbreeding experiment for broiler production. Body weight at eight week was significantly different among crosses. Maximum weight of 740 g was recorded in WR x local strain chicks and least weight of 675 g in WR.

Ramappa _et al._ (1977 a) compared four crosses of broiler involving cornish as male line and New Hampshire and WPR as female lines. There was significant difference for body weight at eight weeks of age among the genetic groups.

Ramappa et al.(1977 b) utilised a diallel cross involving ALP, NH, WC and WPR to compare the performance of the purebreds and crossbreds in different seasons. Season I was September and October and Season II was January and February. They observed that crosses involving WC and WR on the male side were highest body weight in both first and second seasons, whereas crosses involving WC on female side in the first season and WR in the second season had the highest average body weight. For ALP x ALP, ALP x WR, WR x ALP and WR x WR, body weight in the first and second seasons were (males) 732 and 695 g, 718 and 784 g, 789 and 772 g and 913 and 701 g respectively.

Sandikcioglu et al.(1977) reported an eight week body weight of 469 g, 410 g and 451 g in White Cornish, White Plymouth Rocks and New Hampshire breeds respectively.

Aggarwal et al.(1978 a) using four broiler strains - two from Cornish and two from Rock performed a diallel cross and the progeny were compared. They reported that growth rate was higher in crossbreds.

Aggarwal et al.(1978 b) after carrying out diallel cross with four strains of broilers reported a positive estimate of heterosis for eighth and tenth week body weight indicating the superiority of crossbreds over purebreds.

Aggarwal et al.(1979) from a diallel cross experiment involving four strains, two each representing Cornish and Rock reported that body weight at eight and ten weeks were significantly different between genetic groups. Crossbreds were in general heavier than purebreds. At eight and ten weeks they found that breed crosses were heaviest followed by strain cross and purebreds. Rocks weighed heavier when used as a female line and Cornish weighed heavier as a male line at eight weeks.

Combining Ability Effects

A diallel cross involving WC, WR, NH and ALP was studied by Ramappa and Devegowda (1973). They observed a significant GCA effect for tenth week body weight in females but not in males. SCA and reciprocal effects were insignificant in both sexes. Insignificant reciprocal effects (RE) indicated absence of sex linked effects for that trait.

Pati et al. (1975) studying eighth and tenth week body weight in a 4 x 4 diallel cross involving broiler strains reported significant GCA and SCA for body weights. Estimated GCA variances were greater than SCA variance. Reciprocal effects were also significant for eighth and tenth week body weights.

Patro et al.(1975) conducted diallel crossing with WC, WR and NH breeds to study the genetic effects on tenth week body weight. They found that GCA was significant in males, but not in females. The SCA effects were significant both in males and females.

Khar et al. (1976) reported from a 4 x 4 diallel experiment involving WR, WC, NH and ALP breeds that, GCA, SCA and RE were significant for day old weight. Significant GCA and SCA was also seen in tenth week body weight. But the RE were insignificant.

Scanning through the literature we can find that crossbreeding is helpful in improving hatch weight and body weight of chicks at eighth, tenth and twelfth week of age.

Feed Efficiency

Feed efficiency is also an important trait in broiler production. Less efficient broilers consume more feed thereby increasing the cost of production.

Essary et al.(1951) by comparing birds of New Hampshire (NH) of an egg strain and also of a broiler strain, Barred Rock x NH (Broiler), NH (Broiler) x Barred Rock and standard bred BR found that feed efficiency was best in BR x NH (broiler) chicks.

Wohlbier et al.(1961) after experimenting with White Leghorn, New Hampshire and White Rock breeds of fowl reported that at 12 weeks of age feed conversion in White Rocks were the best followed by New Hampshire.

Penamartin et al.(1962) reported that in Rhode Island Red chicks at nine weeks of age, feed conversion index was 3.23.

Kamar and Mostargeer (1963) observed that among RIR, Fayoumi and their crosses, RIR was the most efficient breed in feed conversion.

Tanabe et al.(1964) observed that feed conversion at ten weeks of age in White Leghorn (WL) Barred Plymouth Rock (BPR) and White Rock (WR) was 3.60, 3.44 and 2.74. In WL x BPR, BPR x WL, WL x WR and WR x WL cross, the same was found to be 3.0, 3.22, 3.0 and 3.07 respectively, which was better than WL and BPR.

Pop and Marandici (1966) raised male and female Cornish, Rhode Island Red and Crossbred of these to 61 days of age. Feed conversion was most efficient in the crossbreds, slightly less efficient in the Cornish and considerably less efficient in the RIR.

Sakaida and Nishida (1966) carried out investigations on White Leghorn (WL) Barred Plymouth Rock (BPR) White Cornish (WC) and White Rock males and crossbred males produced by mating WC males with other breeds. They reported that food utilisation efficiency was 3.48 in WL, 2.85 in WR, 2.84 in WC x WR and 2.88 in BPR.

Ghany et al.(1967) conducted growth trials with WPR, NH, Cornish x WPR and WPR x NH chicks. They reported a feed utilisation efficiency of 4.28, 3.42, 3.49 and 3.65 for the four groups respectively.

Litko (1969) reported a feed utilisation efficiency of 2.27, 2.36 and 2.25 in WPR x Cornish, RIR x Cornish and (WPR x RIR) x Cornish chicks respectively.

Latif and Salam (1970) comparing RIR, NH, WPR x RIR and RIR x NH. Chicks reported a feed conversion efficiency of 3.12, 3.22, 2.80 and 3.16 respectively at 12 weeks of age.

Chandra Pho et al.(1971) raised WPR, NH and their reciprocal crosses to an age of 12 weeks. They reported that among the four groups, NH x WR had best feed efficiency (4.60) closely followed by WR x NH (4.8). But WR x NH had better body weight. The crosses in general were superior to purebreds.

Ramappa and Deve Gowda (1971) studied feed efficiency among the progeny of a 4 x 4 diallel cross involving Australorp (ALP), WPR, NH and White Cornish (WC) breeds. They found that feed efficiency was best in purebred WC and WC x WPR. (3.17 and 3.19 respectively). These two groups also had the best overall performance.

Ramappa et al.(1977 a) studying purebreds and crossbreds of ALP, WPR, NH and WC by a diallel system reported that feed efficiency in ALP x ALP, ALP x WPR, WPR x ALP and WPR x WPR in September-October was 3.44, 3.60, 3.25 and 3.47 respectively and in January-February it was 3.31, 3.31, 3.29 and 3.28 respectively.

Prasad et al.(1978) compared purebred WPR, NH x WC, Broiler strain (B) x WR, WR x B and NH x WC chicks for feed efficiency. It was 3.37 in WR x B and 3.5, 3.55 and 3.8 in B x WR, NH x W and WC x NH respectively. In WR pure, it was 4.2.

In general, better feed efficiency was recorded in crossbred chicks compared to purebreds in most of the studies.

Carcass Traits

Carcass quality is one of broiler quality traits. Carcasses with better quality fetch better prices. This trait has been investigated fairly extensively.

Jaap et al.(1950) studied differences in meat yield from different breeds of poultry namely, RIR, WPR, NH, BPR and WL and their crosses. They reported that rate of growth appeared as the major factor increasing both the percent dressed and eviscerated yield at the stage. The relation between live weight and percentage yield is linear. Plymouth Rocks yielded a higher dressed weight than would be expected from their live weight.

Essary et al.(1951) comparing production strain and broiler strain of New Hampshire breed and their crosses with Barred Plymouth Rocks (BPR) observed that BPR x NH (broiler) was superior in dressed weight.

Ranganathan and Arumugam (1967) conducted studies on the dressing yields of Rhode Island Red, White Leghorn and Desi cockerels. Their fasting shrinkage after fasting for 18 hours were 7.5, 7.2 and 6.6 per cent respectively, the difference being significant. The yield of edible parts was reported to be 71.4, 69.2 and 73.2 per cent respectively, the edifference being significant.

Mathur and Ahmed (1968) conducted studies on processing losses and meat yield of commercial broilers at ten weeks of age. They observed that dressed weight was 91.24 and 89.98 per cent of live weight in males and females respectively. They also observed that eviscerated yield being higher in females than males, the values being 71.13 and 71.08 per cent respectively.

Chandra Pho et al.(1971) compared carcass yields in White Rock, New Hampshire and their crosses. He found that the cross WR x NH had the highest eviscerated weight of 892 g. It also had the highest live weight (1264 g).

Prabhakaran and Ranganathan (1971) conducted studies on dressing percentage in White Rocks aged 12 weeks. They reported a shrinkage of 6.08 and 5.94 per cent in males and females when fasted for 16 hours prior to slaughter. Dressing percentage was 64.7 and 64.2 per cent respectively in males and females.

A dressed weight percentage of 79.4 was reported in RIR by Sharma et al. (1971).

Chhabra et al.(1972) using a diallel cross involving WR, WC and NH breeds reported that the cross NH x WC had the highest eviscerated per cent of 70.9. WR purebred had a yield of 67.5 per cent. The crosses WR x NH, WR x WC had a value of 70.1 and 68.9 per cent.

Sapra et al.(1972) compared carcass quality in various breed crosses by utilising diallel cross involving WR, NH and WC. They observed an eviscerated yield of 77.9 per cent in WR purebreds. It was aclosely followed by NH x WR with a value of 76.7 per cent. WR x NH had a yield of 66.1 per cent.

Kaushal et al.(1973) from a diallel cross involving WC, WR and NH breeds reported that NH x WC cross significantly excelled all purebreds and crossbreds except WC x NH crossbreds. WC x NH, NH x WR and WR x NH groups were significantly better than all the purebred groups.

Kosalaraman and Ulaganathan (1975) conducted a study to assess the influence of sex, age and breed on dressing per cent utilising birds from WC, NH and WR breeds aged

8, 10 and 12 weeks. They reported that sex had little or no influence on dressing percentage. Males of NH and WR gave significantly lower dressing percentage than females. Better yield was noticed at 12 weeks. Strains were also different.

Nair et al.(1978) reported in commercial broilers a fasting shrinkage of 5.4 per cent in three hours, dressed yield of 87.9 per cent and ready to cook yield of 64.15 per cent.

Elizabeth et al.(1978) reported a fasting shrinkage of 3.6 per cent, mean dressed yield of 90.05 per cent and ready to cook yield of 71.62 per cent in commercial broilers.

Radhamma Pillai et al.(1978) reported a mean fasting shrinkage of 6.14 per cent, dressed yield of 91.6 per cent, and ready to cook yield of 73.8 per cent in commercial broilers.

Sethuraman and Kothandaraman (1978) reported that in WR males, aged 74 days, after 12 hour fasting, dressing percentage was 64.7.

Crossbreeding also improves carcass yields. From the literature there is evidence that yield is comparatively more in crossbreds.

MATERIALS AND METHODS

MATERIALS AND METHODS

The experiment was conducted at the University Poultry Farm, Mannuthy. The materials for the study came from three breeds: White Plymouth Rocks, (WPR), Australorps (ALP) and Rhode Island Red (RIR), maintained as closed flocks at the farm. The study was conducted during the first quarter of 1979.

Making use of the three breeds, a complete diallel mating was conducted and comparisons were made between the nine genetic groups thus obtained. Fifteen hens and two cocks were put in one pen and nine such pens were utilised. The following matings were carried out.

1. *ALP x WPR	4. RIR x WPR	7. WPR x ALP
2. ALP x RIR	5. RIR x ALP	8. WPR x RIR
3. ALP x ALP	6. RIR x RIR	9. WPR x WPR

Allotment of males and females to the pens were made at random. Progeny were obtained from six sires and 45 dams in each breed.

Hatching eggs were saved for 10 days and chicks were taken out in a single hatch. Chicks were wing banded, weighed and vaccinated against Ranikhet disease on the first day and transferred to the brooder.

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* In crosses, the first part represents the male parent.

The chicks belonging to the different genetic groups were reared seperately. The groups consisted of 20 chicks each. There were two replicates with ten chicks each for the nine genetic groups, thus making eighteen groups and a total number of 180 chicks. They were housed in 18 identical pens, alloted at random and were maintained there for the entire period of the study. Floor brooding was practised. Brooding was continued till four weeks of age. Thereafter only night lights were given. Chicks were fed with a broiler starter and broiler finisher diet formulated as per ISI (1977) specifications. Feed and water were provided ad libitum. Standard managemental practices were followed throughout the entire period of study.

The traits considered were hatch weight, body weights at ten and 12 weeks of age, feed efficiency at ten weeks of age and carcass characteristics at ten and 12 weeks of age.

Body weights were taken at the end of ten weeks and 12 weeks. Weighed quantities of feed were given and balance of feed recorded at the end of ten weeks. Feed efficiency were worked out from the above data.

At ten and twelve weeks of age, ten birds from each genetic group (ie. five from each replicate) were chosen at random and subjected to slaughter studies. Birds were fasted for 12 hours prior to slaughter, giving water ad libitum.

They were killed and processed according to the procedures laid down by Kilpatric and Pond (1960). Pre-slaughter (after fasting), dressed and ready to cook weights of each bird were recorded.

Analytical methods.

Data pertaining to hatch weight, body weights at ten and 12 weeks of age, feed efficiency and carcass yields were subjected to statistical analyses. For body weight, sexes were considered seperately and for other traits, combined data were taken. Body weight at ten weeks was also analysed statistically to find out the possible genetic effects.

Analysis was done to study the overall differences between various genetic groups. All the effects except the error were assumed fixed and the purpose of this assumption was to determine if under the environmental conditions involving in the experiment, the performance of crosses differed to any amount greater than that expected from chance. The chicks belonged to a single hatch and the linear model for the analysis was

$$Y_{ijk} = \mu + c_i + r_j + e_{ijk}$$

where

Y_{ijk} = Observation of the k^{th} progeny of the j^{th} replicate of the i^{th} cross.

μ = Population mean

c_i = Cross effect

r_j = Replicate effect

and e_{ijk} = Random error

Means with standard errors were calculated for the different crosses. Comparisons among the crosses were made by employing Duncan's multiple range test as modified by Kramer (1956). The least significant differences were calculated for each pair of comparisons using the formula

$$LSD = r_p\sqrt{\tfrac{1}{2}\,(1/n1 + 1/n_2)S^2}$$ (Snedecor and Cochran, 1968).

where

LSD - is the least significant difference

r_p - is the significant studentised range values in Duncan's table (5%) at error df.

p - is the number of means

n1, n2 - are the number of observations of the treatments whose means are compared and

S^2 - is the error mean square.

For comparing the sexes and crosses for body weight at 10 weeks and 12 weeks, the sum of squares for the sex was adjusted for differences in number of observations using the following formula (Kempthrone, 1952).

$$Q_j = Y_{.j.} - \sum \frac{n_{ij}}{n_{i.}} \; y_{i.}$$

$$Q_j = (n_{.j} - \sum_i \frac{n_{ij}^2}{n_{i.}})t_j - \sum_{\substack{i \\ j\, j'}} \frac{n_{ij}n_{ij'}}{n_{i.}} \; t_{j'}$$

The F values were calculated based on corrected sum of squares and compared with the table values.

Genetic analysis.

In this experiment a full diallel crossing was made wherein 'P' lines were crossed in all possible combinations inclusive of the purebreds such that 'P' purebred and P (P-1) single cross progeny were obtained. Genetic analysis to find out the difference between genetic groups was done for body weight at ten weeks. Analysis was done by the method described by Griffing (1956).

The mathmatical model assumed for combining ability analysis was

$$x_{ij} = u + g_i + g_j + s_{ij} + r_{ij} + 1/c \sum_k e_{ijk}$$

$i,j = 1,2,\ldots\ldots p$ $\qquad$ p = no. of parents

$k = 1,2,\ldots\ldots c$ $\qquad$ c = no. of observations.

where

μ = is the population mean

g_i (g_j) - is the GCA effect for the i^{th} (j^{th}) parent

s_{ij} - is the SCA effect for the cross between i^{th} and j^{th} parents such that $s_{ij} = -s_{ji}$.

r_{ij} - is the reciprocal effect involving reciprocal crosses between i^{th} and j^{th} parents such that $r_{ij} = -r_{ji}$

and e_{ijk}- is the environmental effect associated with ijk^{th} individual observation.

The following restrictions were imposed on the combining ability effects

$$\sum g_i = 0 \text{ and } \sum s_{cj} = 0 \text{ (for each j)}$$

The analysis of variance table is presented below.

Analysis of variance

Source	df	SS	MSS	EMS
GCA	$p-1$	S_g	M_g	$\sigma^2 + 2p\frac{1}{(p-1)} \sum g_i^2$
SCA	$p\frac{(p-1)}{2}$	S_s	M_s	$\sigma^2 + \frac{2}{p(p-1)} \sum_i \sum_j s_{ij}^2$
RE	$p\frac{(p-1)}{2}$	S_r	M_r	$\sigma^2 + (\frac{2}{p(p-1)} \sum_i \sum_j r_{ij}^2$
Error	M	S_e	M_e'	σ^2

where

$$S_g = \frac{1}{2p} \sum_i (x_{i.} + x_{.i})^2 - \frac{2}{p^2} x^2_{..}$$

$$S_s = \frac{1}{2} \sum_i \sum_j x_{ij} (x_{ij} + x_{ji}) - \frac{1}{2p} (x_{i.} + x_{.j}) + \frac{x^2_{..}}{p^2}$$

$$S_r = \frac{1}{2} \sum_i \sum_j (x_{ij} - x_{ji})^2$$

and $M_e' = \frac{M_e}{c}$ where M_e is the error mean square in the phenotypic analysis, and 'c' the average number of observation per cross.

The average number of observation per cross was found out by the formula

$$n_{\cdot} = \frac{1}{(a-1)} \left(N - \frac{\sum ni^2}{N}\right)$$ Snedecor and Cochran, 1968).

where

a - is the number of treatments

N - total sample size = $\sum ni$

and ni - the size of sample of the i^{th} class

To test the various effects, the following ratios were taken.

GCA $F(p-1), m = \frac{Mg}{M_e'}$

SCA $F \frac{p(p-1)}{2}, m = \frac{Ms}{M_e'}$

RE $F \frac{p(p-1)}{2}, m = \frac{Mr}{M_e'}$

The main effects were estimated as follows

$$\mu = \frac{x_{..}}{p^2}$$

$$\hat{g}_i = \frac{1}{2p} (x_{i.} + x_{.i}) - \frac{x_{..}}{p^2}$$

$$\hat{S}_{ij} = \frac{1}{2} (x_{ij} + x_{ji}) - \frac{1}{2p} (x_{i.} + x_{.i} + x_{j.} + x_{.j}) + \frac{x_{..}}{p^2}$$

$$\hat{r}_{ij} = \frac{1}{2} (x_{ij} - x_{ji})^2$$

The variance of any parent or F1 mean is Var (xij) = M'_e and variance of difference between two means is Var $(x_{ij} - x_{kl}) = 2\sigma^2$.

The variance of difference between two effects were estimated as follows:

$$V_{ar}\ (\hat{g}_i - \hat{g}_j) = \frac{\sigma^2}{p} \quad (i \neq j)$$

$$V_{ar}\ (\hat{s}_{ij} - \hat{s}_{ik}) = \frac{(p-1)\sigma^2}{p} \quad (i \neq k,\ j \neq k)$$

$$V_{ar}\ (\hat{r}_{ij} - \hat{r}_{kl}) = \sigma^2 \quad (i \neq j,\ k \neq l)$$

The various effects of the breeds were compared by using the students 't' test.

RESULTS

RESULTS

Hatch Weight

The means standard error and mean comparisons of hatch weight of the different genetic groups are presented in Table 1 and their analysis of variance in Table 2. Significant ($P < 0.01$) differences were observed among genetic groups for hatch weight, with WPR purebreds showing a hatch weight of 39.1 g which was significantly ($P < 0.05$) higher than that of RIR purebreds (34.7 g) and WPR x RIR (34.3 g). However, this was not significantly ($P < 0.05$) different from that of the rest of the genetic groups. The differences among the genetic groups except WPR purebreds were also statistically non-significant. The hatch weight ranged from 34.3 g in WPR x RIR to 39.1 g in WPR purebreds. When ranked in order of GCA, WPR was found to be the best followed by ALP and RIR. Among crossbreds, ALP x WPR had the highest hatch weight of 38.3 g.

Body weights at ten and twelve weeks

The means, standard error and mean comparisons of body weight at 10 weeks are presented in Table 3 and mean squares of variance in Table 4 and 5. The differences among genetic groups were found to be highly significant ($P < 0.01$). WPR had the highest body weight and RIR had the lowest among males, females and sexes combined. In RIR and WPR, body weights were 657.5 and 1162.2 g among males, 517.0 and 862.1 g among females and 587.3 and 1056.1 g among sexes combined. WPR was also significantly better (P ∠0.05) than all the other groups when sexes were considered seperate and combined. Among crosses, ALP x WPR was best in males and among combined sex (1007.0 and 880.8 g) and WPR x ALP was better among females (804.3 g). When ranked according to GCA, WPR was best followed by ALP and RIR.

Body weight of different crosses at 12th week is presented in Table 6 and its analysis of variance in Table 5. The genetic groups differed significantly. The body weight pattern showed the same trend as at 10th week. WPR was best with a mean body weight of 1268.5 g (sexes combined) and RIR had the lowest weight of 696.0 g. Among crosses WPR x ALP was best with a mean body weight of 1042.5 g. The GCA ranking followed the same order as at 10th week of age. The differences between sexes were also highly significant. (P ∠0.01).

Combining Ability Effects

Genetic effects on body weight at ten weeks of age were calculated by the method described by Griffing (1956). The mean squares of General Combining Ability (GCA), Specific Combining Ability (SCA) and Reciprocal Effects (RE) are presented in Table 7, sexwise and sexes combined. The estimates of various effects are presented in Table 8.

General combining ability effects were found to be highly significant (P ∠0.01) for body weight in males, females as well as in sexes combined. The proportionate contribution of GCA was the largest compared to SCA and RE. From the table of effects, it can be seen that the GCA effects of WPR are all positive and significantly higher than that of RIR and ALP, in males, females and sexes combined. The GCA effects of ALP was significantly higher than that of RIR.

Specific combining ability effects were also found to be highly significant in males, females as well as when sexes were combined. Meansquares of SCA are lower than those of GCA but higher than Reciprocal Effects. ALP x RIR cross had the highest SCA effects in males, females and sexes combined which was significantly higher (P ∠0.05) than the SCA effects of ALP x WPR and RIR x WPR.

The RE was found highly significant (P ∠0.01) in males and in sexes combined, but not in females. From the table of effects (Table 8), it can also be seen that ALP x WPR had the highest value in males, ALP x RIR had the highest value in females as well as sexes combined. But the differences were not statistically significant.

Feed Efficiency

The means, and mean comparisons of feed efficiency are presented in Table 9 and their analysis of variance in Table 10. The differences among the genetic groups were significant (P ∠0.05). WPR x WPR had the best feed efficiency of 3.19 followed by ALP x RIR registering a value of 3.29 and ALP x WPR with a value of 3.45, but their differences were non-significant. ALP x ALP had the least FE of 34.14.

Carcass traits at ten and twelve weeks

The means, standard error and mean comparisons of fasting shrinkage, per cent dressed yield, and per cent ready to cook yield at ten and 12 weeks of age are given in Tables 11 and 13 respectively. The mean squares of variance of the traits at ten and 12 weeks are presented in Tables 12 and 14 respectively.

Significant differences (P ∠0.05) were observed between genetic groups for fasting shrinkage at ten and 12 weeks of age. The value ranged from 3.8 per cent in WPR purebreds to 7.8 per cent in WPR x ALP at ten weeks and from 2.7 per cent in WPR purebreds to 5.0 per cent in WPR x ALP at 12 weeks of age. At both ages, WPR purebreds had the lowest per cent shrinkage. When ranked according to GCA, ALP was found best at ten weeks and RIR was best at 12 weeks.

Highly significant ($P < 0.01$) differences were observed for per cent dressed yield at ten weeks of age, but the differences were found non significant at 12 weeks of age. Dressing per cent was highest in WPR at both ages. It ranged from 79.6 in RIR x ALP to 85.2 in WPR purebreds at ten weeks and from 84.7 in WPR x ALP to 87.9 in WPR purebreds. WPR was followed by ALP purebreds with a mean value of 83.8 per cent at ten weeks and with a value of 86.1 at 12 weeks. Among crosses, ALP x RIR was best at tenth week having a mean value of 83.2 per cent and RIR x WPR at 12 weeks with a value of 86.1 per cent.

Per cent ready to cook yield differed significantly ($P < 0.01$) between genetic groups at ten weeks of age but at 12 weeks, the differences were found to be non significant. WPR purebreds had the highest yield at ten and 12 weeks with a value of 69.8 and 72.2 per cent respectively. The lowest yield was observed in RIR purebreds at ten weeks (64.6 per cent) and in WPR x ALP at 12 weeks (68.0 per cent). Among crosses ALP x WPR had the maximum value of 68.2 per cent at ten weeks and also at 12 weeks with a value of 70.4 per cent. GCA was highest for WPR at ten weeks followed by ALP and RIR. At 12 weeks also WPR had highest GCA, but the second best was RIR.

Table 1. Mean, standard error and GCA ranking of Hatch weight.

Breed of Sire	Breed of Dam ALP	RIR	WPR	GCA
ALP	37.8^{ab} ±0.5	35.2^{ab} ±0.72	38.3^{ab} ±0.86	36.68(2)
RIR	35.4^{ab} ±0.45	34.7^{b} ±0.48	36.7^{ab} ±0.90	35.17(3)
WPR	35.60^{ab} ±0.60	34.3^{b} ±0.67	39.10^{a} ±0.72	37.18(1)

The figures in brackets with GCA are ranks. Means with one superscript in common did not differ significantly ($P \angle 0.05$).

Table 2. Analysis of variance: hatch weight

Source	df	MSS
Crosses	8	58.52**
Replicates	1	5.33
Error	170	9.06

** Significant at $P < 0.01$

Table 3. Mean, standard error and GCA ranking of body weight at 10 weeks in ALP, RIR, WPR and their crosses.

	Breed of sire	Breed of Dam			GCA
		ALP	RIR	WPR	
MALES	ALP	789.5^{cd} ±21.81	869.5^{bc} ±22.63	1007.0^{b} ±25.28	859.35(2)
	RIR	826.1^{c} ±26.78	657.5^{d} ±40.49	903.5^{bc} ±30.98	795.60(3)
	WPR	874.5^{bc} ±14.60	859.5^{c} ±30.89	1162.2^{a} ±43.61	994.82(1)
FEMALES	ALP	604.4^{cd} ±15.24	702.5^{bc} ±20.36	754.5^{ab} ±29.35	686.53(2)
	RIR	649.1^{c} ±22.82	517.0^{d} ±28.71	676.5^{bc} ±43.53	620.35(3)
	WPR	804.3^{ab} ±14.37	660.0^{c} ±30.18	862.1^{a} ±46.10	769.92(1)
COMBINED SEX	ALP	701.8^{d} ±25.46	786.0^{bcd} ±24.22	880.8^{b} ±34.56	774.13(2)
	RIR	728.8^{d} ±26.36	587.3^{e} ±29.04	790.0^{bcd} ±36.80	706.63(3)
	WPR	845.6^{bc} ±13.30	759.8^{cd} ±31.07	1056.1^{a} ±47.05	898.07(1)

Note: The means with at least one superscript in common were not significantly ($P \angle 0.05$) different from each other. The figures in brackets in the column for GCA are ranks.

Table 4. Analysis of variance of body weight at ten weeks

Source	Males		Females		Combined sex	
	df	MSS	df	MSS	df	MSS
Crosses	8	221006.26**	8	91499.42**	8	328178.93**
Replicates	1	355.81	1	4366.78	1	7454.55
Interaction	8	10738.88	8	4456.07	8	220061.70
Error	73	9613.41	66	8688.78	157	8926.88

** Significant at P ∠0.01

Table 5. Analysis of variance of body weight at 10 and 12 weeks in ALP, RIR, WPR and their crosses.

Sources	10 weeks		12 weeks	
	df	MSS	df	MSS
Sexes	1	1,605,874.98**	1	1,517,564.16**
Crosses	8	292,246.53**	8	196,031.47**
Replicates	1	7454.55	1	113.63
Error	164	9488.65	79	15,071.98

** Significant at P ∠0.01

Table 6. Mean, standard error and GCA ranking of body weight at 12 weeks in ALP, RIR, WPR and their crosses (sexes combined).

Breed of sire	Breed of dam			GCA
	ALP	RIR	WPR	
ALP	882.5[b] ±47.60	941.5[b] ±43.01	1037.0[b] ±79.83	953.67(2)
RIR	936.0[b] ±56.68	696.0[c] ±48.93	937.0[b] ±74.24	858.0(3)
WPR	1042.5[b] ±21.82	941.5[b] ±44.24	1268.5[a] ±76.76	1082.5(1)

Means with one superscript in common did not differ significantly ($P \angle 0.05$). Figures in brackets with GCA are ranks.

Table 7. Analysis of variance of GCA, SCA and RE for body weight at ten weeks.

Source	Males		Females		Combined sex	
	df	MSS	df	MSS	df	MSS
GCA	2	63675.31**	2	33703.20**	2	56610.01**
SCA	3	7765.14**	3	5585.42**	3	6533.79**
RE	3	7125.27**	3	1867.95	3	3619.23**
Error	73	951.41	66	933.32	157	459.23

** Significant at P /0.01

Table 8. Estimates of effects of GCA, SCA and RE for body weight at ten weeks of age.

Breed of sire		Breed of Dam		
		ALP	RIR	WPR
ALP	M	-24.68^{b}	$+77.88^{a}$	-30.72^{bc}
	F	-5.74^{b}	$+61.19^{a}$	$+15.22^{ab}$
	S	-18.76^{b}	$+69.64^{a}$	-16.10^{bc}
RIR	M	-21.70^{a}	-88.43^{c}	-27.22^{c}
	F	-26.70^{a}	-71.92^{c}	-29.75^{b}
	S	-28.63^{a}	-86.39^{c}	-36.76^{c}
WPR	M	-66.25^{a}	-22.00^{a}	$+113.11^{a}$
	F	$+24.90^{a}$	-8.25^{a}	$+77.66^{a}$
	S	-17.58^{a}	-15.13^{a}	$+105.15^{a}$

Note: The diagonal sets of figures give the GCA effects. The sets of figures above diagonal are SCA effects. Those below diagonal are reciprocal effects. Figures with one common superscript in a trait and sex did not differ significantly.

M - Males. F-Females. S - Sexes combined.

Table 9. Feed efficiency at 10 weeks of age (sexes combined) in ALP, RIR, WPR and their crosses.

Breed of sire	Breed of dam			GCA
	ALP	RIR	WPR	
ALP	4.14^{b}	3.29^{a}	3.45^{a}	3.77(3)
RIR	3.80^{a}	3.63^{a}	3.54^{a}	3.61(2)
WPR	3.77^{a}	3.77^{a}	3.19^{a}	3.49(1)

Table 10. Analysis of variance of Feed efficiency at 10 weeks.

Source	df	MSS
Crosses	8	0.1686*
Replicates	1	0.006
Error	8	0.0451

* Significant at P ∠0.05

Table 11. Mean per cent carcass yields at 10 weeks of age (sexes combined) in ALP, RIR, WPR and their crosses.

Characteristics	Breed of sire	Breed of dam			GCA
		ALP	RIR	WPR	
Fasting Shrinkage	ALP	4.4^{a}	5.4^{ab}	6.6^{bc}	5.32(1)
	RIR	7.7^{c}	4.4^{a}	7.7^{c}	6.15(2)
	WPR	7.8^{c}	7.3^{c}	3.8^{a}	6.17(3)
Per cent dressed yield	ALP	83.8^{ab}	83.2^{ab}	82.4^{abc}	82.15(3)
	RIR	79.6^{c}	84.7^{a}	81.5^{bc}	82.68(2)
	WPR	80.1^{c}	82.4^{abc}	85.2^{a}	82.80(1)
Per cent Ready to cook yield	ALP	67.0^{abc}	66.3^{bc}	68.2^{ab}	66.67(2)
	RIR	65.2^{bc}	64.6^{c}	65.6^{bc}	65.58(3)
	WPR	66.3^{bc}	67.2^{abc}	69.8^{a}	67.82(1)

Note: Means with one common superscript within a character differ significantly (P ∠0.05). Figures in brackets with GCA are ranks.

Table 12. Analysis of variance of carcass yield at ten weeks.

Source	df	Fasting Shrinkage MSS	Dressed yield MSS	Ready to cook yield MSS
Crosses	8	24.27**	34.18**	24.42**
Replicates	1	0.15	1.48	0.40
Error	76	1.60	5.25	4.73

** Significant at P ∠0.01

Table 13. Mean carcass yields (per cent) at twelve weeks of age inALP, RIR, WPR and their crosses.

Character	Breed of sire	Breed of dam			GCA
		ALP	RIR	WPR	
Fasting Shrinkage	ALP	2.7^{a}	2.1^{a}	3.0^{a}	3.14(2)
	RIR	3.3^{a}	3.0^{a}	3.2^{a}	3.02(1)
	WPR	5.0^{b}	3.5^{a}	2.7^{a}	3.35(3)
Dressed yield	ALP	86.1^{a}	85.8^{a}	85.7^{a}	85.68(3)
	RIR	85.7^{a}	87.0^{a}	86.1^{a}	86.15(2)
	WPR	84.7^{a}	85.3^{a}	87.9^{a}	86.27(1)
Ready to cook yield	ALP	69.0^{a}	69.6^{a}	70.4^{a}	69.23(3)
	RIR	69.4^{a}	69.1^{a}	70.0^{a}	69.58(2)
	WPR	68.0^{a}	70.3^{a}	72.2^{a}	70.52(1)

Means with one superscript in common did not differ significantly ($P < 0.05$). Figures in brackets with GCA are ranks.

Table 14. Analysis of variance of carcass yield at twelve weeks.

Source	df	Fasting shrinkage	Dressed yield	Ready to cook yield
Crosses	8	5.57*	8.11	12.70
Replicates	1	0.55	0.42	0.01
Error	78	1.52	4.09	8.98

* Significant at $P \angle 0.05$

DISCUSSION

DISCUSSION

Hatch Weight

A perusal of the results presented in Table 1 and 2 pertaining to hatch weight would indicate that the differences observed among the genetic groups were significant ($P < 0.01$). This observation is in close agreement with those of Sapra <u>et</u> <u>al</u>.(1972) who opined that the differences between genetic groups were significant for day old weight when a 3 x 3 diallel cross making use of three broiler breeds was conducted. Among the genetic groups, White Plymouth Rock (WPR) purebreds had a hatch weight of 39.1 g. It was significantly higher than RIR purebreds and WPR x RIR. However, genetic groups other than WPR did not differ significantly among themselves. The lowest hatch weight of 34.3 g was recorded in WPR x RIR. It was also observed that WPR had the maximum GCA followed by Australorps (ALP) and RIR. A hatch weight of 39.5 g was reported by Halaj and Uhrin (1969) in WPR. In RIR purebreds, a day old weight of 35.6 g was reported by Chhabra and Sapra (1973). Hatch weight of chicks making use of females of WPR and RIR with males of Cornish breed obtained by Litko (1969) (36.0, 34.5 g respectively) are comparable with the hatch weights of crosses involving WPR and RIR in the present study.

Variation due to GCA for hatch weight has been reported by Khar et al. (1976). The significant differences observed among the genetic groups for this trait in this study might have also been due to GCA. However, the effects of SCA and reciprocal effects cannot be ruled out. It was also observed that WPR topped in GCA ranking and RIR had the lowest rank.

Body Weight

Among the nine genetic groups studied, WPR purebreds had the maximum body weight at ten weeks sexwise as well as sexes combined. The males, females and sexes combined registered a body weight of 1162.2±43.61 g, 862.1±46.1 g and 1056.1±45.1 g respectively among the WPR purebreds. It can also be observed that better body weights were recorded, in general, when WPR was used as one of the parents. None of the crossbreds excelled the performance of WPR purebreds. However crosses of RIR and ALP performed better than their parental purebreds. ALP x RIR cross registered a better body weight (869.5±22.63 g) than their reciprocal (826.1±26.78) in males at ten weeks of age. This observation holds good in respect of females and for sexes combined of the same cross.

In the present study, none of the crosses excelled the performances of WPR purebreds. This must be due to the fact that no selection was carried out in ALP as well as in RIR for body weight. However, selection was being carried out in WPR for broiler traits. Nordskog and Ghostley (1954) had however opined that growth to eight weeks of age appeared to be the consistent expression of hybrid vigour. They also opined that strain crosses and crossbreds averaged four per cent and seven per cent heavier than parents at this age. When the mean weight of six crossbred combinations (sexes combined) were compared with the mean of the three parental breeds, it was observed that crossbreds were 2.1 per cent heavier than the purebreds. In the present study, crosses of RIR and ALP performed better than their parental purebreds. ALP x RIR was found better than its reciprocal (869.5 and 826.1 g). On further analysis, it was also found that the crosses involving ALP and RIR weighed 19.1 per cent heavier than the parental means. The performance was better when ALP was taken as the male parent compared to the reciprocal cross. These observations are in agreement with those of Aggarwal et al. (1978) who reported varying degrees of heterosis for different crosses. The positive estimates at 10 and 12 weeks of age indicated superiority of crossbreds over purebreds in ALP and RIR.

Combining Ability

The mean squares of General Combining Ability (GCA), Specific Combining Ability (SCA) and Reciprocal effects (RE) for body weight at ten weeks of age are presented in Table 7. It was observed that the GCA, SCA and RE were significantly different ($P < 0.01$) in the three breeds among males and also when sexes were combined. However, it was revealed that in females, only GCA and SCA were significantly different ($P < 0.01$) but not RE. Significant differences in GCA among 3 broiler strains were reported by Patro _et al._ (1975) in males. Ramappa and Dev Gowda (1973) also reported a significant difference in GCA in females. The significant differences for SCA effects observed in this study for both sexes are in agreement with those reported by Patro _et al._ (1975), in their study making use of White Cornish, White Rock and New Hampshire in a 3 x 3 diallel study. Yao (1959) and Kan _et al._ (1959) also had demonstrated the importance of SCA for broiler weight.

Highly significant SCA effects obtained in the study for 10th week body weight along with their significant reciprocal effects indicated that both SCA and RE were of considerable importance for this trait. The existence of reciprocal effects for broiler weights were amply demonstrated by Nordskog (1956), Coleman (1958) and Hill (1959). However, Eisen et al.(1967) have failed to demonstrate a significant RE for body weight. The RE at 12 weeks of age could not be worked out since simultaneous slaughter studies were also started from 10th week. Therefore, it could not be assessed whether the RE showed any decline towards 12th week.

The analysis of variance table indicated that the mean squares obtained for GCA were largest suggesting that the additive genetic variance is more important. This observation is in line with those of Hoffman (1943) who reported that the rate of growth of White Rock was as good as those of White Rock x White Cornish. Similarly, Kan et al.(1959), Dev and Singh (1970) also observed that the non-additive gene effects are of little importance as far as body weight was concerned. However in the present study, SCA was also found significant, indicating that the non-additive genes also play a part as far as this trait is concerned. Similar observations are not uncommon in literature (Hill and Nordskog, 1958; Kaushal et al., 1973). Moav (1966) reported that though the heritability for broiler weights are not low, crossing different strains exhibited some gain over purebreeding suggesting that the non-additive genetic variance also play a part in this trait.

Similarly, Patro et al.(1975) also reported that the SCA was significantly more in New Hampshire x White Rock than in White Cornish x White Rock. In the present study, it was found that SCA was highest in ALP x RIR (Males, females and sexes combined). SCA was also observed in ALP x WPR females.

The reciprocal effects studied was found to be highly significant in males and in sexes combined but not in females. It was further observed that ALP x WPR combination had the highest value. It was however found that the differences were not statistically significant. The existence of reciprocal cross differences for broiler weights was demonstrated by Nordskog (1956) Coleman (1958) and Hill (1959). However, Eisen et al.(1967) failed to demonstrate a significant reciprocal effect for body weight. The reciprocal effects were estimated only at the 10th week of age since from 10th week onwards, slaughter studies were also started. So it could not be assessed whether RE decreased at 12 weeks of age.

Feed Efficiency

A perusal of results pertaining to Feed Efficiency (FE) (Table No.9) indicated that the purebred groups had a mean FE of 3.65 as against 3.60 for the crossbred groups. Such refinements in FE have been reported by Ramappa et al. (1977).

Among the purebred combinations, WPR registered the best FE of 3.19 followed by 3.63 of RIR and 4.14 of ALP. Among the crossbreds, ALP x RIR groups registered the best efficiency of 3.29 whereas its reciprocals registered only 3.80 which was the least efficient group among crosses. ALP x WPR, RIR x WPR, WPR x ALP and WPR x RIR recorded FE of 3.45, 3.54, 3.77 and 3.77 respectively. On statistical analysis, it was further observed that this feed efficiency of ALP purebreds (4.14) differed significantly ($P < 0.05$) from the rest of the genetic groups. The FE registered by other genetic groups did not differ significantly among themselves. The feed efficiency of ALP x ALP, ALP x WPR, WPR x ALP and WPR x WPR observed in the present study is comparable to those reported by Ramappa <u>et al.</u> (1977) for the genetic combinations. Prasad <u>et al.</u> (1978) reported a feed efficiency of 4.2 for WPR purebreds. The better FE of 3.19 obtained in the present study might be due to the selection practiced in this strain of WPR for body weight. In commercial broilers, a feed efficiency of 3.76 and 3.2 has been reported by Radhamma <u>et al.</u>(1978) and Elizabeth <u>et al.</u>(1978) respectively.

However, there is immense scope for improvement in feed efficiency in both purebreds and crossbreds. Considering the fact that no selection was practised for 10th week body weight in Australorps and Rhode Island Reds, the feed efficiency registered in the present study were satisfactory. Selection for 10th week body weight in these breeds in itself, will improve feed efficiency and such a selection procedure is a must if these two breeds are to be used for evolving crossbred broilers.

Carcass Traits

A perusal of the results pertaining to carcass traits in Table 11 indicated that genetic groups sired by ALP had a mean per cent shrinkage of 5.32. The next in order was the group sired by RIR which registered a mean fasting shrinkage of 6.15 per cent. The maximum fasting shrinkage was observed for the group sired by WPR (6.17). However, it is to be pointed out that the WPR purebreds had the least value of 3.8 per cent. Prabhakaran and Ranganathan (1971) reported a fasting shrinkage of 6.08 and 5.04 per cent in White Rock at 12 weeks of age. A slightly lower value observed in the present study for WPR purebreds might possibly be due to the reduced fasting time of 12 hours employed in the present study as against 16 hours employed by the above workers. Ranganathan and Arumughan (1967) reported a fasting shrinkage of 7.5 per cent in RIR as against 4.4 per cent obtained in the present study. The difference obtained may be due to the varying fasting time employed (12 hours in the present study Vs. 18 hours). All the genetic groups registered a decreased fasting shrinkage at 12th week (Table 13) compared to 10th week.

The differences observed among the genetic groups with regard to dressed yield was statistically significant. Among the purebreds, WPR registered the maximum dressed yield of 85.2 per cent which is comparable to that of RIR which registered a dressed yield of 84.7 per cent. Among the crossbred groups, ALP x RIR registered a dressed yield of 83.2 per cent which was the maximum. The least dressed yield of 79.6 per cent was recorded by RIR x ALP group. In the order of GCA ranking, WPR was best at 10 and 12 weeks of age followed by RIR and ALP. A dressed yield of 79.4 per cent was reported by Sharma et al.(1971) as against 87.0 per cent in the present study in RIR at 12 weeks of age. The differences might be due to strain differences. Strain differences in dressing yield were also reported by Kosalaraman and Ulaganathan (1975). In general, the genetic groups compared a higher dressed yield at 12 weeks of age compared to 10th week. Similar observations have been made by Kosalaraman and Ulaganathan (1975). However, the differences in dressed yield at 12 weeks of age did not differ significantly.

Among the genetic groups studied, the WPR purebred combination recorded 69.8 per cent Ready to Cook yield which was the maximum observed in the study at 10 weeks. It was also observed that the WPR had the first ranking in GCA for this trait. Next to WPR, ALP purebreds recorded 67 per cent ready to cook yield, and ALP has the second place in GCA ranking. The least value was observed for the RIR purebreds. The differences observed among genetic groups were found to be significant (P $\angle$0.05) at ten weeks of age. Strain and breed differences in eviscerated weight have been reported by Jaap et al.(1950), Mahadevan and Bose (1951) and Kosalaraman and Ulaganathan (1975). Elizabeth et al.(1978) reported a ready to cook yield of 71.62 per cent in commercial broilers. Among the genetic groups studied, only WPR registered a ready to cook yield of 69.8 which is comparable with that in commercial broilers. At 12 weeks of age, all the groups in general, registered a higher ready to cook yield. However, the differences were not statistically significant. Hafez (1955) reported a rapid increase in dressing percentage from one week to four months of age in Fayoumi breed. Kosalaraman and Ulaganathan (1975) reported a better eviscerated yield at 12 weeks of age than at ten weeks. From the data of a diallel cross with broiler strains, Ulaganathan (1979) estimated the genetic variability for eviscerated yield as a percent of live weight which was found to be small.

The observation that WPR purebreds showed a hatch weight of 39.1 g which was significantly ($P \angle 0.05$) higher than that of RIR purebreds and WPR x RIR, when considered in conjunction with the results pertaining to the tenth week body weight clearly suggest that among the genetic groups studied, WPR is the best for broiler production programme. The observation that WPR registered a body weight of 1056.1±45.1 g (sexes combined) at ten weeks of age with a feed efficiency of 3.19 would support the above contention. The results of the slaughter study also support the above conclusion (WPR yielded the maximum dressed yield of 85.2 per cent and ready to cook yield of 69.8 per cent). It was also found that GCA variance is important for tenth week body weight in WPR which suggest that further refinement in body weight could be achieved through purebred selection schemes.

The significant differences for SCA variance observed in the study when considered in the light of the observation that the crosses of ALP and RIR weighed 19.1 per cent heavier than their parental means indicate that if RIR and ALP are to be used for evolving crosses for meat purposes, a further refinement in these breeds is needed which is possible only through crossbred selection schemes, since the non-additive genes appear to be important in these stocks for body weight at tenth week of age. The present strains of RIR and ALP are not suitable for production of broiler chicks.

From the results on the performance of the different crosses studied, it can be concluded that with the present strains, crossbreeding is not beneficial since their performance were not satisfactory for the traits studied. The WPR breed has to be further improved so that it will meet the market requirements.

SUMMARY

SUMMARY

An experiment was conducted to compare Australorp (ALP), Rhode Island Red (RIR) and White Plymouth Rock breeds of chicken and their crosses for broiler production. The results of the study are detailed in this thesis.

All the possible combinations of the three breeds were taken, thus making nine genetic groups - three purebreds and six crossbreds. There were twenty chicks for each genetic group which were divided into two replicates of ten each thus making a total of 180 chicks. They were raised on deep litter from day old to twelve weeks of age under identical conditions of management.

Body weight was recorded at ten weeks of age and the General Combining Ability (GCA), Specific Combining Ability (SCA) and Reciprocal effects (RE) were calculated for body weight at that age. Feed efficiency at 10 weeks of age was calculated. Body weight at twelve weeks were also recorded. Slaughter dstudies were conducted at ten and twelve weeks of age.

The following results were obtained:

1. Among the nine genetic groups studied, WPR purebreds showed the best body weight at ten and twelve weeks of age - 1056.1 and 1268.5 g (sexes combined). All

the crossbreds weighed significantly lower than WPR purebreds. RIR purebreds showed the lowest body weight at both ages - 587.3 and 696.0 g (sexes combined). In GCA ranking also WPR was the best, followed by ALP and RIR.

2. Crosses of RIR and ALP had better body weight than their parents. The crosses were 19.1 per cent heavier compared to the parental mean. The crosses of ALP and WPR were heavier than ALP, but not than that of WPR.

3. GCA variance was significant for tenth week body weight in males, females and sexes combined. Maximum GCA effect was observed in WPR which was significantly higher than ALP and RIR. SCA variance was also significant in males, females and combined sex. SCA effect was significantly higher in ALP x RIR cross. RE was significant in males and combined sex, but not in females. RE was highest in males of ALP x WPR cross and in females and combined sexes of RIR x ALP cross.

4. Feed efficiency (FE) was the best for WPR purebreds (3.19). This was followed by ALP x RIR with an FE of 3.29. ALP purebreds were least efficient, FE being 4.14. The crossbred groups in general exhibited positive heterosis for FE.

5. Slaughter studies revealed that WPR purebreds had the least fasting shrinkage and highest dressed and ready to cook yield (3.8 per cent, 85.2 per cent and 69.8 per cent respectively at ten weeks). Highest fasting shrinkage was shown by WPR x ALP group (7.8 per cent) and ready to cook yield was lowest for RIR purebreds (64.6 per cent).

The results of the present study tend to suggest that, among the three breeds studied, WPR was the best breed suited for broiler production. The present strains of ALP and RIR breeds are not beneficial for production of broiler chicks, since the performance of the purebreds, the crosses between them and also their cross with WPR were not satisfactory for the traits studied.

The statistically significant GCA effect observed for tenth week body weight in WPR indicate that purebred selection schemes could be used for further refinement in body weight in WPR. The significant SCA effect for tenth week body weight observed in ALP and RIR suggest the use of crossbred selection schemes for improving body weights in these two breeds.

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ABSTRACT

PERFORMANCE OF CERTAIN PUREBREDS AND CROSSBREDS FOR BROILER TRAITS

BY

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ABSTRACT OF A THESIS

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ABSTRACT

An experiment was conducted to compare Australorps, (ALP), Rhode Island Red (RIR) and White Plymouth Rock (WPR) breeds of chicken and their crosses for broiler production. All the nine possible combinations of these breeds were taken, the genetic groups being three purebreds and six crossbreds. There were twenty chicks for each group and a total of 180 chicks. They were raised upto twelve weeks of age on deep litter under identical conditions of management. Body weight was recorded at ten and twelve weeks of age. Feed efficiency and genetic effects - General Combining Ability, Specific combining ability and Reciprocal effects on body weight - were also calculated at ten weeks of age. Slaughter studies were conducted at ten and twelve weeks of age.

The results of the study tend to suggest that among the three breeds studied, WPR was the best for broiler production. The other two breeds, ALP and RIR are not beneficial for broiler production since the performance of those breeds, the crosses between them and also their crosses with WPR were not satisfactory for the traits studied.

The statistically significant GCA effect for tenth week body weight observed in WPR indicate that purebred selection schemes could be used for further refinement in body weight in WPR. The significant SCA effect observed for tenth week body weight in ALP and RIR suggest the use of crossbred selection schemes for improving body weights in these two breeds.