A Study on Mortality Pattern in Chicken

कुक्कुट के मृत्यु स्वरूप पर एक अध्ययन

Bhanu Pratap Singh

Thesis

Doctor of Philosophy in Agriculture

(Animal Production)

2001

Department of Animal Production
Rajasthan College of Agriculture
Udaipur

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MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY, UDAIPUR

RAJASTHAN COLLEGE OF AGRICULTURE, UDAIPUR

CERTIFICATE-I

Dated : 30.1.2001

This is to certify that this thesis entitled "**A Study on Mortality Pattern in Chicken**" submitted for the degree of **Doctor of Philosophy** in Agriculture in the subject of **Animal Production** embodies bonafide research work carried out by **Mr. Bhanu Pratap Singh** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of the thesis was also approved by the advisory committee on 25/01/2001.

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Dated : 17/05/2001

This is to certify that this thesis entitled "**A Study on Mortality Pattern in Chicken**" submitted by **Mr. Bhanu Pratap Singh** to the Maharana Pratap University of Agriculture & Technology, Udaipur in fulfillment of the requirements for the degree of **Doctor of Philosophy** in the subject of **Animal Production** was after recommendation by the external examiner defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination was satisfactory, we therefore, recommended that the thesis be approved.

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This is to certify that **Mr. Bhanu Pratap Singh** student of Ph.D. in the Department of Animal Production, has made all corrections/modifications in the thesis entitled "**A Study on Mortality Pattern in Chicken**", which were suggested by the external examiner and the advisory committee in the oral examination held on 17-05-2001. The final copies of the thesis duly bound and corrected were submitted on 24-05-2001

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(B.P. Singh)

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1. Introduction

Livestock sector plays an important role in Indian Economy. Besides being an integral part of day to day lives, their contribution to the national income is valuable. Whereas, 36.88% of the total national income is derived from agricultural sector, the contribution of livestock sector is 26.7 per cent of the agricultural sector. About two third of cultivable land in India is rainfed which is governed by vagaries of monsoon making Indian agriculture unstable. It is animal agriculture that gives stability to agriculture by subsidizing the income of farmers.

Among the many livestock vocations to choose from, poultry has perhaps attracted more attention due to minimum demand in terms of investment like land, skills and resources. Poultry thrives well under wide range of agroclimatic conditions and can successfully be raised if certain minimum management and nutritional regimes are provided. They are efficient biological converters of feed into animal protein of high biological value. It is well established fact that of the total protein requirement about one third should be from animal origin and that both poultry eggs and meat are good source of animal protein for human beings.

Till 1960, poultry keeping in India was largely a backyard venture and not much attention was paid to breeding, feeding, management and disease for commercial poultry production. Now the scenario has changed and poultry in India has been recognized by government as well as financial institutions as having enough employment potential. From a backyard venture this has now been accepted as a full time occupation by rural as well as educated masses in urban areas.

The production of eggs which was only 60-80 per deshi bird per year has now reached a level of 290 for improved laying hybrids. The broiler chick, which earlier attained 1 kg live weight in 8 weeks period has now reached the stage of 1 kg per bird by 5 weeks age. The broiler farming especially has grown by leaps and bounds in the recent past. Among all the sectors of meat production, per cent increase in the broiler meat was highest in our country.

India is the fourth largest producer of eggs and eighth largest producer of broiler in the world with an annual output of 30,000 million eggs and 1,000 million broilers which yield 5 lakh tonnes of poultry meat. The poultry sector provides employment to almost 100 million people (India Agriculture, 1999). The growth rate in egg production at 10 per cent and in broiler production at 20 per cent has been registered during the last decade in the country (Anonymous, 1996).

Due to increasing human population, the demand for poultry meat and egg warrants that Indian Poultry industry has still to go a long way to fulfil the bare minimum requirement of poultry meat and eggs. To achieve this goal poultry is to be exploited for more and more production and it is to be expanded further to a very large scale. This high production itself is an important stress factor, which enhances the risk of the occurrence of disease/ diseases in the flock. The high mortality rate among poultry results in heavy economic losses to poultry industry, and it is the biggest problem besetting poultry development in India. Moreover, the success of the poultry breeding projects also depends on simultaneous poultry diseases control programme. No attempt has ever been made to analyse in detail the data on poultry diseases prevalent in the state of Rajasthan. While in advanced countries such information are routinely collected, analysed and published. Information on effect of genetic groups, season, age, sex, egg weight and age of parent on mortality pattern and prevalence of

disease in the country is scanty. Keeping this in view the present study was planned with the following objectives :

1. To study the effect of genetic groups on mortality in chicken.
2. To study the effect of non-genetic factors like season, age, sex, egg weight and age of parent on mortality in chicken.
3. To study the mortality pattern due to various diseases/ causes in chicken.
4. To find out the effect of genetic group, age and season on the prevalence of various diseases.
5. To estimate the association between meteorological parameters and mortality in chicken.

2. Review of Literature

Mortality pattern in chicken depends on several factors. Amongst these genetic groups, season, age, sex, egg weight, age of parent are some of the important factors affecting mortality. A study on effect of these factors on the incidence of various diseases as well as the pattern of mortality will help to take appropriate managerial measures to reduce mortality in chicken.

2.1 EFFECT OF GENETIC GROUP :

Watts and Rac (1958) reported 10.6, 6.8, 4.4 and 3.9 per cent mortality in Australorp, WLH, Crossbred and RIR breeds respectively with an overall mortality of 7.2 per cent. The mortality up to 10 days age due to Omphalitis, unabsorbed yolk, Pneumonia, Uricaemia and Pullorum, respectiv ly was 43.1, 33.8, 7.8, 1.0 and 0.67 per cent in Australorp, 62.6, 31.2, 3.3, 1.8 and 1.2 per cent in WLH, 51.7, 25.9, 8.3, 11.9 and 3.5 per cent in Crossbred and 49.4, 24.7, 13.6, 6.8 and 5.6 per cent in RIR.

Aggarwal and Sapra (1971) studied the effect of age and breed on 5628 WLH, Deshi and their cross-bred chicks and 2908 RIR, Deshi and their cross-bred chicks. The average per cent mortality in WLH, RIR, Deshi and their reciprocal crosses during different ages are given in Table 2.1. Mortality upto 12 weeks age was 21.13 per cent in WLH, 27.88 per cent in RIR, 34.38 – 39.5 per cent in Deshi and 24.89 – 40.33 per cent in 2-way crosses.

Table 2.1 : Average per cent mortality in WLH, RIR, *desi* and their reciprocal crosses during different ages

Breed/breed cross	0-1 week	1-4 weeks	4-8 weeks	8-12 weeks	Overall mortality* 0-12 weeks
WLH x WLH (1,804)	8.71a	9.45a	1.69a	2.97a	21.13
WLH x desi (1,059)	17.46b	15.13b	2.02a	4.10a	40.33
Desi x WLH (1,718)	10.15a	11.78a	1.92a	3.93a	24.89
Desi x desi (1,047)	10.70b	12.75b	2.07a	1.65b	34.38
RIR x RIR (890)	15.39a	9.76b	4.19a	2.24a	27.98
RIR x desi (599)	14.07a	10.61c	7.17b	3.27a	33.89
Desi x RIR (815)	10.95b	7.46a	4.75b	2.65a	29.08
Desi x desi (604)	20.10c	8.78a	7.45b	5.80b	39.50

Figures within parentheses are the number of chicks hatched

$$\text{* Overall mortality} = \frac{\text{Total chicks died during 12 weeks}}{\text{Total chicks hatched}} \times 100$$

Figures marked by same letters in a column do not differ significantly at 5 per cent level of probability

Figures scored by a line in a row do not differ significantly at 5 per cent level of probability

Jackson *et al.* (1972) concluded a total mortality and serological survey of nine batches of broilers chicks of four broiler farms. They reported that of 69,088 broiler chicken observed from day-old to processing age, 2890 (4.16%) died. The mortality in individual batches varied from 1.18 to 6.40 per cent. Jagadeesh Babu (1974) studied the mortality pattern among poultry in Banglore area using data of three different sources, namely S_1, S_2 and S_3 layer flock, broiler flock and mixed respectively. The detailed results are shown in Table 2.2 which shows that coccdiosis was the major disease in purebred chicken.

Table 2.2 : Source-wise, breed-wise and disease wise distribution of mortality

	Source															
	S1		S2						S3							
	CHL	%	WLH	WC	AL	NH	Total	%	WLH	WR	WC	AL	NH	RIR	Total	%
Lymphoid loucosis	146	39.25	25	16	9	23	73	23.70	36	7	7	9	3	25	87	23.97
Marek's disease	68	18.28	32	10	15	28	85	27.60	38	4	8	5	7	30	92	25.93
Coccidiosis	42	11.29	48	37	23	19	127	41.23	39	23	19	5	9	10	105	28.93
Miscellaneous groups of diseases	116	31.18	13	-	1	9	23	7.47	16	34	1	1	9	18	79	21.70
Total	372	100.00	118	63	48	79	308	100.00	129	68	35	20	28	83	363	100.00

CHL – Commercial strain of hybrid layer,
WLH – White Leghorn,
WC – White Cornish,
AL – Australorp,
NH – New Hampshire,
RIR – Rhode Island Red,
WR – White Rock

Mohan *et al.* (1978) studied the incidence of chicks mortality in four different strains of WLH. The total number of chicks died between 0-8 weeks of age in four different strains of WLH were 696. The per cent mortality encountered under each strains and pooled over strains age wise and disease wise are shown in Table 2.3 and 2.4 respectively.

Table 2.3 : Week-wise incidence of per cent mortality for various strains

Weeks	Strain of WLH				
	L_{33}	L_{55}	L_{77}	L_{99}	Pooled
1st	0.93	0.93	1.29	0.76	0.98
2nd	0.85	1.15	1.14	1.40	1.12
3rd	1.19	2.50	0.98	0.39	1.38
4th	0.53	1.59	0.41	0.32	0.78
5th	0.68	1.62	1.22	2.41	1.43
6th	2.43	1.37	1.36	1.20	1.63
7th	0.80	1.34	0.90	1.08	1.04
8th	1.00	0.28	1.57	0.69	0.86
0-8 weeks	8.12	10.30	8.53	7.98	8.84

Table 2.4 : Strain-wise per cent mortality for various diseases

Disease	Strain of WLH				
	L_{33}	L_{55}	L_{77}	L_{99}	Pooled
Omphalitis	10.91	11.88	10.52	2.38	9.62
Ascites	9.19	9.01	13.81	9.52	10.20
Coccidiosis	25.28	22.95	25.31	34.92	25.13
Nephrosis	10.91	6.14	9.21	1.58	7.18
Enteritis	5.74	6.95	0.65	13.17	4.59
Hepatitis	1.14	2.45	0.00	3.96	1.86
Air sacculitis	0.00	14.09	1.97	0.00	1.86
Pneumonia	3.44	43.27	0.00	2.38	2.44
Avitaminosis A	14.02	10.81	3.28	3.95	2.72
Miscellaneous	29.31	32.37	34.21	38.09	33.04

Coccidiosis was the main cause of death followed by Ascites, Omphalites and Nephrosis. The mortality between 0-8 weeks ranged between 7.98 to 10.30 per cent in four strains of WLH. Further they also observed that the differences for periods within each strains separately and pooled over strains were non-significant. The various strains differed significantly only for the occurrence of omphalitis and air sacculitis, however, the incidence of mortality due to omphalitis, Ascites and Coccidiosis varied significantly from period to period.

Srinivasan *et al.* (1980) studied the mortality losses in Turkeys, during the period 1972-77 at the Haryana Agricultural University Farm and observed that the death rate in Turkey ranged from 5.30% to 32.22%. The mortality in Broad Breasted Bronze Turkey in most of the years, was higher than the Beltsville Turkey.

Hafez (1997) observed that the mortality rates varies according to the chicken lines between 0.3 and 28.8%. Rodriguez *et al.* (1997) found significant effect of genotype on mortality in chicken.

2.2 EFFECT OF SEASON/ MONTHS :

Viraraghavan and Nair (1965) observed significant influence of season on the incidence of ALC. The incidence of ALC was greatest in North-East monsoon period. The incidence in the cold season (October, December) were nearly equal. The incidence was lowest in hot season (March, April).

Hall *et al.* (1974) studied the effect of season on various poultry diseases. It was observed that incidence of Air-Sac disease was higher in January to March, coccidiosis in April to June followed by July to September.

Chatterjee (1980) reported the result of investigation of disease problem in about 1000 Poultry Farms in and around Calcutta. It was observed that the prevalence of various diseases in different months of the year was Ranikhet disease during April, May, June and August; Fowl Pox in September; ALC in October; Fowl Cholera in October; Pseudomoniasis during January February, July, August and September and Intestinal Coccidiosis from March to September.

Hartmann *et al.* (1980) studied the incidence of mortality in three Leghorn lines and their crosses reared in cold and normal environment. The mortality due to Marek's disease differed in different genotypes only in cold environment which indicated the existence of an interaction between genotype and season.

Thakur *et al.* (1981) observed that Brooder Pneumonia was not very common in summer season. This was more frequently noted in winter affecting mostly the young chicks.

Suneja *et al.* (1985b) studied the mortality pattern in Turkeys, the higher mortality ranging from 25.31 to 45.23 per cent occurred during the period from February to May (except March) in pullet of 0-1 weeks

age. The mortality was higher in birds of 1-6 weeks than 0-1 weeks age group during the above months. The per cent mortality in birds of 6-12 weeks ranged from 0.00 to 17.70 and higher in the month of June, July and January. Highest mortality in 12-18 weeks age turkeys was also observed in June. Non-significant effect of month of hatching on per cent mortality was in evidence during 18-24 weeks of age. However, in adults highest mortality 8.29% was recorded in the month of June which differed significantly from that in all the other months.

Sharma and Kaushik (1986) analysed the autopsy reports of 14564 broilers for 5 years. They reported that coliform infection contributed to maximum mortality (80.75%). It was 42.64% during winter, 15.61% in summer and 2.5% during rainy season. CRD caused 15.48% of the total mortality, including 6.48% during rainy season, 6.04% in winter and 2.95% in summer season. Ranikhet disease accounted for major 62.77% of the total mortality caused due to various viral diseases resulting in 23.91%, 22.30 and 16.76% mortality during winter, summer and rainy season respectively. Marek's disease was second important viral disease. It contributed 22.74% to the total mortality of which 11.95% in rainy season, 6.41% in winter and 4.37% in summer.

2.3 EFFECT OF AGE :

Coles (1955) observed that mortality due to Fowl Paralysis and Leucosis was more during the adult period (20-78 weeks old) than during rearing period (0-20 weeks old).

Jordan (1956) found that neural Lymphomatosis prevailed chiefly at 4-6 months of age and that over 50% of the birds with visceral Lymphomatosis died at 6-12 months of age.

Viraraghvan and Nair (1965) studied 110 cases of ALC whose age was known. The youngest chick affected was 15 weeks old and the oldest, 208 weeks. Birds with Erythroblastosis were youngest, their average age being 35.8 weeks. Next in frequency were those with neural Lymphomatosis, visceral Lymphomatosis and Orteoketrosis, their average ages being 44.8, 48.8 weeks and 56.5 weeks respectively.

Gordon (1966) reported the highest mortality in 0-4 weeks age group and lowest in adult broiler due to bacterial diseases. Aspergillosis occounted only 0.24% of the total mortality in 6-10 weeks old broilers.

Aggarwal and Sapra (1971) studied the mortality at different ages in White Leghorn, Rhode Island Red, Deshi and their reciprocal crosses. It was found that the per cent mortality decreased with increase in age in almost all the genetic groups. Babu *et al.* (1974) reported that the mortality commenced at a high level of 7% frequency before the 5th week and recorded a peak of 20% in the age group of 10-15 weeks. There was a fall in mortality between 20-25 weeks i.e. from 20% to 11% but again recorded second peak of 13% in 25-30 weeks. From 31 weeks onwards the frequency came down to 8% and thereafter it steadily declined approaching zero.

Damodaran and Thanikachalam (1974) studied the occurrence of mortality in different ages in fowls. They found that the mortality rate was 4.6 per cent during first week of life, 73.9 per cent at 1 to 12 weeks, 6.6 per cent at 12-20 weeks and 14.91 per cent over 20 weeks of age.

Mohan *et al.* (1978) analysed the data on mortality from 0-8 weeks in four WLH strains, the results are shown in Table 2.5.

Table 2.5 : Showing week-wise mortality for various diseases encountered in percentage (pooled-over strains)

Diseases	Age in weeks							
	1	2	3	4	5	6	7	8
Omphalitis	38.80	35.82	70.89	2.98	0.00	0.00	1.49	0.00
Ascites	11.26	25.35	25.35	11.26	7.04	16.90	0.00	2.81
Coccidiosis	0.54	1.63	2.17	8.69	20.10	23.36	26.08	17.39
Nephrosis	0.00	16.00	42.00	8.00	8.00	8.00	8.00	10.00
Enteritis	9.37	0.00	15.62	6.25	28.12	4.37	3.12	3.12
Hepatitis	0.00	7.69	7.69	0.00	15.38	30.76	0.00	38.46
Air sacculitis	0.00	0.00	7.69	7.69	53.84	30.76	0.00	0.00
Pneumonia	5.88	0.00	11.76	11.76	11.76	41.17	11.76	5.88
Avitaminosis A	5.26	10.52	0.00	0.00	36.84	21.05	5.26	21.05
Miscellaneous	26.08	13.47	17.39	10.43	15.21	13.91	8.26	5.21

The maximum mortality due to Ascites was observed between 2nd and 3rd week, but the mortality neverthless occurred every week up to 8 weeks of age. However, Omphalitis was found to occur at its maximum only in the age group of 0-4 weeks. The incidence of Nephrosis was seen to be highest in the 2nd and 3rd week after which there was a uniform trend.

The results of disease investigation in chicken conducted by Chatterjee (1980) revealed that a maximum mortality of 49.65 per cent occurred during 3 to 12 weeks of life. From day old to three weeks of age the mortality was 43.66 per cent. Only 6.69 per cent of the birds died after 12 weeks of age.

Srinivasan *et al.* (1980) carried out a survey of mortality in Turkeys at HAU, Farm and reported that the prevalence of mortality ranged between 5.3 to 32.2 per cent during five years period. The maximum mortality was observed during first six weeks of life.

Suneja *et al.* (1985b) observed significantly higher mortality in turkey chicks of 0-1 (29.4%) and 1-6 (33.63%) weeks age as compared to all the other age groups. The mortality in birds of 6-12 weeks age (6.51%) was significantly lower than 0-1 and 1-6 weeks age groups but higher than 12-18 (1.44), 18-24 weeks (0.98) and adults (1.52).

Panda *et al.* (1986) and Viswanathan *et al.* (1980) noted higher mortality in younger birds. Sharma and Kaushik (1986) studied a total of 14564 autopsy reports of broilers for 5 year from 1979-83 of Haryana state and observed that Coliform infections caused highest mortality (52.50%) in 0-5 weeks and lowest (1.10%) in adult broilers. The highest total mortality (71.06%) due to various bacterial diseases was recorded in 0-5 weeks and the lowest (2.65%) in 21-25 weeks group. The CRD caused the highest mortality (7.14%) in 6-10 and lowest (0.22%) in 6-20 weeks age groups. Ranikhet disease accounted for 62.77% of the total mortality due to various viral diseases, causing highest mortality (36.44%) among 6-10 weeks old broilers. Similarly, Marek's disease caused highest mortality at 14.72% in 6-10 weeks old and lowest at 0.44% in adult broilers. ALC caused maximum (5.54%) mortality in adults and minimum in 0-5 weeks old broilers. Aspergillous caused 12.58 % mortality in 0-5 weeks age group. The highest mortality due to parasitic diseases was 41.02% in 0-5 weeks age group and lowest at 0.47% in adults.

However, maximum mortality (0.82%) occurred due to Ascaridiasis in adults. Haemorrhagic enteritis and heatstroke caused 36.77% and 18.23% of total mortality, being highest at 18.82% and 9.53% in 6-10 weeks age group, respectively. The highest mortality due to Pneumonia (12.55%) observed in 0-5 weeks age group. The maximum mortality due to Rickets, salt poisoning, deficiencies of Vitamins E and β_1 feed poisoning and ulcerative enteritis occurred during 0-5 weeks old age while due to Hepatitis in 16-20 weeks and Vitamin A deficiency in adult broilers.

Kumanan *et al.* (1988) observed maximum mortality in age group of 21-72 weeks. Ghadasara *et al.* (1992) concluded that the mortality rate was higher among layers (49.21%) as compared to chicks (26.23%) and growers (24.50%).

Rodriguez *et al.* (1997) found the highest mortality between 113 and 140 days and the lowest during 22 and 56 days of age in chicken maintained by small holder in Yucatan, Mexico.

Anjum *et al.* (1998) observed maximum mortality of 5.95% in broilers of 7 weeks age. Horn *et al.* (1998) observed the total mortality during 20 weeks growing period was 24.3 and 33.3 in males and 7.9 and 11.7% in females for two different strains of broilers.

2.4 EFFECT OF SEX :

De Gruchy (1956) studied the mortality pattern in a flock of 3000 turkeys during one complete rearing season and observed no significant difference with regard to sex in mortality due to cold, coccidiosis, Nephritis and Black head diseases. The incidence of Picked vent and Staphylococcus infection was more in males than in females.

Viraraghvan and Nair (1965) observed that the sex had no significant influence an incidence of ALC. Purchase and Biggs (1967) reported that females were more susceptible to Marek's disease than males. The gonads were involved more frequently in females than in males in Rhode Irland Red and Brown Leghorn. In the Rhode Island Red there was a greater incidence of liver lesions in females than in males.

Jones *et al.* (1978) in a survey found reproductive disorders, cellulitis, cannibalism, kidney lesions, liver haemorrhages and Marek's disease as quite common conditions in females while staphylococcal synvitis and acute heart failure were common in males.

Jackson *et al.* (1972) reported 72% deaths due to Oedema of lungs, 75% due to Perosis and 70% due to Ascitis in males. In addition,

males had a significantly higher incidence of infectious bronchitis. They further reported a significantly higher incidence of Marek's disease in females and debility in males.

Jagadeesh Babu *et al.* (1974) reported that mortality due to Marek's disease and Coccidiosis was higher in male birds of younger age group with a peak at 10 to 15 weeks of age. In the female birds, the coccidiosis and Marek's disease reached their peak at 5 to 10 and 10 to 15 weeks, respectively, while other diseases were more frequent at 25 to 30 weeks of age.

Srinivasan *et al.* (1980) reported the mortality in Turkeys was greater in male than females in 18-24 weeks age group (sexing was done before 18 weeks of age). In adults of about 24 weeks, females mortality was more than that of males, but the differences in mortality in 18-24 and over 24 weeks were non-significant.

Suneja *et al.* (1985b) observed that differences of mortality in male (1.15%) and female (0.89%) birds of 8-24 weeks was not significant but in adults, the mortality in males was found to be some what higher (3.82%) to that in female (1.20%).

2.5 EFFECT OF EGG WEIGHT :

Skoglund and Tomhave (1949) and Wiley (1950) found no relationship of egg weight and mortality.

O' Neil (1955) reported that those chicks hatching with the highest percentage of the original weight of the eggs are heavier at eight weeks of age, more efficient in feed consumption and have a lower mortality.

Skoglund *et al.* (1952) found that broiler chicks hatched from eggs weighing less than 50 g were not as profitable as chicks from large eggs. However, they further stated that in periods of egg scarcity the

smaller egg can be used particularly in both unfavourable shipping and early brooding conditions can be avoided.

Skoglund *et al.* (1952) further showed a trend toward higher mortality in chicks hatched from small eggs, but found no significant differences in mortality due to egg weight.

Tindell and Morris (1964) found that egg weight groups, when intermingled, tended to have greater mortality and weight loss when compared to the same egg weight groups housed separately. However, they found no differences in mortality due to hatching egg weight.

Mc Naughton *et al.* (1978) used a total of 7400 mixed-sex broilers in two experiments. In each experiment 925 chicks were housed after hatching from either 29 weeks old breeder hen eggs weighing either 47-54 and 57-62 g or 58 weeks old breeder hen eggs weighing either 57-62 or 67-74 g. The results are shown in Table 2.6.

Table 2.6 : Effect of breeder age and hatching egg weight on chick mortality

Breeder age :	Mortality, % (weeks of age)				
egg wt.	1	2	3	4-8	Total'
Experiment 1					
29 wks. : 47-54 g.	3.35	1.56	0.23	1.02	6.16c
29 wks. : 57-62 g.	2.49	0.78	0.22	0.78	4.27b
58 wks. : 57-62 g.	1.51	0.55	0.33	0.88	3.27ab
58 wks. : 67-74 g.	1.62	0.55	0.33	0.44	2.94a
Experiment 2					
29 wks. : 47-54 g.	5.40	0.91	0	0.81	7.12b
29 wks. : 57-62 g.	4.22	0.34	0.22	1.44	5.92b
58 wks. : 57-62 g.	1.51	0.11	0.33	0.22	2.17a
58 wks. : 67-74 g.	1.62	0.22	0	0.77	2.61a

They concluded that higher mortality occurred when chicks were hatched from eggs weighing 47-54 g compared to either 57-62 or 67-74 g hatching eggs in both the experiments.

2.6 EFFECT OF AGE OF PARENT :

Hays and Spear (1952) showed that broiler chicks mortality from young breeders was significantly higher than was observed in chicks from older breeders, without considering the effect of egg weight. From another study Hays (1955b) explained that the reason for high mortality from chicks hatched from young parents was that older parents are likely to produce more viable chicks.

Mc Naughton *et al.* (1978) used a total of 7400 mixed-sex broilers in two experiments. In each experiment 925 chicks were housed after hatching from either 47-54 or 57-62 g or 58 weeks old breeder hen eggs weighing either 57-62 or 67-74 g. The results are shown in Table 2.6. It was found that mortality in chicks hatched from 29 week old breeder hen eggs was higher as compared to eggs hatched from 58 weeks-old breeders.

2.7 EFFECT OF CAUSE OF DEATH :

Hemsley (1964) observed highest mortality due to coccidiosis in 4-6 weeks of age group.

At Mathura, Prakash and Rajya (1970) observed that ALC incidence was highest (12.99%) in crossbred, followed by Rhode Island Red (12.90 %) and lowest (7.23%) in White Leghorns. The overall highest incidence (22%) was recorded during the month of September, October and November and lowest (13%) in December, January and February. They also reported that ALC incidence was highest (57.14%) in the age groups of 15 months and above, lower (25.29%) in 6-9 months and lowest (0.47 %) in 1-3 months age group.

Sivadas *et al.* (1970) analysed the postmortem reports of 22,084 birds at Kerala Veterinary College and Research Institute from 1961 to 1968 and reported 58.8% mortality due to Leucosis in chicken of the age group of 3-6 months.

Gupta and Dwivedi (1971) observed at Mathura, 0.0, 0.3, 1.9, 2.4 and 12.3% mortality due to ALC in Poultry of age groups of 0-4, 4-8, 8-12, 12-16 and 16 weeks to 1 year respectively. Further, the prevalence of ALC was recorded as 13.0, 12.0 and 5.0% during the month of September, April and July respectively. The mortality due to hepatitis was 10 per cent during summer and 11.44 per cent during spring months. The incidence was 2.1 and 1.0 per cent in 0-4 weeks and 16 weeks to 1 year age group of chicken.

Babu *et al.* (1974) studied the mortality pattern at 3 different farms in Bangalore area and reported 29.34 and 23.48% mortality in poultry due to Lymphoid Leucosis and Marek's disease respectively. The incidence of Lymphoid Leucosis in 20-30 weeks was 76%, whereas that of Marek's disease was 22 and 19 per cent in 10-15 weeks in females and males respectively.

Damodaran and Thanikachalam (1974) analysed the autopsy findings of 38, 188 poultry and reported 96.8% mortality due to ALC in Kerala.

Kulasegaram (1975) analysed the postmortem records of about 500 chicken per year for the period 1960 to 1974 at Peradeniya (Celon) and reported 12, 2 and 30 to 40% mortality due to Newcastle disease, ALC and Marek's disease respectively.

Kothandaraman (1976) studied the incidence of poultry diseases in Tamil Nadu and observed that Ranikhet and Fowl Pox were prevalent throughout the state. ALC, Marek's disease, Respiratory infections,

Colisepticaemia, Ascaridiasis, Coccidiosis and Gout were other diseases commonly encountered in Poultry.

Nayak (1976) reported per cent mortality in poultry at Bangalore, on the basis of necropsies performed, as Fowl Pox 2.0, Ranikhet 4.0, Marek's disease 6.2 and Lymphoid Leucosis 9.0 per cent. He also reported that mortality due to egg bound was very low in poultry.

Kronberger and Schuppel (1977) observed that the commonest cause of death was disorders of the digestive tract (25%), followed by bacterial disease (14.3%), liver disease (10.3%), parasitic diseases (8.5%), respiratory diseases (7.8%), gout (6.3%), injuries (5.8%), mycosis (5.4%), circulatory disorders (4.0%), neoplasma (1.8%), genital diseases (1.7%), viral diseases (1.5%), amyloidosis (0.9%) and nervous diseases (0.9%) in birds.

Jones *et al.* (1978) surveyed the cause of mortality in three broiler breeder flocks during laying period and observed that the commonest causes of death were reproductive disorders (24.9%), cellulites (12.0%), injury due to cannibalism (12.0%), Kidney lesions (9.5%), liver hacmorrhagic (7.1%), Marek's disease (4.9%) and staphylococcal synovitis (4.1%) in females while staphylococcal synovitis (33.8%) acute heart failure (14.3%) in males.

Kalra (1978) reported that main disease observed in poultry during the last eight years in Haryana were Coccidiosis, Haemorrhagic enteritis, Spirochaetosis, CRD, Ranikhet, Marek's disease, Lymphoid Leucosis, Fowl Pox, Ascaridiosis and Tapeworm infection.

Viswanathan *et al.* (1980) analysed 7,174 autopsy reports for the period 1972 to 1976 at Madras and reported 24 and 1.0 per cent mortality due to Coryza and CRD respectively. Further, Coryza was more common in growers and CRD both in growers and adults. In another study Viswanathan *et al.* (1980) conducted the autopsy of

9,810 poultry at Madras and concluded that the mortality due to various diseases from 1972 to 1976 was 14, 54, 6 and 26% in the age groups of 0-1, 2-12, 13-20 weeks and adults and that the mortality due to neoplastic disease and Ranikhet was 4.2% and 5.9% respectively.

Ahmad and Irfan (1981) reported mortality rates of 17.5, 5.31, 5.1, 4.48, 3.26, 1.34, 0.48 and 0.16% due to New castle disease, Spirochaetosis, Cannibalism, heat exhaustion, nutritional deficiency and Lymphoid leucosis in layers around Lahore in Pakistan.

Guarda *et al.* (1981) reported 31, 8.5 and 15% mortality due to CRD, Coryza and Escherichia enteritis respectively on seven large poultry farms, rearing about 20,000 broilers in Italy.

Chakraborty *et al.* (1982) reported the mortality in poultry due to pasteurellosis and colisepticaemia 11.40 and 13.5% respectively in Calcutta area.

Madhekar *et al.* (1982) performed the autopsies an 4, 151 poultry and reported the mortalities 9.59, 5.6, 1.80 and 0.63% due to Colibacillosis, Fowl cholera, Coryza and CRD respectively in Andhra Pradesh areas.

Panda *et al.* (1982) reported the incidence of diseases in the five white leghorn strains on the basis of necropsy findings over a period of three years at Central Avian Research Institute, Izatnagar. The disease pattern observed included Enteritis, Colibacillosis, Coccidiosis, unabsorved yolk, Marek's disease and Gout.

Mohiyuddeen (1982) observed 1.47, 2.74 and 2.03 per cent mortality due to Hepatitis in 0-8, 8-20 and above 20 weeks of age.

Viswanathan (1980), Mohiyuddeen (1982) and Srinivas *et al.* (1983) reported that mortality due to egg bound was very low in poultry.

Inayathulla Khan *et al.* (1983) recorded about 10% mortality in poultry due to Spirochaetosis in Andhra Pradesh.

Kaushik and Kalra (1983) reported 380 cases of Ocular form of Marek's disease in a flock of 2,200 three months old white leghorn chicks at Ambala Farm (Haryana).

Ramachandra Reddy *et al.* (1983) analysed 1246 poultry necropsies conducted during the period 1981 to 1982 at Chittoor (Andhra Pradesh) and reported 13.3, 3.1 and 1.9% mortality due to ALC, Ranikhet disease and Marek's disease respectively.

Srinivas *et al.* (1983) analysed 1,755 poultry necropsies, performed in Kurnool district (Andhra Pradesh) during the year 1979 to 1982 and identified Fowl pox, Ranikhet disease, Lymphoid Leucosis and Marek's disease as important viral diseases.

Chowdhury *et al.* (1983) reported as higher as 53.80 per cent mortality in WLH and 25.0 per cent in RIR from a period of 7 months in laying.

Sah *et al.* (1984) reported that 20.93 per cent mortality (under farm condition) in WLH, while it was 30.64 per cent of deshi birds up to 204 days of age.

Reid *et al.* (1984) in a survey on 30,000 chicks in Australia, conducted during the period 1979 to 1980, reported the mortality at 18.7% from Marek's disease, 0.3% from Fowl Pox and 0.9% from ILT.

Based on 20235 and 14564 Autopsy reports of Fowls and Broilers Sharma (1985) observed the frequency of mortality due to bacterial, viral, fungal and parasitic and miscellaneous pathological conditions and the results are shown in Table 2.7, 2.8, 2.9, 2.10 and 2.11.

Table 2.7 : Seasonwise proportional mortality ratios in Fowls and Broilers

Diseases	Season							
	Summer		Rainy		Winter		Total	
	F	B	F	B	F	B	F	B
Bacterial								
Coliform infection	860 (28.38)	212 (5.61)	272 (8.98)	34 (2.50)	632 (20.86)	579 (42.64)	1764** (58.22)	825** (60.75)
Chronic Respiratory disease	252 (8.32)	40 (2.95)	285 (9.41)	88 (6.48)	418 (13.80)	82 (6.04)	955** (31.53)	210** (15.46)
Coryza	31 (1.02)	4 (0.29)	25 (0.85)	23 (1.69)	99 (3.27)	35 (2.58)	155** (5.12)	62 (4.57)
Fowl cholera	84 (2.77)	10 (0.74)	20 (0.66)	-	-	-	104** (3.43)	10 (0.74)
Fowl typhoid	-	-	16 (0.53)	179 (13.18)	13 (0.43)	63 (4.64)	29* (0.96)	242** (17.82)
Spirochaetosis	2 (0.07)	-	4 (0.13)	-	17 (0.56)	9 (0.66)	23 (0.76)	9 (0.66)
Viral								
Ranikhet disease	240 (8.27)	153 (22.30)	379 (13.06)	115 (16.76)	579 (20.57)	164 (23.91)	1216** (41.90)	432* (62.77)
Marek's disease	303 (10.44)	30 (4.37)	276 (9.51)	82 (11.95)	431 (14.85)	44 (6.41)	1010** (34.80)	156** (22.74)
Avian Leucosis Complex	76 (2.26)	12 (1.75)	103 (3.55)	24 (3.50)	355 (12.23)	62 (9.04)	534** (18.40)	98** (14.29)
Fowl pox	74 (2.55)	-	11 (0.38)	-	57 (1.96)	-	142** (4.89)	-
Fungal and Parasitic								
Aspergillosis	174 (3.30)	155 (4.09)	87 (1.65)	162 (4.27)	270 (5.12)	382 (10.07)	531** (10.07)	699** (14.43)
Thrush	12 (0.23)	-	16 (0.30)	5 (0.13)	187 (3.55)	4 (0.11)	215** (4.08)	9 (0.24)
Coccidiosis	729 (13.82)	540 (14.24)	921 (17.46)	511 (13.47)	1986 (37.65)	1931 (50.91)	3636** (60.93)	2982** (78.62)
Ascaridiasis	213 (4.04)	3 (0.08)	226 (4.28)	19 (0.50)	311 (5.90)	75 (1.98)	750** (14.22)	97** (2.56)
Tapeworms infestation	9 (0.17)	-	34 (0.64)	-	100 (1.90)	6 (0.16)	143** (2.71)	6 (0.16)

** = P < 0.01, * = P < 0.05

F = Fowl, B = Broilers

Table 2.8 : Seasonwise proportional mortality ratios of miscellaneous pathological conditions in Fowls and Broilers

Pathological Conditions	Season							
	Summer		Rainy		Winter		Total	
	F	B	F	B	F	B	F	B
Haemorrhagic Enteritis	653 (4.23)	791 (9.06)	500 (5.54)	819 (9.38)	1234 (13.67)	1599 (18.32)	2387** (26.44)	3209** (36.77)
Pneumonia	447 (4.95)	317 (3.63)	224 (2.48)	389 (4.46)	950 (10.52)	872 (9.99)	1621** (17.96)	1578** (18.08)
Heat stroke	1178 (13.05)	1237 (14.17)	309 (3.42)	354 (4.06)	-	-	1487** (16.47)	1591** (18.23)
Egg peritonitis	263 (2.91)	42 (0.48)	147 (1.63)	34 (0.39)	436 (4.83)	113 (1.29)	846** (9.37)	189** (2.17)
Avitaminosis-A	215 (2.38)	4 (0.05)	192 (2.13)	36 (0.41)	328 (3.63)	43 (0.49)	735** (8.14)	83 (0.95)
Retention of yolk	256 (2.54)	169 (1.94)	16 (0.18)	95 (1.09)	241 (2.67)	275 (3.15)	513** (5.68)	539** (6.18)
Rickets	69 (0.76)	32 (0.37)	66 (0.73)	19 (0.22)	256 (2.84)	472 (5.41)	391** (4.33)	523** (5.99)
Salt poisoning	37 (0.41)	156 (1.79)	27 (0.30)	93 (1.07)	143 (1.58)	394 (4.51)	207** (2.29)	643** (7.37)
Ulcerative enteritis	34 (0.38)	-	104 (1.15)	-	56 (0.62)	73 (0.84)	194** (2.15)	73 (0.84)
Feed poisoning	3 (0.03)	1 (0.01)	107 (1.19)	4 (0.05)	81 (0.90)	27 (0.31)	191* (2.12)	32 (0.37)
Gout	14 (0.16)	13 (0.15)	33 (0.37)	14 (0.16)	77 (0.85)	79 (0.91)	124** (1.37)	106** (1.21)
Riboflavin deficiency	4 (0.04)	-	28 (0.31)	-	90 (1.00)	-	122** (1.35)	-
Vitamin E deficiency	58 (0.64)	-	30 (0.33)	-	10 (0.11)	60 (0.69)	98** (1.09)	60 (0.69)
Egg bound	12 (0.13)	-	4 (0.04)	-	24 (0.27)	-	40* (0.44)	-
Salpingitis	40 (0.44)	-	-	-	-	-	40 (0.44)	-
Connibalism	-	-	17 (0.19)	26 (0.30)	-	-	17 (0.19)	26 (0.30)
Hepatitis	6 (0.06)	-	-	-	-	5 (0.05)	6 (0.06)	5 (0.05)
Fatty liver and kidney syndrome	3 (0.03)	16 (0.18)	-	-	1 (0.01)	31 (0.36)	4 (0.04)	47* (0.54)
Thiamine deficiency	-	10 (0.11)	-	2 (0.02)	3 (0.03)	11 (0.13)	3 (0.03)	23 (0.26)
Prolapse of oviduct	-	-	-	-	2 (0.02)	-	2 (0.02)	-

** = P < 0.01, * = P < 0.05

F = Fowl, B = Broilers

Table 2.9 : Proportional mortality ratios in different age groups of fowls and broilers

Disease	Age groups (weeks)													
	0 - 5		6 - 10		11 - 15		16 - 20		21 - 25		Above 25		Total	
	F	B	F	B	F	B	F	B	F	B	F	B	F	B
Bacterial														
Coliform infection	1290 (42.57)	713 (52.50)	213 (7.08)	78 (5.74)	43 (1.42)	-	53 (1.75)	19 (1.40)	32 (1.06)	-	133 (4.39)	15 (1.10)	1764** (58.22)	125** (60.75)
CRD	62 (2.05)	27 (1.99)	105 (3.47)	97 (7.14)	86 (2.84)	38 (2.80)	128 (4.22)	3 (0.22)	132 (4.36)	25 (1.014)	442 (14.59)	20 (1.47)	955** (31.52)	210** (15.46)
Coryza	32 (1.06)	37 (2.72)	60 (1.98)	25 (1.84)	19 (0.63)	-	6 (0.20)	-	9 (0.30)	-	29 (0.96)	-	155** (5.12)	62 (4.57)
Fowl cholera	3 (0.10)	-	-	-	-	-	65 (2.15)	-	6 (0.20)	10 (0.74)	30 (0.99)	-	104** (3.43)	10 (0.74)
Fowl typhoid	10 (0.33)	188 (13.84)	-	1 (0.07)	-	-	2 (0.07)	45 (3.31)	-	1 (0.07)	17 (0.56)	7 (0.52)	29 (0.96)	242** (17.82)
Spirochaetosis	-	-	-	1 (0.07)	-	1 (0.07)	2 (0.07)	-	12 (0.40)	-	9 (0.30)	7 (0.52)	23 (0.76)	9 (0.66)
Viral														
Ranikhet	104 (3.58)	135 (19.68)	268 (9.86)	250 (36.44)	156 (5.38)	44 (6.41)	188 (6.48)	-	58 (2.00)	2 (0.29)	424 (14.61)	1 (0.15)	1216** (41.90)	432** (62.97)
Marek's disease	11 (0.38)	32 (3.21)	42 (1.45)	101 (14.72)	184 (6.34)	15 (2.19)	373 (12.85)	-	145 (5.00)	15 (2.19)	255 (8.79)	3 (0.44)	1010** (34.80)	156** (22.74)
ALC	-	3 (0.44)	20 (0.69)	25 (3.64)	15 (0.52)	14 (2.04)	96 (3.31)	11 (1.60)	70 (2.41)	7 (1.02)	333 (11.47)	38 (5.54)	534** (18.40)	98** (14.29)
Fowl Pox	-	-	26 (0.90)	-	17 (0.59)	-	7 (0.24)	-	40 (1.38)	-	52 (1.79)	-	142** (4.89)	-
Parasitic Diseases														
Aspergillosis	221 (4.19)	477 (12.58)	138 (2.62)	205 (5.40)	157 (2.98)	4 (0.11)	8 (0.15)	6 (0.16)	2 (0.04)	-	5 (0.09)	7 (0.18)	531** (10.07)	699** (18.43)
Thruser	-	-	31 (0.59)	9 (0.24)	17 (0.32)	-	9 (0.17)	-	109 (2.07)	-	49 (0.93)	-	215** (4.08)	9 (0.24)
Coccidiosis	1269 (24.00)	1556 (41.02)	1786 (33.86)	1337 (35.25)	278 (5.27)	55 (1.45)	102 (1.93)	16 (0.42)	98 (1.86)	-	103 (1.95)	18 (0.47)	3636** (68.93)	2982** (78.62)
Ascaridiasis	54 (1.02)	27 (0.71)	225 (4.27)	24 (0.63)	78 (1.48)	12 (0.32)	61 (1.16)	3 (0.08)	50 (0.95)	-	282 (5.35)	31 (0.82)	750** (14.22)	97** (2.56)
Tapeworms infestation	-	-	26 (0.49)	6 (0.16)	33 (0.63)	-	13 (0.25)	-	13 (0.25)	-	58 (1.10)	-	143** (2.71)	6 (0.16)

*** Significant at P < 0.01, - = Not calculated, NS = Not significant, Figures in parentheses indicate percentage*

Table 2.10 : Proportional mortality ratios of miscellaneous pathological conditions in different age groups of fowls from 1979 to 1983

Pathological Conditions	Age groups (weeks)						
	0-5	6-10	11-15	16-20	21-25	Above 25	Total
Haemorrhagic Enteritis	610 (6.76)	1343 (14.88)	267 (2.96)	36 (0.40)	9 (0.10)	122 (1.35)	2387 (26.44)
Pneumonia	1112 (12.32)	358 (3.97)	45 (0.50)	15 (0.17)	12 (0.13)	79 (0.88)	1621 (17.96)
Heat stroke	456 (5.05)	432 (4.79)	129 (1.43)	164 (1.82)	54 (0.60)	252 (2.79)	1487 (16.47)
Egg peritonitis	-	-	-	15 (0.17)	50 (0.55)	781 (8.65)	846 (9.37)
Avitaminosis-A	48 (0.53)	275 (3.05)	93 (1.03)	40 (0.44)	108 (1.20)	171 (1.89)	735 (8.14)
Retention of yolk	512 (5.67)	1 (0.01)	-	-	-	-	513 (5.68)
Rickets	206 (2.28)	89 (0.99)	6 (0.07)	-	14 (0.16)	76 (0.84)	391 (4.33)
Salt poisoning	87 (0.96)	36 (0.40)	13 (0.14)	33 (0.37)	10 (0.11)	28 (0.31)	207 (2.29)
Ulcerative enteritis	7 (0.08)	56 (0.62)	29 (0.32)	22 (0.24)	18 (0.20)	62 (0.69)	194 (2.15)
Feed poisoning	24 (0.27)	26 (0.29)	83 (0.92)	12 (0.13)	9 (0.10)	37 (0.41)	181 (2.12)
Gout	1 (0.01)	15 (0.17)	34 (0.38)	27 (0.30)	29 (0.32)	18 (0.20)	124 (1.37)
Riboflavin deficiency	106 (1.17)	4 (0.04)	10 (0.11)	-	-	2 (0.02)	122 (1.35)
Vitamin E deficiency	93 (1.03)	5 (0.06)	-	-	-	-	98 (1.09)
Egg bound	-	-	-	5 (0.06)	11 (0.12)	24 (0.27)	40 (0.44)
Salpingitis	-	-	-	-	-	40 (0.44)	40 (0.44)
Cannibalism	-	-	-	17 (0.19)	-	-	17 (0.19)
Hepatitis	-	-	-	-	-	6 (0.06)	6 (0.06)
Fatty liver and kidney syndrome	3 (0.03)	1 (0.01)	-	-	-	-	4 (0.04)
Thiamine deficiency	-	2 (0.02)	-	-	-	1 (0.01)	3 (0.03)
Prolapse of oviduct	-	-	-	-	-	2 (0.02)	2 (0.02)
Total	3265 (36.17)	2643 (29.28)	709 (7.65)	386 (4.28)	324 (3.59)	1701 (18.84)	9028 -

Figures in parentheses indicate percentage

Table 2.11 : Proportional mortality ratios of miscellaneous pathological conditions in different age groups of broilers from 1979 to 1983

Pathological Conditions	Age groups (weeks)						
	0-5	6-10	11-15	16-20	21-25	Above 25	Total
Haemorrhagic Enteritis	1392 (15.95)	1642 (18.82)	91 (1.04)	26 (0.30)	5 (0.06)	53 (0.61)	3209 (36.77)
Heat stroke	350 (4.01)	832 (9.53)	188 (2.15)	183 (2.10)	4 (0.05)	34 (0.39)	1591 (18.23)
Pneumonia	1095 (12.55)	356 (4.08)	59 (0.68)	21 (0.24)	-	47 (0.54)	1578 (18.08)
Salt poisoning	384 (4.40)	235 (2.69)	21 (0.24)	2 (0.02)	1 (0.01)	-	643 (7.37)
Retention of yolk	539 (6.18)	-	-	-	-	-	539 (6.18)
Rickets	363 (4.16)	156 (1.79)	-	-	2 (0.02)	2 (0.02)	523 (5.99)
Egg Peritonitis	-	-	-	21 (0.24)	-	168 (1.93)	189 (2.17)
Gout	75 (0.86)	26 (0.30)	-	-	-	5 (0.06)	106 (1.21)
Avitaminosis-A	14 (0.16)	25 (0.29)	5 (0.06)	4 (0.05)	10 (0.11)	25 (0.29)	83 (0.95)
Ulcerative enteritis	73 (0.84)	-	-	-	-	-	73 (0.84)
Vitamin E deficiency	60 (0.69)	-	-	-	-	-	60 (0.69)
Fatty liver and Kidney syndrome	47 (0.54)	-	-	-	-	-	47 (0.54)
Feed poisoning	10 (0.11)	18 (0.22)	1 (0.01)	1 (0.01)	2 (0.02)	-	32 (0.37)
Cannibalism	-	-	-	26 (0.30)	-	-	26 (0.30)
Thiamine deficiency	20 (0.23)	3 (0.03)	-	-	-	-	23 (0.26)
Hepatitis	-	-	-	3 (0.03)	-	2 (0.02)	5 (0.05)
TOTAL	4422 (50.67)	3293 (37.73)	365 (4.18)	287 (3.29)	24 (0.28)	336 (3.85)	8727

Figures in parentheses indicate percentage

Based on 11,431 effective autopsies Ghodasara *et al.* (1992) found that the major cases of mortality among chicks were Yolk sac infection (31.45%), Pneumonia (13.67%) and Coccidiosis (12.87%). Among the growers Coccidiosis (35.26%), Marek's disease (17.41%), Ranikhet disease (7.62%) and Enteritis (7.34%) were predominant diseases. Fatty liver haemorrhagic syndrome (16.48%), Marek's disease (16.20%), Lymphoid Leucosis (11.48%) and heat stroke (6.81%) were revealed as the main causes of mortality in layers.

Jagrit (1999) reported that out of 600 broilers chicks, 13 chicks died during the entire experimental period of 0-8 weeks. The over all mortality was 2.17%. The mortality of chicks ranged from 2.00 to 2.67% among different genetic groups. Maximum mortality at 1.0% occurred during IInd week of age inclusive of all the genetic groups. Mortality was almost similar for different genetic groups. Enteritis was the major cause of death (30.77%) followed by Coryza-Enteritis (23.08%), Coccidiosis (23.08%), CRD (15.38%) and Infectious Coryza (7.69%).

A summary of diseases associated with mortality in birds, as recorded by different workers in India and abroad is presented in Table 2.12.

Table 2.12 : Per cent mortality (within parenthesis) due to various diseases in chicken

Author	Diseases in descending order of frequency	Country of work
Jordan, 1956	Accident and injury (20.0), Chilling (18.0), Tumours (16.5), Caecal coccidiosis (11.0)	England
Watts and Rac, 1958	Omphalitis (48.7), Unabsorbed yolk (30.7), Pneumonia (6.9), Uricaemia (7.8), Pullorumdisease (4.6), Chicken upto 10 days only	England

Author	Diseases in descending order of frequency	Country of work
Schilling, 1963	Helminth infection (12.1), Salpingo peritonitis (10.1), Leucosis (8.8), New Castle disease (8.8), Poisoning (8.3), Non-specific enteritis (5.6), Pullorum disease (6.5), Tuberculosis (5.6), Ectoparasites (4.6), Liver disease (4.3), Marek's disease (4.1), Visceral gout (1.7), Coccidiosis (1.6), Coligranuloma (1.5)	Hanover
Nosaka and Minura, 1964	Parasitic diseases (29.8), Coccidiosis (58.0), Ascaridiasis (33.0), Enteritis (16.4), Leucosis complex (7.1), Peritonitis (6.1), Cannibalism (5.2)	Japan
Prusas, 1964	Coccidiosis (30.0), Falty nutrition and husbandry (27.0), Pullorum disease (22.8), Fowl paralysis (6.4), Ascaridiasis (3.0), Gout (2.5)	Berlin (Germany)
Hall *et al.*, 1969	Leucosis complex (28.51), Coccidiosis (26.79), Helminth infestation (10.45), Enteritis (7.52), Air-sae disease (7.44), Colibacillosis (4.96), Paratyphoid (3.39), Infectious synovitis (3.2), CRD (2.46), Ulcerative enteritis (1.36), Aspergillosis (1.03)	U.S.A.
Mostafa *et al.*, 1969	Coccidiosis (32.5), Ranikhet disease (26.0), Sinutisit (19.0), Infectious larynogotracheitis (11.0)	Beghdad
Sivadas *et al.*, 1970	Diseases of Respiratory tract and Pericardium (15.0), Coccidiosis (14.0), Internal parasites and enteritis (13.3)	Kerala (India)
Dexter *et al.*, 1972(a)	Intestinal coccidiosis (14.1), Marek's disease (12.0), Pneumonia (9.3), Lymphoid leucosis (8.4), *E. coli* septicalmia (7.5)	Ireland

Author	Diseases in descending order of frequency	Country of work
Jackson *et al.*, 1972	Yolk sac/ Naval infection (1.31), Oedema of lungs (0.65), Starvation syndrome (0.53), Infectious Bronchitis (0.34)	Australia
Hall *et al.*, 1974	Omphalitis (12.15), Air-Sac disease (6.29), Colibacillosis (5.9), Ascaridiasis (5.89), Infectious synovitis (4.76), Aspergillosis (3.01), CRD (2.29), Ulcerative enteritis (2.19), Lymphoid leucosis (1.71), Reproductive disorders (1.36), Intestinal coccidiosis (1.14)	U.S.A.
Jagadeesh Babu *et al.*, 1974	Lymphoid leucosis (29.0), Coccidiosis (26.0), Marek's disease (23.5), Miscellaneous causes gout, Ulcerative enteritis, Fatty-liver syndrome, salpingo-peritonitis and Pneumonia (21.0)	India
Byme and Lowndes, 1975(a)	Pneumonia (17.4), Coccidiosis (12.0), E. coli septicaemia (9.0), Lymphoid leucosis (5.8), Peritonitis (5.5), Poisoning (5.4), Yolk-sac infection (4.5), CRD (3.0), Marek's disease (2.4)	Ireland
Nayak, 1976	Intestinal coccidiosis (27.0), Lymphoid leucosis (9.0), Marek's disease (6.2), Unabsorbed yolk (5.4), Non-specific enteritis (5.0), Ascaridiasis (4.3), Ranikhet disease (4.0), Egg peritonitis (3.0), Colibacillosis (2.5)	Karnataka (India)
Dovos *et al.*, 1977(a)	Coccidiosis (6.9), Marek's disease and other tumours (3.5), New castle disease (0.2)	Belgium
Kronberger and Schuppel, 1977	Digestive disorders (25.0), Liver disease (10.3), Parasites (8.5), Respiratory disease (7.8), Injuries (5.8)	Belgium

Author	Diseases in descending order of frequency	Country of work
Randal *et al.*, 1977	Kidney lesions (20.0), Reproductive disorder (15.0), Cannibalism and other injury (11.0), Marek's disease (10.6)	Belgium
Mohan *et al.*, 1978	Coccidiosis (26.0), Ascites (10.2), Omphalitis (9.6), Nephorosis (7.2), Enteritis (4.6), Pneumonia (2.4), Hepatitis (1.9), Air-Sacculitis (1.9)	India
Chatterjee, 1980	Pneumonia and sinusitis (38.45), Coccidiosis (25.16), Aspergillosis (21.75), Fowl cholera (1.16), Vitamin deficiency (1.09), Ranikhet (0.58)	Calcutta (India)
Guarda *et al.*, 1980	CRD (31.0), Enteritis (15.0), Coccidiosis (10.0), Coryza (8.5)	Italy
Viswanathan *et al.*, 1980	Debility (35.6), Digestive disorders (29.8), Parasitic infestation (11.7), Cannibalism (7.1)	India
Madhekar *et al.*, 1981	Coccidiosis (22.6), Ranikhet disease (15.73), Colibacillosis (9.59), Miscellaneous causes (6.1), Fowl cholera (5.6), Tabeworm infection (5.21), Ascaridiasis (3.5), Pox (2.6), Coryza (1.8)	India
Mhoomaiah and Rama Rao, 1982	(a) Coccidiosis (16.36), Heat stroke (2.41), Ascites (1.73), Marek's disease (0.88), Ranikhet disease (0.76). (b) Coccidiosis (19.7), Marek's disease (10.59), Lymphoid leucosis (9.89), Ranikhet disease (6.74), Tapeworm and Round worm infections (5.87), Heat stroke (0.61). (c) Tapeworm and Roundworm infection (16.63), Lymphoid leucosis (7.05), Ranikhet disease (2.38), Coccidiosis (1.68)	India
Rodriguez *et al.*, 1997	Coccidiosis (10.5), Marek's disease (7.6)	Yucatan (Mexico)

3. Materials and Methods

The experimental materials used and methods applied in this study are presented under following sub sections.

3.1 Experimental materials

3.2 Data

3.3 Statistical methods

3.1 EXPERIMENTAL MATERIALS :

3.1.1 Location and History of the Poultry Farm :

The data used in the present study were collected from the Poultry Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur. Udaipur is situated in the step of Aravali hills at 24°34' N latitude and 74°42' E longitude with an elevation of 579.5 meters above mean sea level. This region falls under agro-climatic zone IV A (sub-humid southern plain and Aravali hills) of Rajasthan.

The region enjoys a typical sub-humid type climate characterised by mild winter and summer associated with high relative humidity. The average weekly maximum and minimum atmospheric temperature and relative humidity varies from 2.6 – 42.1°C and 11 - 94 %, respectively. Udaipur receives an average annual rainfall of about 637 mm most of which (90 per cent) is contributed by south-west monsoon.

The erstwhile Government Poultry Farm, Udaipur was transferred to Rajasthan College of Agriculture, Udaipur during the year 1958-59 when White Leghorn and Rhode Island Red breeds were maintained. Later in 1966 the PL 480 Poultry breeding scheme entitled "Effectiveness of different methods of utilizing available sources of germ-

plasm in improving the productive performance of Poultry" was introduced on the farm. This led to transformation of the poultry farm from physical, manpower and genetic stock viewpoint.

3.1.2 Breeds (Genetic group) Maintained at Farm :

The foundation stock was purchased from different Government Poultry Farms of other states. The following breeds were maintained at the farm.

(i) White Leghorn – The flock was brought from Ludhiana.

(ii) Rhode Island Red – The flock was maintained at the College Poultry Farm since long as a closed flock.

(iii) Kadaknath – Collected from the tribal area of Jhabua of M.P. and adjoining Dahod area of Gujarat state.

(iv) Deshi – A mixture of red and grey jungle fowl was collected from all over Rajasthan.

(v) Black Australorp – Purchased from Government Poultry Farm, Ajmer.

(vi) Broiler – White Cornish, White Rock, Synthetic broiler male and female line IVRI strains.

(vii) Crosses – 2 and 3 way crosses of White Leghorn, Rhode Island Red, Deshi breeds of chicken. The details are given below.

2 way crosses : WD*, DW, RD, DR, RW and WR

3 way crosses : R-WD, R-DW, W-RD, W-DR, D-RW and D-WR.

3.1.3 Feeding, Housing and Management :

3.1.3.1 Feeding :

Balanced chick, grower, layer and broiler starter and finisher rations were prepared as per BSI specification at the farm using different feed ingredients like maize, barley, sorghum, cut rice, groundnut cake, wheat bran, fish meal, rice polish, molasses, corn

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* In crosses first letter denotes male parent, where W = White Leghorn, D = Deshi and R = Rhode Island Red

gluten meal etc. as per their availability and cost in the market. Mineral mixture at 2% was added in all mashes while 3% lime stone powder was mixed in layer mash only. Antibiotics and coccidiostats were also added regularly in the feed mash. The prepared mash was offered to chicks, growers, layers and broilers once a day in the afternoon. Feed was offered in chick and growers' feeder to chicks and growers. However, adult birds were offered feed in flock/hanging feeders.

3.1.3.2 Housing and Management :

(i) Hatching management :

The eggs were collected at every two hours interval every day from different laying and breeding pens and these were marked for identification. The eggs were graded according to size and genetic group and were stored in cold storage room with a temperature of 10-15°C. Candling was done to select eggs prior to hatching. Selected eggs were set in Jamesway incubator for hatching. Standard management practices were followed prior and during incubation and hatching. Chicks were kept in incubator for 24 hours after hatching to dry the feathers.

(ii) Brooding management :

Unsexed healthy chicks were transferred to brooding pens 24 hours after hatching. They were reared in a clean, disinfected and well ventilated intensive type deep-littered brooder house measuring 3.6 m x 2.4 m size, equipped with 1.5 m x 1.2 m electric brooder. About 200 day-old chicks in each brooding pen were kept. The floor was littered using dry rice husk to a thickness of about 3-4 inches depending on the season of brooding. Standard management practices regarding brooding, feeding, watering and disease control were followed during brooding. Chicks were kept in brooding pens upto 8 weeks of age thereafter they were shifted to grower house. Debeaking was done after 4 weeks of age.

(iii) Grower management :

Chicks were transferred from brooding pen to growing pens of 7.7 m x 7.7 m size, according to genetic groups, after 8 weeks of age. No artificial light was provided during the growing stage i.e. between 8-18 weeks of age. After 18 weeks artificial light was provided and lighting period was slowly increased to 16 hours by the end of 20th weeks of age. Identical standard management practices were followed for all the birds.

(iv) Layer management :

The birds of different breeds/genetic groups confined in well ventilated laying pens of 7.7 m x 7.7 m size. The floor was littered with rice husk to a thickness of 8-10 cm. All laying pens were equipped with individual trapnest. Approximately 16 hours of light was provided daily in the laying pens. Standard management practices were followed for all the birds. Each pen was provided with plenty of fresh and clean water. Well water was supplied from overhead tank connected with pipe lines with a tap from which water was received in a water trough kept in one corner of pen on a wirenet lying over water pit to provide regular water supply. During severe cold/hot months lower part of windows were covered with gunny bags to protect the birds from extreme weather stress.

3.1.4 Health coverage :

The following vaccination schedule was followed at the poultry farm.

Chick's age	Disease	Name of vaccine
1 day	Marek's disease	Cell-free or cell-associated turkey herpes virus
1 day	Ranikhet disease	Ranikhet disease vaccine strain F(RDF) or Lassota
6-8 weeks	Ranikhet disease	Ranikhet disease vaccine Mukteswar strain (RDM) or R_2B
8-10 weeks	Fowl pox	Chick embryo- adapted Fowl pox.

3.2 DATA :

3.2.1 Collection of Data :

3.2.1.1 Mortality data :

The data pertaining to number of birds exposed to risk and birds died at Poultry Farm, Rajasthan College of Agriculture, Udaipur between April 1961 to December 1996 were collected and the effect of year, season, sex and genetic group on mortaility and effect of year, season, sex, genetic group, egg weight, age of parent and causes was studied on mortality pattern (Frequency of birds died).

As the number of birds in each group were not constant throughout the month because of addition due to transfer in a particular group and subtraction on account of death and sale. Hence, the highest strength/ number, of birds on first day of month was considered as number of birds exposed to risk in that particular group.

In all 95242 birds died during the period and were subjected to autopsy to find out the exact cause of death. Since very few birds died due to Cannibalism, Ricket, and Marek's disease, hence, these were grouped into other causes. In case, exact cause of death was not diagnosed, these were grouped as unspecified cause of death.

3.2.1.2 Meteorological data :

The meteorological data were collected from the meteorological observatory of Rajasthan College of Agriculture, Udaipur. Weekly average of meteorological parameters were taken to study the effect of climatological factors on mortality in chicken. The meteorological parameters included in the study were maximum and minimum temperature and maximum and minimum relative humidity.

3.2.2 Classification of Data :

The data with respect to mortality spread over a period of 36 years extending from 1961 to 1996 were classified on the following basis, to study the effect of non-genetic factors.

3.2.2.1 Genetic group : The data pertaining to mortality in various genetic groups were classified as follows.

(i) White Leghorn (WLH)

(ii) Rhode Island Red (RIR)

(iii) Kadaknath

(iv) Deshi

(v) Black Australorp (BA)

(vi) Broilers

(vii) Crosses.

3.2.2.2 Season : To study the effect of seasons the mortality data were classified as under.

(i) Summer – April to June

(ii) Rainy – July to September

(iii) Autumn – October to November

(iv) Winter – December to January

(v) Spring – February to March.

3.2.2.3 Age : The data of mortality were classified into following age groups.

(i) 0 to 2 months

(ii) 2 to 5 months

(iii) Over 5 months

3.2.2.4 Sex : To study the effect of sex on mortality pattern the whole data were classified as under :

(i) Unsexed growers

(ii) Male

(iii) Female

3.2.2.5 Egg weight : The data of mortality were classified according to the following four egg weight groups. Which were available from May, 1968 to April, 1972 only.

(i) Less than 45 g

(ii) 46 to 50 g

(iii) 51 to 55 g

(iv) Over 55 g

3.2.2.6 Age of parent : To study the effect of age of parents on mortality, the data were classified according to the following age groups. The above data were available from May, 1968 to April, 1972 period only.

(i) Less than 8 months

(ii) 8 to 12 months

(iii) 13 to 16 months

(iv) Above 16 months

3.2.2.7 Cause of mortality : On the basis of autopsy findings the mortality data were classified according to following cause of depth :

I) Coryza

II) Chronic Respiratory disease

III) Enteritis

IV) Pneumonia

V) Ranikhet (New Castle Disease)

VI) Fowl pox

VII) Avian Leucosis complex

VIII) Hepatitis

IX) Coccidiosis

X) Spirochaetosis

XI) Parasitic diseases

XII) Low vitality

XIII) Packing

XIV) Egg bound

XV) Climatic stress

XVI) Others

XVII) Unspecified

3.2.2.8 Post mortem : The birds died during the period of study were sent to Veterinary Hospital, Udaipur for autopsy examination to find out the exact cause of death.

3.3 STATISTICAL METHODS :

3.3.1 Estimation of Effect of Non-genetic Factors :

Since the mortality represented in percentage and values varied beyond the limit of 30-70%, hence the data were transformed prior to analysis using Arch Sins transformation (Anscombe, 1948). To test the effect of non-genetic factors, the two factor CRD for exact mortality while RBD using year as replication for mortality pattern were under taken.

3.3.2 Critical Difference Test :

To test the differences among the sub-group means, the critical difference test was used.

3.3.3 Computation of Association :

The association in terms of correlation and regression between meteorological variables (maximum and minimum temperature and maximum and minimum relative humidity) and mortality according to different genetic groups and cause of death were worked out. For

estimation of these association, the weekly averages of meteorological parameters and number of birds died during that particular week was used.

3.3.3.1 Phenotypic correlation : The phenotypic correlation of meteorological variables with number of birds died were computed as product moment correlatin with following formula

$$r_{xy} = \frac{Cov_{xy}}{\sigma_x \sigma_y}$$

Where, r_{xy} is the simple correlation between traits x and y.

Cov_{xy} is the phenotypic covariance between trait x and y, and σ_x and σ_y are the phenotypic standard deviation of trait x and y, respectively.

The significance of the phenotypic correlation was tested as per Snedecor and Cochran, 1968 equations.

$$t\,(n-2) = r\sqrt{\frac{n-2}{1-r^2}}$$

3.3.3.2 Partial Correlation : To estimate the effect of one variable over the other keeping the rest variables constant, partial correlations were computed using Snedecor and Cochran, 1968 equations.

$$r\,y\,1.2 = \frac{r\,y^1 - ry^2\, r_{12}}{\sqrt{(1-r^2y^2)\,(1\,r^2_{12})}}$$

3.3.3.3 Simple Regression : To estimate the relative importance of each independent variables with the dependent variables, the regression coefficients were worked out using Snedecor and Cochran, 1968 equations.

$$\hat{y} = a + bx$$

$$b_{yx} = \Sigma xy \,/\, \Sigma x^2$$

$$a = \overline{Y} - b\,\overline{X}$$

$$t\,(n-2) = b_{yx} \,/\, SEb$$

$$SEb = \sqrt{S^2_{yx} \,/\, \Sigma x^2}$$

$$S^2yx = \frac{\Sigma y^2 - (\Sigma xy)^2 \,/\, \Sigma x^2}{n-2}$$

$$\Sigma x^2 = \Sigma X^2 - (\Sigma X^2) \,/\, n$$

$$\Sigma y^2 = \Sigma Y^2 - (\Sigma Y^2) \,/\, n$$

$$\Sigma xy = \Sigma XY - (\Sigma X)\,(\Sigma Y) / n$$

4. Results

Results of the present study are presented as under :

4.1 Non-genetic factors affecting overall mortality pattern in chicken.

4.2 Non-genetic factors affecting mortality pattern in different genetic groups of chicken.

4.3 Non-genetic factors affecting mortality pattern due to different causes in chicken.

4.4 Non-genetic factors affecting actual mortality in chicken.

4.5 Meteorological parameters.

4.6 Association between meteorological variables and mortality in different genetic groups.

4.7 Association between meteorological variables and different causes of mortality.

4.1 NON-GENETIC FACTORS AFFECTING OVERALL MORTALITY PATTERN IN CHICKEN :

The results of analysis of variance for mortality pattern is given in Table 4.1. It is revealed that genetic group, season, age, sex, age of parent and cause of death had significant ($P < 0.01$) influence on mortality pattern in chicken. However, the effect of egg weight and year on this parameter was found to be statistically non-significant

Out of the total deaths (95242), maximum deaths were observed in White Leghorn (29.27%) followed by crosses (27.97%), Broilers (23.73%), Rhode Island Red (10.96%), Deshi (5.81%) and Black Australorp (1.81%). A minimum mortality at 0.45% was observed in Kadaknath (Fig. 4.18). Based on transformed values, significantly higher mortality was observed in White Leghorn as compared to other genetic groups. The differences among Crosses, Broilers and Rhode

Island Red and that between Deshi and Black Australorp and Black Australorp and Kadaknath were non-significant (Table 4.2).

Mortality pattern across different non-genetic factors are presented in (Table 4.3). Highest mortality was observed in summer and lowest in autumn (Fig. 4.2). The differences in mortality amongst seasons were significant ($P < 0.05$) except that between winter and spring seasons.

In all 49.55% mortality occurred upto 2 month's of age. Significantly higher mortality was observed in 0-2 months age group as compared to 2-5 and over 5 months age groups (Fig. 4.2). The differences between 2-5 and over 5 months chicken were non-significant (Table 4.3).

In all 76.35% mortality was observed upto growing stage i.e. upto 18 weeks of age and remaining 23.65% in adults. Among adults 19.39% mortality was found in males and 80.61% in females (fig. 4.2).

Based on transformed values, significantly higher mortality was observed during growing stage as compared to adult age. Further, the mortality was also significantly higher in females than males (Table 4.3). Though the differences due to egg weight were non-significant on mortality pattern but higher actual frequency of mortality (34.48%) was observed in egg weight group of <45 g and lower (11.16%) in egg weight group of > 55 g (Table 4.3).

Age of parent was also a major component of mortality as indicated from Table 4.1. In all 77.28% mortality was observed in chicken whose parents were below 8 months of age. The critical test results based on transformed values indicated that mortality was significantly higher in progeny whose parental age was less than 8 months as compared to those whose age was more than 8 months. The

differences between parental age of 13-16 and over 16 months on one hand and 8-12 months age group on the other were also significant but that between former groups were non-significant (Table 4.3).

Mortality pattern across different causes/ disease in chicken is presented in (Table 4.4). The results revealed that causes of mortality in descending order were Coryza (40 %), Chronic Respiratory disease (10.26 %), Enteritis (8.83 %), Avian Leukosis Complex (7.56 %), Coccidiosis (6.0%), Spriochaetosis (5.95 %), Ranikhet disease (5.71 %) and others minor diseases (< 4.0 %). The critical test based on transformed values indicated that deaths due to Coryza were significantly higher than all other causes (Fig. 4.3 and Table 4.4). The differences among deaths due to Chronic Respiratory disease, Enteritis, Avian Leukosis Complex and Coccidiosis were small and non-significant ($P < 0.05$). Likewise, differences were non-significant ($P < 0.05$) amongst disease/ causal groups like Spirochaetosis, packing, Pneumonia and Parasites; Parasites, egg bound and Hepatitis; egg bound, Hepatitis, climatic stress and unspecified factors, Hepatitis, climatic stress, unspecified factors and Fowlpox.

Since the effect of genetic groups and different causes were found to be significant on frequency of mortality (mortality pattern) based on pooled data, hence, detailed study was undertaken for individual genetic group and causes, The factors considered for individual study were season, age and sex.

The effect of egg weight was non-significant on mortality pattern and data on age of parent were not available for all the genetic groups included in the study, hence these factors were not included in further detailed study.

Table 4.1 : Analysis of variance showing the effect of non-genetic factors on mortality pattern in chicken

Source of variation	d.f.	Sum of Squares	Mean sum of squares	F. values
Genetic group				
Between years	35	950.34	27.15	0.157
Between genetic groups	6	30435.20	5072.53	29.356**
Error	210	36287.10	172.80	
Season				
Between years	35	149.94	4.28	0.092
Between seasons	4	5154.67	1288.67	27.779**
Error	140	6494.62	46.39	
Age				
Between years	35	48.99	1.40	0.011
Between age groups	2	5512.31	2756.15	22.464**
Error	70	8588.57	122.70	
Sex				
Between years	35	140.10	4.01	0.033
Between sexs	2	45317.00	22658.50	183.989**
Error	70	8620.58	123.15	
Egg weight				
Between years	4	4.21	1.05	0.014
Between egg weight groups	3	616.30	205.43	2.641
Error	12	933.32	77.78	
Age of parent				
Between years	4	1.24	0.31	0.007
Between age of parent groups	3	13589.50	4529.84	109.238**
Error	12	497.61	41.47	
Cause				
Between years	35	861.16	24.61	0.476
Between causes	16	48752.90	3047.06	58.978**
Error	560	28931.90	51.66	

** = $P < 0.01$, * = $P < 0.05$

Table 4.2 : Mortality pattern across different genetic groups in chicken

Genetic groups	Number died	Per cent mortality	Mean transformed values of per cent mortality
1. White Leghorw	27878	29.27	34.64^{a}
2. Rhode Island Red	10438	10.96	20.58^{b}
3. Kadaknath	428	0.45	1.88^{d}
4. Deshi	5529	5.81	8.42^{c}
5. Black Australorp	1721	1.81	6.00^{cd}
6. Broilers	22602	23.73	23.37^{b}
7. Crosses	26646	27.97	24.58^{b}

Mean transformed values superscripted by different letters differed significantly

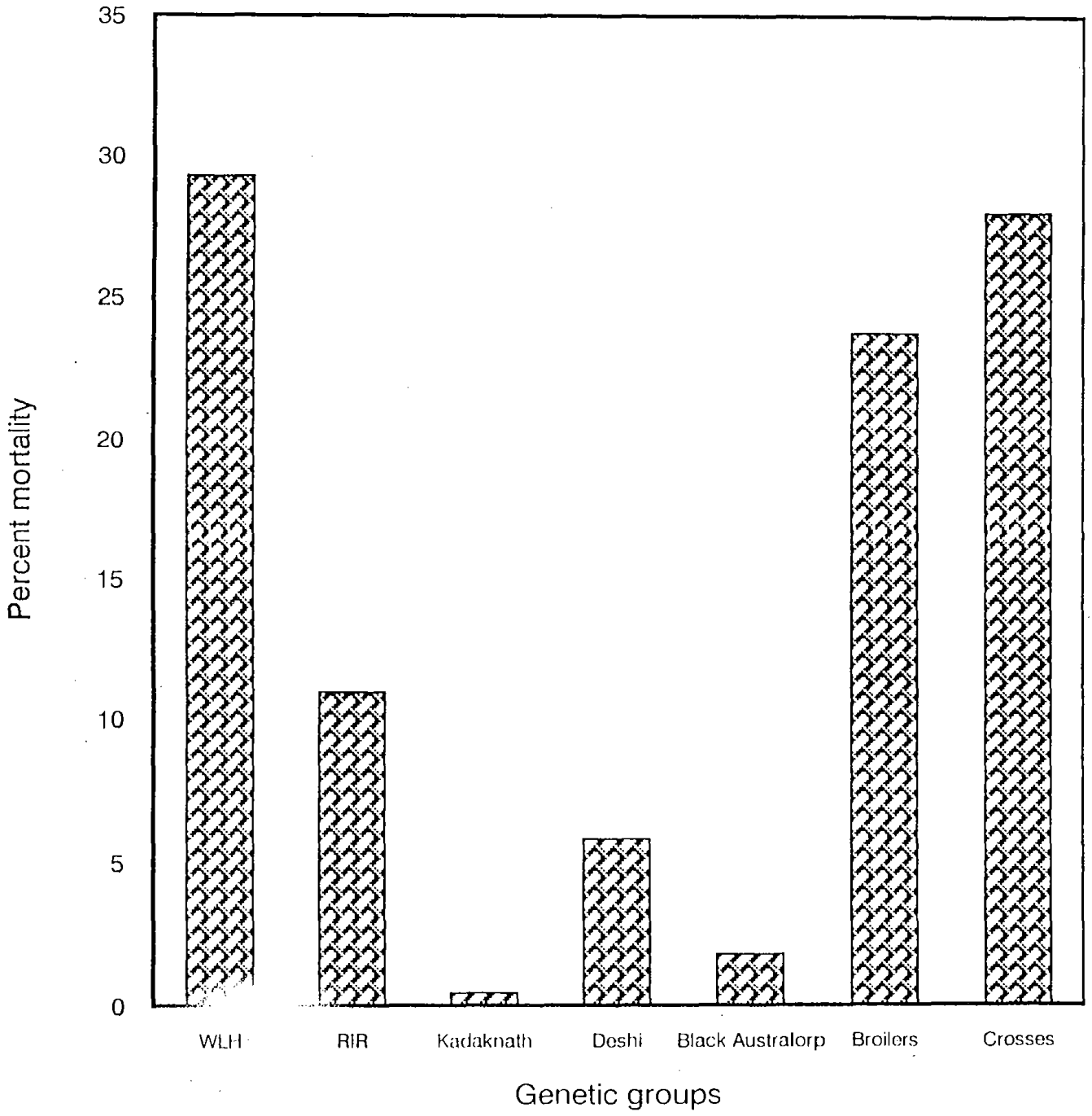

Fig.4.1: Mortality pattern across different genetic groups in chicken

Table 4.3 : Mortality pattern across different non-genetic factors in chicken

Non-genetic factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Seasons			
Summer	34271	35.98	34.59[a]
Rainy	20724	21.76	28.69[b]
Autumn	10128	10.64	19.40[d]
Winter	14314	15.03	22.58[c]
Spring	15805	16.59	23.30[c]
Age			
0-2 months	47200	49.55	44.61[a]
2-5 months	25735	27.02	29.73[b]
Over 5 months	22307	23.43	29.20[b]
Sex			
Unsexed Growers	72717	76.35	60.36[a]
Male	4368	4.58	11.47[c]
Female	18157	19.07	26.14[b]
Egg weight			
Less than 45 g	3146	34.48	36.03[a]
46 – 50 g	2469	27.06	26.00[a]
51 – 55 g	2491	27.30	32.74[a]
Over 55 g	1018	11.16	21.86[a]
Age of parent			
Less than 8 months	7808	77.28	64.08[a]
8 – 12 months	2288	22.65	25.85[b]
13 – 16 months	6	0.06	0.53[c]
Over 16 months	1	0.01	0.26[c]

Mean transformed values superscripted by different letters differed significantly

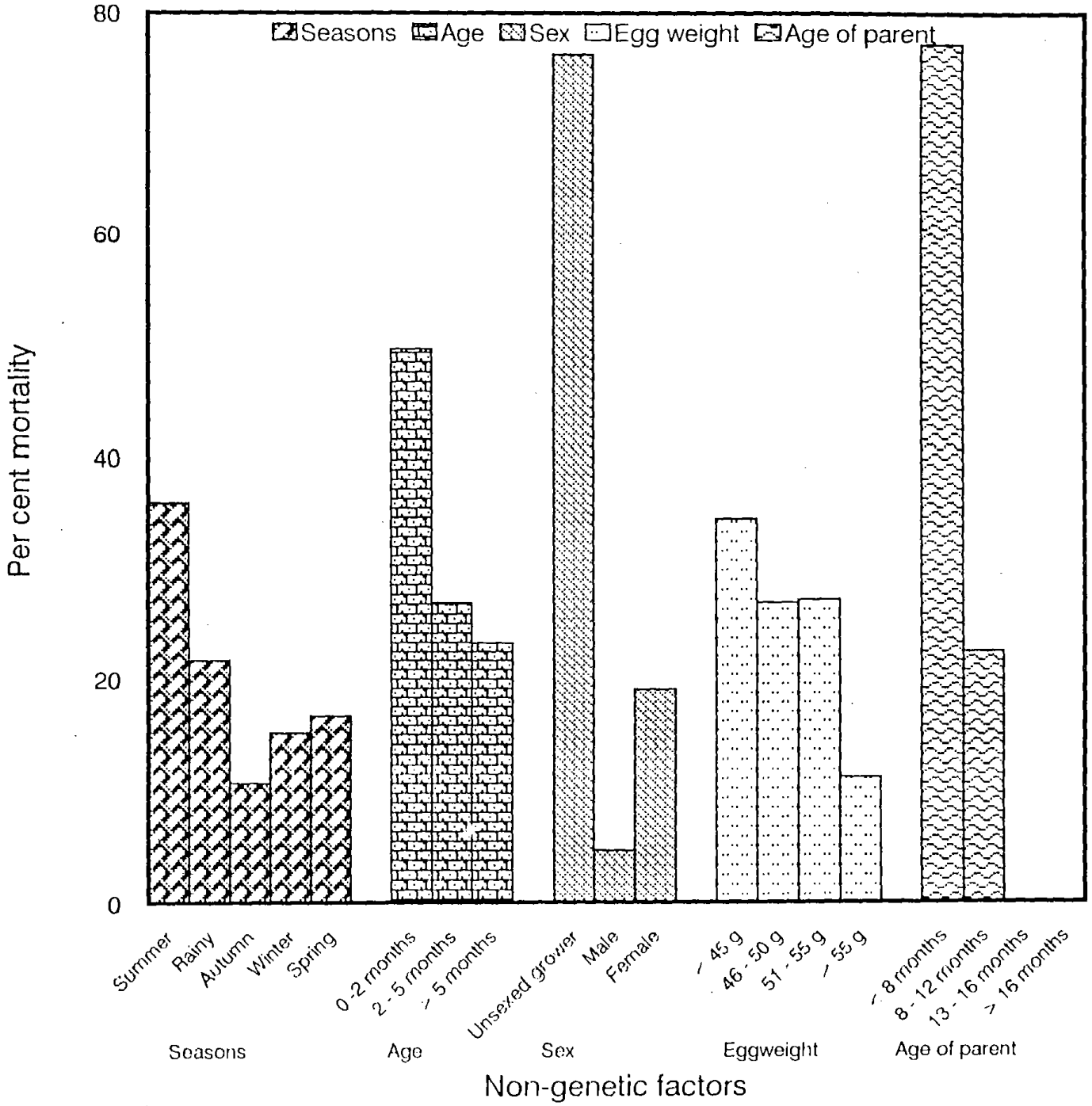

Fig.4.2: Mortality pattern across different non-genetic factors in chicken

Table 4.4 : Mortality pattern across different diseases/causes in chicken

Causes/ Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
1. Coryza	38623	40.55	39.42^{a}
2. Chronic Respiratory disease	9772	10.26	15.41^{bc}
3. Enteritis	8417	8.83	14.63^{bc}
4. Pneumonia	1815	1.90	6.99^{ef}
5. Ranikhet	5439	5.71	3.62^{ghi}
6. Fowl pox	140	0.14	0.80^{i}
7. Avian Leucosis complex	7209	7.56	15.88^{b}
8. Hepatitis	533	0.55	2.82^{ghi}
9. Coccidiosis	5715	6.00	12.30^{cd}
10. Spirochaetosis	5675	5.95	5.67^{fg}
11. Parasites (Endoparasities)	1426	1.49	6.17^{fg}
12. Low vitality	3733	3.91	10.15^{de}
13. Packing	2642	2.77	9.78^{def}
14. Egg bound	863	0.90	4.97^{gh}
15. Climatic stress	412	0.44	1.74^{hi}
16. Others	2619	2.74	8.95^{ef}
17. Unspecified	209	0.21	1.96^{hi}

Mean transformed values superscripted by different letters differed significantly

4.2 NON-GENETIC FACTORS AFFECTING MORTALITY PATTERN IN DIFFERENT GENETIC GROUPS OF CHICKEN

4.2.1 Effect of Season : The effect of season was found to be highly significant ($P < 0.01$) on mortality pattern in WLH, RIR, Deshi and crosses and it was significant ($P < 0.05$) in BA. On the other hand, the effect was non-significant in Kadaknath and Broiler (Table 4.5).

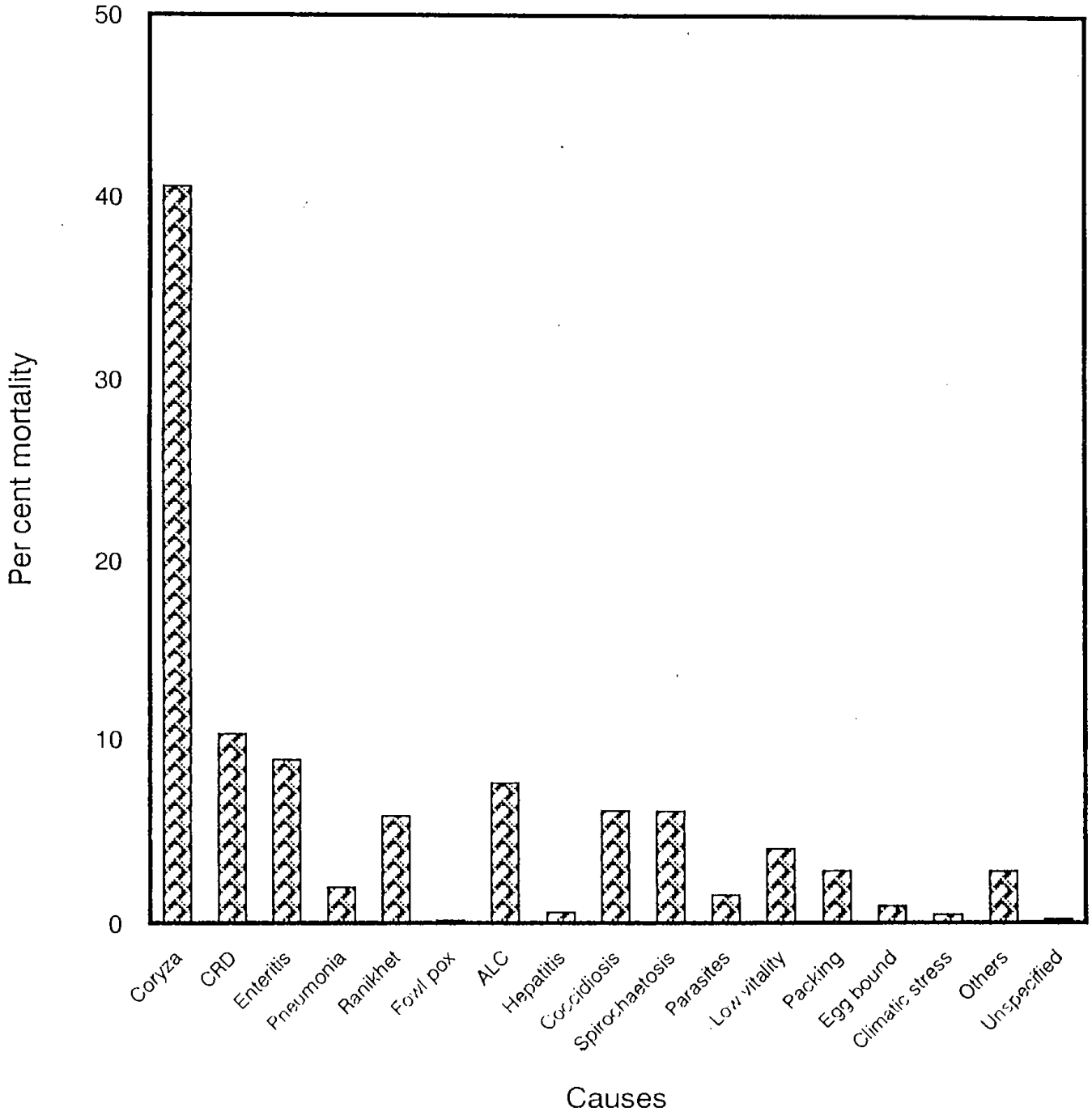

Fig.4.3: Mortality pattern across different causes in chicken

The actual frequency of mortality was higher during summer in all the genetic groups which ranged from 31.05% in Broiler to 39.91% in WLH (Fig. 4.4). Based on transformed values, the frequency of mortality during summer was significantly higher in WLH, RIR, Deshi, Crosses and BA as compared to mortality during other seasons. Likewise, mortality in WLH and RIR in rainy season was also greater than other seasons ($P < 0.05$). The differences between mortality during autumn and winter and winter and spring seasons were non-significant in WLH, RIR and Deshi, but that between Autumn and spring was significant ($P < 0.05$) in these genetic groups. The frequency of mortality was non-significant during rainy, winter and spring seasons in crosses (Table 4.6).

4.2.2 Effect of Age : The results of analysis of variance (Table 4.7) revealed that the differences in mortality pattern due to age groups were significant in White Leghorm but that were non-significant in other genetic groups. In all 39.17% mortality was observed in 0-2 months age group, while 30.18 and 30.65% mortality in 2-5 and > 5 months age groups, respectively in WLH (Table 4.8). The results of critical difference test indicated that mortality was significantly higher during 0-2 months as compared to 2-5 months age group. However, the differences in mortality during 0-2 and > 5 months and 2-5 and > 5 months were non-significant in WLH (Table 4.8). As far as the other genetic groups except RIR; is concerned, in general the frequency of mortality was also highest during 0-2 months age and lowest during 2-5 months of age groups, though the differences were non-significant (Fig. 4.5).

4.2.3 Effect of Sex : The effect of sex was significant ($P < 0.01$) on mortality pattern of all the genetic groups included in the study (Table 4.9). The actual frequency of mortality was higher during grower stage as compared to adult i.e. male and female in all the genetic groups (Fig. 4.6).

The actual frequency of mortality in different genetic groups across unsexed grower and adults (male and female) are shown in Fig. 4.6. It indicated that the highest mortality at 94.28% was observed in Broilers and lowest at 61.74% in RIR during unsexed grower stage. On the other hand, the maximum mortality at 8.02 and 30.24% was observed in males and females of RIR and minimum at 0.79 and 4.95% in Broilers respectively.

The results of critical test revealed that frequency of mortality was significantly higher in grower chicks as compared to adult male and female. The differences between adult male and female groups were also significant in all the genetic groups (Table 4.10).

4.2.4 Effect of Cause : The effect of different cause of death was highly significant in all the genetic groups included in the study (Table 4.11). The mortality pattern across different causes of death in various genetic groups are shown in Table 4.12 to 4.18. The frequency of death in WLH and RIR was highest at 36.85 and 33.10% due to Coryza and lowest at 0.14 and 0.15% due to climatic stress (Fig. 4.7 & 4.8). However, in other genetic groups viz., Kadaknath, Deshi, Black Australorp, Broiler and crosses, the mortality was maximum due to Coryza and minimum due to Fowl pox (Fig. 4.9 to 4.13).

The results of critical difference test based on transformed values indicated that significantly higher birds died due to Coryza in all the genetic groups as compared to other causes. As far as other causes/ diseases are concern, no definite trend was observed over different genetic groups.

Table 4.5 : Analysis of variance showing the effect of season on mortality pattern in different genetic groups of chicken

Genetic groups	Source of variation		Error
	Between years	Between seasons	
White Leghorn			
d.f.	35	4	140
M.S.S.	5.61	2498.06**	69.12
Rhode Island Red			
d.f.	35	4	140
M.S.S.	5.96	1706.88**	118.79
Kadaknath			
d.f.	15	4	60
M.S.S.	66.86	1091.70	540.10
Deshi			
d.f.	22	4	88
M.S.S.	26.59	20.67.05**	306.31
Black Australorp			
d.f.	24	4	96
M.S.S.	27.25	815.34*	273.61
Broiler			
d.f.	24	4	96
M.S.S.	21.37	239.78	195.33
Crosses			
d.f.	29	4	116
M.S.S.	28.68	1068.02**	231.40

** = $P < 0.01$, * = $P < 0.05$

Table 4.6 : Mortality pattern across various seasons in different genetic groups of chicken

Genetic groups	Seasons				
	Summer	Rainy	Autumn	Winter	Spring
White Leghorn					
Actual number died	11125	7005	2231	3195	4322
Actual per cent mortality	39.91	25.13	8.00	11.46	15.50
Mean per cent mortality (Transformed values)	37.31^{a}	29.83^{b}	16.87^{d}	19.58^{cd}	22.29^{c}
Rhode Island Red					
Actual number died	3980	2519	1006	1279	1654
Actual per cent mortality	38.13	24.13	9.64	12.25	15.85
Mean per cent mortality (Transformed values)	35.81^{a}	26.34^{b}	18.18^{d}	20.23^{cd}	23.67^{c}
Kadaknath					
Actual number died	135	94	43	68	88
Actual per cent mortality	31.54	21.96	10.05	15.89	20.56
Mean per cent mortality (Transformed values)	36.57^{a}	21.96^{a}	18.20^{a}	18.31^{a}	16.27^{a}
Deshi					
Actual number died	2085	1145	309	630	1387
Actual per cent mortality	37.22	20.71	5.59	11.39	25.09
Mean per cent mortality (Transformed values)	37.50^{a}	21.10^{bc}	11.34^{c}	20.31^{bc}	24.52^{b}
Black Australorp					
Actual number died	642	374	142	232	331
Actual per cent mortality	37.30	21.73	8.25	13.49	19.23
Mean per cent mortality (Transformed values)	31.68^{a}	25.37^{b}	16.92^{b}	22.80^{b}	19.42^{b}
Broiler					
Actual number died	7018	3937	3418	4394	3835
Actual per cent mortality	31.05	17.42	15.12	19.44	16.97
Mean per cent mortality (Transformed values)	29.02^{a}	22.52^{a}	24.30^{a}	26.62^{a}	21.36^{a}
Crosses					
Actual number died	9313	5650	2979	4516	4188
Actual per cent mortality	34.95	21.20	11.18	16.95	15.72
Mean per cent mortality (Transformed values)	32.51^{a}	24.46^{bc}	16.99^{d}	27.27^{ab}	20.73^{bcd}

Mean transformed values superscripted by different letters differed significantly

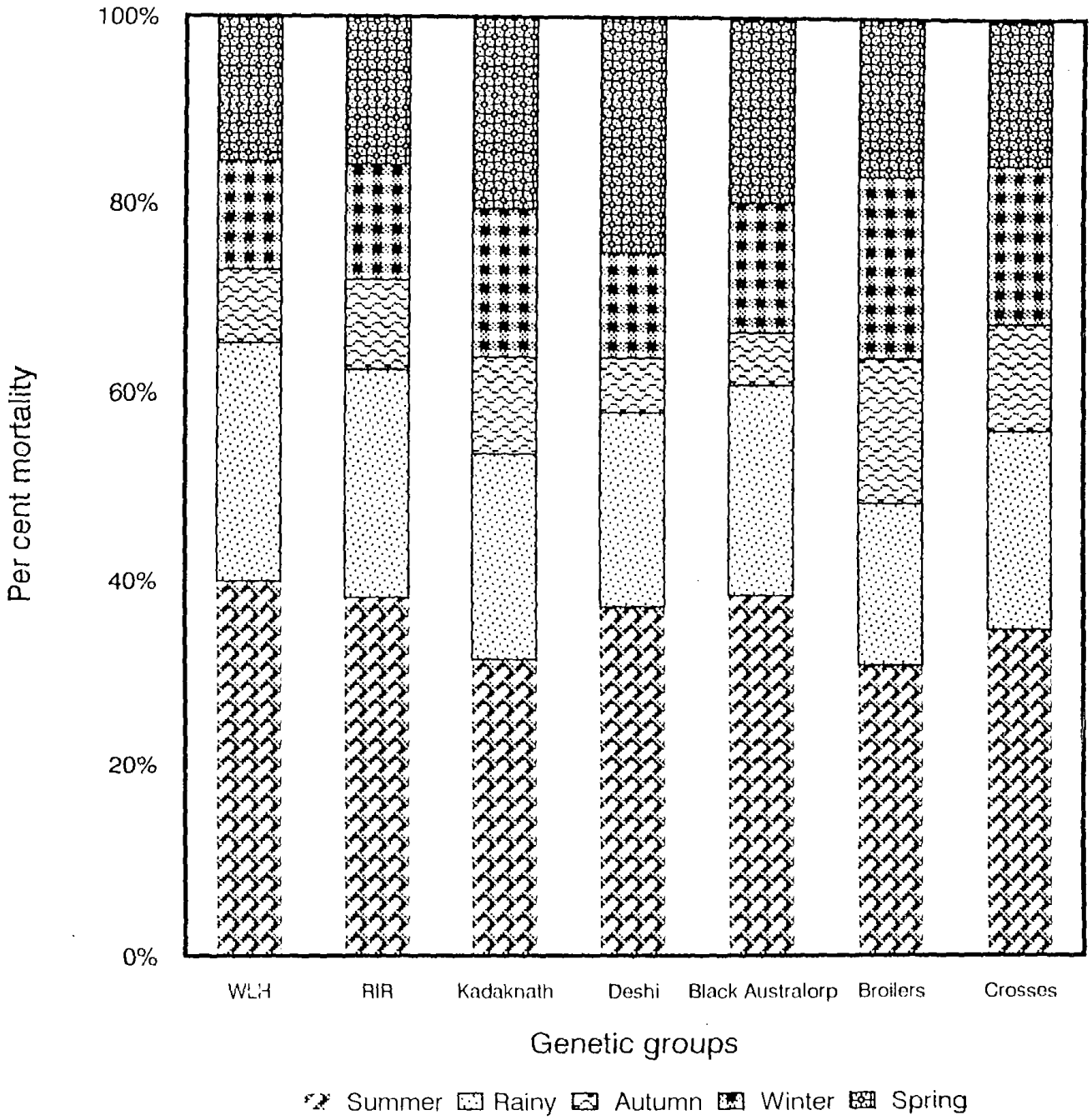

Fig.4.4: Mortality pattern across various seasons in different genetic groups of chicken

Table 4.7 : Analysis of variance showing the effect of age group on mortality pattern in different genetic groups of chicken

Genetic groups	Source of variation		Error
	Between years	Between age groups	
White Leghorn			
d.f.	35	2	70
M.S.S.	1.13	542.48**	147.33
Rhode Island Red			
d.f.	35	2	70
M.S.S.	4.28	536.78	294.85
Kadaknath			
d.f.	15	2	30
M.S.S.	16.88	1911.36	818.38
Deshi			
d.f.	22	2	44
M.S.S.	13.62	698.24	750.15
Black Australorp			
d.f.	24	2	48
M.S.S.	12.48	1301.89	665.81
Broiler			
d.f.	24	2	48
M.S.S.	4.53	6153.96	512.72
Crosses			
d.f.	29	2	58
M.S.S.	7.26	301.08	506.33

** = $P < 0.01$, * = $P < 0.05$

Table 4.8 : Mortality pattern across various age groups in different genetic groups of chicken

Genetic groups	Age groups		
	0-2 Months	2-5 Months	Over 5 Months
White Leghorn			
Actual number died	10920	8412	8546
Actual per cent mortality	39.17	30.18	30.65
Mean per cent mortality (Transformed values)	38.96[a]	31.46[b]	33.47[ab]
Rhode Island Red			
Actual number died	3541	2903	3994
Actual per cent mortality	33.93	27.81	38.26
Mean per cent mortality (Transformed values)	35.03[a]	29.96[a]	37.54[a]
Kadaknath			
Actual number died	193	122	113
Actual per cent mortality	45.09	28.50	26.41
Mean per cent mortality (Transformed values)	44.02[a]	22.18[a]	32.48[a]
Deshi			
Actual number died	2914	1237	1378
Actual per cent mortality	52.70	22.37	24.93
Mean per cent mortality (Transformed values)	37.90[a]	26.93[a]	33.34[a]
Black Australorp			
Actual number died	901	428	392
Actual per cent mortality	52.35	24.87	22.78
Mean per cent mortality (Transformed values)	36.50[a]	24.73[a]	37.84[a]
Broiler			
Actual number died	16276	5053	1273
Actual per cent mortality	72.01	22.36	5.63
Mean per cent mortality (Transformed values)	50.87[a]	25.25[a]	22.37[a]
Crosses			
Actual number died	12455	7580	6610
Actual per cent mortality	46.74	28.45	24.81
Mean per cent mortality (Transformed values)	36.97[a]	30.63[a]	33.63[a]

Mean transformed values superscripted by different letters differed significantly

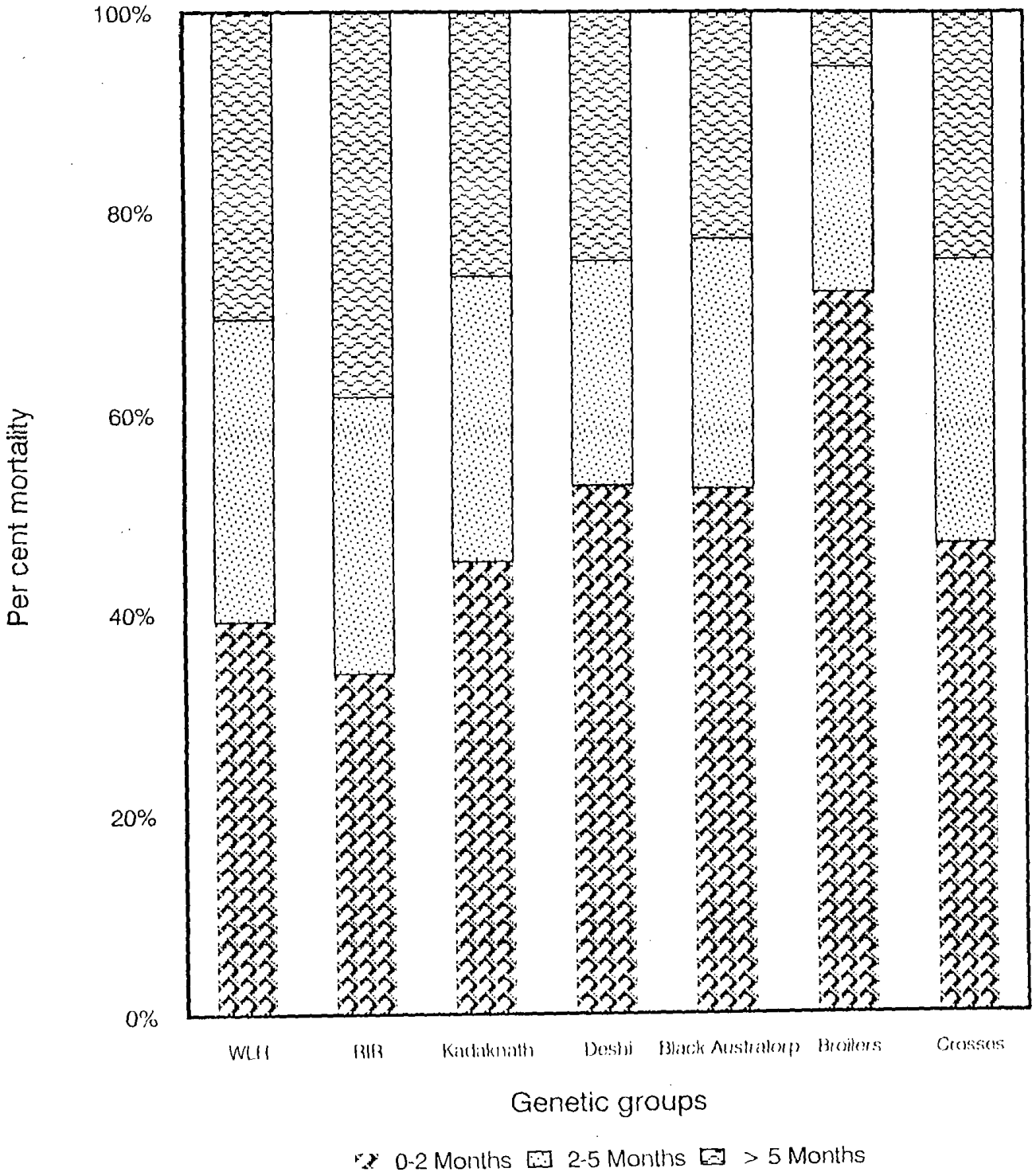

Fig.4.5: Mortality pattern across various age groups in different genetic groups of chicken

Table 4.9 : Analysis of variance showing the effect of sex on mortality pattern in different genetic groups of chicken

Genetic groups	Source of variation		
	Between years	Between sexes	Error
White Leghorn			
d.f.	35	2	70
M.S.S.	3.39	1770.20**	135.29
Rhode Island Red			
d.f.	35	2	70
M.S.S.	5.95	13778.4**	251.06
Kadaknath			
d.f.	15	2	30
M.S.S.	10.80	9949.31**	789.09
Deshi			
d.f.	22	2	44
M.S.S.	10.08	11926.40**	511.39
Black Australorp			
d.f.	24	2	48
M.S.S.	8.89	10171.90**	657.77
Broiler			
d.f.	24	2	48
M.S.S.	1.61	25546.80**	561.10
Crosses	29	2	58
d.f.	6.15	17359.20**	432.87
M.S.S.			

** = $P < 0.01$, * = $P < 0.05$

Table 4.10 : Mortality pattern across sexes in different genetic groups of chicken

Genetic groups	Sex groups		
	Unsexed grower	Male	Female
White Leghorn			
Actual number died	19148	1464	7266
Actual per cent mortality	68.68	5.26	26.06
Mean per cent mortality (Transformed values)	55.97[a]	11.78[c]	30.62[b]
Rhode Island Red			
Actual number died	6444	837	3157
Actual per cent mortality	61.74	8.02	30.24
Mean per cent mortality (Transformed values)	52.42[a]	13.29[c]	32.78[b]
Kadaknath			
Actual number died	316	22	90
Actual per cent mortality	73.83	5.14	21.03
Mean per cent mortality (Transformed values)	57.61[a]	7.85[c]	29.76[b]
Deshi			
Actual number died	4150	392	987
Actual per cent mortality	75.06	7.09	17.85
Mean per cent mortality (Transformed values)	56.67[a]	11.70[c]	27.94[b]
Black Australorp			
Actual number died	1323	66	332
Actual per cent mortality	76.87	3.84	19.29
Mean per cent mortality (Transformed values)	51.93[a]	11.59[c]	31.99[b]
Broiler			
Actual number died	21310	179	1113
Actual per cent mortality	94.28	0.79	4.93
Mean per cent mortality (Transformed values)	67.04[a]	5.52[c]	21.22[b]
Crosses			
Actual number died	20026	1408	5212
Actual per cent mortality	75.16	5.28	19.56
Mean per cent mortality (Transformed values)	56.31[a]	8.21[c]	31.23[b]

Mean transformed values superscripted by different letters differed significantly

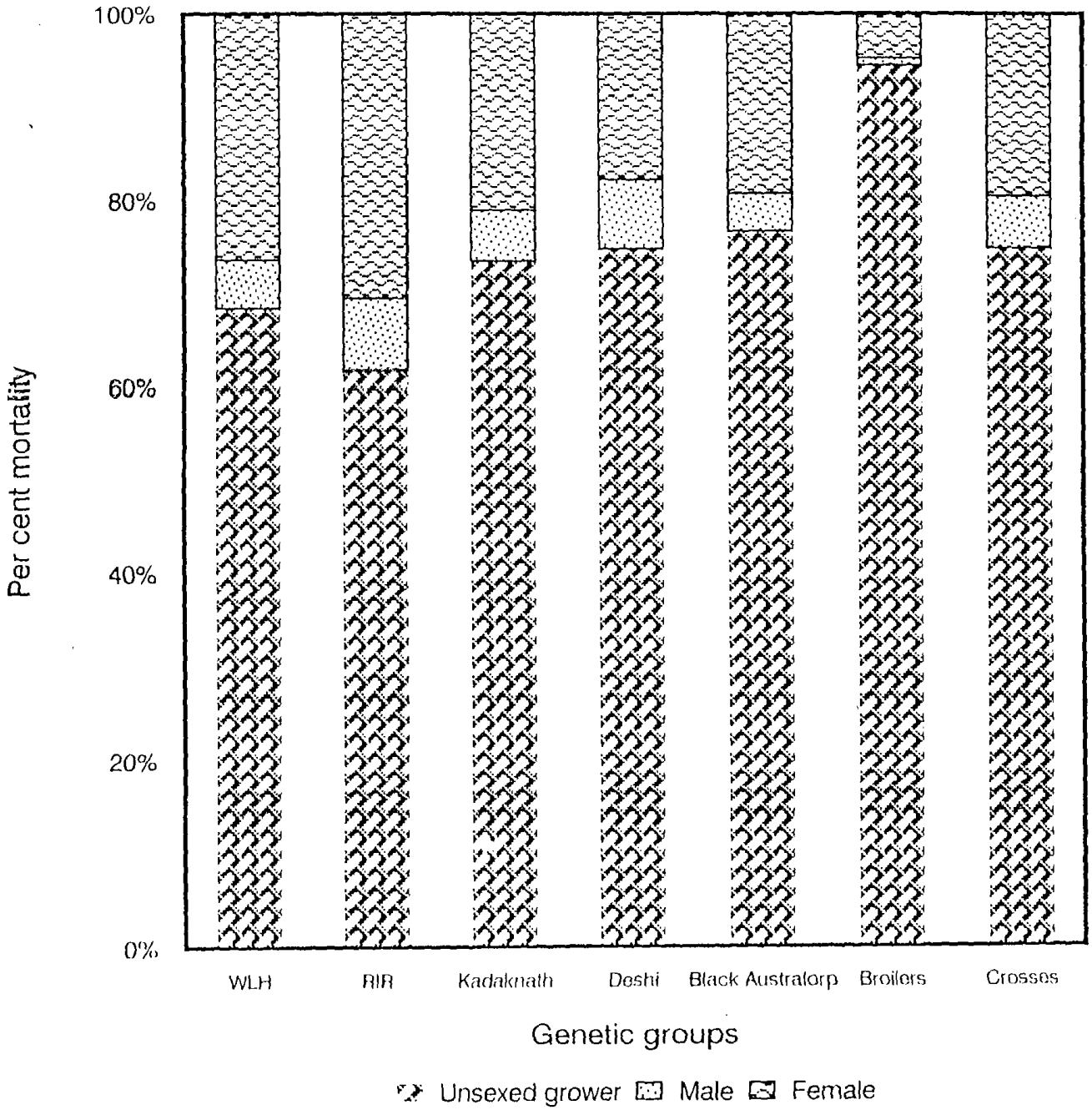

Fig.4.6: Mortality pattern across various sexes in different genetic groups of chicken

Table 4.11 : Analysis of variance showing the effect of cause of death on mortality pattern in different genetic groups of chicken

Genetic groups	Source of variation		
	Between years	Between causes	Error
White Leghorn			
d.f.	35	16	-
M.S.S.	25.76	2856.11**	54.34
Rhode Island Red			
d.f.	35	16	-
M.S.S.	27.07	2812.07**	71.19
Kadaknath			
d.f.	15	16	-
M.S.S.	37.74	1982.56**	14.00
Deshi			
d.f.	22	16	-
M.S.S.	35.77	2295.28**	24.71
Black Australorp			
d.f.	24	16	-
M.S.S.	38.72	2090.94**	22.08
Broiler			
d.f.	24	16	-
M.S.S.	22.54	2829.15**	36.54
Crosses			
d.f.	29	16	-
M.S.S.	38.05	2440.06**	37.41

** = $P < 0.01$

Table 4.12 : Mortality pattern in White Leghorn across different causes of death

Causes / Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
1. Coryza	10272	36.85	37.96^{a}
2. Chronic Respiratory disease	2195	7.87	16.00^{b}
3. Enteritis	2228	7.99	14.74^{b}
4. Pneumonia	970	3.48	7.35^{cde}
5. Ranikhet	1120	4.02	3.58^{fg}
6. Fowl pox	66	0.24	1.01^{g}
7. Avian Leucosis complex	2420	8.68	17.64^{b}
8. Hepatitis	123	0.44	2.90^{fg}
9. Coccidiosis	1677	6.02	10.66^{c}
10. Spirochaetosis	2110	7.57	5.33^{ef}
11. Parasites (Endoparasities)	641	2.30	7.12^{de}
12. Low vitality	1515	5.43	9.27^{cd}
13. Packing	974	3.49	9.85^{cd}
14. Egg bound	459	1.65	5.60^{ef}
15. Climatic stress	40	0.14	1.32^{g}
16. Others	998	3.58	9.73^{cd}
17. Unspecified	71	0.25	1.67^{g}

Mean transformed values superscripted by different letters differed significantly

Table 4.13 : Mortality pattern in Rhode Island Red across different causes of death

Causes / Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
1. Coryza	3455	33.10	37.05^{a}
2. Chronic Respiratory disease	1027	9.84	16.13^{bc}
3. Enteritis	848	8.12	13.79^{c}
4. Pneumonia	291	2.79	6.54^{def}
5. Ranikhet	396	3.79	3.09^{fgh}
6. Fowl pox	55	0.53	1.09^{h}
7. Avian Leucosis complex	1077	10.32	18.50^{b}
8. Hepatitis	44	0.42	2.01^{gh}
9. Coccidiosis	340	3.26	7.34^{de}
10. Spirochaetosis	1034	9.91	7.45^{de}
11. Parasites (Endoparasities)	144	1.38	6.40^{def}
12. Low vitality	424	4.06	8.21^{de}
13. Packing	720	6.90	9.20^{d}
14. Egg bound	167	1.60	5.05^{fg}
15. Climatic stress	17	0.15	1.06^{h}
16. Others	368	3.53	9.26^{d}
17. Unspecified	31	0.30	1.58^{gh}

Mean transformed values superscripted by different letters differed significantly

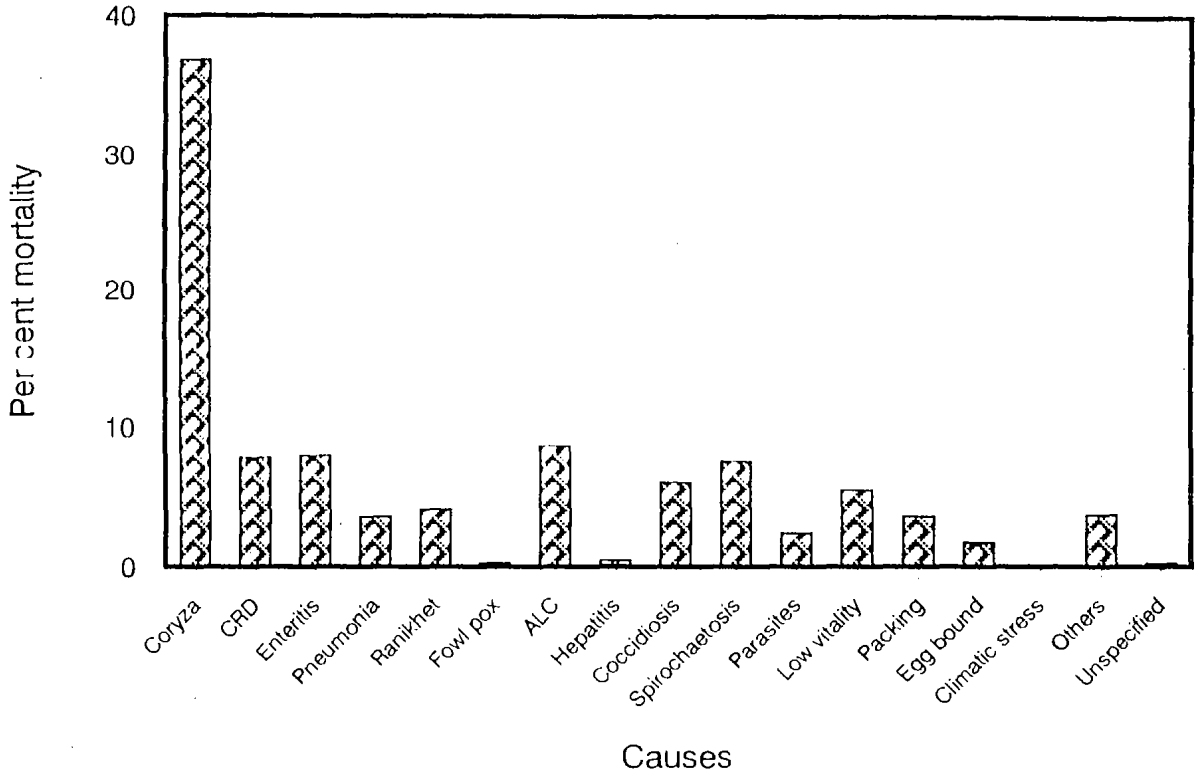

Fig.4.7: Mortality pattern in White Leghorn across different causes of death

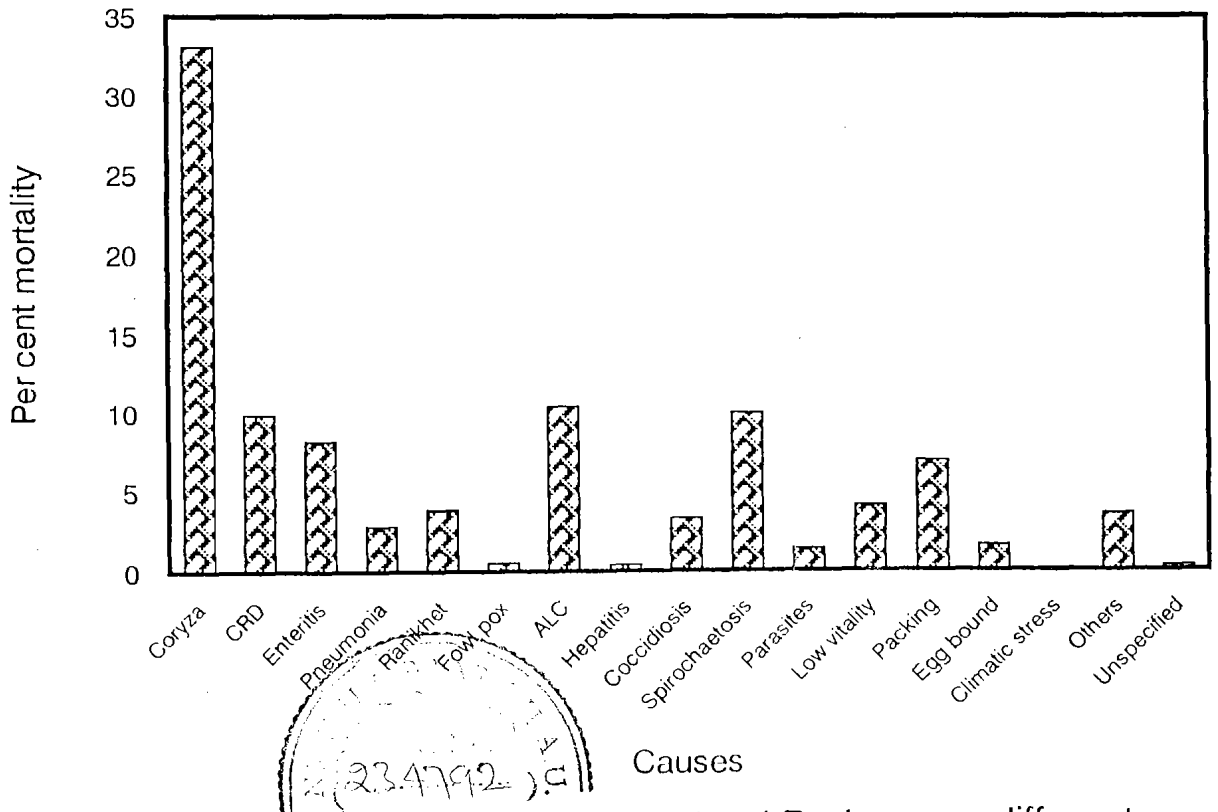

Fig.4.8: Mortality pattern in Rhode Island Red across different causes of death

Table 4.14 : Mortality pattern in Kadaknath across different causes of death

Causes / Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
1. Coryza	167	39.03	45.56^{a}
2. Chronic Respiratory disease	49	11.45	14.37^{b}
3. Enteritis	77	17.99	11.51^{bc}
4. Pneumonia	0	0.00	0.00^{d}
5. Ranikhet	15	3.50	4.86^{cd}
6. Fowl pox	0	0.00	0.00^{d}
7. Avian Leucosis complex	74	17.29	14.11^{b}
8. Hepatitis	1	0.23	1.29^{d}
9. Coccidiosis	13	3.04	3.70^{cd}
10. Spirochaetosis	0	0.00	0.00^{d}
11. Parasites (Endoparasities)	11	2.58	4.36^{cd}
12. Low vitality	2	0.46	5.62^{cd}
13. Packing	0	0.00	0.00^{d}
14. Egg bound	0	0.00	0.00^{d}
15. Climatic stress	3	0.70	2.06^{d}
16. Others	15	3.50	7.34^{bcd}
17. Unspecified	1	0.23	0.33^{d}

Mean transformed values superscripted by different letters differed significantly

Table 4.15 : Mortality pattern in Deshi across different causes of death

Causes / Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
1. Coryza	2902	52.49	42.12[a]
2. Chronic Respiratory disease	262	4.75	10.29[c]
3. Enteritis	258	4.67	11.35[c]
4. Pneumonia	186	3.36	3.96[de]
5. Ranikhet	20	0.36	1.84[e]
6. Fowl pox	1	0.02	0.49[e]
7. Avian Leucosis complex	254	4.59	18.16[b]
8. Hepatitis	8	0.14	1.49[e]
9. Coccidiosis	186	3.36	8.41[cd]
10. Spirochaetosis	470	8.50	5.39[cde]
11. Parasites (Endoparasities)	82	1.49	8.25[cd]
12. Low vitality	611	11.05	10.69[c]
13. Packing	185	3.35	8.74[cd]
14. Egg bound	29	0.52	1.78[e]
15. Climatic stress	5	0.09	0.50[e]
16. Others	62	1.12	5.39[cde]
17. Unspecified	8	0.14	1.37[e]

Mean transformed values superscripted by different letters differed significantly

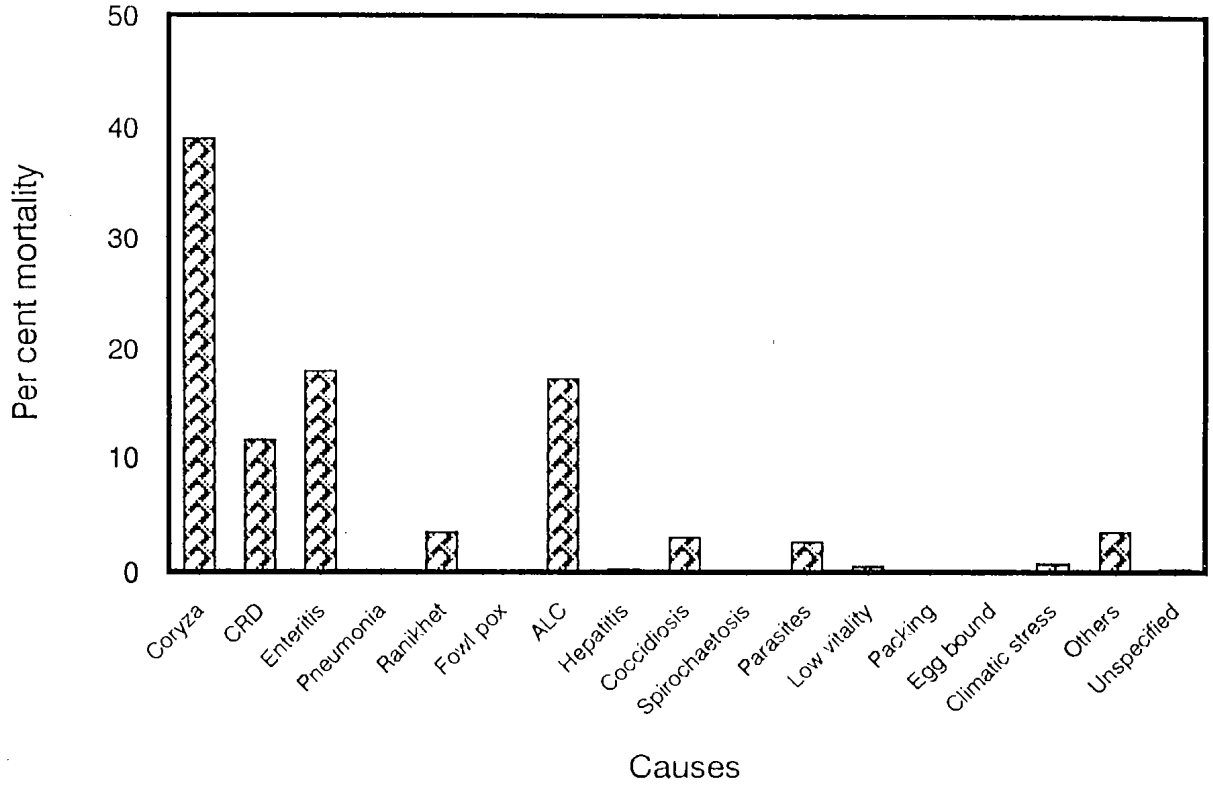

Fig.4.9: Mortality pattern in Kadaknath across different causes of death

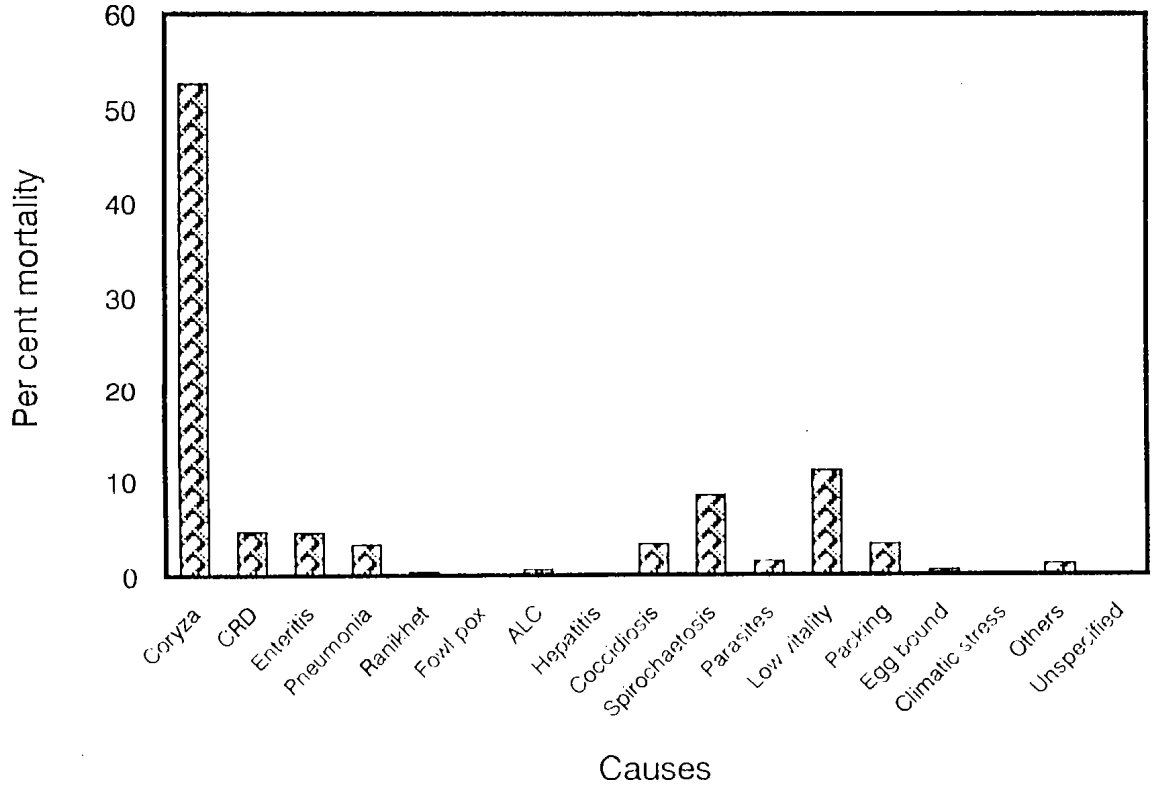

Fig.4.10: Mortality pattern in Deshi across different causes of death

Table 4.16 : Mortality pattern in Black Australorp across different causes of death

Causes / Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
1. Coryza	719	41.78	34.69^{a}
2. Chronic Respiratory disease	286	16.62	18.13^{b}
3. Enteritis	203	11.80	15.35^{bc}
4. Pneumonia	16	0.93	2.76^{efg}
5. Ranikhet	53	3.08	2.27^{fg}
6. Fowl pox	0	0.00	0.00^{g}
7. Avian Leucosis complex	164	9.53	18.37^{b}
8. Hepatitis	11	0.64	2.31^{efg}
9. Coccidiosis	119	6.90	10.99^{cd}
10. Spirochaetosis	11	0.64	1.49^{fg}
11. Parasites (Endoparasities)	22	1.28	7.76^{de}
12. Low vitality	16	0.93	2.65^{efg}
13. Packing	26	1.51	4.98^{efg}
14. Egg bound	14	0.81	3.36^{efg}
15. Climatic stress	7	0.41	0.95^{g}
16. Others	49	2.58	6.35^{def}
17. Unspecified	5	0.29	1.54^{fg}

Mean transformed values superscripted by different letters differed significantly

Table 4.17 : Mortality pattern in Broiler across different causes of death

Causes / Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
1. Coryza	11451	50.66	43.90^{a}
2. Chronic Respiratory disease	2926	12.95	19.40^{b}
3. Enteritis	2217	9.81	13.61^{bc}
4. Pneumonia	147	0.64	3.87^{def}
5. Ranikhet	1288	5.70	3.28^{def}
6. Fowl pox	12	0.05	0.49^{f}
7. Avian Leucosis complex	1005	4.45	11.20^{c}
8. Hepatitis	245	1.08	2.10^{def}
9. Coccidiosis	1763	7.80	12.95^{c}
10. Spirochaetosis	46	0.20	4.46^{def}
11. Parasites (Endoparasities)	189	0.84	3.76^{def}
12. Low vitality	546	2.42	5.74^{de}
13. Packing	126	0.56	3.87^{def}
14. Egg bound	15	0.07	0.77^{f}
15. Climatic stress	176	0.78	1.75^{def}
16. Others	413	1.83	6.23^{d}
17. Unspecified	37	0.16	1.05^{ef}

Mean transformed values superscripted by different letters differed significantly

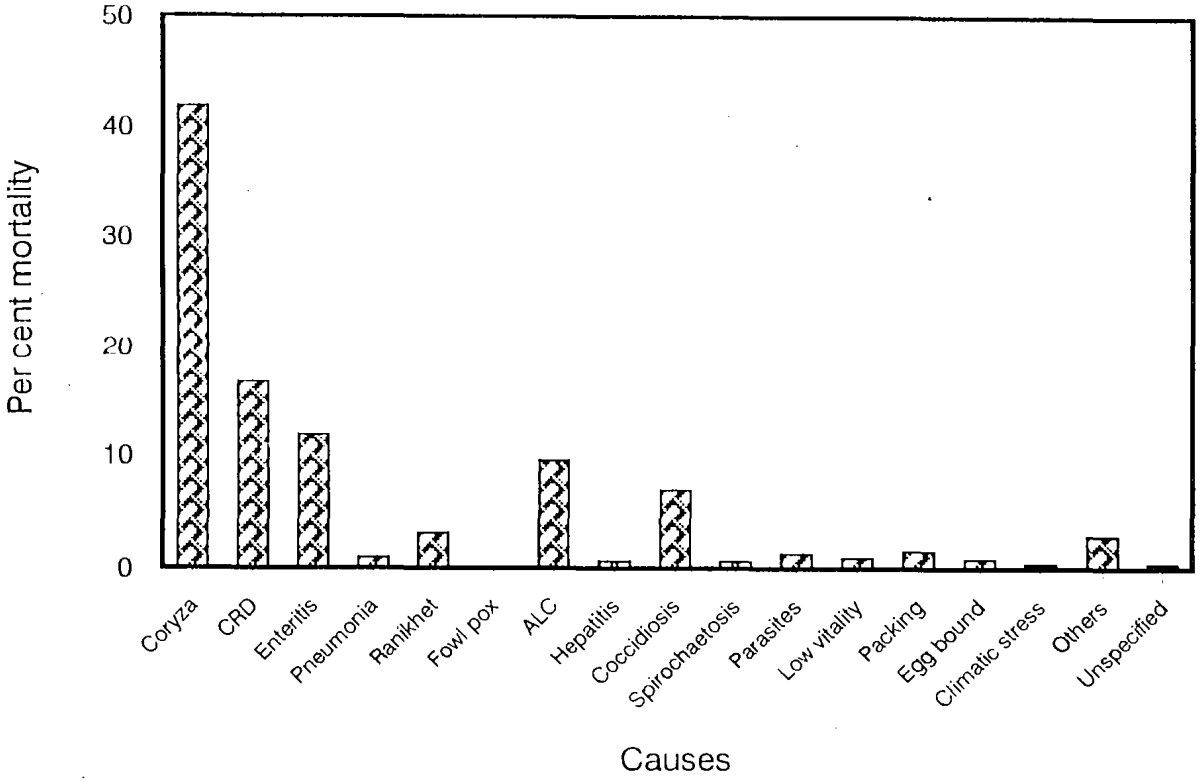

Fig.4.11: Mortality pattern in Black Australorp across different causes of death

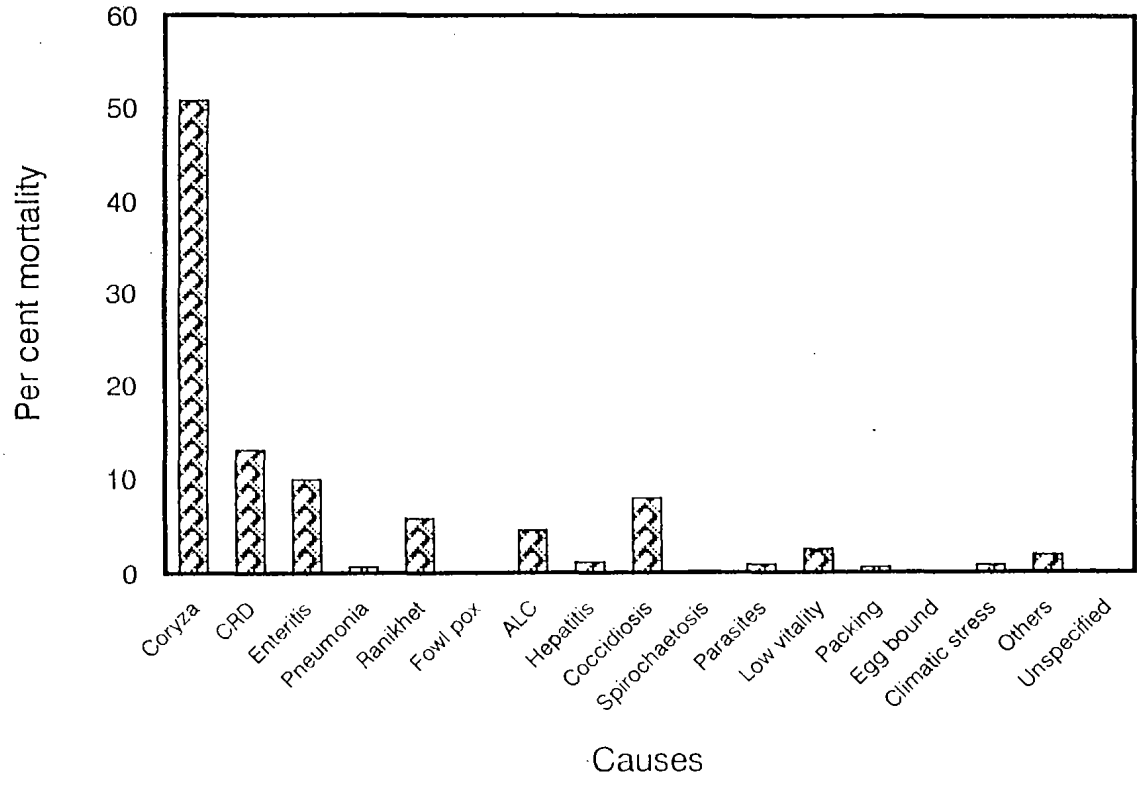

Fig.4.12: Mortality pattern in Broilers across different causes of death

Table 4.18 : Mortality pattern in Crosses across different causes of death

Causes / Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
1. Coryza	9657	36.24	37.08^{a}
2. Chronic Respiratory disease	3028	11.36	16.80^{b}
3. Enteritis	2586	9.71	14.86^{bc}
4. Pneumonia	205	0.77	3.69^{hij}
5. Ranikhet	2547	9.56	3.34^{hij}
6. Fowl pox	6	0.02	0.28^{j}
7. Avian Leucosis complex	2215	8.30	17.21^{b}
8. Hepatitis	101	0.40	2.08^{ij}
9. Coccidiosis	1617	6.07	12.55^{cd}
10. Spirochaetosis	2004	7.52	4.95^{fghi}
11. Parasites (Endoparasities)	337	1.26	6.62^{efgh}
12. Low vitality	619	2.32	8.49^{def}
13. Packing	611	2.29	9.93^{de}
14. Egg bound	179	0.67	4.16^{ghij}
15. Climatic stress	164	0.62	1.62^{ij}
16. Others	714	2.68	7.78^{efg}
17. Unspecified	56	0.21	1.86^{ij}

Mean transformed values superscripted by different letters differed significantly

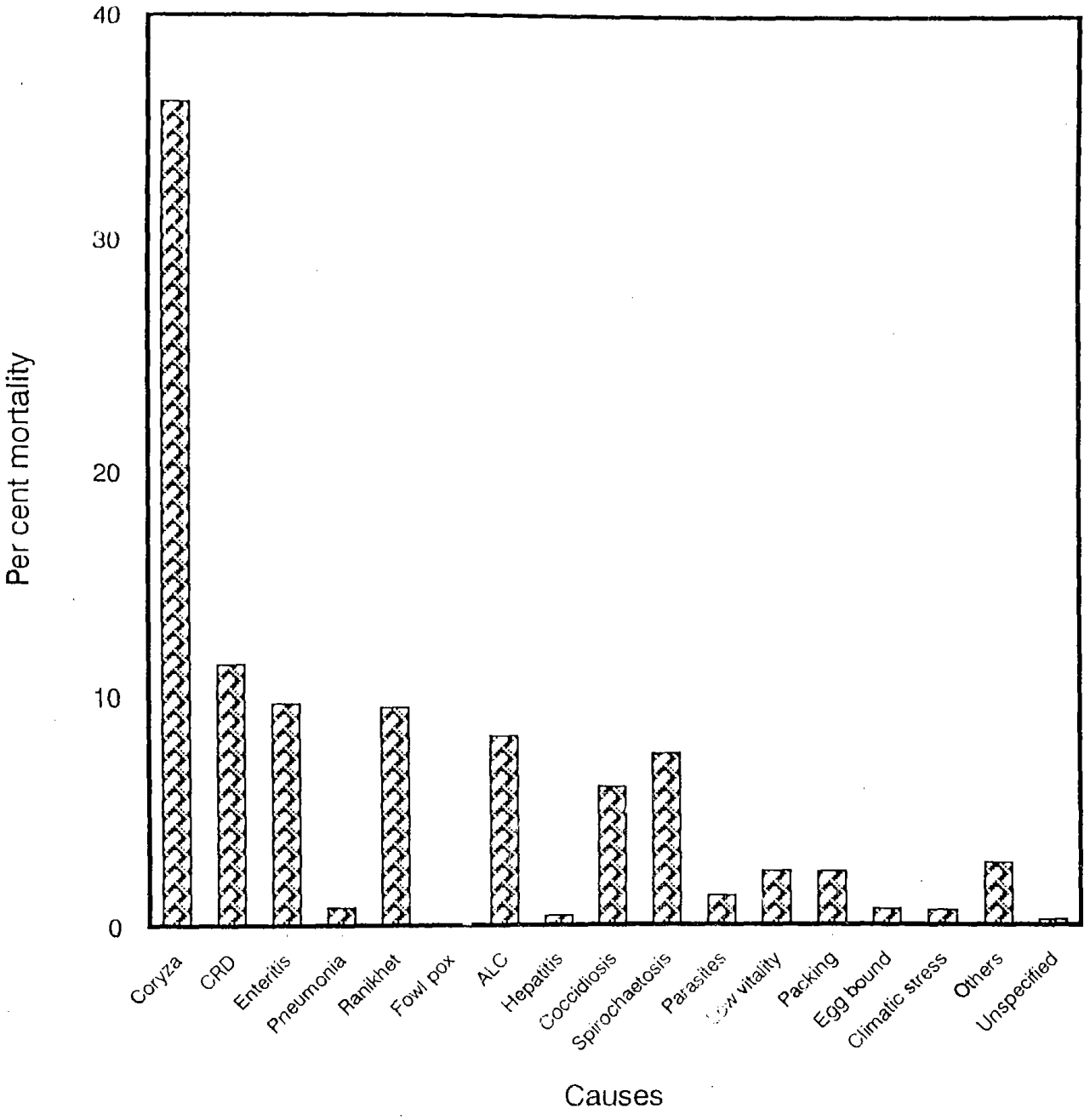

Fig.4.13: Mortality pattern in Crosses across different causes of death

4.3 NON-GENETIC FACTORS AFFECTING MORTALITY PATTERN DUE TO DIFFERENT CAUSES IN CHICKEN :

4.3.1 Effect of Season : The seasonal variations on frequency of mortality due to Coryza, Chronic Respiratory disease, Coccidiosis, Enteritis, Avian Leucosis complex, Pneumonia, Packing, Egg bound, other diseases, unspecified diseases and Spirochaetosis were significant. However, mortality pattern was unaffected by season due to Ranikhet, Fowl pox, Hepatitis, Low vitality, Parasites and Climatic stress (Table 4.19). The actual frequency of mortality and transformed values during different seasons due to different causes are presented in Table 4.22 to 4.38. Based on transformed values the deaths due to Coryza were significantly higher during summer and lower during autumn season. However, the differences in frequency of mortality between rainy, winter and spring seasons were non-significant (Table 4.22 & Fig. 4.14).

The frequency of mortality due to CRD was significantly higher during summer and rainy seasons as compared to other seasons. The differences between autumn and winter seasons were however non-significant (Table 4.23 & Fig. 4.14). The deaths due to Coccidiosis occurred more frequently during rainy season, which did not significantly differ from frequency of mortality during spring season (Table 4.24). Summer, winter and autumn season showed similar mortality pattern due to Coccidiosis (Fig. 4.14).

Based on the transformed values, the frequency of mortality due to Enteritis was significantly higher in summer and rainy season as compared to autumn, winter and spring seasons. However, the differences between these three seasons were non-significant (Table 4.25).

The actual frequency of mortality due to Avian Leucosis Complex (Fig. 4.14) was higher during rainy season (31.26%) closely followed by Summer (30.32%) while it was lowest during Winter (11.68%). However, based on transformed values the mortality due to Avian Leucosis Complex was significantly higher during rainy season as compared to spring season. The differences between summer, autumn and winter seasons were non-significant (Table 4.28).

The death due to Pneumonia was significantly higher during autumn season as compared to rainy, summer and spring seasons. However, the differences between winter and autumn season on one hand and winter and summer on the other were non-significant. The per cent mortality due to Pneumonia was significantly lower during rainy and spring seasons. However, the differences between rainy, spring and summer seasons were non-significant (Table 4.29).

The mortality due to packing was significantly higher during summer season as compared to other seasons. However, differences between rainy, autumn, winter and spring seasons were non-significant (Table 4.32).

Like packing, the mortality due to Egg bound was also significantly higher during summer season than other seasons. The variations among rainy, autumn, winter and spring seasons were, however, non-significant (Table 4.33).

The frequencies of birds died due to other cause/ diseases than that included in the study such as crop impaction, Ricket, Haemorrhagic diseases, etc. was significantly higher during summer as compared to other seasons. The death during rainy on one hand and autumn, winter and spring on the other were also significant (Table 4.35).

The exact cause of death was not diagnosed in 209 birds out of 95242 deaths. This was included in unspecified group of cause of death. Based on the transformed values, the frequency of such deaths was significantly higher during summer as compared to rainy, autumn, winter and spring seasons. The differences between these seasons were non-significant (Table 4.36).

The results of critical difference test indicated that the deaths due to Spirochaetosis were significantly lower during winter season as compared to summer and rainy season. The frequency of mortality during summer, rainy, autumn and spring on one hand and autumn, winter and spring on the other were non-significant (Table 4.37).

Though the seasonal differences in mortality due to Ranikhet, Fowl Pox, Hepatitis, Low vitality, Parasites and climatic stress were non-significant but based on actual frequency data the frequency of birds died due to Ranikhet disease was highest during summer at 80.71% and lowest during autumn seasons at 0.04% (Table 4.26 & Fig. 4.14)).

The incidence of Fowl Pox was higher at 57.14% during rainy while no birds died during autumn and winter seasons (Fig. 4.14). The death due to Hepatitis was higher at 31.90% during both summer and spring seasons while lower at 8.26% during winter season (Table 4.30 & Fig. 4.14). The death due to low vitality (Table 4.31) was more frequent (29.76%) in summer while less frequent during autumn season (8.25%). Higher mortality at 29.38% due to Parasites was observed during summer and lower at 12.83% during rainy seasons (Table 4.34). As far as deaths due to climatic stress are concerned among the total death maximum at 66.02% was found during summer and minimum at 2.67% during spring season (Table 4.38 & Fig. 4.14).

4.3.2 Effect of Age : The analysis of variance showing the effect of age on mortality pattern due to different causes are given in Table 4.20. The differences due to age groups were highly significant with respect to mortality due to Coryza, Coccidiosis, Avian Leucosis Complex, Hepatitis, Low vitality, Egg bound, Parasitic, Spirochaetosis and other diseases. However, its effect was non-significant in mortality due to chronic Respiratory disease, Enteritis, Ranikhet, Fowl pox, Pneumonia, Packing, unspecified factors and climatic stress.

The actual number of death, frequency of death and transformed values of per cent mortality due to different causes across various age groups is given in Table 4.22 to 4.38.

In all 65.62% of actual deaths were observed due to Coryza in chicks between 0-2 months of age group (Fig. 4.15). Based on transformed values, the mortality was significantly higher in 0-2 months age group as compared to 2-5 and above 5 months age groups. However, differences in mortality pattern between 2-5 and above 5 months were also significant (Table 4.22).

Among the total birds died due to Coccidiosis 57.64% was observed in 0-2 months age, 37.46% in 2-5 months age and 4.90% in above 5 months age group (Fig. 4.15). Based on transformed values significantly lower mortality was observed in age group of birds over 5 months as compared to birds below 5 months of age. The variation in mortality during 0-2 and 2-5 months were however, non-significant (Table 4.24).

In all maximum mortality (61.85 %) due to Avian Leucosis Complex was observed in birds above 5 months age group while minimum at 8.34% in 0-2 months age group (Fig. 4.15). The critical difference test on transformed values revealed that mortality was

significantly higher in birds above 5 months age group as compared to those of 0-2 and 2-5 months age groups. However, the difference between 0-2 and 2-5 months age group were also significant (Table 4.28).

The actual frequency of death due to Hepatitis across different age group showed that maximum per cent mortality (53.66%) was observed in birds above 5 months of age while minimum (12.57%) in 2-5 months age group (Fig. 4.15). The mortality due to Hepatitis was significantly higher in above 5 months age groups than below 5 months age groups. However, differences in mortality between 0-2 and 2-5 months age groups were non-significant (Table 4.30).

The incidence of mortality due to low vitality was highest at 86.71% during 0-2 months age while lowest at 3.08% in above 5 months age group (Fig. 4.15). Based on transformed values the mortality with respect to low vitality was significantly higher in 0-2 months age as compared to 2-5 and above 5 months age groups. The differences between these two groups were however, non-significant (Table 4.31).

The frequency of mortality due to egg bound as expected was 99.07% in above 5 months age group (Fig. 4.15) which was significantly different the other groups (Table 4.33). In all 69.57% mortality due to parasites was observed in the age group over 5 months while 19.07 and 11.36 %, respectively, in 2-5 and 0-2 months age groups (Fig. 4.15). The critical test on transformed values also indicated that mortality was significantly lower upto 5 months of age group as compared to birds over 5 months of age. The variation in mortality between 0-2 and 2-5 months of age groups was however, non-significant (Table 4.34).

The mortality due to diseases other than that included in the present study were higher (38.45%) in birds over 5 months age group than 2-5 (26.27%) and 0-2 months (35.28%) age groups (Fig. 4.15). The critical difference results showed that mortality due to above reasons were significantly lower during 0-2 and 2-5 months age groups than over 5 months age groups. The differences in mortality between 0-2 and 2-5 months age groups were however non-significant (Table 4.35).

Among the total birds died due to Spirochaetosis more than 60% mortality was observed in over 5 months age groups (Fig. 4.15). Based on transformed values, the mortality due to Spirochaetosis was significantly higher in more than 5 months age as compared to 0-2 and 2-5 months of age groups. However, differences in mortality between 0-2 and 2-5 months age groups were non-significant (Table 4.37).

The effect of age was non-significant on mortality due to Chronic Respiratory Disease, Enteritis, Ranikhet, Fowl Pox, Climatic stress, Pneumonia and Packing (Table 4.20). But based on actual frequency of birds died due to Chronic Respiratory Disease, Enteritis, Ranikhet, Fowl Pox and climatic stress was higher in 0-2 months age group and lower in over 5 months age group. However, the reverse trend was observed in frequency of birds died due to Pneumonia and Packing (Table 4.22 to 4.38 & Fig. 4.15).

4.3.3 Effect of Sex : The analysis of variance showing the effect of sex and year on mortality pattern due to different causes are shown in Table 4.21. The frequency of mortality due to causes included in the study was affected significantly ($P < 0.01$) by sex while year had no effect. The frequency of mortality due to Coryza, CRD, Coccidiosis, Enteritis, RD, Pneumonia, Hepatitis, Low Vitality, Packing, others, unspacified and climatic stress were maximum in unsexed growers and

minimum in males, while mortality due to Fowl Pox was maximum in growers and minimum in females (Fig. 4.16).

The ALC, Parasites and Spiroehaetosis was more pronounced in female and less in males. As expected the death due to egg bound was maximum (99.07%) in females and very few (0.93%) during grower stage (Fig. 4.16). Based on transformed values the death due to Coryza, CRD, Coccidiosis, Enteritis, Pneumonia Low Vitality and Packing were significantly higher during grower stage as compared to adults i.e., male and females. The differences between male and female were also significant (Table 4.22 to 4.38). The occurrence of death due to RD and Fowl Pox was also significantly higher during grower than male and female but the differences in mortality between males and females were non-significant (Table 4.26 and 4.27).

The mortality due to ALC and Parasites were significantly higher in females as compared to unsexed growers and males. The unsexed grower encountered significantly higher mortality than females (Table 4.28 and 4.34). Based on transformed values, the mortality due to Hepatitis, other diseases, unspecified and climatic stress were significantly higher in grower and females as compared to males. The differences between grower and female were however non-significant (Table 4.30, 4.35, 4.36 and 4.38). The occurrence of mortality due to spirochaetosis was significantly higher in females than males. The variation in mortality among grower and males; grower and females were non-significant (Table 4.37).

Table 4.19 : Analysis of variance showing the effect of season on mortality pattern due to different causes/diseases

Causes/ Diseases	Source of variation		
	Between years	Between seasons	Error
1. Coryza			
d.f.	35	4	140
M.S.S.	10.32	659.52**	111.78
2. Chronic Respiratory disease			
d.f.	32	4	128
M.S.S.	26.62	1269.11**	241.03
3. Enteritis			
d.f.	35	4	140
M.S.S.	16.02	665.74**	204.39
4. Pneumonia			
d.f.	30	4	120
M.S.S.	37.72	3130.33**	460.35
5. Ranikhet			
d.f.	15	4	60
M.S.S.	19.63	1366.56	1242.26
6. Fowl Pox			
d.f.	4	4	16
M.S.S.	0.00	1630.81	1124.97
7. Avian Leucosis Complex			
d.f.	35	4	140
M.S.S.	18.52	1339.83**	137.49
8. Hepatitis			
d.f.	19	4	76
M.S.S.	36.51	1484.22	715.69
9. Coccidiosis			
d.f.	20	4	120
M.S.S.	26.13	1699.45**	476.75
10. Spirochastosis			
d.f.	16	4	64
M.S.S.	31.68	2291.90*	818.46
11. Parasites (Endoparasities)			
d.f.	29	4	116
M.S.S.	27.35	373.61	267.71
12. Low Vitality			
d.f.	28	4	112
M.S.S.	34.95	756.10	342.56
13. Packing			
d.f.	29	4	116
M.S.S.	40.95	1316.84**	377.82
14. Egg Bound			
d.f.	29	4	116
M.S.S.	42.80	961.55*	303.65
15. Climatic Stress			
d.f.	20	4	80
M.S.S.	10.02	1369.68	974.54
16. Others			
d.f.	30	4	120
M.S.S.	16.37	1654.37**	155.23
17. Unspecified			
d.f.	19	4	76
M.S.S.	34.31	2751.73*	923.62

** = $P < 0.01$, * = $P < 0.05$

Table 4.20 : Analysis of variance showing the effect of age on mortality pattern due to different causes/diseases

Causes/ Diseases	Source of variation		
	Between years	Between age groups	Error
1. Coryza			
d.f.	35	2	70
M.S.S.	2.23	12624.70**	79.91
2. Chronic Respiratory disease			
d.f.	32	2	64
M.S.S.	8.12	335.37	466.64
3. Enteritis			
d.f.	35	2	70
M.S.S.	5.13	98.79	344.70
4. Pneumonia			
d.f.	30	2	60
M.S.S.	12.79	877.93	748.84
5. Ranikhet			
d.f.	16	2	32
M.S.S.	188.28	24.81	1242.67
6. Fowl Pox			
d.f.	4	2	8
M.S.S.	2.55	3776.97	1195.28
7. Avian Leucosis Complex			
d.f.	35	2	70
M.S.S.	4.37	12608.60**	297.55
8. Hepatitis			
d.f.	19	2	38
M.S.S.	12.30	6945.25**	1084.43
9. Coccidiosis			
d.f.	30	2	60
M.S.S.	7.01	6886.57**	494.18
10. Spirochastosis			
d.f.	16	2	32
M.S.S.	12.63	8998.41**	369.19
11. Parasites (Endoparasities)			
d.f.	30	2	60
M.S.S.	113.49	16495.90**	228.85
12. Low Vitality			
d.f.	28	2	56
M.S.S.	8.1[illegible]	35141.60**	244.99
13. Packing			
d.f.	29	2	58
M.S.S.	11.61	328.72	757.69
14. Egg Bound			
d.f.	30	2	60
M.S.S.	87.40	63386.80**	249.02
15. Climatic Stress			
d.f.	20	2	40
M.S.S.	7.19	3600.25	1431.20
16. Others			
d.f.	30	2	60
M.S.S.	8.14	2567.98**	377.77
17. Unspecified			
d.f.	19	2	38
M.S.S.	10.77	3055.12	1187.14

** = $P < 0.01$, * = $P < 0.05$

Table 4.21 : Analysis of variance showing the effect of sex on mortality pattern due to different causes/diseases

Causes/ Diseases	Source of variation		
	Between years	Between sexs	Error
1. Coryza			
d.f.	35	2	70
M.S.S.	3.96	42728.10**	76.38
2. Chronic Respiratory disease			
d.f.	32	2	64
M.S.S.	7.79	15570.60**	419.00
3. Enteritis			
d.f.	35	2	70
M.S.S.	6.98	18691.20**	286.57
4. Pneumonia			
d.f.	30	2	60
M.S.S.	13.81	11668.40**	567.94
5. Ranikhet			
d.f.	15	2	30
M.S.S.	6.16	9210.26**	1095.66
6. Fowl Pox			
d.f.	4	2	8
M.S.S.	0.90	12548.80**	17.25
7. Avian Leucosis Complex			
d.f.	35	2	70
M.S.S.	2.65	7807.36**	288.08
8. Hepatitis			
d.f.	19	2	38
M.S.S.	11.40	8951.37**	1043.51
9. Coccidiosis			
d.f.	30	2	60
M.S.S.	4.21	43102.40**	230.63
10. Spirochastosis			
d.f.	16	2	32
M.S.S.	14.57	1694.22**	528.63
11. Parasites (Endoparasities)			
d.f.	30	2	60
M.S.S.	110.84	13967.20**	214.05
12. Low Vitality			
d.f.	28	2	56
M.S.S.	2.58	56461.80**	77.31
13. Packing			
d.f.	29	2	58
M.S.S.	10.56	10760.90**	581.52
14. Egg Bound			
d.f.	29	2	58
M.S.S.	2.04	41943.70**	578.42
15. Climatic Stress			
d.f.	20	2	40
M.S.S.	3.61	12484.70**	1143.89
16. Others			
d.f.	30	2	60
M.S.S.	10.10	10602.30**	443.19
17. Unspecified			
d.f.	19	2	38
M.S.S.	9.45	7280.12**	1091.29

** = $P < 0.01$, * = $P < 0.05$

Table 4.22 : Mortality pattern due to Coryza across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	11125	28.80	31.75[a]
Rainy	7191	18.62	24.89[b]
Autumn	4897	12.68	17.71[c]
Winter	7442	19.27	24.76[b]
Spring	7968	20.63	25.24[b]
Age			
0 – 2 months	25344	65.62	54.42[a]
2 – 5 months	9114	23.60	28.44[b]
Over 5 months	4165	10.78	18.07[c]
Sex			
Unsexed grower	34341	88.91	71.26[a]
Male	892	2.31	7.77[c]
Female	3390	8.78	16.32[b]

Mean transformed values superscripted by different letters differed significantly

Table 4.23 : Mortality pattern due to Chronic Respiratory disease across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	4335	44.36	32.13[a]
Rainy	2409	24.65	27.38[ab]
Autumn	776	7.94	17.59[c]
Winter	1040	10.64	18.41[c]
Spring	1212	12.41	21.65[bc]
Age			
0 – 2 months	4782	48.94	36.29[a]
2 – 5 months	2835	29.01	29.97[a]
Over 5 months	2155	22.05	33.88[a]
Sex			
Unsexed grower	7611	77.89	55.63[a]
Male	412	4.21	12.51[c]
Female	1749	17.90	29.55[b]

Mean transformed values superscripted by different letters differed significantly

Table 4.24 : Mortality pattern due to Enteritis across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	2867	34.06	28.23^{ab}
Rainy	2061	24.49	28.78^{a}
Autumn	897	10.66	18.79^{c}
Winter	1301	15.46	21.72^{c}
Spring	1291	15.33	23.03^{abc}
Age			
0 – 2 months	3811	45.28	35.28^{a}
2 – 5 months	3257	38.70	34.17^{a}
Over 5 months	1349	16.02	32.02^{a}
Sex			
Unsexed grower	7067	83.96	57.79^{a}
Male	255	3.03	13.35^{c}
Female	1095	13.01	26.81^{b}

Mean transformed values superscripted by different letters differed significantly

Table 4.25 : Mortality pattern due to Pneumonia across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	156	8.60	17.89b^{c}
Rainy	164	9.03	12.66^{c}
Autumn	604	33.28	37.21^{a}
Winter	704	38.79	26.55^{ab}
Spring	187	10.30	15.07^{c}
Age			
0 – 2 months	439	24.19	27.67^{a}
2 – 5 months	628	34.60	32.61^{a}
Over 5 months	748	41.21	38.31^{a}
Sex			
Unsexed grower	1054	58.07	50.97^{a}
Male	212	11.68	12.22^{c}
Female	549	30.25	33.28^{b}

Mean transformed values superscripted by different letters differed significantly

Table 4.26 : Mortality pattern due to Ranikhet across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	4390	80.71	14.78[a]
Rainy	239	4.39	22.35[a]
Autumn	2	0.04	8.43[a]
Winter	391	7.19	16.08[a]
Spring	417	7.67	32.87[a]
Age			
0 – 2 months	2955	54.33	30.61[a]
2 – 5 months	1398	25.70	28.31[a]
Over 5 months	1086	19.97	30.09[a]
Sex			
Unsexed grower	4345	79.89	57.40[a]
Male	105	1.93	10.62[b]
Female	989	18.18	24.73[b]

Mean transformed values superscripted by different letters differed significantly

Table 4.27 : Mortality pattern due to Fowl pox across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	52	37.14	33.78[a]
Rainy	80	57.14	38.19[a]
Autumn	0	0.00	0.00[a]
Winter	0	0.00	0.00[a]
Spring	8	5.72	17.99[a]
Age			
0 – 2 months	112	80.00	33.40[a]
2 – 5 months	26	18.57	56.26[a]
Over 5 months	2	1.43	1.54[a]
Sex			
Unsexed grower	137	97.86	88.08[a]
Male	2	1.43	1.54[b]
Female	1	0.71	1.08[b]

Mean transformed values superscripted by different letters differed significantly

Table 4.28 : Mortality pattern due to Avin Leucosis Complex across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	2186	30.32	30.81^{ab}
Rainy	2253	31.26	31.76^{a}
Autumn	1026	14.23	21.78^{abc}
Winter	842	11.68	20.18^{bc}
Spring	902	12.51	18.98^{c}
Age			
0 – 2 months	601	8.34	17.54^{c}
2 – 5 months	2149	29.81	27.96^{b}
Over 5 months	4459	61.85	53.89^{a}
Sex			
Unsexed grower	2747	38.11	35.69^{b}
Male	731	10.14	17.54^{c}
Female	3731	51.75	46.71^{a}

Mean transformed values superscripted by different letters differed significantly

Table 4.29 : Mortality pattern due to Hepatitis across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	170	31.90	18.66^{a}
Rainy	64	12.01	24.94^{a}
Autumn	85	15.93	22.22^{a}
Winter	44	8.26	7.05^{a}
Spring	170	31.90	29.98^{a}
Age			
0 – 2 months	286	53.66	21.02^{b}
2 – 5 months	67	12.57	20.69^{b}
Over 5 months	180	33.77	53.13^{a}
Sex			
Unsexed grower	353	66.23	32.97^{a}
Male	22	4.13	9.41^{b}
Female	158	29.64	51.63^{a}

Mean transformed values superscripted by different letters differed significantly

Table 4.30 : Mortality pattern due to Coccidiosis across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	879	15.38	17.52^{b}
Rainy	1804	31.57	32.90^{a}
Autumn	657	11.50	14.00^{b}
Winter	1089	19.05	14.47^{b}
Spring	1286	22.50	24.33^{ab}
Age			
0 – 2 months	3294	57.64	45.21^{a}
2 – 5 months	2141	37.46	36.30^{a}
Over 5 months	280	4.90	16.12^{b}
Sex			
Unsexed grower	5406	94.59	73.74^{a}
Male	58	1.02	4.97^{c}
Female	251	4.39	14.39^{b}

Mean transformed values superscripted by different letters differed significantly

Table 4.31 : Mortality pattern due to Spirochaetosis across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	3083	54.33	31.72^{a}
Rainy	1868	32.92	30.97^{a}
Autumn	326	5.74	12.21^{ab}
Winter	124	2.19	5.20^{b}
Spring	274	4.82	21.61^{ab}
Age			
0 – 2 months	296	5.22	12.79^{b}
2 – 5 months	1757	30.96	25.30^{b}
Over 5 months	3622	63.82	57.39^{a}
Sex			
Unsexed grower	2052	36.16	32.46^{ab}
Male	1031	18.17	23.49^{b}
Female	2592	45.67	43.42^{a}

Mean transformed values superscripted by different letters differed significantly

Table 4.32 : Mortality pattern due to Parasites across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	419	29.38	28.46[a]
Rainy	183	12.83	19.63[a]
Autumn	266	18.66	25.07[a]
Winter	259	18.16	24.34[a]
Spring	299	20.97	20.82[a]
Age			
0 – 2 months	162	11.36	16.77[b]
2 – 5 months	272	19.07	19.59[b]
Over 5 months	992	69.57	58.06[a]
Sex			
Unsexed grower	430	30.15	28.49[b]
Male	90	6.31	11.65[c]
Female	906	63.54	53.82[a]

Mean transformed values superscripted by different letters differed significantly

Table 4.33 : Mortality pattern due to Low vitality across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	1111	29.76	30.60[a]
Rainy	439	11.76	17.86[a]
Autumn	308	8.25	18.67[a]
Winter	854	22.88	22.25[a]
Spring	1021	27.35	24.10[a]
Age			
0 – 2 months	3237	86.71	71.39[a]
2 – 5 months	381	10.21	15.56[b]
Over 5 months	115	3.08	7.45[b]
Sex			
Unsexed grower	3593	96.25	81.31[a]
Male	45	1.21	2.68[c]
Female	95	2.54	7.30[b]

Mean transformed values superscripted by different letters differed significantly

Table 4.34 : Mortality pattern due to Packing across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	1218	46.10	34.19[a]
Rainy	636	24.07	22.51[b]
Autumn	207	7.83	22.97[b]
Winter	244	9.24	16.52[b]
Spring	337	12.76	20.09[b]
Age			
0 – 2 months	642	24.30	31.92[a]
2 – 5 months	848	32.10	30.74[a]
Over 5 months	1152	43.60	36.97[a]
Sex			
Unsexed grower	1444	54.66	50.76[a]
Male	323	12.22	12.90[c]
Female	875	33.12	32.93[b]

Mean transformed values superscripted by different letters differed significantly

Table 4.35 : Mortality pattern due to Egg bound across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	282	32.67	32.44[a]
Rainy	191	22.13	20.71[b]
Autumn	173	20.05	23.28[b]
Winter	105	12.17	19.67[b]
Spring	112	12.98	18.23[b]
Age			
0 – 2 months	0	0.00	0.00
2 – 5 months	8	0.93	4.60[b]
Over 5 months	855	99.07	81.24[a]
Sex			
Unsexed grower	8	0.93	11.77[b]
Male	0	0.00	0.00
Female	855	99.07	73.27[a]

Mean transformed values superscripted by different letters differed significantly

Table 4.36 : Mortality pattern due to Climatic stress across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	272	66.02	30.50[a]
Rainy	25	6.07	16.16[a]
Autumn	47	11.41	22.87[a]
Winter	57	13.83	10.95[a]
Spring	11	2.67	12.55[a]
Age			
0 – 2 months	246	59.71	20.07[a]
2 – 5 months	124	30.10	26.62[a]
Over 5 months	42	10.19	45.30[a]
Sex			
Unsexed grower	369	89.56	37.19[a]
Male	7	1.70	3.24[b]
Female	36	8.74	50.53[a]

Mean transformed values superscripted by different letters differed significantly

Table 4.37 : Mortality pattern due to Others across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	1083	41.35	35.41[a]
Rainy	630	24.05	28.25[b]
Autumn	264	10.08	18.00[c]
Winter	354	13.52	20.11[c]
Spring	288	11.00	20.15[c]
Age			
0 – 2 months	924	35.28	27.17[b]
2 – 5 months	688	26.27	29.16[b]
Over 5 months	1007	38.45	43.84[a]
Sex			
Unsexed grower	1624	62.01	46.73[a]
Male	154	5.88	11.52[b]
Female	841	32.11	38.94[a]

Mean transformed values superscripted by different letters differed significantly

Table 4.38 : Mortality pattern due to Unspecified diseases across different non-genetic factors

Factors	Number died	Per cent mortality	Mean transformed values of per cent mortality
Season			
Summer	95	45.45	38.04[a]
Rainy	47	22.49	22.18[b]
Autumn	33	15.79	17.23[b]
Winter	12	5.74	8.43[b]
Spring	22	10.53	11.03[b]
Age			
0 – 2 months	67	32.05	27.64[a]
2 – 5 months	42	20.10	20.70[a]
Over 5 months	100	47.85	44.72[a]
Sex			
Unsexed grower	109	52.15	45.29[a]
Male	12	5.74	9.30[b]
Female	88	42.11	38.28[a]

Mean transformed values superscripted by different letters differed significantly

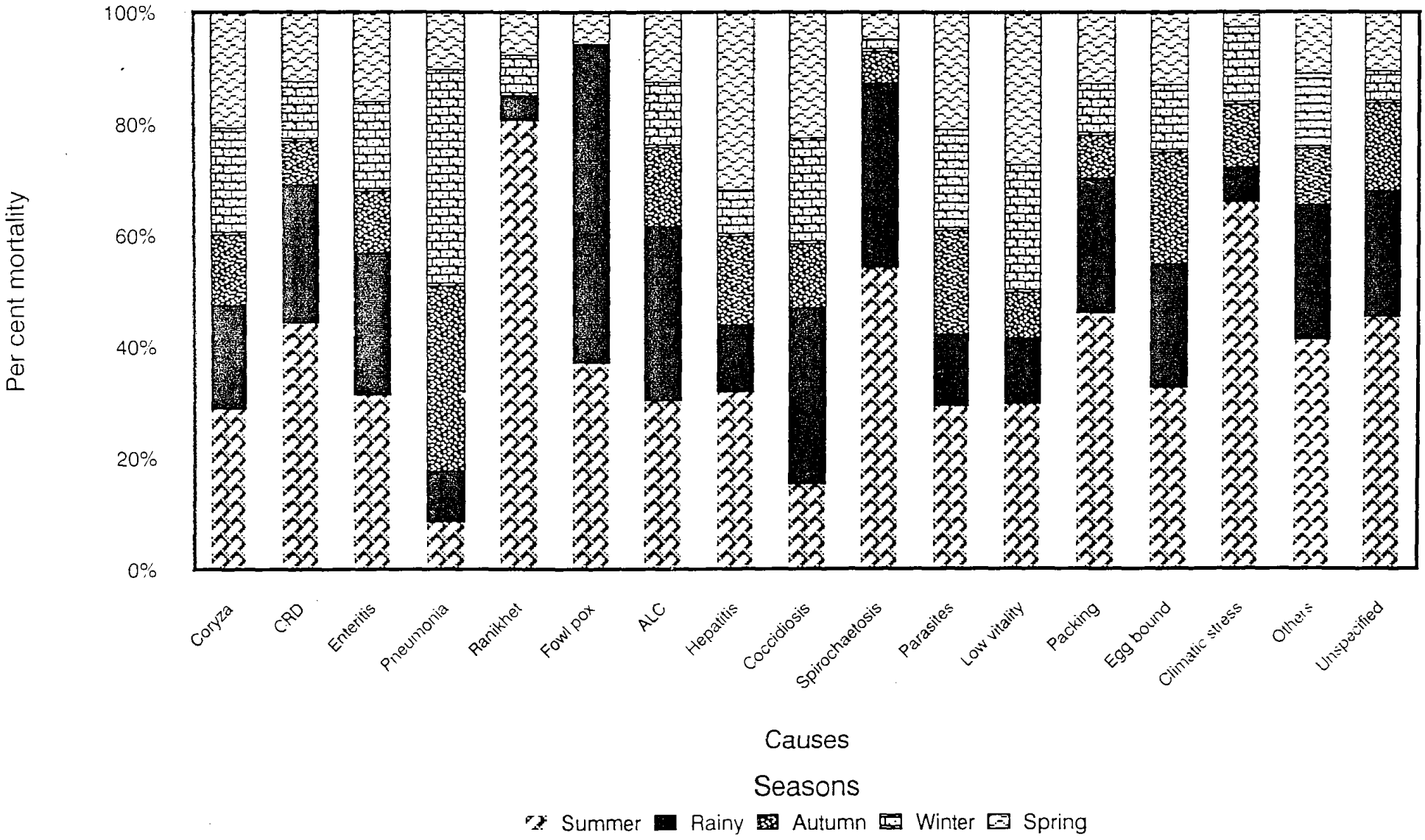

Fig. 4.14. Mortality pattern due to different causes across various seasons

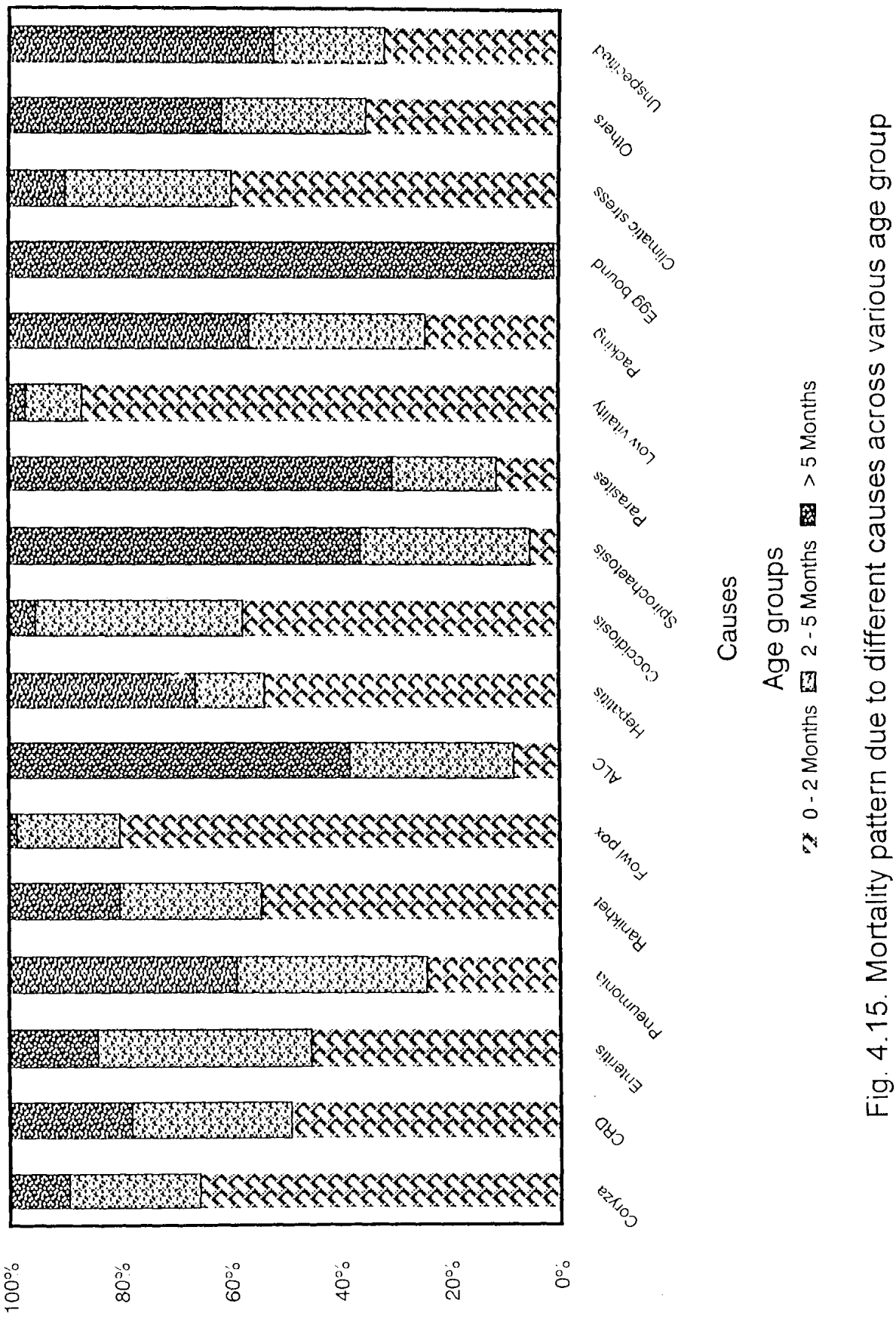

Fig. 4.15. Mortality pattern due to different causes across various age group

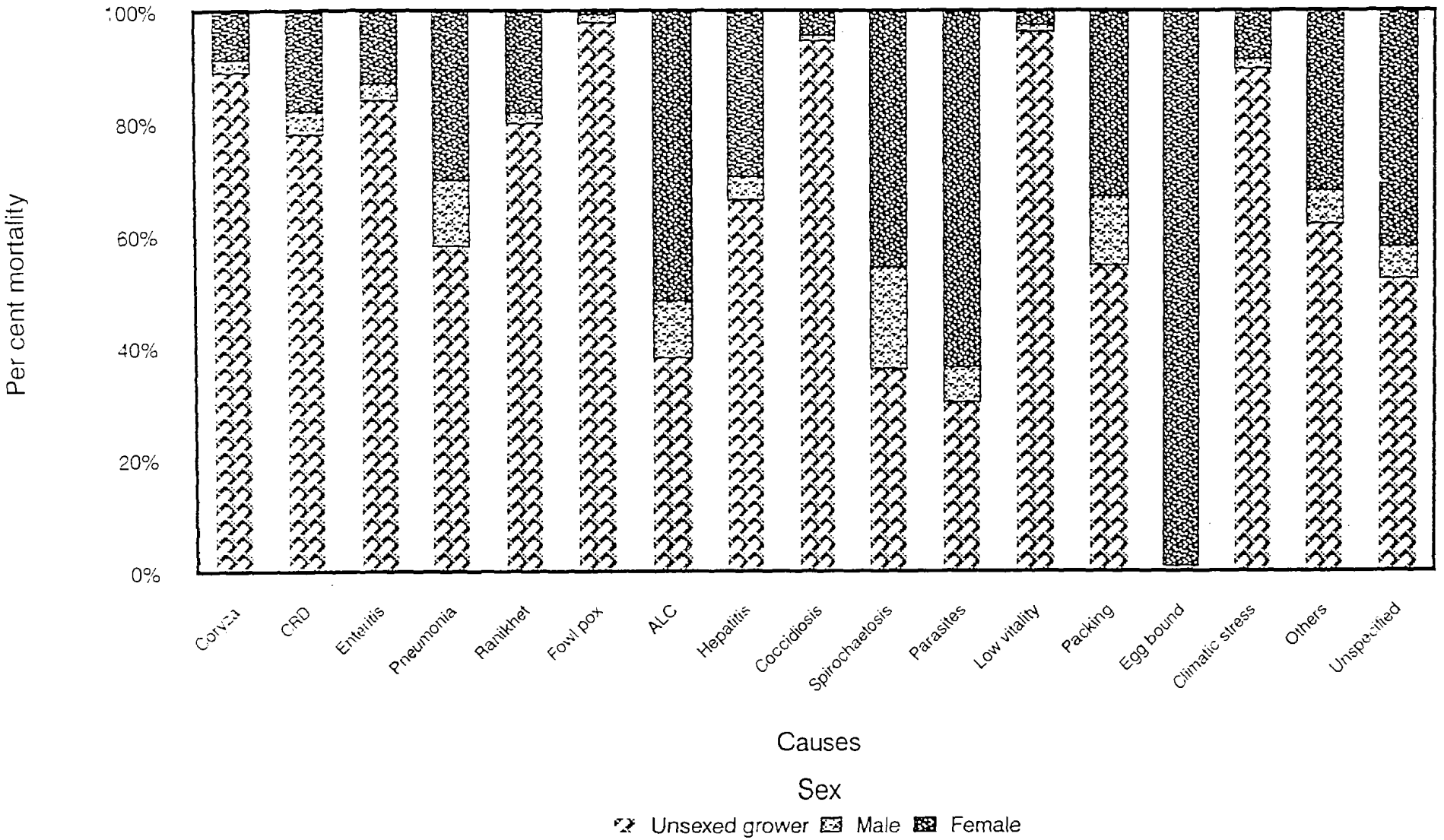

Fig. 4.16. Mortality pattern due to different causes across sexes

4.4 NON-GENETIC FACTORS AFFECTING ACTUAL MORTALITY IN CHICKEN :

4.4.1 **Effect of Season :** The analysis of variance results showing the effect of year and season across grower, male, female and total on season are presented in Table 4.39.

Table 4.39 : Analysis of variance showing the effect of year and season on mortality in grower, male, female and total

Source of variation	MSS			
	Grower	Male	Female	Total
Between years	523.47**	410.64**	251.99**	365.15**
Between seasons	2780.85**	2056.62**	1556.90**	1760.76**
Error	102.10	87.27	53.55	51.02

* $P < 0.01$, ** $P < 0.05$

The results showed that the variation due to years and seasons were highly significant in grower, adult i.e. male and female as well as in total mortality. The results of critical difference test on transformed values indicated that the mortality in unsexed grower during summer were significantly higher than autumn and winter seasons. However, differences in mortality between autumn and winter; winter spring and rainy; summer, rainy and spring seasons were non-significant. Similarly in male, the mortality was significantly higher during summer as compared to autumn, winter and spring but differences were non-significant with that of mortality during rainy season. The mortality during autumn, winter and spring on one hand and rainy and autumn seasons on the other were, however, non-significant (Table 4.40). The mortality in females and total was significantly higher during summer and rainy seasons than mortality during autumn, winter and spring seasons. The differences between summer and rainy season on one hand and autumn, winter and spring on the other were non-significant (Table 4.40). The year wise mortality are shown in Annexure I.

Table 4.40 : Per cent mortality across various seasons

Seasons	Mean per cent mortality							
	Grower		Male		Female		Total	
	Tr	Re	Tr	Re	Tr	Re	Tr	Re
Summer	17.54^{c}	9.09	12.00^{c}	4.33	15.32^{b}	6.98	19.05^{b}	10.66
Rainy	14.47^{bc}	6.25	10.70^{bc}	3.45	14.12^{b}	5.96	16.89^{b}	8.45
Autumn	7.23^{a}	1.54	6.76^{ab}	1.38	10.28^{a}	3.19	11.79^{a}	4.18
Winter	9.96^{ab}	2.99	4.30^{a}	0.56	9.06^{a}	2.48	12.39^{a}	4.61
Spring	12.93^{bc}	5.00	5.02^{a}	0.76	8.88^{a}	2.38	12.99^{a}	5.06

Tr = Transformed
Re = Retransformed
Mean transformed values superscripted by different letters differed significantly

4.4.2 Effect of Genetic Group :

The results of analysis of variance as shown in Table 4.41, depicted that variation due to years and genetic groups in unsexed grower, male, female and total were highly significant.

Table 4.41 : Analysis of variance showing the effect of year and genetic groups on mortality in grower, male, female and total

Source of variation	MSS			
	Grower	Male	Female	Total
Between years	523.47**	410.64**	251.99**	365.15**
Between genetic groups	414.07**	291.23**	274.85**	455.35**
Error	112.77	95.30	59.19	56.34

* *P < 0.01*, ** *P < 0.05*

The mortality as per cent of birds died from total number of birds exposed to risk across different genetic groups in unsexed grower, male, female and total are presented in Table 4.42.

Table 4.42 : Per cent mortality across various genetic groups

Seasons	Mean per cent mortality							
	Grower		Male		Female		Total	
	Tr	Re	Tr	Re	Tr	Re	Tr	Re
White leghorn	13.28^{ab}	5.28	8.81^{ab}	2.35	11.80^{ab}	4.19	13.72^{ab}	5.63
Rhode Island Red	10.62^{a}	3.40	7.45^{ab}	1.68	10.97^{ab}	3.63	12.93^{a}	5.01
Kadaknath	13.71^{ab}	5.62	6.26^{ab}	1.19	16.10^{b}	7.69	18.63^{d}	10.21
Deshi	14.53^{b}	6.30	9.91^{b}	2.96	12.23^{ab}	4.49	17.91^{cd}	9.46
Black Australarp	10.95^{a}	3.61	5.12^{a}	0.79	10.50^{ab}	3.32	14.46^{abc}	6.24
Broiler	10.49^{a}	3.22	7.45^{ab}	1.68	9.78^{a}	2.89	13.53^{ab}	5.47
Crosses	14.52^{b}	6.29	8.45^{ab}	2.16	12.07^{ab}	4.37	15.18^{abcd}	6.86

Tr = Transformed
Re = Retransformed
Mean transformed values superscripted by different letters differed significantly

The results of critical difference test based on transformed values (Table 4.42) indicated that mortality in RIR, BA and broilers were significantly lower during unsexed grower as compared to Deshi and Crosses. The differences between WLH, RIR, Kodaknath, BA and broilers on one hand and WLH, Kadaknath, Deshi and Crosses on the other were, however, non-significant.

In case of males the mortality was significantly lower in BA than Deshi birds. However, the differences between BA, Broilers, Crosses, WLH, RIR and Kadaknath and Deshi, Broiler, Crosses, WLH, RIR and Kadaknath were non-significant. While in females the mortality was significantly higher in Kadaknath than broiler. The differences in mortality between Broiler, Crosses, BA, Deshi, RIR and WLH and Kadaknath, Deshi, BA, Crosses, RIR and WLH were however, non-significant (Table 4.42).

The mortality over all the groups were significantly lower in RIR as compared to Kadaknath and Deshi. The variation of mortality in WLH, RIR, BA, Broiler and Crosses; WLH, BA, Broiler and crosses; Deshi, BA and crosses and Kadaknath, Deshi and crosses were however, non-significant (Table 4.42).

4.5 METEOROLOGICAL PARAMETERS :

To study the meteorological parameters across different months and seasons parameters included in the study were maximum and minimum temperature, maximum and minimum relative humidity. The averages of these parameters according to months and seasons are summarised in Appendix II and III, respectively.

4.5.1 Montlhy Variation in Meteorological Parameters : The averages of meteorological parameters across different months are shown in Fig. 4.17 & 4.18.

4.5.2 Seasonal Variation in Meteorological Parameters :

The averages of meteorological parameters across different seasons are depicted in Appendix III.

4.6 ASSOCIATION BETWEEN METEOROLOGICAL VARIABLES AND MORTALITY IN DIFFERENT GENETIC GROUPS :

The simple and partial correlation coefficients between meteorological parameters and mortality among different genetic groups are presented in Table 4.43 and 4.45, respectively, while the regression coefficients are shown in Table 4.44. The results revealed that maximum and minimum temperature had positive and significant association in Deshi while negative and significant in Broiler. Similarly, the minimum temperature had negative and significant relationship

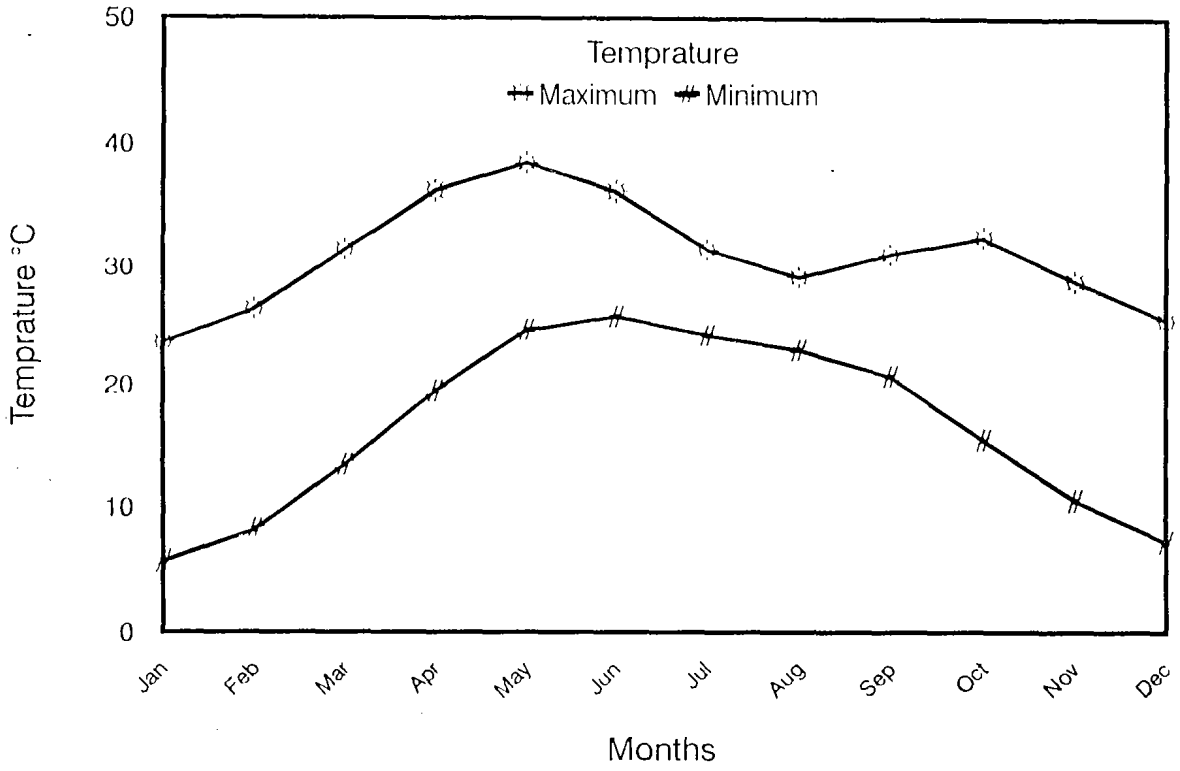

Fig.4.17: Average maximum and minimum temprature according to solar months

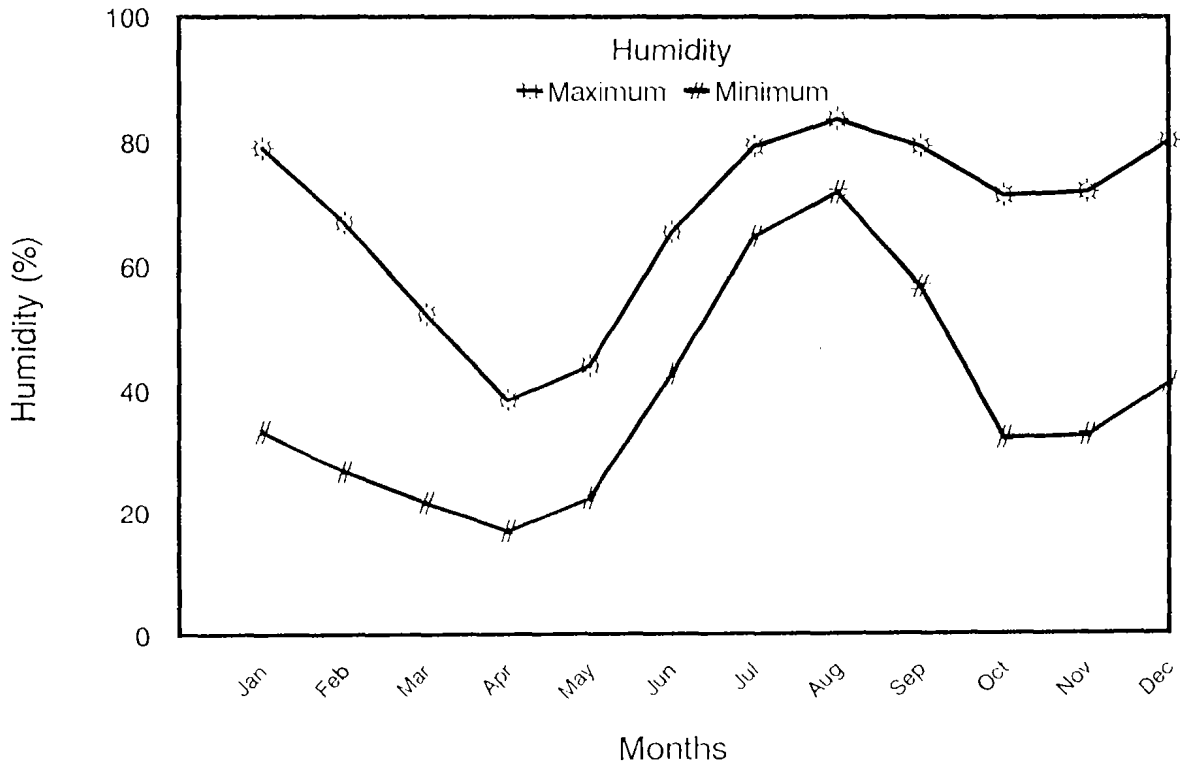

Fig.4.18: Average maxmimum and minimum humidity according to solar months

with mortality in Black Australorp. However, other coefficients were low and non-significant (Table 4.43).

The maximum humidity had negative and significant association with mortality in all the genetic groups except Kadaknath. On the other hand negative and significant ($P < 0.05$) association was observed between minimum humidity and mortality in White Leghorn, Kadaknath and Black Australorp (Table 4.43). All the partial correlation coefficients between meteorological variables and mortality were low and non-significant (Table 4.45) in different genetic groups.

The regression coefficients among maximum temperature and mortality in different genetic groups indicated that mortality increased significantly by 0.480 unit and decreased by 0.590 unit for every one degree rise in maximum temperature in Deshi and Broiler respectively. Similarly with one degree decrease in minimum temperature the mortality increased significantly by 0.320, 0.068, 0.670 units in Deshi, Black Australorp and Broiler respectively (Table 4.44).

As far as maximum humidity is concerned, the mortality decreased significantly by 0.190, 0.055, 0.150, 0.053, 0.150, 0.240 units respectively in while Leghorn, Rhode Island Red, Deshi, Black Australorp, Broiler and Crosses with one per cent increase in maximum humidity. Similarly, the mortality decreased slightly by 0.071, 0.016 and 0.029 units in White Leghorn, Kadaknath and Black Australorp with one per cent increase in minimum humidity (Table 4.44).

Table 4.43 : Simple correlation coefficient among meteorological variables and mortality in different genetic groups of chicken

Genetic groups	Meteorological variables			
	Temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
1. White Leghorn	-0.006	0.042	-0.125**	-0.059*
2. Rhode Island Red	0.025	0.005	-0.091**	-0.003
3. Kadaknath	0.044	-0.061	-0.122	-0.176*
4. Deshi	0.163**	0.160**	-0.200**	0.032
5. Black Australorp	-0.007	-0.101*	-0.184**	-0.112*
6. Broiler	-0.086**	-0.145**	-0.075*	-0.061
7. Crosses	-0.012	0.018	-0.104**	-0.042

** *P < 0.05*, * *P < 0.01*

Table 4.44 : Simple regression coefficient among meteorological variables and mortality in different genetic groups of chicken

Genetic groups	Meteorological variables			
	Temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
1. White Leghorn	-0.032	0.160	-0.190**	-0.071*
2. Rhode Island Red	0.056	0.008	-0.055**	-0.0014
3. Kadaknath	0.016	-0.013	-0.012	-0.016*
4. Deshi	0.480**	-0.320**	-0.150**	0.017
5. Black Australorp	-0.007	-0.068*	-0.053**	-0.029*
6. Broiler	-0.590**	-0.670**	-0.150*	-0.110
7. Crosses	-0.100	0.099	-0.240**	-0.075

** *P < 0.05*, * *P < 0.01*

Table 4.45 : Partial correlation coefficient among meteorological variables and mortality in different genetic groups of chicken

Genetic groups	Meteorological variables			
	Temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
1. White Leghorn	-0.048	0.053	-0.114	-0.013
2. Rhode Island Red	0.025	-0.015	-0.099	0.039
3. Kadaknath	0.049	-0.031	-0.073	-0.153
4. Deshi	0.071	0.136	-0.216	0.117
5. Black Australorp	0.094	-0.088	-0.140	-0.060
6. Broiler	-0.001	-0.093	0.004	-0.012
7. Crosses	-0.054	0.076	-0.111	-0.035

4.7 ASSOCIATION BETWEEN METEOROLOGICAL VARIABLES AND DIFFERENT CAUSES OF MORTALITY :

Association in terms of correlation and regression coefficients among meteorological parameters and mortality occurred due to different causes are presented in Table 4.46 to 4.48. The simple correlation coefficients of maximum temperature with mortality due to Packing, Egg bound and Spirochaetosis were positive and significant while coefficients were negative and significant with mortality occurring due to Pneumonia, Coccidiosis, Hepatitis and Parasitis. The other coefficients were low and non-significant (Table 4.46).

The minimum temperature had positive and significant correlation with mortality occurring due to Packing, Egg bound, others and Spirochaetosis while negative and significant with mortality due to Pneumonia, Coccidiosis, Enteritis, hepatitis and low vitality (Table 4.46).

The mortality due to Coccidiosis had positive and significant relationship with maximum humidity. However, mortality due to Chronic Respiratory Disease, Ranikhet, Pneumonia, Hepatitis, Packing and Spirochaetosis had negative and significant association with maximum humidity (Table 4.46).

The minimum humidity had negative and significant correlation with mortality due to Coryza, Enterisis, Pneumonia and others diseases not included in the study. On the other hand the other coefficients were low and non-significant (Table 4.46).

All the partial correlation coefficients among the meteorological parameters and mortality due to different causes were low and non-significant (Table 4.48).

Mortality in chicken decreased significantly by 1.100, 0.290 and 0.073 units and increased significantly by 0.130, 0.170 and 2.30 units due to Coccidiosis, Hepatitis, Parasitis, Pneumonia, Packing and Spirochaetosis respectively for every one degree rise in maximum temperature (Table 4.47).

The regression coefficients between minimum temperature and cause of mortality depicted that the mortality increased significantly by 0.110, 0.130, 0.028, 2.00 and others 0.130 units due to Pneumonia, Packing, Egg bound, Spirochaetosis and others than diseases included in the study while decreased significantly by 0.430, 0.150 and 0.320 units respectively due to Coccidiosis, Enteritis and Hepatitis for every one degree rise in minimum temperature (Table 4.47).

As far as humidity is concerned, the mortality due to Chronic Respiratory Disease, Ranikhet, Pneumonia, Hepatitis, Packing and Spirochaetosis decreased significantly by 0.130, 6.700, 0.031, 0.078, 0.039 and 0.28 units respectively for every one per cent rise in

maximum humidity while mortality due to Coccidiosis increased significantly by 0.28 units for every one per cent rise in maximum humidity (Table 4.47).

Every one degree rise in minimum humidity caused a significant decrease in mortality due to Coryza by 0.140 units, Enteritis by 0.100 units, Ranikhet by 4.700 units, Pneumonia by 0.034 units and other diseases by 0.026 units (Table 4.47).

Table 4.46 : Simple correlation coefficient among meteorological variables and mortality due to different causes/ diseases

Causes of mortality	Meteorological variables			
	Atmospheric temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
1. Coryza	0.036	-0.005	-0.015	-0.126**
2. Chronic Respiratory disease	0.048	-0.042	-0.098**	0.016
3. Enteritis	-0.052	-0.079*	0.035	-0.151**
4. Pneumonia	-0.130**	-0.170**	-0.134**	-0.156**
5. Ranikhet	0.181	0.007	-0.309*	-0.268
6. Fowl pox	0.506	0.183	0.035	-0.425
7. Avian Leucosis complex	-0.052	-0.014	-0.033	-0.037
8. Hepatitis	-0.177*	-0.304**	-0.197*	-0.139
9. Coccidiosis	-0.175**	-0.112*	0.165**	0.009
10. Spirochaetosis	0.347**	0.451**	-0193**	-0.076
11. Parasites (Endoparasities)	-0.098*	-0.024	-0.024	-0.075
12. Low vitality	-0.064	-0.007	-0.079	-0.024
13. Packing	0.140**	0.164**	-0.134**	-0.025
14. Egg bound	0.107*	0.145**	-0.033	-0.024
15. Climatic stress	0.226	0.177	-0.222	-0.013
16. Others	0.007	0.147**	0.000	-0.102**
17. Unspecified	0.188	0.083	-0.110	-0.170

*** P < 0.05, * P < 0.01*

Table 4.47 : Simple regression coefficient among meteorological variables and mortality due to different causes/ diseases

Causes of mortality	Meteorological variables			
	Atmospheric temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
1. Coryza	0.180	-0.017	-0.021	-0.140**
2. Chronic Respiratory disease	0.230	-0.130	-0.130**	0.018
3. Enteritis	-0.150	-0.150*	0.026	-0.100**
4. Pneumonia	-0.130**	-0.110**	-0.031**	-0.034**
5. Ranikhet	14.00	0.410	-6.700*	-4.700*
6. Fowl pox	1.600	0.460	0.023	-0.210
7. Avian Leucosis complex	-0.066	-0.012	-0.011	-0.0093
8. Hepatitis	-0.290*	-0.320**	-0.078*	-0.047
9. Coccidiosis	-1.100**	-0.43*	0.28**	0.013
10. Spirochaetosis	2.30**	2.00**	-0.28**	-0.068
11. Parasites (Endoparasities)	-0.073*	-0.012	-0.0049	-0.011
12. Low vitality	-0.130	-0.010	-0.044	-0.0098
13. Packing	0.170**	0.130**	-0.039**	-0.0069
14. Egg bound	0.030*	0.028**	-0.0024	-0.0012
15. Climatic stress	0.630	0.350	-0.200	-0.013
16. Others	0.0098	0.130**	0.00011	-0.026**
17. Unspecified	0.099	0.028	-0.010	-0.022

*** P < 0.05, * P < 0.01*

Table 4.48 : Partial correlation coefficient among meteorological variables and mortality due to different causes/ diseases

Causes of mortality	Meteorological variables			
	Atmospheric temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
1. Coryza	0.029	-0.026	0.023	-0.125
2. Chronic Respiratory disease	0.046	-0.051	-0.090	0.076
3. Enteritis	-0.012	-0.050	0.105	-0.180
4. Pneumonia	-0.027	-0.139	-0.003	-0.094
5. Ranikhet	0.055	0.138	-0.181	-0.202
6. Fowl pox	-0.318	0.562	0.251	-0.647
7. Avian Leucosis complex	-0.063	0.027	-0.026	-0.034
8. Hepatitis	-0.014	-0.218	-0.207	0.139
9. Coccidiosis	-0.090	-0.031	0.131	-0.046
10. Spirochaetosis	0.087	0.353	-0.154	0.056
11. Parasites (Endoparasities)	-0.110	0.042	-0.018	-0.080
12. Low vitality	-0.109	0.024	-0.113	-0.007
13. Packing	0.075	0.112	-0.108	0.059
14. Egg bound	0.052	0.110	-0.005	0.002
15. Climatic stress	0.071	0.052	-0.172	0.045
16. Others	0.025	0.147	0.079	-0.100
17. Unspecified	0.110	-0.012	-0.037	-0.104

** $P < 0.05$, * $P < 0.01$

5. Discussion

5.1 NON-GENETIC FACTORS AFFECTING OVERALL MORTALITY PATTERN IN CHICKEN :

5.1.1 Effect of Genetic Group :

The effect of genetic groups on mortality pattern was highly significant. Significant difference in mortality between genetic groups were also reported by Aggarwal and Sapra (1971) and Rodriguez *et al.* (1997). Out of total deaths (95242) maximum deaths were observed in WLH (29.27 %), followed by crosses (27.97 %), Broilers (23.73 %), RIR (10.96 %), Deshi (5.81 %) and BA (1.81 %). Minimum mortality at 0.45 per cent was observed in Kadaknath. Higher mortality at 53.8 per cent in WLH and 25.0 per cent in RIR than that observed in this study was reported by Chowdhury *et al.* (1983). On the other hand, Sah *et al.* (1984) observed higher mortality in Deshi (30.64 %) than WLH (20.93 %) under farm conditions, a finding in contradiction with the results obtained in this study. Higher frequency of mortality in WLH, crosses and Broilers as compared to other genetic groups were due to the fact that the birds of these genetic groups were quite large in number as compared to other genetic groups.

5.1.2 Effect of Season :

The mortality pattern was significantly ($P < 0.01$) affected by season, a finding in agreement with those of Viraraghvan and Nair (1965), Hartmann *et al.* (1980), Thakur *et al.* (1981) and Sharma and Kaushik (1986).

The mortality in descending order was observed in summer, rainy, spring, winter and autumn seasons. High atmospheric temperature with low

humidity during summer and moderate temperature with high humidity during rainy season may be the probable reason of high mortality during summer and rainy seasons. On the other hand, moderate temperature with moderate humidity during autumn season was probable cause of low mortality during this season.

5.1.3 Effect of Age :

The mortality varied significantly between different age groups. Similar results were also reported by Coles (1955), Babu *et al.* (1974), Chatterjee (1980), Suneja *et al.* (1985b), Panda *et al.* (1986) and Sharma and Kaushik (1986). In all 49.55 per cent mortality occurred up to 2 months of age while 27.02 and 23.43 per cent of the total mortality occurred during 2-5 and over 5 months of age respectively. Coles (1955) observed higher mortality due to fowl paralysis and Leucosis during the adult period (20-78 weeks) age than during rearing period (0-20 weeks). Gordon (1966) reported highest mortality in 0-4 weeks age group and lowest in adult broilers due to bacterial diseases. Aggarwal and Sapra (1971) found that the per cent mortality decreased with increase in age in almost all the genetic groups. Damodaran and Thanikachalam (1974) observed the mortality rate was 4.6 per cent during first week of age, 73.9 per cent at 1-12 weeks, 6.6 per cent at 12-20 weeks and 14.91 per cent over 20 weeks of age in fowl. On the other hand, Chatterjee (1980) found that maximum mortality of 49.65 per cent occurred during 3 to 12 weeks of life. From day old to 3 weeks of age the mortality was 43.66 per cent and only 6.69 per cent of the birds died after 12 weeks of age. Diversent reports of mortality pattern over different age groups might be due to different strains/ genetic groups as well as different climatic and managemental practices followed at different poultry farms.

5.1.4 Effect of Sex :

The differences in mortality pattern due to sexes were also significant ($P < 0.01$), which is in consonance with the reports of Jackson *et al.* (1972) and Srinivasan *et al.* (1980). In all 76.35 per cent mortality was observed up to unsexed growing stage i.e. up to 18 weeks of age and remaining 23.65 per cent in adults. Among the adults 19.39 per cent mortality was found in males and 80.61 per cent in females. Lower frequency of mortality in males was due to the fact that most of the males were sold after sexing except those kept for breeding purpose.

5.1.5 Effect of Egg Weight :

The egg weight had no effect on mortality pattern in chicken (Table 4.1). Skoglund and Tomhave (1949) and Wiley (1950) also observed no relationship between egg weight and mortality. On the other hand, Skogland *et al.* (1952) showed a trend towards higher mortality in chicks hatched from small eggs but found no significant differences in mortality due to egg weight. The results, however indicated that eggs weighing less than 45 gms may not be used for hatching as there was relatively higher mortality in chicks hatched from such eggs.

5.1.6 Effect of Age of Parent :

Age of parent affected the mortality pattern significantly ($P < 0.01$). The mortality was significantly higher in followers whose parental age was less than 8 months as compared to those whose age was more than 8 months. The differences between parental age of 13-16 and over 16 months on one hand and 8-12 months age group on the other were also significant. However, the differences between 13-16 and over 16 months age group were non-significant. Hays and Spear (1952) showed that mortality in broiler chicks hatched from young breeders was significantly higher than that observed in chicks from older breeders,

without considering the effect of egg weight. In another study Hays (1955) concluded that older parents are likely to produce more viable chicks. Further Mc Naughton *et al.* (1978) also observed higher mortality when chicks were hatched from 29 weeks old breeder hen eggs as compared to eggs from 58 weeks old breeder. From the results it is concluded that chicks should not be hatched from eggs whose parental age is less than 12 months, for achieving lower mortality. However, when sufficient eggs from older parents are not available then eggs from birds between 8-12 months can also be used.

5.1.7 Effect of Cause of Death :

The effect of cause of death on mortality pattern was significant ($P < 0.01$). Similar results were also reported by Sivadas *et al.* (1970), Ramachandra Reddy *et al.* (1983) and Reid *et al.* (1984). More than 40 per cent of total deaths observed were due to Coryza followed by CRD (10.26 %), Enteritis (8.83 %), ALC (7.56 %), Coccidiosis (6.00 %), Spirochaetosis (5.95 %) and Ranikhet disease (5.71 %). The per cent mortality due to other causes were less than 4.0 per cent of the total deaths (Table 4.4). Chatterjee (1980) reported 38.45 per cent death due to Pneumonia and Sinusitis, 25.16 per cent due to Coccidiosis, 21.75 per cent due to Aspergillosis, 1.16 per cent due to Fowl cholera, 1.09 per cent due to vitamin deficiency and 0.58 per cent due to Ranikhet in Poultry at Calcutta, which is quite different than that observed in this study. Guarda *et al.* (1980) observed maximum mortality at 31.0 per cent due to CRD, 15.0 per cent due to Enteritis, 10.0 per cent Coccidiosis and 8.5 per cent due to Coryza. While Viswanathan *et al.* (1980) found debility was the major cause of death (35.6 %) followed by digestive disorders (29.8 %), parasitic infestation (11.7 %), and Cannibalism (7.1 %).

Madhekar *et al.* (1981) reported Coccidiosis (22.16 %) was the major cause of death while death due to Coryza was minimum at (1.81 %). Similarly, Mhoomaiah and Rama Rao (1982) also observed higher mortality in birds due to Coccidiosis (16.36 %), followed by heat stroke (2.41 %), Ascites (1.73 %), Marek's disease (0.88 %) and Ranikhet disease (0.76 %).

Divergent reports of different workers on diseases resulting in varying level of mortality may be due to differences in the genetic groups/ strains of birds and composition of flock, locations, climatic condition and managemental practices followed at different farms.

Looking to these facts, it is essential to study the effect of important non-genetic factors i.e. season, age and sex on individual genetic groups and cause of death. It will help to take appropriate managemental measures to reduce mortality in chicken.

5.2 NON-GENETIC FACTORS AFFECTING MORTALITY PATTERN IN DIFFERENT GENETIC GROUPS OF CHICKEN :

5.2.1 Effect of Season :

The seasonal differences in mortality pattern were significant in WLH, RIR, Deshi, Crosses and BA, but non-significant in Kadaknath and Broiler. The results indicated that mortality in most of the genetic groups were significantly affected by season and therefore appropriate preventive measures and managemental practices during different seasons would help in reducing mortality in chicken.

The transformed values depicted that the frequency of mortality was significantly higher during summer in WLH, RIR, Deshi, crosses and BA as compared to mortality during other seasons (Table 4.6). The mortality in Kadaknath and Broiler was also higher during summer as

compared to other seasons though the differences were non-significant. The high temperature during summer has adverse effect on feed intake and growth rate. It also increase metabolic stress on birds, cannibolism and has favourable effect on multiplication of external parasites and few diseases, thereby resulting in increased mortality. Appropriate summer management like protection of birds from direct sun light, hot air, provision of curtains during mid day, feeding during cooler part of day, provision of sufficient cool drinking water and spray of insecticide will help to reduce the summer mortality.

The mortality in WLH and RIR was also significantly higher during rainy than autumn, winter and spring seasons indicating that WLH and RIR strains of chicken are more susceptible to high humidity which is prevalent during rainy season. On the other hand the differences in mortality during winter and spring and winter and autumn were non-significant in WLH and RIR suggesting that winter and autumn seasons were the best seasons in terms of lower mortality in both WLH and RIR breeds of chicken.

5.2.2 Effect of Age :

Mortality pattern in WLH was significantly affected by age, while its effect on other genetic groups was non-significant. In all 39.17 per cent mortality was observed during 0-2 months, 30.18 per cent during 2-5 months and 30.65 per cent over 5 months age group in WLH. Though in the other genetic groups the mortality was also on higher side during 0-2 months as compared to other age groups but the differences were non-significant. The results suggested that preventive measures against diseases and extensive management particularly during 0-2 months of age would considerably reduce the mortality in chicken in all the genetic groups under investigation. A decrease in

mortality rate with increase in age was reported by several workers (Gordon, 1966 Aggarwal and Sapra, 1971 Suneja *et al.*, 1985b).

5.2.3 Effect of Sex :

Sex had highly significant effect on mortality pattern of all the genetic groups. The frequency of mortality was significantly higher in unsexed grower as compared to male and female in all the genetic groups. Differences between male and female were also significant. The higher mortality in females as compared to males was due to the fact that only selected breeding males were kept on the farm after sexing while all the females were reared upto productive life.

5.3 NON-GENETIC FACTORS AFFECTING MORTALITY PATTERN DUE TO DIFFERENT CAUSES IN CHICKEN :

5.3.1 Coryza :

In all 40.55 per cent mortality in chicken was due to Coryza, a bacterial disease. Based on the transformed values, it was significantly higher than any other causes included in the study. Among the total deaths due to Coryza, significantly higher birds died during summer and lower during autumn. The differences between rainy, winter and spring seasons were non-significant. The incidence of death due to Coryza was significantly higher during 0-2 months of age as compared to 2-5 and over 5 months of age. Similarly in unsexed growers it was 88.91 per cent while 2.31 and 8.78 per cent was observed in male and female. The results indicated that Coryza was the major killer of poultry in this zone. Low lying areas, moist clay soil, dampness, heavy rainfall and insanitary environment offers favourable conditions for its onset and spread. The incidence of this disease can be minimised by adopting preventive measures during 0-2 months of age. Sharma (1985) concluded that Coryza is the serious killer in fowl and broilers. On the

other hand, low prevalance of Coryza in other parts of the country has been reported by Viswanathan *et al.* (1980), Srinivasan *et al.* (1980), Guarda *et al.* (1981), Inayathulla Khan *et al.* (1983). Further Viswanathan *et al.* (1980) reported that death due to Coryza was more common in growers, a finding in contradiction to that observed in this study.

5.3.2 Chronic Respiratory Disease :

In chicken, total mortality recorded due to CRD was 10.26 per cent indicating that CRD is also an important cause of mortality in chicken. Slightly higher frequency of mortality at 14.0, 15.46 and 15.38 per cent due to CRD was reported by Reid *et al.* (1984), Sharma and Kaushik (1986) and Jagrit (1999) respectively.

Higher frequency of deaths due to CRD at 31 per cent of total mortality as compared to frequency of mortality observed in the study was reported by both Chatterjee (1980) and Guarda *et al.* (1980). However, very low frequency of deaths due to this disease at 2.46, 2.29, 1.0 and 0.63 per cent were reported by Hall *et al.* (1969), Hall *et al.* (1974), Viswanathan *et al.* (1980) and Madhekar *et al.* (1982) respectively.

Significantly higher deaths occurred during summer and rainy season as compared to autumn and winter season. The differences in deaths between rainy and spring; autumn, winter and spring and summer and rainy seasons were however non-significant. Though the differences with respect to age group on mortality pattern were non-significant due to CRD but higher frequency of total deaths were observed during 0-2 months of age as compared to other groups. The mortality in unsexed grower was significantly higher than male and

females. However, differences between male and female were also significant. Sharma and Kaushik (1988) observed that maximum number of broilers died during rainy, closely followed by winter and minimum during summer. Further, they also found highest mortality during 6-10 weeks of age and lowest in 16-20 weeks of age.

5.3.3 Enteritis :

Enteritis accounted 8.83 per cent of the total deaths in chicken, which is significantly different from other diseases/ causes included in the study except CRD, ALC, Coccidiosis, low vitality and packing. The incidence of deaths due to enteritis were significantly higher during summer and rainy seasons as compared to autumn and winter seasons. The differences between summer, spring and rainy season on the one hand and autumn and winter on other were non-significant. Mortality due to this disease was significantly higher during unsexed growers than male and female i.e. older age. The differences between male and female were also significant. Kalra (1978) reported haemorrhagic-enteritis as one of the main disease in Haryana. Jagrit (1999) observed that 30.77 per cent of the total death was due to enteritis and concluded that it is the major killer of birds. Higher frequency of mortality as compared to that observed in the present study at 16.4 and 15.0 per cent respectively were reported by Nosaka and Minura (1964), Guarda *et al.* (1980). However, lower frequency of mortality than observed in the study at 7.52 and 4.6 per cent respectively were reported by Hall *et al.* (1969) and Mohan *et al.* (1978).

5.3.4 Pneumonia :

Pneumonia accounted for 1.90 per cent of total mortality in chicken. A similar mortality due to pneumonia at 2.4 per cent was reported by Mohan *et al.* (1978). On the other hand considerably higher

mortality at 17.96 and 18.08 per cent among miscellaneous and pathological causes in fowl and broilers respectively were reported by Sharma and Kaushik (1986). A very high mortality at 38.45 per cent due to pneumonia and sinusitis was reported by Chatterjee (1980). The mortality due to pneumonia at 6.9, 9.3 and 17.4 per cent respectively were reported by Watts and Rac (1958) in England, Dexter *et al.* (1972a) and Byme and Lowndes (1975a) in Ireland. The mortality due to pneumonia was significantly higher during winter and autumn season. Similarly the unsexed growers (0-18 weeks) were affected significantly more by pneumonia as compared to sexed chicken. Sharma and Kaushik (1986) also reported highest mortality due to pneumonia in winter and 0-5 weeks old age group which is in confirmation with this study.

5.3.5 Ranikhet :

Out of 95242 deaths 5439 (5.71 %) was accounted by Ranikhet disease. The effect of season and age group were found to be non-significant. The deaths due to ranikhet disease was significantly higher in unsexed grower than male and female. The difference between male and female were, however, non-significant. Kalra (1978) observed Ranikhet as one of the main disease. Lower frequency of mortality due to Ranikhet disease as compared to frequency of mortality observed in the study were reported by Nayak (1976), Viswanathan *et al.* (1980) Mhoomaiah and Rama Rao (1982), Ramachandra Reddy *et al.* (1983) and Ghodasara *et al.* (1992).

5.3.6 Fowl Pox :

The mortality due to fowl pox was lowest at 0.14 per cent of total death. The effect of season and age were non-significant while that of sex were significant on mortality due to Fowl pox. The deaths due to

Fowl pox was significantly higher (97.86 per cent) in unsexed grower than adults (male and female). Nayak (1976) and Madhekar *et al.* (1981) reported mortality due to fowl pox as 2.0 and 2.61 per cent respectively. Reid *et al.* (1984) found that only 0.3 per cent birds died due to this disease in Australia. However, Srinivas *et al.* (1983) reported fowl pox is an important viral disease in Andhra Pradesh. The results indicated that the birds up to the age of 5 months are more susceptible to this disease. Timely vaccination of all chicks (6-10 weeks age) might have helped to have such low mortality in chicks at this farm.

5.3.7 Avian Leucosis Complex :

In all 7.56 per cent of birds died due to ALC. The ALC was more prevalent during summer (30.32) and rainy (31.26 %) seasons. Out of total deaths due to ALC, maximum mortality at 61.85 per cent was observed in over 5 months of age group and 51.75 per cent in females indicating it a disease of adult bird. Nosaka and Minura (1964) and Ramachandra Reddy *et al.* (1983) observed incidence of death due to ALC was 7.1 and 13.3 per cent of total deaths. On the other hand, very low per cent (2 %) of mortality due to ALC was found by Kulasegaram (1975) at Peradeniya (Ceylon). Prakash and Rajya (1970) observed the overall highest incidence (22 %) was recorded during the month of September to November and lowest (13 %) during December to February. They also reported that ALC incidence was highest at 57.14 per cent in the age group of over 5 months, 25.29 per cent in 6-9 months and 0.47 per cent (lowest) in 1-3 months age group. More than 55 per cent mortality due to leucosis incidence of 3-6 months age group was reported by Sivadas *et al.* (1970). Maximum mortality due to ALC was observed in > 16 months age group by Gupta and Dwivedi (1971). Further Damodaran and Thanikachalam (1974) found 96.8 per cent of

total mortality in Poultry due to ALC in Kerala. ALC caused 14.29 per cent total mortality out of which 9.04 per cent during winter, 3.50 per cent during rainy and 1.75 per cent in summer season. the ALC caused maximum mortality in adults and minimum in 0-5 weeks old broilers (Sharma and Kaushik, 1986).

5.3.8 Hepatitis :

Hepatitis accounted for 0.55 per cent of total mortality in chicken. The differences due to age and sex were significant in mortality caused by Hepatitis, while the effect of season was non-significant. Mortality due to hepatitis was significantly higher in over 5 months age group as compared to other age groups. Similarly the mortality was significantly higher in unsexed grower and females than males.

Mohan *et al.* (1978) reported 1.9 per cent of mortality due to hepatitis on the other hand negligible rate of 0.06 and 0.05 per cent of total mortality in fowls and broilers of 6-12 weeks and adults respectively were reported by Sharma and Kaushik (1986). Mohiyuddeen (1982) observed 1.47 per cent mortality due to Hepatitis in 0-8 weeks, 2.74 per cent in 8-20 weeks and 2.03 per cent in 20 weeks and above age group of birds. Gupta and Dwivedi (1971) reported 2.1 and 1.0 per cent mortality due to heptatitis in 0-4 and 16 weeks to 1 year age group of chicken respectively. They further reported incidence of hepatitis as 10 per cent during summer months and 11-44 per cent during spring season. But the present study shows more than 60 per cent of the birds died due to this disease during spring and summer seasons.

The results indicate that the incidence of hepatitis was more in over 5 month age groups. The low frequency of mortality in male may be due to the rearing of limited males only for breeding after sexing.

5.3.9 Coccidiosis :

Coccidiosis accounted 6.0 per cent of the total mortality in chicken. Less than 15 per cent of mortality was observed by Sivadas *et al.* (1970), Guarda *et al.* (1980), Dovos *et al.* (1977), Ghodasara *et al.* (1992) and Rodriguez *et al.* (1997). On the contrary very high mortality due to this among protozoan diseases at 68.93 and 78.62 per cent of the total deaths in broilers respectively was reported by Sharma and Kaushik (1986). Similarly Nosaka and Minura (1964) also observed that Coccidiosis accounted for 58 per cent of the total mortality. On the other hand, the mortality ranging from 16 to 30 per cent were reported by Mhoomaiah and Rama Rao (1982), Jagadeesh Babu *et al.* (1974) and Chatterjee (1980).

Out of total deaths, on account of coccidiosis, significantly highest mortality occurred during rainy season as compared to summer, autumn and winter seasons. Higher humidity or atmospheric moisture during rainy season favours to increase in number of coccidia in poultry litter and may be the probable reason of higher mortality due to Coccidiosis during rainy season. Coccidiosis accounted significantly higher mortality during 0-2 and 2-5 months age groups than over 5 months of age. Similarly unsexed grower were affected significantly more from this disease than adults male and females. Sharma and Kaushik (1986) also observed highest mortality (41.02 %) in 0-5 months old and lowest (0.47 %) in adults broilers. Hemsley (1964) reported the highest mortality due to Coccidiosis among 4-6 weeks broilers. Coccidiosis spreads from bird to bird through eating or drinking contaminated food, water, litter or other material contaminated with coccidia. To reduce the incidence of this disease proper hygiene, sanitation and good managements recommended.

5.3.10 Spirochaetosis :

Spirochaetosis accounted 5.95 per cent of the total mortality in chicken. The deaths due to Spirochaetosis was significantly higher during summer and rainy than winter season. However, the difference in mortality pattern between summer, rainy autumn and spring season on one hand and between autumn, winter and spring on other were non-significant. Spirochaetosis caused significantly higher mortality in over 5 months of age groups as compared to 0-2 and 2-5 months age group. Similarly unsexed grower and females were more affected by this disease. Like CRD, Enteritis, Ranikhet, the Spirochaetosis is also a major disease of poultry found in Haryana (Kalra, 1978). Ahmad and Irfan (1981) and Inayathulla Khan *et al.* (1983) also observed 5.31 and 10.0 per cent of total mortality due to Spirochaetosis in poultry at Lahore (Pakistan) and Andhra Pradesh respectively. For the prevention and control of this disease vaccination can protect chickens against Fowl spirochaetosis. Control of Ticks which act as vectors, by regular spray of insecticides specially during March – April and October – November will help to reduce the incidence of mortality by this disease.

5.3.11 Parasites :

Endoparasites accounted only 1.49 per cent of total mortality in chicken. Seasons had no effect on morality due to endoparasites. Restricted mortality due to endoparasites might be on account of regular and effective deworming schedule followed at the farm. Kronberger and Schuppel (1977) observed a total of 8.5 per cent mortality due to parasites. Hall *et al.* (1974) and Madhekar *et al.* (1981) observed mortality of 5.89 and 3.5 per cent respectively due to Ascaridiosis while Mhoomaiah and Rama Rao (1982) and Madhekar *et*

al. (1981) respectively found 16.36 and 5.21 per cent of deaths due to tape worm and round worm infestation.

Ascariaris, roundworms, tapeworm and Caecal worms are the common parasites of this region which cause poor growth and low production.

Age of birds affected mortality related with parasite such that significantly higher per cent mortality occurred in over 5 months of age group as compared to 0-2 and 2-5 months age groups. Females were more susceptible to this disease than unsexed grower and male. Proper sanitary and hygienic measures are the most essential requisites. .Therefore regular and scheduled deworming should be followed for reduction in mortality due to endoparasites.

5.3.12 Low Vitality:

In all 3.91 per cent birds died due to low vitality. Significantly higher frequency of mortality due to low vitality was observed in 0-2 months old chicks. However, differences between 2-5 month and over 5 months age group were non-significant. 86.71 per cent mortality occurred up to the age of 0-2 months. Balanced rationing and management practices during chick or grower stage may reduce the mortality due to low vitality.

5.3.13 Packing:

Packing accounted for 2.77 per cent total deaths in chicken. As expected significantly higher mortality was observed during summer as compared to other seasons. The unsexed grower had significantly higher mortality than adults. The mortality in males was significantly lower than females. In fact the over crowding associated cannibalism accounted for 0.19 and 0.30 per cent total mortality in 16-20 weeks old fowls and broilers respectively as reported by Sharma and Kaushik (1986). On the other hand Mohiyuddeen (1982) observed higher mortality (22.85 %) in 8-20 weeks and 9.51 per cent in 20 weeks and

above age groups of birds. However, the present results are comparable to those of Damodaran and Thani (1974) who reported 0.66 per cent mortality due to cannibalism, over crowding, nutritional deficiency, faulty debeaking and less number and placement of egg nest which are the important contributory factors for cannibalism. Hence these points should be considered in management of birds.

5.3.14 Egg bound :

In all 0.90 per cent mortality was due to egg bound. Significantly higher mortality was observed during summer as compared to other reasons. As expected the egg bound accounted higher mortality in over 5 months age group i.e. adult female. Sharma and Kaushik (1986) found similar results with 0.44 per cent incidence of death due to egg bound in fowls only while no case was observed in broilers. Nayak (1976), Viswanathan *et al.* (1980), Mohiyuddeen (1982) and Srinivas *et al.* (1983) have also reported lower mortality due to egg bound. Balanced feeding and appropriate management during growing stage resulted in keeping the birds in healthy condition which in turn reduced the incidence of such cases. The lighting of the pen should be so adjusted during growing period of pullets to avoid early sexual maturity which leads to high mortality due to egg bound.

5.3.15 Climatic Stress :

0.44 per cent birds (412) out of 95242 died due to climatic stress. Maximum proportion (66.02 %) of birds died during summer and minimum during spring season on account of climatic stress. The incidence of climatic stress was more up to the stage of 5 months. Heat stroke caused 13.05 and 14.17 per cent mortality respectively in fowls and broilers during summer and 3.42 and 4.06 per cent during rainy season as reported by Sharma and Kaushik (1986). They also reported

that incidence of heat stroke was higher in chick and growers stage which is in consonance with present study. Damodaran and Thanikachalam (1974) and Viswanathan *et al.* (1980) also reported higher death due to heat stroke in poultry in 20 weeks and above age groups which is contrary to present findings. Excessively high temperature in poultry houses which is a common occurrence during summer is the cause of heat stroke a heat prostrain. The affected bird show accelerated breathing, rise in body temperature (109-110°C) and prostrain culminating in death. Good ventilation, abundance of fresh drinking water, an ample accommodation in the house to avoid over crowding are helpful in preventing heat stroke. Use of curtains on doors and windows of pen particularly during hot part of the day is also important measure to avoid heat stroke.

5.3.16 Others :

The mortality due to diseases/ causes other than that included in the study were 2.74 per cent of the total deaths. Significantly higher mortality was observed during summer and rainy seasons as compared to other seasons. The birds up to the age of 5 months were more encountered to these diseases/ causes than other groups.

5.3.16.1 Ricket : Sharma and Kaushik (1986) reported 4.33 and 5.99 per cent mortality in fowls and broilers respectively due to rickets which is in contradiction to the present results. Low frequency of mortality due to ricket as observed in the present study indicated feeding of balanced ration particularly with respect to Vitamin D, calcium and phosphorus supplements like bonemeal and oyster shell in the poultry mashes and exposure of the chicks to direct sunlight daily reduced the incidence of such diseases.

5.3.16.2 Marek's Disease : Mhoomaiah and Rama Rao (1982) observed 0.88 per cent mortality due to Marek's disease which is almost equal to the present results. However, higher mortality from 6.2 – 23.5 per cent were reported by Dexter *et al.* (1972), Babu *et al.* (1974), Nayak (1976), Randal *et al.* (1977) and Rodriguez *et al.* (1997). Contrary to the present results Sharma and Kaushik (1986) concluded that Marek's disease was the 2nd important viral disease in broilers. It contributed 22.74 per cent of the total mortality (11.95 per cent in rainy season 6.40 per cent in winter and 4.37 per cent in summer). They also reported that highest mortality of 14.72 per cent in 6-10 weeks old and lowest mortality of 0.44 per cent in adults broilers.

5.3.17 Unspecified :

The exact cause of deaths was not diagnosed in 209 birds (0.21 %). Out of 95242 deaths, 45.45 per cent of such birds died during summer which was significantly different from frequency of birds died during the other seasons. The unspecified cause of death were significantly higher in unsexed grower and adult females.

5.4 NON-GENETIC FACTORS AFFECTING ACTUAL MORTALITY IN CHICKEN :

5.4.1 Effect of Season :

The actual total mortality based on number of birds exposed to risk was significantly higher during summer and rainy season as compared to Autumn, Winter and Spring seasons. Similar results were also observed in adults females in the present study indicating Autumn, Winter and Rainy seasons as favourable seasons for low mortality in birds. On the other hand high temperature during summer and high humidity during rainy seasons may be the probable reasons of high mortality during these seasons. But the results of partial correlation

suggested that modification in the physical environment of pens would reduce mortality in chicken. The mortality in growers and males during different seasons also followed similar trend.

5.4.2 Effect of Genetic Groups :

The total mortality across different genetic groups indicated that the mortality was significantly higher in Kadaknath and Deshi as compared to WLH, RIR and Broilers, indicating that the high producing strains like WLH, RIR, BA can be maintained in this environment with low mortality as compared to the local strains (Deshi and Kadaknath). The mortality in crosses range in between deshi and WLH, RIR and BA.

5.5 METEOROLOGICAL PARAMETERS :

5.5.1 Monthly Variation in Meteorological parameters :

Month of April to June were the hottest when the average maximum temperature was above 36.0°C and average minimum temperature ranged between 19.48 – 25.72°C. The month of July, August, September also had higher atmospheric temperature above 29°C with humidity above 79 per cent. During October and November the average atmospheric temperature and humidity varied between 28.79 – 32.49°C and 71.46-72.0 per cent respectively. The temperature was almost equal to average temperature during July - September while humidity was lower during October and November than above period. The maximum and minimum temperature was lowest during the months of December and January while the humidity was almost equal to the average humidity during July to September. The maximum and minimum temperature starts increasing from February onwards and remain pleasant upto the March. During this period the humidity also varies in a moderate range.

Considering the above meteorological parameters across the solar months of the year, it may be concluded that the year may be divided into 5 seasons. The identified seasons would be April to June as summer, July to September as Rainy, October to November as Autumn, December to January as winter and February to March as spring.

5.5.2 Seasonal Variation in Meteorological Parameters :

Means of different meteorological parameters revealed that there is clear cut seasonal variation observed. As expected the highest temperature (maximum and minimum) and lower humidity was observed during the summer season. The rainy season was characterised with slight decrease in maximum temperature with high humidity. Autumn was recognized with lower temperature and humidity as compared to rainy season maintaining the maximum temperature almost similar to rainy season. A clear cut variation was observed with respect of maximum and minimum temperature but there was increase in humidity over Autumn. Further increase in maximum and minimum temperature with moderate humidity over the winter was identified as spring season.

Since season is a cumulative effect of meteorological parameters therefore it is appropriate to estimate the association in terms of correlation and regression between meteorological variables (maximum and minimum temperature and humidity) and mortality according to different genetic groups and cause of death to suggest suitable management practices for reduction in mortality.

5.6 ASSOCIATION BETWEEN METEOROLOGICAL VARIABLES AND MORTALITY IN DIFFERENT GENETIC GROUPS :

The results of simple correlation indicated that the maximum and minimum temperature had positive and significant association in Deshi

while negative and significant in Broilers. Similarly the maximum temperature had negative and significant relationship with mortality in BA, However, other coefficients were low and non-significant. The maximum humidity had significant association with mortality in all the genetic groups except Kadaknath while minimum humidity had negative and significant association in WLH, Kadaknath and BA. On the other hand all the partial correlation coefficient between meteorological variables and mortality were low and non-significant. It indicates that in the presence of other independent variables in the model of partial correlation nullify the association that observed in simple correlation. Further it is suggested that the climatic condition of zone does not have any significant influence on mortality in all the genetic groups and hence it is concluded that all the genetic groups under investigation can be maintained in the climatic conditions of Udaipur zone.

5.7 ASSOCIATION BETWEEN METEOROLOGICAL VARIABLES AND DIFFERENT CAUSES OF MORTALITY :

The simple correlation coefficients of maximum temperature with mortality due to packing, egg bound, spirochaetosis were positive and significant, while coefficient were negative and significant with mortality due to Pneumonia, Coccidiosis, Hepatitis, Parasites. The minimum temperature had positive and significant correlation with mortality occurring due to packing, Egg bound, others and Spirochaetosis while negative and significant with mortality due to Pneumonia, Coccidiosis, Enteritis, Hepatitis and low vitality. The mortality due to Coccidiosis had positive and significant relationship with maximum humidity, however, mortality due to CRD, Ranikhet, Pneumonia, Hepatitis, Packing and Spirochaetosis had negative and significant association with maximum humidity. The minimum humidity had negative and

significant correlation with mortality due to Coryza, Enteritis, Pneumonia and other diseases not included in the study while the others coefficients were low and non-significant. Broadly the results indicated that the incidence of death increases as maximum and minimum temperature increases, while reverse trend was observed in mortality due to pneumonia. As expected the population of Coccidia in litter increase with increase in humidity resulting in higher mortality due to Coccidiosis.

The results of partial correlation coefficients indicated presence of other meteorological variables included in the model, the association between meteorological variables and mortality in question was nulified. Similar observations were also noted in partial correlation between meteorological variables and mortality in different genetic groups.

6. Summary and Conclusion

Mortality data pertaining to WLH, RIR, Kadaknath, Deshi, Black Australorp, Broilers and Crosses used in the present study were collected from the Poultry Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur.

In all 95242 birds died during the study period i.e., April 1961 to December 1996 and were subjected to autopsy to findout the exact cause of death. The meteorological data used were collected from the meteorological observatory of Rajasthan College of Agriculture, Udaipur. The objective of the present study were :

1. To study the effect of genetic groups on mortality in chicken.
2. To study the effect of non-genetic factors like season, age, sex, egg weight and age of parent on mortality in chicken.
3. To study the mortality pattern due to various diseases/ causes in chicken.
4. To find out the effect of genetic group, age and season on the prevalence of various diseases.
5. To estimate the association between meteorological parameters and mortality in chicken.

The non-genetic factors viz. year (1961-1996), genetic group, season (Summer, Rainy, Autumn, Winter and Spring), age (0-2 months, 2-5 months and over 5 months), sex (unsexed growers, male and female), egg weight (less than 45 g, 46-50 g, 51-55 g and over 55 g) and cause (Coryza, Chronic Respiratory disease, Enteritis, Pneumonia, Ranikhet, Fowl Pox, Avian Leucosis Complex, Hepatitis, Coccidiosis,

Spirochaetosis, Parasites, Low vitality, Packing, Egg bound, Climatic stress, others and unspecified were studied in relation to mortality and mortality pattern of birds. The association in terms of correlation and regression between meteorological variables and number of birds died were also worked out.

The effect of genetic groups, season, age, sex, age of parents and causes on overall mortality pattern in chicken was found to be highly significant. The frequency of mortality was significantly higher in WLH (29.27 %), summer (35.98 %), 0-2 months old chicks (49.55 %), unsexed grower (76.35 %) and in chicks born of parents ageing less than 8 months (77.28 %). Similarly Coryza (40.55 %) was the main cause of death as compared to other diseases.

The effect of season was found to be highly significant on mortality pattern in WLH, RIR, Deshi and crosses and it was significant in BA. The actual frequency of mortality was higher during summer in all genetic groups which ranged from 31.05 % in broiler to 39.91 % in WLH.

The differences in mortality pattern due to age groups were significant only in WLH. On the other hand the effect of sex was highly significant on mortality pattern of all the genetic groups included in the study. The frequency of mortality was significantly higher in unsexed grower as compared to adult male and female. The variation due to different cause of death was highly significant in all the 7 genetic groups.

The frequency of death in WLH and RIR was highest at 36.85 and 33.10% due to Coryza and lowest at 0.14 and 0.15 % due to climatic stress. In other genetic groups viz., Kadaknath, Deshi, BA, Broiler and Crosses the mortality was also maximum due to Coryza but minimum due to Fowl Pox.

The effect of seasonal variation on frequency of mortality due to Coryza, CRD, Coccidiosis, Enteritis, ALC, Pneumonia, Packing, Egg bound, other diseases, unspecified diseases, spirochaetosis were significant. However, season had no effect on mortality pattern in Ranikhet, Fowl Pox, Hepatitis, Low Vitality and Parasites. A high frequency of mortality observed due to Coryza, CRD, Enteritis, Ranikhet, Hepatitis, Spirochaetosis, Parasites, Low Vitality, Packing, Egg bound, Climatic stress, others and unspecified in summer; Fowl Pox, ALC and Coccidiosis in Rainy and Pneumonia in Winter season.

Frequency of birds died due to ALC, Spirochaetosis, Pneumonia, Parasites, Packing, Egg bound others and unspecified was high in chicken over 5 months of age as compared to 0-2 and 2-5 months age groups. However, deaths due to other causes was much higher in 0-2 months age group.

The adult females were more encountered to ALC, Spirochaetosis, Parasites and egg bound as compared to unsexed grower and adult males. On the other hand deaths due to Coryza, CRD, Enteritis, Pneumonia, Ranikhet, Fowl Pox, Hepatitis, Coccidiosis. Other and unspecified were higher in unsexed growers.

The mortality based on number of birds exposed to risk were significantly higher during Summer in unsexed growers than Autumn and Winter season. Similarly in male the mortality was significantly higher during summer as compared to Autumn, Winter and Spring seasons. The mortality in females and total was significantly higher during Summer and Rainy as compared to mortality during Autumn, Winter and Spring seasons.

Based on transformed values the mortality in RIR, BA and Broiler were significantly lower during unsexed grower period as compared to Deshi and Crosses. In case of males the mortality was significantly

lower in BA than Deshi birds while in case of females the mortality was significantly higher in Kadaknath than broilers. The mortality over all the groups were significantly lower in RIR as compared to Kadaknath and Deshi.

The maximum and minimum temperature had positive and significant association in Deshi while negative and significant in broilers. Similarly maximum temperature had negative and significant relationship with mortality in BA. However, other coefficients were low and non-significant. The maximum humidity had negative and significant association with mortality in all the genetic groups except Kadaknath while minimum humidity had negative and significant association in WLH, Kadaknath and BA. On the other hand all the partial correlation coefficients between meteorological variables and mortality were low and non-significant.

The simple correlation coefficient of maximum temperature with mortality due to packing, egg bound, spirochaetosis were positive and significant while coefficients were negative and significant with mortality due to Pneumonia, Coccidiosis, Hepatitis, Parasites. The minimum temperature had positive and significant correlation with mortality occurred due to Packing, egg bound, others and spirochaetosis, while negative and significant with mortality due to Pneumonia, Coccidiosis, Enteritis, Hepatitis and low vitality. Coccidiosis had positive and significant relationship with maximum humidity. However, mortality due to CRD, Ranikhet, Pneumonia, Hepatitis, Packing and Spirochaetosis had negative and significant association with maximum humidity. The minimum humidity had negative and significant correlation with mortality due to Coryza, Enteritis, Pneumonia, and other diseases not included in the study while other coefficients were low and non-significant.

The following conclusion can be drawn from the results of the present study :

1. The mortality in chicken is significantly affected by non-genetic factors viz., genetic group, season, age, sex, age of parent and causes.
2. Summer is the most unfavourable season with respect to mortality in all the genetic groups included in the study. Similarly rainy season is also not conducive for WLH, RIR strains.
3. The mortality decreased with increase in age in all the genetic groups.
4. In all the genetic groups the mortality is higher in unsexed growing chicks.
5. Egg weighing less than 45 g may not be used for hatching as high mortality in chicks hatched from such eggs were observed.
6. Chicks should not be hatched from eggs whose parental age is less than 12 months for achieving lower mortality. However, when sufficient eggs from older parents are not available than eggs from birds between 8-12 months can also be used.
7. Coryza is the main cause of death in all the genetic groups.
8. The birds are more susceptible to Coryza, CRD, Enteritis, Ranikhet, Hepatitis, Spriochaetosis, Parasites, Low vitality, Packing, egg bound, Climatic stress, others and unspecified causes during summer as compared to other seasons and hence need better care and management in summer.
9. The incidence of death due to Fowl Pox, ALC and Coccidiosis in Rainy and Pneumonia in Winter season can be reduced by good management.

10. Protective measures for Coryza, CRD, Enteritis, Ranikhet, Fowl Pox, Hepatitis, Coccidiosis, Low vitality and Climatic stress, need to be specially used in birds below 2 months of age. Chickens above 5 months age were more susceptible to ALC, Spirochatosis, Pneumonia, Parasites, Packing, Egg bound, others and unspecified causes which should be taken care of.

11. The incidence of death due to ALC, Spirochaetosis, Parasites and Egg bound is higher in adult females while death due to Coryza, CRD, Enteritis, Pneumonia, Ranikhet, Fowl Pox, Hepatitis, Coccidiosis, Low vitality, Packing, Climatic Stress, others and unspecified is higher in unsexed growers.

12. Mortality due to Packing, Egg bound and Spirochaetosis can be reduced by good summer management practices and that due to Pneumonia, Coccidiosis, Hepatitis, Parasites, by Protecting chicken from low temperatures.

13. Increase in maximum humidity increases mortality due to Coccidiosis.

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ABSTRACT

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The mortality data of 95242 birds died during the period of April 1961 to December 1996, pertaining to WLH, RIR, Kadaknath, Deshi, BA, Broiler and Crosses were collected from the Poultry Farm, Rajasthan College of Agriculture, Udaipur.

The effect of year, genetic group, season and sex on mortality and the effect of year, genetic group, season, age, sex, egg weight, age of parent and cause was studied on mortality pattern (Frequency of birds died). The association in terms of correlation and regression between meteorological variables and number of birds died were also worked out.

The analysis of variance revealed that genetic group, season, age, sex, age of parent and causes had highly significant effect on overall mortality pattern in chicken. The frequency of mortality was significantly high in WLH (29.27 %), summer (35.98)$^{0}_{2}$, 0-2 months age group (49.55 %), unsexed growing chicks (76.35 %) and chicks born of parent ageing less than 8 months (77.28 %). Similarly, Coryza (40.55 %) was the main cause of death.

The frequency of mortality was higher during summer in all the genetic groups which ranged from 31.05 % in Broiler to 39.91% in WLH. The differences in mortality pattern due to season was found to be highly significant in WLH, RIR, Deshi and Crosses.

The effect of age group was significant only in WLH while the effect of sex on mortality pattern was highly significant in all the genetic groups. The frequency of mortality was significantly higher in unsexed grower. The variation due to different cause of death was highly significant in all the genetic groups.

The frequency of death in WLH and RIR was highest at 36.85 and 33.10 % respectively due to Coryza and lowest at 0.14 and 0.15 % due to Climatic stress. In other genetic groups also the mortality was higher due to Coryza but it was lowest due to Fowl Pox.

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The season had no effect on mortality pattern in Ranikhet, Fowl Pox, Hepatitis, Low vitality and Parasites. However, the effect of seasonal variation on frequency of mortality due to Coryza, CRD, Coccidiosis, Enteritis, ALC, Pneumonia, Packing, Egg bound, other diseases, unspecified and Spirochaetosis was significant.

The birds above 5 months age were susceptible to ALC, Spirochaetosis, Pneumonia, Parasites, Packing, Egg bound, others and unspecified cause of death as compared to 0-2 and 2-5 months age groups. On the other hand deaths due to Coryza, CRD, Enteritis, Pneumonia, Ranikhet, Fowl Pox, Hepatitis, Coccidiosis, others and unspecified cause of death were higher in unsexed growers. The mortality in unsexed growers based on number of birds exposed to risk was significantly higher during summer than Autumn and Winter season. Similarly, the mortality in male, female and total was significantly higher during summer and rainy seasons.

The mortality in RIR, BA and Broiler were significantly lower in unsexed growers as compared to Deshi and Crosses and in Case of males the mortality was significantly lower in BA than Deshi, while in case of females the mortality was significantly higher in Kadaknath than Broilers.

The maximum and minimum temperature had positive and significant association with mortality in Deshi but it was negative and significant in Broilers. Maximum temperature had negative and significant association with mortality in BA. However, other coefficients were low and non-significant. The maximum humidity had negative and significant relationship with mortality in all the genetic groups except Kadaknath.

The simple correlation coefficient of maximum temperature with mortalilty due to Packing, Egg bound, Sirochaetosis were positive and significant. The minimum temperature had positive and significant correlation with mortality. Coccidiosis had positive and significant relationship with maximum humidity.

सारांश

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शोध कर्ता

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मुख्य सलाहकार

राजस्थान कृषि महाविद्यालय के कुक्कुट प्रक्षेत्र से अप्रैल 1961 से दिसम्बर 1996 तक के व्हाइट लेगहॉर्न, रोड आउलेण्ड रेड, कड़कनाथ, देशी, ब्लेक आस्ट्रालोर्प, ब्रायलर एवं संकर कुक्कुट के 95242 मृत्यु आंकड़े संकलित किये गऐ।

मृत्यु पर वर्ष, अनुवांशिक रागुह, मौराम एवं लिंग के प्रभाव एवं वर्ष, अनुवांशिक रागुह, मौसम, आयु, लिंग, अण्डे का वजन, पैत्रिक आयु एवं कारक का मृत्यु स्वरूप पर अध्ययन किया गया। मौसमी विचरकों एवं मृत्यु कुक्कुट संख्या के बीच संबंधों का भी अध्ययन किया गया।

विश्लेषण विचरण से पाया गया कि अनुवांशिक समुह, मौसम, आयु पैत्रिक आयु एवं मृत्यु के कारकों का उच्च व्यंजक प्रभाव पूर्णरूप से पड़ा है। मृत्यु की उच्च व्यंजक बारंबारता व्हाईट लेगहार्न (29.27%), ग्रीष्म ऋतु (25.98%), 0–2 माह आयु वर्ग (49.55%), लिंग रहित कुक्कुट (76.35%) तथा 8 माह से कम पैत्रिक आयु के कुक्कुट में 77.28%) था। इसी प्रकार कोराइजा (40.55%) मृत्यु का मुख्य कारक रहा।

ग्रीष्म ऋतु में मृत्यु की बारंबारता सभी अनुवांशिक में अधिक रही (31.05%) ब्रायलर तथा 39.91%) व्हाईट लेगहॉर्न में पाया गया। मौसम के कारण व्हाइट लेगहार्न, रोड आईलेण्ड रेड, देशी एवं संकर समुह में मृत्यु स्वरूप का उच्च व्यंजक प्रभाव पाया गया।

आयु समुह का व्यंजक केवल व्हाइट लेगहार्न में जबकि मृत्यु पर लिंग का प्रभाव सभी अनुवांशिक समुहों पर उच्च व्यंजक था। उच्च व्यंजक की मृत्यु बारंबारता अनसेक्सडग्रोवर मे था। मृत्यु के विभिन्न कारकों का विचरण व्यंजक उच्च कोटि का सभी अनुवांशिक समुहों में पाया गया।

मृत्यु बारंबारता कोराईजा द्वारा व्हाइट लेगहॉर्न (36.85%), रोड आइलेण्ड रेड (33.10%) सबसे अधिक पाया गया एवं मौसमी तनाव से सबसे कम (0.14%) एवं (0.15%) पाया गया। अन्य अनुवांशिक समुहों में भी मृत्यु कोराईजा से अधिक रही लेकिन कुक्कुट चेचक से सबसे कम पाया गया।

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रानीखेत, कुक्कुट चेचक, हीपेटाईटिस, लो वाईटेलिटी एवं पैरासाईट पर मौसम का प्रभाव नहीं पाया गया। जबकि व्यंजक मृत्यु बारंबारता पर मौसमी विचरकों का प्रभाव कोराईजा, सी आर डी, काक्सीडियोसिस, इन्ट्रडिटिस, ए एल सी, निमोनिया, पैकिंग, एग बाउण्ड, अन्य रोग, अनस्पेसिफाइड एवं स्पाइरोकिटोसिस में पाया गया। 0–2 एवं 2–5 माह आयु समुह की अपेक्षा 5 माह से अधिक आयु के कुक्कुट ए एल सी, स्पाइरोकिटोसिस, निमोनिया, पैरासाईट, पैकिंग, एग बाउण्ड, अर्दश एवं अनस्पेसिफाइड कारकों से प्रभावित रहे। दूसरी तरफ अनसेक्सडग्रोवर में मृत्यु कोराईजा, सी आर डी, इन्ट्राईटिस, निमोनिया, रानीखेत, कुक्कुट चेचक, हिपेटाईटिस, काक्सिडियोसिस, अदर्श एवं अनस्पेसीफाईड कारकों से ज्यादा रही। अनसेक्सडग्रोवर की वास्तविक मृत्यु ग्रीष्म में वंसत एवं शरद ऋतु से व्यंजकात्मक अधिक रही। इसी प्रकार नर, मादा एवं कुल मृत्यु ग्रीष्म एवं वर्षा ऋतु में उच्च व्यंजकात्मक पाई गई।

देशी एवं संकर की तुलना में आई आर आई, बी ए, एवं ब्रायलर के अनसेक्सडग्रोवर में मृत्यु दर निम्न व्यंजकात्मक रही जबकि मृत्यु मादा कड़कनाथ में ब्रायलर की अपेक्षा अधिक रही। अधिकतम एवं न्यूनतम तापक्रम का घनात्मक एवं व्यंजकात्मक सम्बन्ध देशी, लेकिन नाकारात्मक व्यंजक प्रभाव ब्रायलर कुक्कुट की मृत्यु से रहा।

अधिकतम तापक्रम का नाकारात्मक व्यंजकात्मक सम्बन्ध बी ए में पाया गया जबकि अन्य गुणांक निम्न व सार्थक थे। अधिकतम आद्रता का नाकारात्मक व सार्थक सम्बन्ध कड़कनाथ के अलावा सभी अनुवांशिक समुहों के मृत्यु से पाया गया।

अधिकतम तापक्रम का मृत्यु के साथ साधारण सह–सम्बन्ध गुणांक, पैकिंग, एराबैण्ड, स्पाईरोकिटोसिस, से धनात्मक एवं सार्थ पाया गया। न्यूनतम तापक्रम का मृत्यु के साथ धनात्मक व सार्थक सह–सम्बन्ध पाया गया। काक्सिडियोसिस का अधिकतम आद्रता के साथ धनात्मक एवं सार्थक सम्बन्ध पाया गया।

Annexure I : Year wise per cent mortality across sexes

Year	Sexes			
	Unsexed grower	Male	Female	Total
61	4.97	8.12	4.35	7.46
62	1.93	1.97	2.28	2.20
63	2.59	2.94	2.71	2.84
64	3.78	1.99	3.32	3.68
65	2.98	2.52	2.51	3.05
66	11.19	5.28	4.79	10.20
67	18.52	12.22	9.90	17.36
68	10.86	4.61	8.76	10.48
69	10.49	17.45	9.71	12.52
70	12.51	12.93	10.83	11.35
71	3.25	5.93	8.35	6.89
72	8.34	5.27	6.44	8.91
73	3.14	1.26	3.69	3.71
74	3.56	3.78	4.94	5.13
75	3.37	3.36	1.73	4.00
76	2.62	1.53	2.91	3.13
77	3.10	5.34	3.11	4.27
78	5.95	4.88	3.14	4.51
79	4.14	8.82	4.81	5.30
80	5.42	3.89	5.41	6.85
81	6.66	5.71	4.39	5.84
82	6.03	2.71	4.07	6.16
83	7.29	2.11	4.53	5.66
84	5.17	2.69	4.64	6.16
85	10.29	3.14	5.23	9.99
86	10.22	10.11	16.49	15.86
87	3.29	1.86	6.25	4.83
88	7.86	2.81	3.26	7.45
89	16.30	5.74	5.64	13.98
90	18.92	4.13	5.97	15.83
91	10.51	6.31	10.87	11.96
92	12.38	4.14	7.32	11.93
93	12.17	2.02	5.96	11.65
94	7.49	1.08	4.82	6.58
95	8.52	4.54	6.79	9.70
96	9.94	0.80	4.87	8.76

Appendix II : Averages of meteorological parameters according to solar months

Months	Meteorological variables			
	Atmospheric temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
January	23.51 ± 0.03	5.69 ± 0.03	79.02 ± 0.12	33.21 ± 0.11
February	26.33 ± 0.04	8.18 ± 0.04	66.99 ± 0.16	26.58 ± 0.10
March	31.45 ± 0.03	13.43 ± 0.03	52.27 ± 0.13	21.52 ± 0.10
April	36.26 ± 0.02	19.48 ± 0.03	38.23 ± 0.08	16.82 ± 0.07
May	38.50 ± 0.02	24.54 ± 0.03	43.82 ± 0.22	22.19 ± 0.09
June	36.20 ± 0.03	25.72 ± 0.02	65.44 ± 0.13	42.50 ± 0.15
July	31.49 ± 0.03	24.13 ± 0.01	79.31 ± 0.09	64.76 ± 0.13
August	29.16 ± 0.02	22.89 ± 0.02	83.69 ± 0.12	71.96 ± 0.15
September	31.12 ± 0.03	20.72 ± 0.05	79.29 ± 0.13	56.73 ± 0.20
October	32.49 ± 0.03	15.48 ± 0.05	71.46 ± 0.15	32.17 ± 0.16
November	28.79 ± 0.03	10.54 ± 0.04	72.01 ± 0.18	32.57 ± 0.19
December	25.43 ± 0.03	7.22 ± 0.03	80.20 ± 0.12	41.03 ± 0.57

Appendix III : Averages of meteorological parameters according to season

Months	Meteorological variables			
	Atmospheric temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
Summer	36.67 ± 0.02	22.80 ± 0.02	48.92 ± 0.10	27.48 ± 0.09
Rainy	30.70 ± 0.12	22.88 ± 0.02	80.85 ± 0.07	64.55 ± 0.11
Autumn	30.48 ± 0.03	12.83 ± 0.04	71.99 ± 0.12	32.48 ± 0.12
Winter	24.40 ± 0.02	6.46 ± 0.02	79.57 ± 0.09	36.91 ± 0.28
Spring	29.33 ± 0.03	11.26 ± 0.03	58.26 ± 0.12	23.62 ± 0.07