INFLUENCE OF MATING RATIO ON FERTILITY AND HATCHABILITY IN JAPANESE QUAILS

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Thesis submitted in partial fulfillment of the
requirement for the degree of

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DECLARATION

I hereby declare that the thesis entitled **"INFLUENCE OF MATING RATIO ON FERTILITY AND HATCHABILITY IN JAPANESE QUAILS"** is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

Mannuthy

SURAJ A. AMRUTKAR

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Certified that this thesis, entitled **"INFLUENCE OF MATING RATIO ON FERTILITY AND HATCHABILITY IN JAPANESE QUAILS"** is a record of research work done independently by **SURAJ A. AMRUTKAR** under my guidance and supervision and it has not formed the basis for the award of any degree, diploma, fellowship or associateship to him.

Mannuthy,
2-5-09.

Dr. Leo Joseph

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CERTIFICATE

We, the undersigned members of the Advisory committee of **SURAJ A. AMRUTKAR,** a candidate for the degree of Master of Veterinary Sciences in Poultry Science, agree that the thesis entitled **"INFLUENCE OF MATING RATIO ON FERTILITY AND HATCHABILITY IN JAPANESE QUIALS"** may be submitted by **SURAJ A. AMRUTKAR,** in partial fulfillment of the requirement for the degree.

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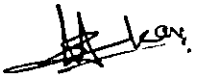

SURAJ A. AMRUTKAR

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SURAJ A. AMRUTKAR

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Introduction

1. INTRODUCTION

Poultry farming in India is now recognized as an organized and scientifically based industry and a potential tool to fight poverty and malnutrition. There is considerable scope for increasing the egg production further to meet the growing demand. The importance of quails in the poultry scenario of India is well recognized and quail production has registered a remarkable progress in the country since its introduction during mid seventies.

Japanese quail farming offers a viable and practical solution to the problems of animal protein shortage and unemployment in developing countries. For small holder farmers, it is an important source of income and employment generating venture besides providing nourishing food. Quail farming has been accepted by farmers as a potential alternative to chicken farming because of its small size, short incubation period, less floor space requirement, rapid growth, early onset of egg production, short generation interval, high rate of egg production, less susceptibility to disease and low feed intake. The annual egg mass production in quail is 20 times higher than adult female body weight, whereas in chicken it is only 10 times.

Quails are one of the most efficient biological machines for converting feed into animal protein of high biological value. At present in India, quails occupy the third largest position among poultry species next to chicken and duck. Quail meat is renounced for richness in vitamins, essential amino acids, unsaturated fatty acids, phospholipids and macro and micro elements. In quail egg and quail meat, cholesterol level is low as compared to chicken. Quails can adapt to varying environmental condition because of its hardy nature. Quail production requires less investment, gives quick return and higher profits and hence can be adapted by rural mass quickly.

Though the nutritional and managemental requirements have been standardized, the aspect of parental mating ratio has not been investigated in detail. Too many or too few quail males in the unit could lead to a higher

proportion of infertile eggs. Quail males are aggressive and when there are too many of them, a phenomenon called "psychological castration" often arises as a result of forming a peak order or dominance pyramid. Cocks at the base of the pyramid are usually knocked about and prevented from mating by the stronger, more dominant males. As phenomenon progress, despite the fact that they are physiologically normal, the cocks will fail to mate even if they are separated and given hen for their own. On the other hand, placing too few cocks in the unit will result in omission of some hens from being mated. The recommendations for the sex ratio in breeder quails were based on reports of Shanaway (1994). But the growth and production properties of quail lines have changed considerably by selection and breeding in later years and therefore sex ratio requirement are also likely to change.

Currently the mating ratio employed in University Poultry Farm KAU Mannuthy is 1:3, which results in an overall hatchability of 60 to 70 per cent. If a wider mating ratio can result in an equally good fertility and hatchability, it can be practiced in breeding units. The number of males can be reduced and the space saved can be utilized to house female quails. The expenditure on male quails and the feed can also be reduced and it would result in a higher return to the entrepreneur. Therefore an experiment was planned with the following objectives.

1) To study the influence of varying mating ratios on fertility and hatchability in Japanese quail.

2) To suggest an ideal mating ratio in Japanese quail.

Review of literature

2. REVIEW OF LITERATURE

2.1 BODY WEIGHT

Sachdev and Ahuja (1986) reported that egg line Japanese quails had a body weight of 181 to 200 g at 6 weeks of age.

Shrivastav *et al.* (1993) reported a body weight gain of 18.8 g in female breeder Japanese quails in 100 days of production.

Ozbey *et al.* (2004) reported that broiler Japanese quails reared under a constant temperature of 35^0C had a body weight of 167.78 g at 6 weeks of age, while those reared under 18 to 24^0 C had 177.61 g body weight.

Lekshmi (2005), while carrying out an experiment on the utilization of dried cuttle fish waste silage in Japanese quail layer ration reported that the mean body weight of layer quails at 6 weeks of age ranged from 159.67 to 160.05 g and that at 26 weeks of age from 199.43 to 204.77 g.

The mean body weight in the experimental groups was in range of 166.96 to 174.50 g at 6 weeks of age and 196.20 to 205.16 g at 26 weeks of age, Sheena (2005).

Preethymol (2006) evaluated the effect of dietary supplementation of lysine and methionine on the production performance of layer Japanese quails from 6 to 26 weeks of age and recorded a mean body weight of 180.0 g at 6 weeks of age and 225.83 g at 26 weeks of age.

Raseena (2006) reported that the mean body weight recorded at 6 weeks of age in quails ranged from 185.01 to186.56 g and that at 26 weeks of age ranged from 220.52 to 223.31 g.

In an experiment to evaluate the utilization of dried fish waste and fermented fish waste silage in Japanese quail, Preeta (2007) found that the mean body weight at 6 weeks of age was 189.37 g and at 16 weeks it was 213.15 g.

Bhadra (2008) reported that the average body weight of the quails was 155.50 g at 6 weeks of age and 205.51 g at 26 weeks of age.

Shamna (2008) reported that the cumulative body weight recorded in groups ranged from 156.57 g to 169.63 g at 6 weeks of age.

2.2 AGE AT SEXUAL MATURITY (ASM)

Sachdev and Ahuja (1986) observed that egg line Japanese quails within a body weight range of 161 to 180 g at 6 weeks of age reached sexual maturity at 78 days of age, while those with in the range of 181 to 200 g body weight reached sexual maturity at 66 days of age with an average age at sexual maturity of 73.18 days.

Padmakumar (1993) reported that the age at first egg was 55 days and age at 50 per cent production was 72 days for Japanese quails.

Lekshmi (2005) reported that the average age at first egg was 46.25 days and mean age at 50 per cent production was 71.75 days in layer quails.

Sheena (2005) observed that the quails having mean body weight of 172.24 g attained sexual maturity at an average age of 47 days and 50 per cent production at 58 days of age.

Preethymol (2006) observed that layer Japanese quail attained sexual maturity at 42 days and 50 per cent production at 51 days of age.

Raseena (2006) reported that in layer Japanese quails with a mean body weight of 185.23 g at 6 weeks of age, the average age at first egg, 10 per cent and 50 per cent egg production were 42, 43 and 47 days, respectively.

Preeta (2007) reported that the average age at first egg, 10 per cent and 50 per cent production in Japanese layer quails having a mean body weight of 189.37 g at 6 weeks of age were 42.50, 44.50, and 50.00 days, respectively.

Bhadra (2008) observed that the absolute age at first egg was 48, 50, 49 and 49 days and the mean age at 50 per cent production was 55.50, 56.25, 55.75 and 56.00 days in four experimental groups, respectively.

2.3 EGG PRODUCTION

While assessing the protein requirement of female breeder Japanese quails using purified diet, Johri and Vohra (1977) reported that quails had a quail day egg production of 62.6 per cent for a period of 44 days starting from 50 per cent production.

Yamane *et al.* (1979) reported that quail day egg production ranged from 83.6 to 88.8 per cent.

Arscott and Goeger (1981) reported that the average egg production of Japanese quails was 66.5 per cent.

Ross and Dominy (1990) observed that quail housed egg production ranged from 75.9 to 88.6 per cent from 9 to 31 weeks.

Shrivastav *et al.* (1993) reported that hen day egg production in per cent was obtained 65.02 per cent up to 16 weeks of age.

Soares *et al.* (2003) reported that Japanese quail layers from 7 to 14 weeks of age had 76.7 per cent egg production.

Lekshmi (2005) reported quail housed egg number of 90.32 and quail housed percentage of 64.4 from 6 to 26 weeks of age.

Sheena (2005) reported cumulative quail housed number per quail ranging from 60.38 to 80.80 with the corresponding percentage ranging from 43.13 to 57.71 in experimental groups while assessing the effect of protease supplementation in layer quails for a period from 6 to 26 weeks of age.

Preethymol (2006) reported that Japanese quails cumulative Quail Housed Number (QHN) and Quail day number (QDN) was of 110.36 and 112.70 with corresponding percentages of 78.83 and 80.50 in control group from 7 to 26 weeks of age.

Raseena (2006) studied the effects of dietary inclusion of azolla at different levels in production performance of Japanese quails from 7 to 26 weeks of age and reported cumulative QHN varying from 112.18 to 120.00 among dietary groups.

In a study on the utilization of dried fish waste and fermented fish waste silage in layer Japanese quails from 7 to 26 weeks of age, Preeta (2007) reported maximum quail housed number and percentage as 91.74 and 65.53, respectively in quails fed with dried fish waste.

Bhadra (2008) studied dietary supplementation of turmeric and Tulasi in layer quails and reported the quail house cumulative egg number during the period from 7 to 26 weeks of age ranged from 87.25 to 94.83 and the corresponding percentage were 62.32 to 67.73.

2.4 EGG WEIGHT

Johri and Vohra (1977) reported an average egg weight of 9.0 g in Japanese quail breeder hens, while Arscott and Goeger (1981) reported that it ranged from 9.6 to 9.8 g.

Ross and Dominy (1990) reported mean egg weight of 10.89 and 10.96 g in layer Japanese quails.

Shrivastav *et al.* (1993) found that breeding Japanese quails had a mean egg weight of 9.47 g at 16 weeks of age.

Shukla *et al.* (1993) examined the effect of dietary supplementation of zinc on egg production and egg quality characteristics of Japanese quail and found that the quails had the average egg weight of 11.56 g from 7 to 19 weeks of age.

Sreenivasaiah (1998) stated that Japanese quails lay eggs weighing on an average of 10 g ranging from 6.4 to 13.8 g.

Japanese quail layers from 7 to 14 weeks of age had an average egg weight of 9.32 g (Soares *et al.*, 2003).

Lekshmi (2005) reported the average egg weight ranging from 10.73 to 10.81 g in dietary groups while assessing utilization of dried cuttle fish waste silage in Japanese quail layer ration and showed no significant difference in egg weight among the dietary groups.

In a study on the supplementation of protease on production performance of Japanese quail layers fed low protein diet from 6 to 26 weeks of age, Sheena (2005) reported mean egg weight varying from 10.40 to 11.14 g.

Preethymol (2006) observed an average egg weight of 11.17 g in layer Japanese quails.

In a study on the effect of dietary inclusion of azolla at different levels in layer Japanese quails, Raseena (2006), recorded an average egg weight of 11.27g in the control group from 7 to 26 weeks of age.

Thiruvengadam *et al.* (2006) conducted a study in 68 weeks old laying hens to assess the production performance by feeding standard designer feed with 0.3 per cent tulasi, 0.1 per cent turmeric, 0.3 per cent keelanelli and a combination of 0.1 per cent tulasi and keelanelli each and 0.03 per cent turmeric. They observed that egg weight was not significantly affected by supplementing turmeric or tulasi.

Preeta (2007) reported an average egg weight of 11.91 g in quails from 7 to 26 weeks of age.

Yalcin *et al.* (2007) conducted a study on the effects of dietary garlic powder on production performance in nine week old layer Japanese quails for a period of 21 weeks. They concluded that garlic powder at the rate of 0.5 and 1.0 per cent increased egg weight by 0.19 and 0.12 g, respectively.

Bhadra (2008) reported that the overall mean egg weight for three consecutive days towards the end of 10, 14, 18 and 26 weeks of age were 10.74, 10.71, 10.64 and 10.62 gm in the experimental groups, respectively.

2.5 MATING RATIO AND FERTILITY & HATCHABILITY

2.5.1 Quails

Woodard and Abplanalp (1967) reported that Japanese quails with a mating ratio of 1: 1, 2, 3, 4, 5 and 6, the fertility obtained was 81.4, 81.4, 68.6, 49.6, 61.6 and 53.7 per cent, respectively. The hatchability was 83.0, 81.4, 81.1, 77.4, 81.1 and 79.0 per cent, respectively, in the six mating groups.

Shrivastav *et al.* (1993) reported that at 16 weeks of age, fertility, hatchability on total eggs and hatchability on fertile eggs was 84.73, 74.32 and 87.46 per cent, respectively, in 1:2 mating ratio.

Shanaway (1994) reported that fertility of quail eggs was affected by mating sex ratio. In 1:3 ratio, maximum fertility obtained was 95.4%. In 1:4 ratio, fertility was 93.45% but n 1:5 ratio, the fertility decreased to 89 % and in 1: 6 ratio, the fertility further decreased to 86%.

Asasi and Jaafar (2000) reported that Japanese quails maintained with a mating ratio of 1:1, 2, 3 and 4, fertility recorded was 93.3, 92, 62 and 94.5 per cent respectively and hatchability obtained was 76, 80, 60 and 88 per cent, respectively.

KAU (2001) suggested that good fertility can be obtained with 1:2 mating ratio in Japanese quail.

Baser *et al.* (2002) compared a sex ratio sex ratio of 1: 1, 2 and 3 in Japanese quails. They reported that fertility and hatchability on total eggs were not influenced by sex ratio.

Erensayn (2002) reported a range of fertility from 63.47 to 77.53 per cent, hatchability on total eggs from 56.81 to 70.34 per cent and hatchability on fertile eggs from 69.44 to 74.72 per cent in Japanese quails of young and old groups. The sex ratio was not specified.

Seker *et al.* (2004) conducted studies on sex ratio of 1: 2 and 1:3 in 10 and 20 weeks old quails. The group with 1: 3 sex ratio had a significantly ($P< 0.05$) higher hatchability in 10 week old quails while the fertility was significantly higher in 20 week old quails.

2.5.2 Other Species

Wyeld and Wyeld (1979) reported that good fertility was obtained with 1: 8 mating ratio in ducks.

Lake *et al.* (1985) reported that good fertility was obtained with 1: 10-15 mating ratio by artificial insemination in Turkey.

North and Bell (1990) reported that good fertility was obtained with 1: 10 - 11 mating ratio in chicken.

Peter and Henry (2000) reported that in Bobwhite quails, the male: female ratio of 1: 1 resulted in high egg production, fertility and hatchability as compared to 1: 2 and 1: 3 ratios.

Chotesangasa (2001) reported that mean fertility during 35 to 44 weeks of age in the mating ratios of 1:7, 1:10, 1:13 and 1:16 were 88.21, 91.20, 88.20 and 79.82, per cent, respectively, and during 34 to 44 weeks of age in the mating ratios 1:8, 1:12 and 1:16, the mean fertility were 84.31, 90.84 and 81.76 per cent, respectively in Thai native chicken flock.

KAU (2001) suggested that good fertility can be obtained with 1:6 to1:8 mating ratio in layer ducks, 1:8 ratio in heavy chicken breeds and 1:10 ratio in light chicken breeds and 1:5 ratio in Turkeys.

Deeming and Wadland (2002) reported that 1:8 male-female mating ratio gave four per cent higher fertility than 1:12 ratio in commercial pheasant.

Lee *et al.* (2003) reported that either 1:9 or 1:11 male:female ratio, but not 1:13 male female ratio, seems suitable to sustain reproductive performance of broiler breeder through out the laying period.

Jalaludeen *et al.* (2004) reported that in Kuttnad ducks reared under open range system, 60 to 75 per cent fertility could be obtained with mating ratio of 1 male for 20 to 25 females.

2.6 COST AND RETURN

Padmakumar (1993) reported that margin over feed cost per bird in 315 (days) was Rs. 16.32

Lekshmi (2005) reported that margin per egg over feed cost was Re. 0.31 from 6 to 16 weeks of age.

Sheena (2005) observed that cost of feed per egg was 0.50 rupees from 6 to 26 weeks of age.

Bhadra (2008) reported that the margin of return per quail from 6 to 26 weeks of age was 5.95 rupees.

2.7 METEOROLOGICAL OBSERVATIONS

Somanathan (1980) reported a maximum temperature ranging from 31.14 to 35.14°C, minimum temperature ranging from 21.15 to 25.80°C and average relative humidity (R.H.) ranging from 58.49 to 84.39 per cent during the period from January to June in the years 1974 to 1978 at the Meteorological observatory unit, Mannuthy. The measurements were taken at latitude of 10° 32" N, longitude of 76° 16" E and altitude of 22.25 m above MSL for 5 years and average values were reported.

Narayanankutty (1987) observed a maximum temperature of 32.2°C, minimum temperature of 28.9°C and R.H. of 56 to 68 per cent inside the experimental house at Mannuthy during January to February 1987, when an experiment was carried out in Japanese quails.

Padmakumar (1993) noticed maximum temperatures of 33.4, 36.18 and 32.74°C inside the experimental house during the periods of Dec-Jan, Apr-May and May-Jun, respectively at Mannuthy. The minimum temperatures were 20.90, 24.64 and 24.42 ° C in the respective periods. The R.H. in the F.N. was 74.8, 81.2 and 87.8 per cent and in the A.N. was 35.6, 48.2 and 65.2 per cent in the respective periods, when an experiment was carried out in Japanese quails.

Sheena (2005) reported a maximum temperature of 34.2°C, minimum temperature of 23.3°C and R.H. of 78.1 per cent at 8 a.m. and 43.5 per cent at 2 p.m. inside the experimental house at Mannuthy during Dec 2004 to May 2005, when an experiment was carried out in Japanese quails.

Preethymol (2006) noted a maximum temperature of 37.07 ° C, minimum temperature of 22.91 ° C and R.H. of 91.43 per cent at 8 a.m. and 53.25 per cent at 2 p.m. inside the experimental house at Mannuthy during January to June 2006, when an experiment was carried out in Japanese quails.

Bhadra (2008) reported that a maximum temperature of 32.14° C, minimum temperature of 26.59° C and relative humidity of 77.98 per cent in the F.N. and 61.09 per cent in the A.N. inside the experimental house from December- 2007 to May-2008 at Mannuthy.

Materials and Methods

3. MATERIALS AND METHODS

An experiment was carried out in the Department of Poultry Science, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, to study the influence of mating ratio on fertility, hatchability and other production traits in Japanese quail. The experiment was carried out from August to December, 2008.

3.1 EXPERIMENTAL MATERIALS

Japanese quails maintained at the University Poultry Farm, Mannuthy formed the experimental subjects of the study. Quails at 5 weeks of age were procured and housed in cages for the experiment.

3.2 EXPERIMENTAL LAYOUT

The experiment was conducted during the laying phase of Japanese quails from six to sixteen weeks of age. At six weeks of age, 304 Japanese quail pullets and 72 males were weighed and distributed randomly to four treatment groups with four replicates per treatment. The number of males and females allotted to each replicate and treatment was as follows.

Group	Sex ratio	Per replicate		Per treatment	
		Male	Female	Male	Female
T_1	1 : 3	6	18	24	72
T_2	1 : 4	5	20	20	80
T_3	1 : 5	4	20	16	80
T_4	1 : 6	3	18	12	72
Grand Total				72	304

3.3 HOUSING AND MANAGEMENT OF QUAILS

The quails in each replicate were housed in cages having a dimension of 60 x 60 cm x 25 cm. The cage house, cages, feeders and water troughs were thoroughly cleaned and disinfected one week prior to the experiment.

The Quails were fed standard quail breeder ration throughout the experimental period containing 22.75 per cent crude protein and 2650 kcal metabolizable energy per kg diet. The per cent ingredient composition of the experimental ration is given in Table 1 and the proximate composition of the ration is presented in Table 2.

The Quail lost by culling or mortality was substituted to maintain the mating ratio. The quails were provided with feed and water *ad libitum* throughout the experimental period. Standard managemental procedures were adopted identically to all treatment groups during the entire period of experiment.

3.4 OBSERVATIONS RECORDED

3.4.1 Body Weight

Body weights of all birds were recorded at the end of six and sixteen weeks of age in grams and the means were calculated.

3.4.2 Age at Sexual Maturity

The age at first egg and at 10 and 50 per cent production (days) were recorded in each replicate.

3.4.3 Egg Production

The egg production was recorded daily from six to sixteen weeks of age in each replicate and expressed as number and per cent. The weekly egg number and per cent was calculated from this data.

Table 1. Per cent ingredient composition of Quail breeder ration.

Sl. no.	Ingredient	Breeder diet
1	Maize	55.00
2	Soyabean meal	25.00
3	Unsalted dried fish	8.00
4	De-oiled Rice Bran	2.00
5	Di-calcium phosphate	2.00
6	Calcite powder	7.75
7	Salt	0.25
	Total	100.00
Added per 100 kg feed		
8	Merivite (g)	10.00
9	Nicomix (g)	10.00
10	DL-Methionine (g)	25.00
11	UTPP (g)	100.00
12	Bio choline (g)	100.00
13	E -care- Se (g)	10.00
14	Terfoli(g)	25.00
15	Trace minerals mix (g)	130.00

Note:

1. Calcite powder: Limestone powder containing 38 per cent Calcium.
2. Merivite (Wockhardt Ltd, Mumbai). Composition per gram: Vitamin A: 82500 IU, Vitamin B_2:52 mg, Vitamin D_3: 12000 IU, Vitamin K: 10 mg, Calcium: 166 mg, Phosphate: 395 mg.
3. Nicomix-be: Vitamin B_1:8mg, Vitamin B_6:16 mg, Vitamin B_{12}: 80µg, Niacin: 120mg, Calcite pantothenate: 80 mg, Vitamin E: 80 mg, Folic acid: 8mg.
4. DL- Methionine: Contains 99 per cent methionine.
5. UTPP-5 Powder (Tetragon Chemic Pvt. Ltd., Bangalore) contains treated Aluminosilicates, Propionates, Formates and acetates.
6. Bio-choline with choline chloride activity (Indian Herbs Research and supply Co., Ltd., U.P.)
7. E-care-Se Super Forte (Tetragon chemic Pvt. Ltd. Bangalore): Each contains Vitamin E: 500 g, Selenium 1g per kg .
8. Terfoli Powder (TTK health care).- Herbal feed supplement
9. Trace mineral mixture : TM-6. Composition per Kg: Cobalt: 1 g, Copper: 2g, Iodine: 2 g, Iron: 20 g, Zink: 52 mg, Manganese: 55g.

Table 2. Chemical composition of Quail breeder ration on dry matter basis.

Sl. No.	Parameters	Per cent
	Analyzed Value	
1	Dry matter	89.90
2	Crude protein	22.75
3	Ether extract	2.83
4	Crude fibre	3.18
5	Total Ash	8.63
6	Acid insoluble ash	3.06
7	Calcium	3.40
	Calculated Values	
1	ME (kcal/kg)	2650
2	Phosphorus (%)	0.45
3	Lysine (%)	1.40
4	Methionine (%)	0.46
5	Threonine (%)	1.05

3.4.4 Egg Weight

All the eggs laid by the quails among the treatment groups were collected and weighed in mass at 8, 12 and 16 weeks of age. Based on these data, mean egg weight was worked out.

3.4.5 Fertility and Hatchability

The fertility and hatchability were tested in eight weekly batches of eggs collected from 9 to 16 weeks of age. The eggs were collected replicate wise and were kept in the storage room daily. Seven days collection was set on the eighth day and eight such batches were utilized for the present study. The hatches were taken replicate wise in separate trays and the number of quail chicks and un-hatched eggs were recorded. The un-hatched eggs were opened and the number of fertile and infertile eggs was recorded. From this data, the fertility and hatchability on total and fertile eggs were calculated replicate wise and treatment wise each week.

3.4.6 Feed Consumption

The total feed consumed in each treatment was recorded separately. This data was used to calculate the cost of production.

3.4.7 Cost and return

The actual cost and return during the experimental period from 6 to 16 weeks of age was recorded. The cost of the breeders (males and females) prevailing in University Poultry Farm, Mannuthy and cost of feed utilized during the period were used in the calculations. The expenditure for lighting charges and incubation cost in the hatchery was estimated. The meat value at 16 weeks was calculated based on the body weight and other current sales price in the farm. The manure output was estimated.

Following rates were used for the calculations.

1. Cost of female breeder quail-Rs.20 per bird.
2. Cost of male breeder quail-Rs. 16 per bird.
3. Cost of quail breeder ration - Rs.16.5 per Kg.
4. Cost of lighting – 70 paise per bird
5. Cost of incubation -50 paise per egg
6. Day old quail –Rs. 5 per chick
7. Meat value –Rs. 90 per kg.
8. Manure- 50 paise per Kg.

3.5 Meteorological parameters

The monthly mean value on maximum and minimum temperature and relative humidity (Forenoon and Afternoon) during the experimental period was obtained from the meteorological station at KAU, Vellanikkara, Thrissur (Anon., 2008).

3.7 Statistical Analysis

Data collected on various parameters were statistically analyzed as described by Snedecor and Cochran (1994).

Results

4. RESULTS

The results of the experiment carried out to study the influence of mating ratio on fertility, hatchability and other production traits in Japanese quails are presented in this chapter.

4.1 BODY WEIGHT

Data on mean body weight of quails at 6 and 16 weeks of age in the treatment groups are presented in Table 3 and graphically depicted in Figure 1.

The mean body weight for the treatment groups T1, T2, T3 and T4 were 176.43, 175.86, 179.72 and 187.51 g, respectively, at 6 weeks of age. Statistical analysis of the mean data of 6^{th} week body weight revealed significant difference between treatment means. The T1, T2 and T3 treatment groups were similar but T4 group differed significantly ($p<0.05$) from the other groups.

The mean body weight for the treatment groups T1, T2, T3 and T4 were 206.43, 210.90, 210.52 and 222.34 g, respectively at 16 weeks of age. Statistical analysis of the data revealed significant difference between treatment means. Treatment T4 (1: 6) differed significantly from T1, T2 and T3 treatment groups ($p<0.05$) whereas the latter groups were similar.

4.2 AGE AT FIRST EGG AND AT 10 AND 50 PER CENT PRODUCTION

The data on age at first egg and at 10 and 50 per cent production in different mating ratio groups are presented in Table 4 and graphically depicted in figure 2.

The age at first egg in the treatment groups T1, T2, T3 and T4 were 41, 42, 41 and 41 days, respectively.

Table 3. Mean (± SE) of body weight (g) of Japanese quails in the treatment groups and replicates at 6 & 16 weeks of age.

Age in weeks	Treatment groups	Body weight (g)				Mean
		R1 (n = 96)	R2 (n = 100)	R3 (n = 96)	R4 (n = 84)	
6	T1 (1:3)	170.32	178.54	183.83	173.03	176.43^{b} ± 3.00
	T2 (1:4)	172.63	167.82	173.74	189.23	175.86^{b} ±2.87
	T3 (1:5)	181.32	173.74	183.63	180.19	179.72^{b} ±2.11
	T4 (1:6)	185.31	189.23	186.00	189.50	187.51^{a} ±1.08
16	T1 (1:3)	203.23	198.67	207.30	216.52	206.43^{b} ±3.79
	T2 (1:4)	213.57	207.33	204.89	217.81	210.90^{b} ±2.94
	T3 (1:5)	212.90	206.37	207.23	215.58	210.52^{b} ±2.22
	T4 (1:6)	225.10	218.32	221.32	224.63	222.34^{a} ±1.58

Means carrying similar superscript within an age group do not differ significantly ($p<0.05$)

Fig.1. Mean body weight at 6 and 16 weeks of age

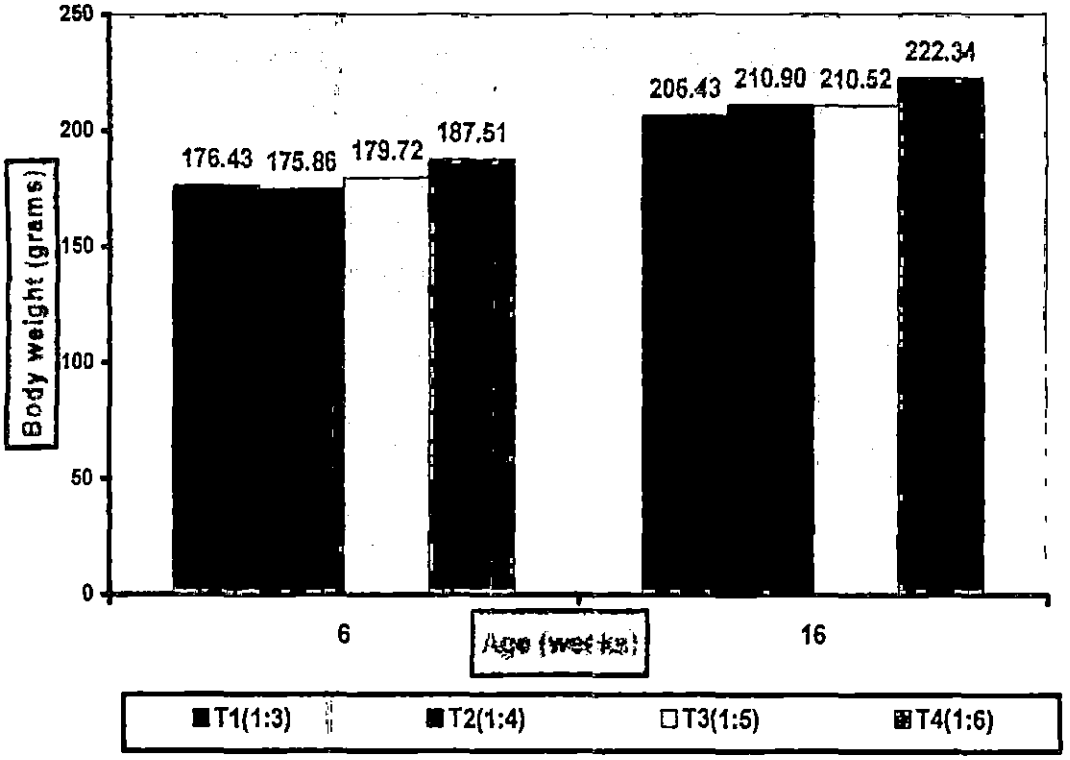
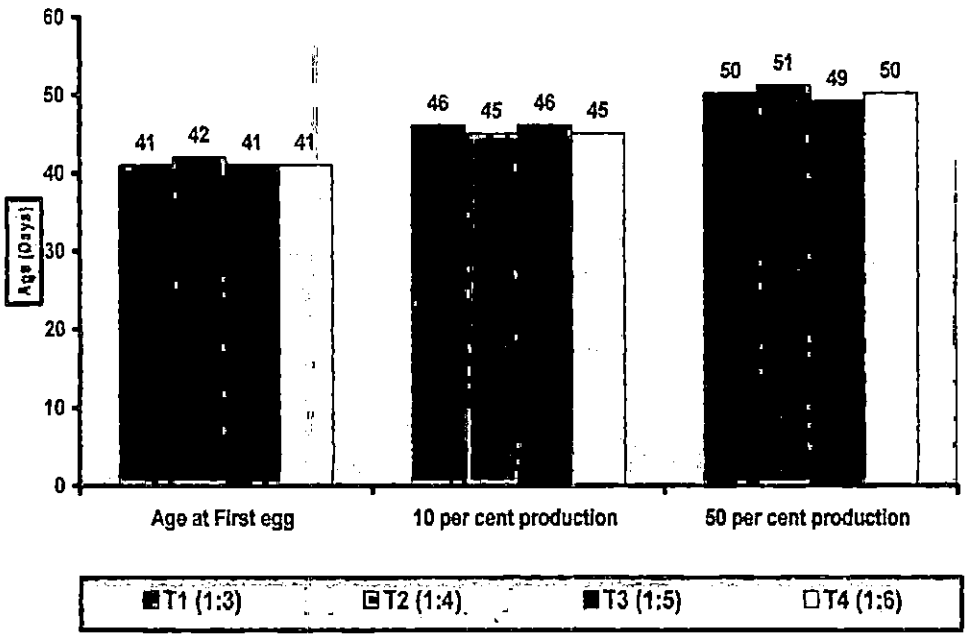


Table 4. Age at first egg and at 10 and 50 per cent production (days) in the experimental groups.

Parameter	Age (days)			
	T1 (1:3)	T2 (1:4)	T3 (1:5)	T4 (1:6)
Age at first egg	41	42	41	41
10 per cent production	46	45	46	45
50 per cent production	50	51	49	50

Fig.2. Age at first egg and at 10 and 50 per cent production



The age at 10 per cent production in the different treatment groups T1, T2, T3 and T4 were 46, 45, 46 and 45 days, respectively.

The age at 50 per cent production in the different treatment groups T1, T2, T3 and T4 were 50, 51, 49 and 50 days, respectively.

4.3 EGG PRODUCTION

4.3.1 Weekly mean number and mean per cent egg production

The weekly mean egg number and mean per cent egg production in treatment groups calculated based on the number of quails housed in each groups are presented in Table 5 and Table 6, respectively. The weekly data on mean per cent egg production in different treatment groups are depicted in Figure 3.

The weekly mean egg number and mean per cent egg production in treatment groups T1 showed increase in egg production from 7 to 12 weeks of age. The initial production was 21.23 per cent at 7 weeks of age. The peak production of 6.74 eggs per quail (96.23 per cent) was attained at 12 weeks of age. The quails in this treatment group maintained egg production above 90 per cent from 12 to 16 weeks of age. The overall egg production was 58.05 eggs (82.92 per cent).

The treatment group T2 with a mating ratio 1:4 showed initial production of 25.36 per cent at 7 weeks of age. The peak production 6.55 egg per quail (93.57 per cent) was attained at 11 weeks of age. The quails in this group maintained egg production above 90 per cent from 11 to 14 weeks of age but dropped marginally below 90 per cent at 15 and 16 weeks of age. The overall production was 57.95 eggs (82.78 per cent).

The treatment group T3 with a mating ratio 1:5 showed initial production of 29.46 per cent at 7 weeks of age, which was the highest among the treatment groups. The peak production 6.72 egg per quail (96.07 per cent) was attained at 12 weeks of

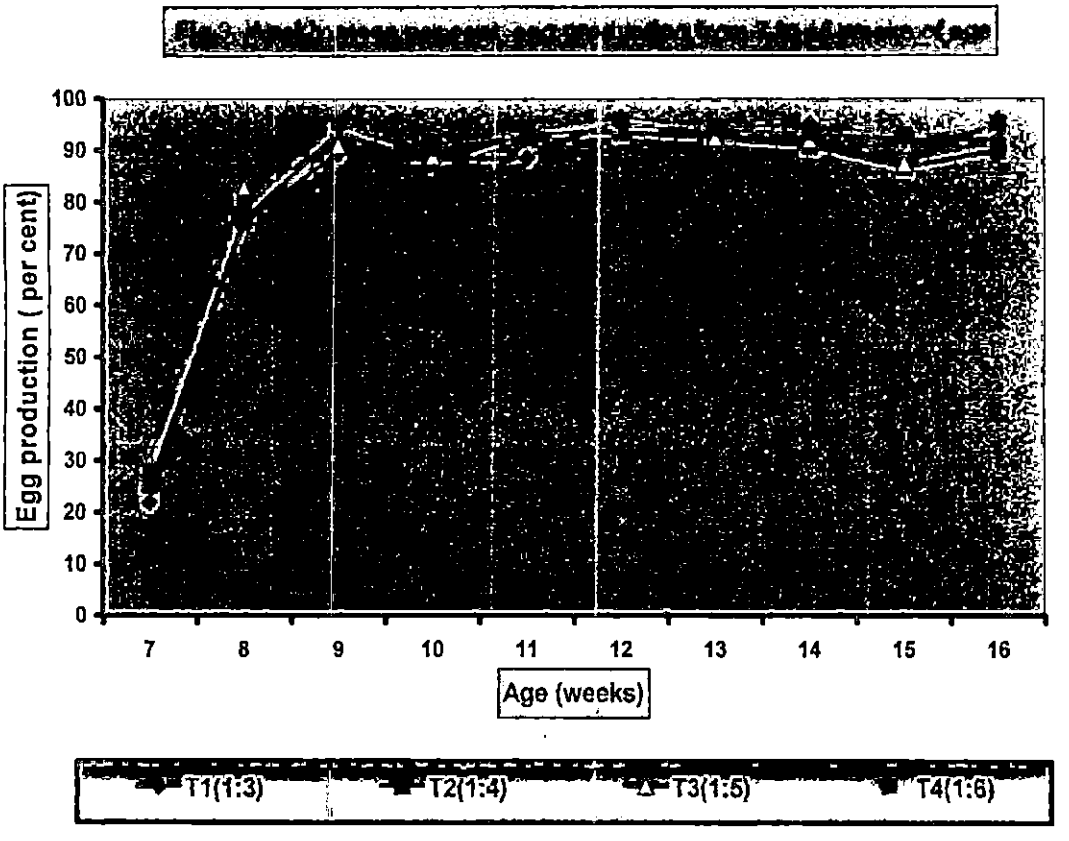
Table 5. Weekly mean egg number from 7 to 16 weeks of age in the experimental groups.

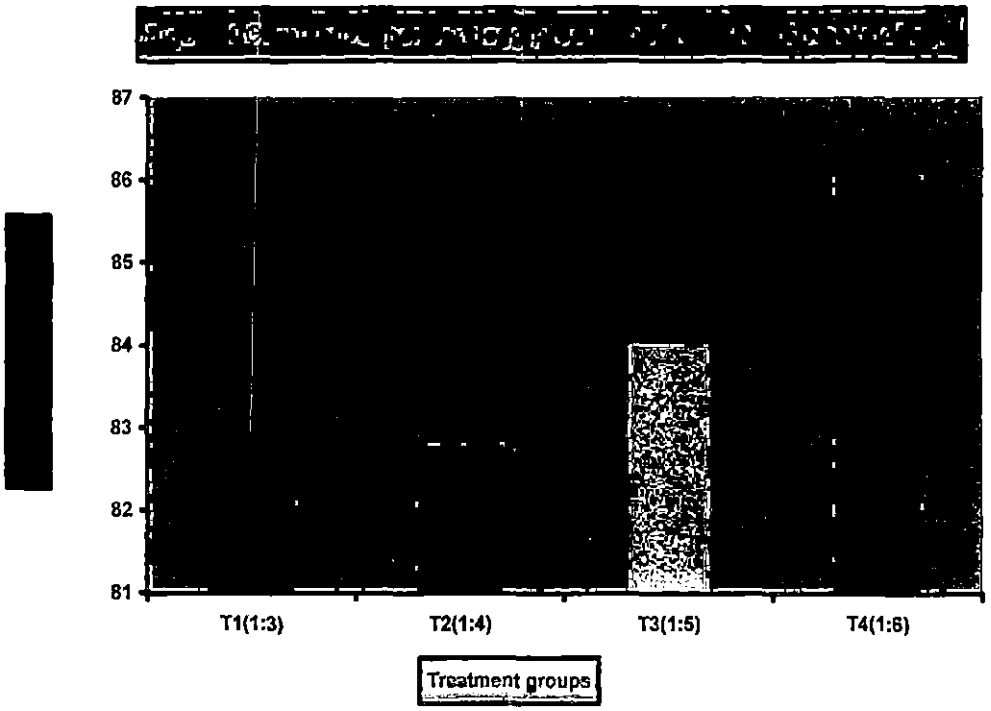
Age in weeks	Weekly mean egg number			
	T1 (1:3)	T2 (1:4)	T3 (1:5)	T4 (1:6)
7	1.49	1.77	2.06	1.94
8	5.71	5.35	5.79	5.57
9	6.26	6.46	6.36	6.65
10	6.17	6.11	6.21	6.33
11	6.19	6.55	6.53	6.54
12	6.74	6.54	6.72	6.68
13	6.56	6.46	6.46	6.60
14	6.65	6.35	6.44	6.54
15	6.43	6.06	6.11	6.49
16	6.44	6.29	6.70	6.65
Cumulative	58.05	57.95	59.39	60.24

Table 6. Weekly mean per cent egg production from 7 to 16 weeks of age in the experimental groups.

Age in weeks	Weekly Mean Per cent Egg production			
	T1 (1:3)	T2 (1:4)	T3 (1:5)	T4 (1:6)
7	21.23	25.36	29.46	27.78
8	81.55	76.43	82.68	79.56
9	89.48	93.32	90.89	95.04
10	88.1	87.32	88.75	90.48
11	88.49	93.57	93.21	93.45
12	96.23	93.39	96.07	95.44
13	93.65	92.32	92.32	94.25
14	95.04	90.71	91.96	93.45
15	91.87	86.61	87.32	92.66
16	92.06	89.82	95.71	95.04
Overall mean	82.92	82.78	84.04	86.05

The difference among the mean values were not significant ($p<0.05$) within each age group.


Egg production (per cent)
100
90
80
70
60
50
40
30
20
10
0
7
8
9
10
11
12
13
14
15
16
Age (weeks)
T1(1:3)
T2(1:4)
T3(1:5)
T4(1:6)


87
86
85
84
83
82
81
T1(1:3)
T2(1:4)
T3(1:5)
T4(1:6)
Treatment groups

age. The quails in this group maintained egg production above 90 per cent from 9 to 16 weeks of age except at 10 and 15 weeks of age. The drop at these ages was only marginal (1.25 to 2.68 per cent) which was regained in the subsequent weeks.

The treatment group T4 with a mating ratio 1: 6 showed initial production of 27.78 per cent at 7 weeks of age. The peak production 6.68 egg per quail (95.44 per cent) was attained at 12 weeks of age. This group attained an egg production 95.04 per cent at 9 weeks of age and has maintained the egg production above 90 per cent up to 16 weeks of age.

The overall mean per cent egg production from 7 to 16 weeks of age in treatment groups T1, T2, T3 and T4 were 82.92, 82.78, 84.04 and 86.05 per cent, respectively.

Statistical analysis of the mean data on egg production revealed no significant difference among treatment groups at all ages.

4.4 MEAN EGG WEIGHT

The mean egg weight was calculated based on the mass egg weight recorded for all eggs attained at 8, 12 and 16 weeks of age in different treatment groups. The results are presented in Table 7 and graphically depicted in Figure 5.

At 8 weeks of age, the mean egg weight was 10.90, 10.83, 10.86 and 10.97 g in treatment groups T1, T2, T3 and T4, respectively. Egg weights were statistically ($p<0.05$) similar among the treatment groups.

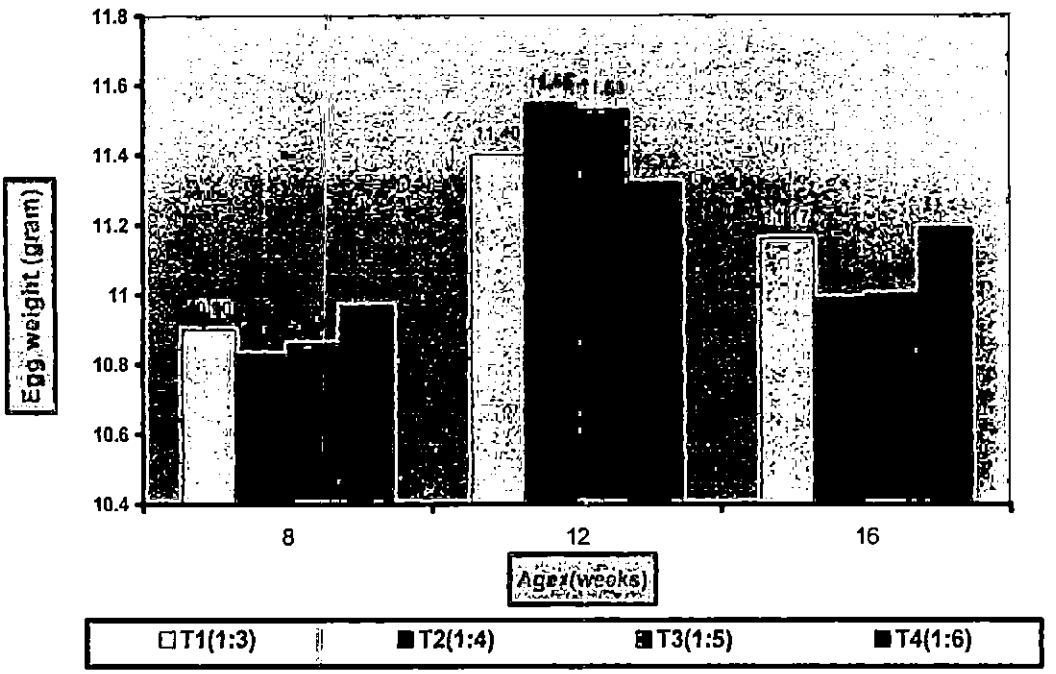
The mean egg weight was 11.40, 11.55, 11.53 and 11.32 g in treatment groups T1, T2, T3 and T4, respectively at 12 weeks of age. The egg weight was similar among the treatment groups.

Table 7. Mean (± SE) of egg weight (g) in experimental groups at 8, 12 and 16 weeks of age.

Age in weeks	Experimental groups	Egg weight, g				Mean
		R1	R2	R3	R4	
8	T1 (1:3)	10.79	10.85	11.05	10.91	10.90 ± 0.056
	T2 (1:4)	10.75	10.96	10.87	10.68	10.83 ± 0.052
	T3 (1:5)	10.66	11.12	10.98	10.68	10.86 ± 0.113
	T4 (1:6)	11.23	10.93	10.89	10.83	10.97 ± 0.089
12	T1 (1:3)	11.33	11.56	11.23	11.48	11.40 ± 0.074
	T2 (1:4)	11.44	11.63	11.85	11.28	11.55 ± 0.122
	T3 (1:5)	11.42	11.61	11.72	11.37	11.53 ± 0.081
	T4 (1:6)	11.43	11.33	11.56	10.96	11.32 ± 0.128
16	T1 (1:3)	10.94	11.19	11.34	11.2	11.17 ± 0.832
	T2 (1:4)	11.11	10.99	10.88	10.99	10.99 ± 0.469
	T3 (1:5)	11.06	10.78	11.07	11.09	11.00 ± 0.073
	T4 (1:6)	11.38	10.92	11.11	11.36	11.19 ± 0.109

The mean value differences were not significant ($p<0.05$) within each age group.

Fig.5.Mean egg weight at 8, 12 and 16 weeks of age



The mean egg weights were 11.17, 10.99, 11 and 11.19 g in treatment groups T1, T2, T3 and T4, respectively, at 16 weeks of age. The egg weight was similar among the treatment groups.

Statistical analysis of the mean data on egg weight revealed no significant difference ($p<0.05$) among treatment groups at 8, 12 and 16 weeks of age.

4.5 FERTILITY OF EGG

4.5.1 Mean Fertility of Egg

The weekly mean fertility of egg in the treatment groups from 9 to 16 weeks is presented in Table 8. The weekly fluctuation in fertility of egg in different treatment groups are depicted in Figure 6.

The treatment groups T1 with a mating ratio of 1:3 showed an initial fertility of 89.77 per cent at 9 weeks of age. The peak fertility of 95.06 per cent was attained at 13 weeks of age. The quails in this group maintained fertility above 90 per cent from 11 weeks of age.

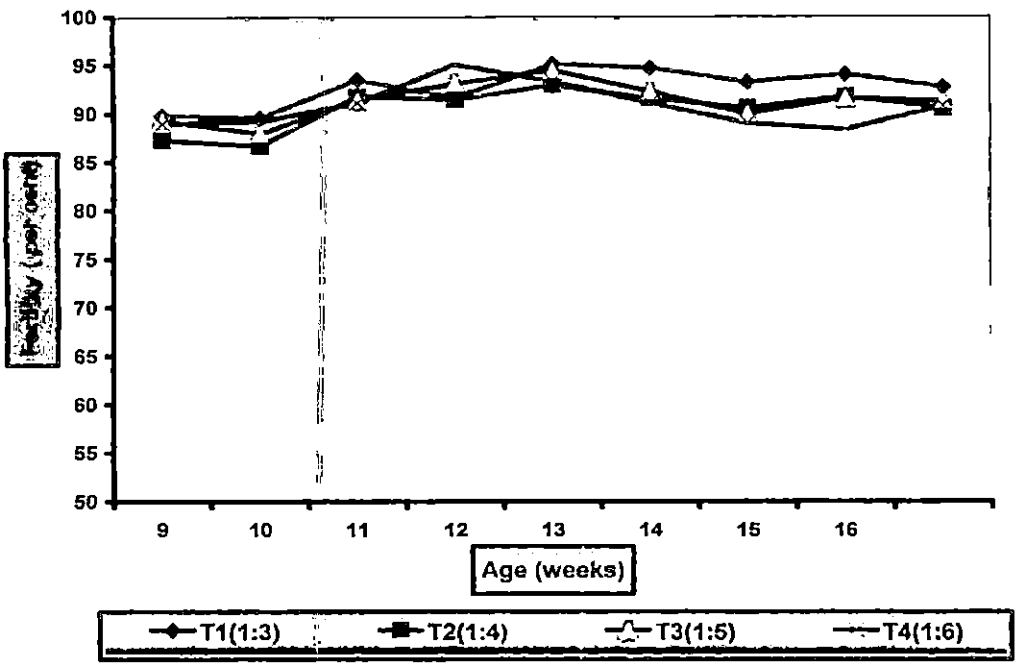
The treatment group T2 with a mating ratio 1:4 showed initial fertility of 87.24 per cent at 9 weeks of age. The peak fertility 92.90 per cent was attained at 13 weeks of age. The quails in this group maintained fertility above 90 per cent from 11 to 16 weeks of age.

The treatment group T3 with a mating ratio of 1:5 showed initial fertility of 89.31 per cent at 9 weeks of age. The peak fertility 94.40 per cent was attained at 13 weeks of age. The quails in this group maintained the fertility above 90 per cent from 11 to 16 weeks of age except 15 weeks of age, where it dropped marginally below 90 per cent (89.92 per cent).

Table 8. Mean (± SE) at fertility per cent of eggs from 9 to 16 weeks of age in the experimental groups.

Age in weeks	Fertility (%)			
	T1 (1:3)	T2 (1:4)	T3 (1:5)	T4 (1:6)
9	89.77	87.24	89.31	88.93
10	89.52	86.63	87.93	89.18
11	93.45	91.79	91.35	91.04
12	91.60	91.38	93.06	95.02
13	95.06	92.90	94.40	93.28
14	94.65	91.48	92.22	91.04
15	93.17	90.53	89.92	88.94
16	93.99	91.70	91.52	88.28
Overall Mean	92.65 ±0.75	90.45 ±0.81	91.21 ±0.72	90.71 ±1.09

Fig.6. Fertility of eggs from 9 to 16 weeks of age



The treatment group T4 with a mating ratio of 1:6 had initial fertility of 88.93 per cent at 9 weeks of age, which peaked to 95.02 per cent at 12 weeks of age. The peak fertility was observed one week earlier than other treatment groups. The quails in this group maintained fertility above 90 per cent from 11 to 14 weeks of age but dropped marginally at 15 and 16 weeks of age.

The overall mean fertility in the treatment groups T1, T2, T3 and T4 were 92.65, 90.45, 91.21 and 90.71 per cent, respectively.

Statistical analysis of the mean data of fertility revealed no significant difference among treatment groups at all ages.

4.6 HATCHABILITY

4.6.1 Mean Hatchability on Total Eggs Set (HTES)

The weekly mean hatchability on total egg set in the treatment groups observed from 9 to 16 weeks of age is presented in Table 9. The weekly fluctuation in hatchability of egg on total egg set in treatment groups are depicted in Figure 7.

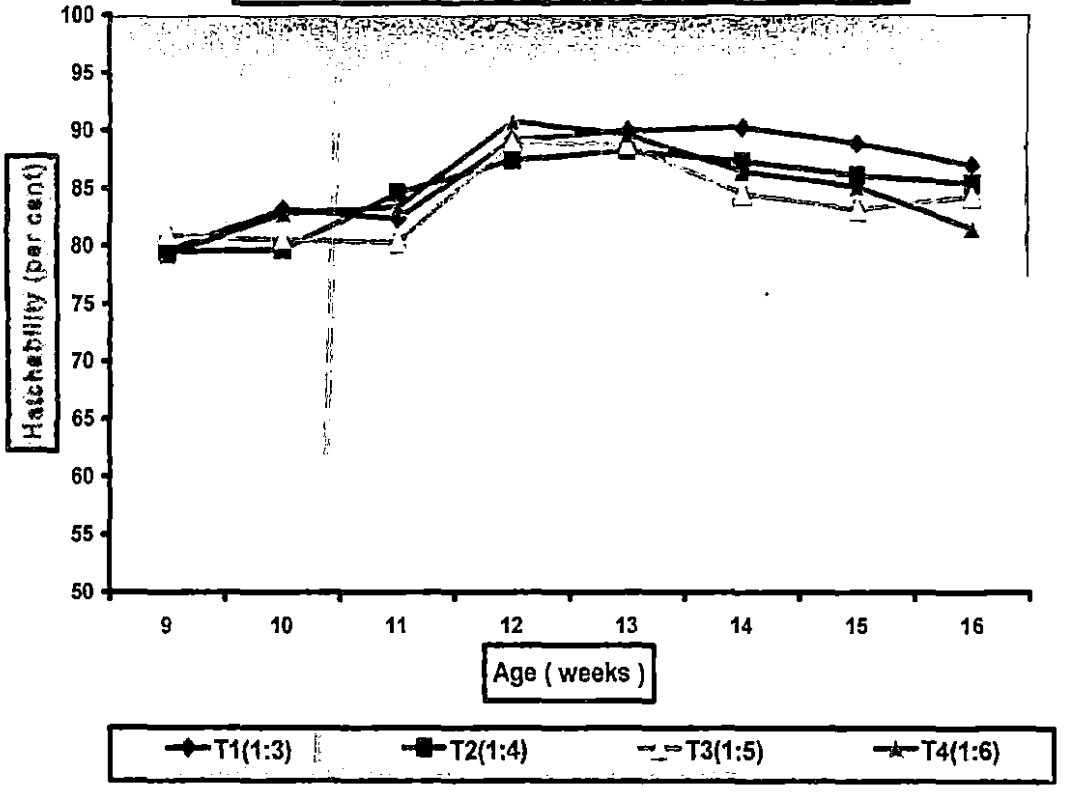
The treatment group T1 with a mating ratio 1:3 showed initial HTES of 79.55 per cent at 9 weeks of age. The peak hatchability of 90.15 per cent was attained at 14 weeks of age. The quails in this groups maintained hatchability on total egg above 80 per cent from 10 to 16 weeks of age.

The treatment groups T2 with a mating ratio 1:4 had an initial HTES of 79.48 per cent at 9 weeks of age. The quails in this group maintained hatchability on total egg set above 80 per cent from 11 to 16 weeks of age.

Table 9. Mean (± SE) of hatchability per cent on total egg from 9 to 16 weeks of age in the experimental groups.

Age in weeks	Hatchability on total egg (%)			
	T1 (1:3)	T2 (1:4)	T3 (1:5)	T4 (1:6)
9	79.55	79.48	80.86	79.15
10	83.14	79.63	80.48	82.78
11	82.31	84.54	80.26	83.33
12	89.08	87.36	88.93	90.66
13	89.91	88.17	88.67	89.59
14	90.15	87.22	84.43	86.35
15	88.77	86.01	83.06	85.03
16	86.86	85.27	84.20	81.38
Overall Mean	86.22 ±1.42	84.71 ±1.20	83.86 ±1.21	84.78 ±1.40

Fig. 7 Hatchability on total eggs from 9 to 16 weeks of age



The T3 treatment group with a ratio 1:5 had an initial HTES of 80.86 per cent at 9 weeks of age. Peak HTES in this group was 88.93 per cent at 12 weeks of age. The HTES was maintained above 80 per cent from 9 to 16 weeks of age.

Initial HTES in the treatment group T4 with a mating ratio 1:6 was 79.15 per cent at 9 weeks of age. The peak hatchability was 90.66 per cent at 12 weeks of age. The HTES was maintained above 80 per cent from 10 to 16 weeks of age.

The overall mean hatchability on total egg in the treatment groups T1, T2, T3 and T4 were 86.22, 84.71, 83.86 and 84.78 per cent, respectively.

Statistical analysis of the mean data of hatchability on total egg revealed no significant difference between treatments means at all ages.

4.6.2 Mean Hatchability on Fertile Egg Set (HFES)

The weekly mean hatchability on fertile eggs set in the different treatment groups recorded from 9 to 16 weeks is presented in Table 10. The data are depicted graphically in Figure 8.

The treatment groups T1 (1:3) recorded initial HFES of 88.61 per cent at 9 weeks of age. The HFES peaked to 97.25 per cent at 12 weeks of age. The HFES was maintained above 90 per cent from 10 to 16 weeks of age except 11 weeks of age, where it dropped marginally.

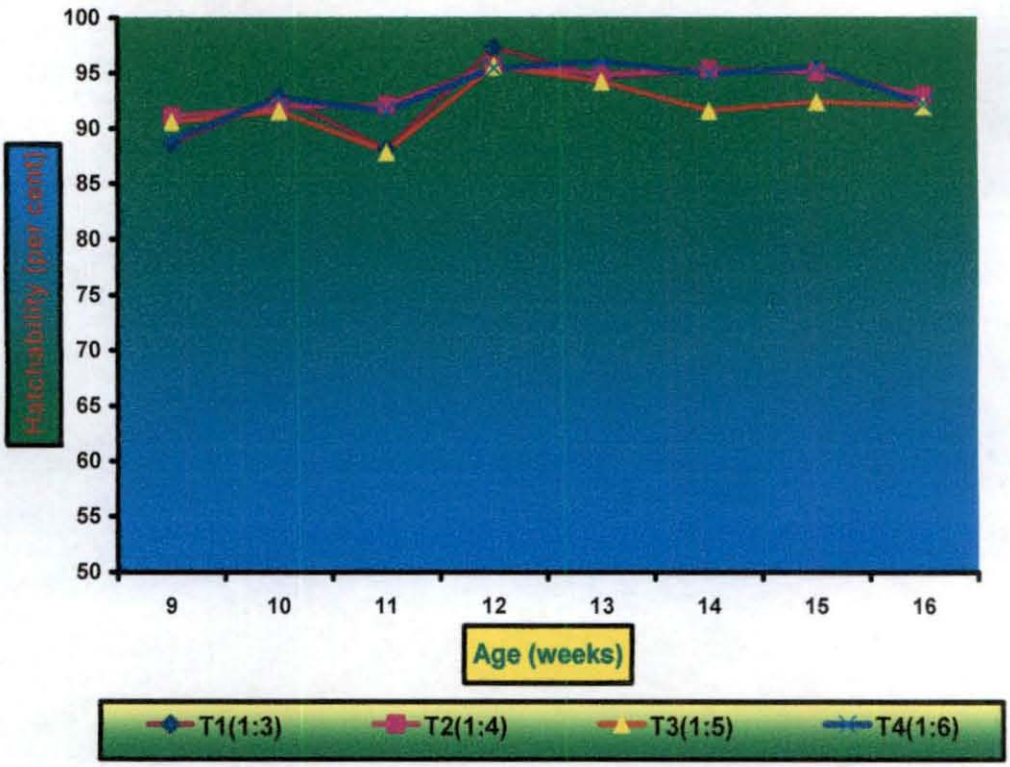
The quails of T2 groups (1:4) recorded initial HFES of 91.11 per cent at 9 weeks of age. A peak of 95.60 per cent was observed at 12 weeks of age. A HFES of 90 per cent and above was maintained from 9 to 16 weeks of age.

Initial HFES in the treatment groups T3 (1:5) was 90.54 per cent at 9 week of age. The peak HFES of 95.56 per cent was observed at 12 weeks of age. This group also maintained HFES above 90 per cent from 9 to 16 weeks of age except at 11 weeks of age, where it dropped marginally.

Table 10. Mean (± SE) of hatchability per cent on fertile eggs from 9 to 16 weeks of age in the experimental groups.

Age in weeks	Hatchability on Fertile egg (%)			
	T1 (1:3)	T2 (1:4)	T3 (1:5)	T4 (1:6)
9	88.61	91.11	90.54	89.00
10	92.88	91.92	91.53	92.82
11	88.08	92.10	87.86	91.53
12	97.25	95.60	95.56	95.41
13	94.58	94.90	94.19	96.05
14	95.25	95.34	91.56	94.85
15	95.27	95.00	92.38	95.61
16	92.42	92.99	92.00	92.19
Overall Mean	93.04 ±1.15	93.62 ±1.81	91.95 ±0.82	93.43 ±1.06

Fig.8. Hatchability on fertile eggs from 9 to 16 weeks of age



The1: 6 mating groups (T4) had an HFES of 89.00 per cent at 9 weeks of age. This group peaked at 13 week of age with a HFES of 96.05 per cent 13 weeks of age. An HFES above 90 per cent was maintained from 10 to 16 weeks of age.

The overall mean hatchability on fertile egg in treatment groups T1, T2, T3 and T4 were 93.04, 93.62, 91.95 and 93.43 per cent, respectively.

Statistical analysis of the mean data of hatchability on fertile egg set revealed no significant difference between treatment means.

4.7 CHICK PRODUCTION

4.7.1 Weekly Chick Production

The weekly chick production from 9 to 16 weeks of age in the experimental groups is presented in Table 11 and the data are depicted graphically in Figure 9.

A total of 3219 quail chicks were obtained from T1 (1: 3) from 72 females and 24 males. The number of chicks ranged from 365 at 10 weeks to 424 at 12 weeks of age. The average number of quail chicks per female breeder was 44.71.

The number of quails per week ranged from 387 at 9 weeks to 461 at 8 weeks of age in T2 (1: 4). A total of 3453 quail chicks were obtained with a mean of 43.16 chicks per dam from 80 dams and 20 males.

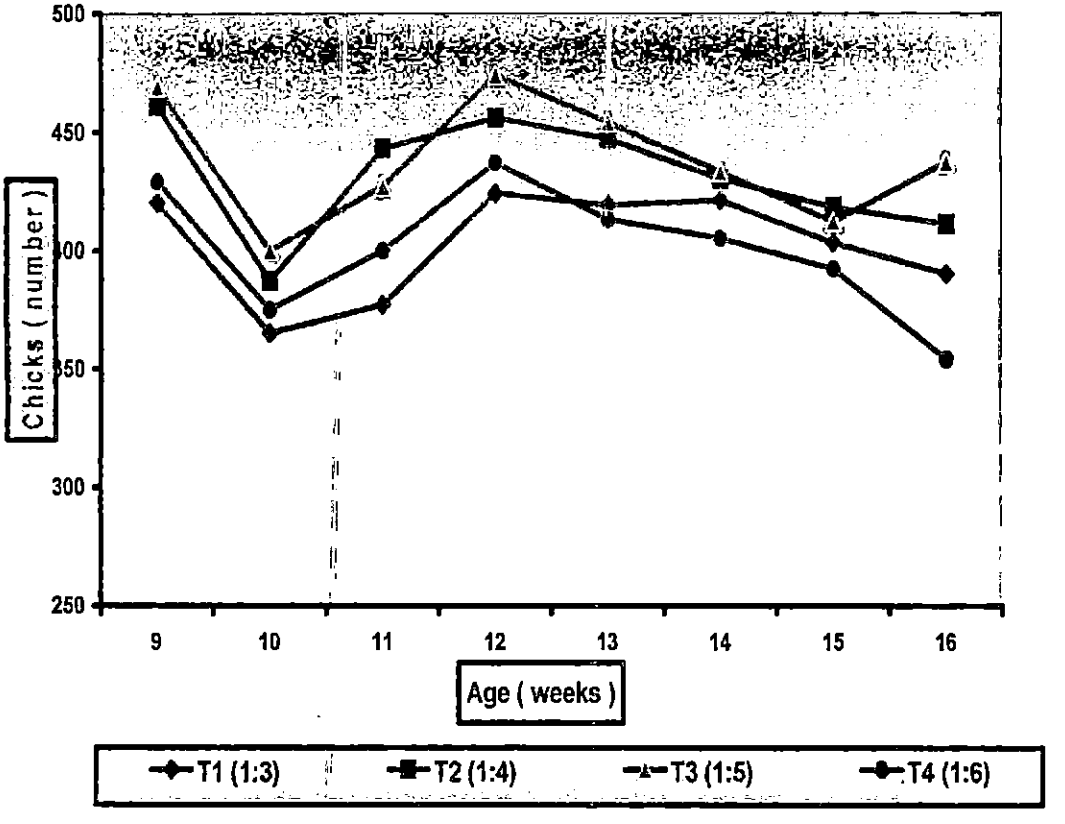
A total of 3506 quail chicks were obtained in T3 from 80 females and 16 males (1: 5) with an average 43.83 chicks per female. The number of chicks ranged from 400 at 10 weeks to 474 at 12 weeks of age.

The T4 had 72 females and 12 males, which produced 3205 quail chicks which averaged 44.51 per females. The chick production ranged from 354 at 16^{th} week to 437 at 12^{th} week.

Table 11. Chicks obtained from 9 to 16 weeks of age in the experimental groups.

Age in weeks	No. of chicks			
	T1 (1:3)	T2 (1:4)	T3 (1:5)	T4 (1:6)
9	420	461	469	429
10	365	387	400	375
11	377	443	427	400
12	424	456	474	437
13	419	447	454	413
14	421	430	433	405
15	403	418	412	392
16	390	411	437	354
Total	3219	3453	3506	3205
Average No. of quail chicks per female	44.71	43.16	43.83	44.51

Fig.9. Chicks obtained from 9 to 16 weeks of age



4.8 COST AND RETURN

The cost and return of the chick production in the Japanese quails as influenced by different mating ratio were worked out and presented in Table 12 and Figure 10.

The cumulative feed intake in the treatment groups T1, T2, T3 and T4 were 204, 214, 204 and 179 kg, respectively. The feed cost in the treatment groups T1, T2, T3 and T4 were Rs.3366, 3531, 3366 and 2954, respectively.

The cost of electricity arrived per quail breeder was 70 paise. The total cost of electricity in the treatment groups T1, T2, T3 and T4 were Rs. 67, 70, 67 and 59, respectively.

The cost of Incubation of quail egg was calculated as 50 paise per egg. The cost of incubation of quails in the treatment groups T1, T2, T3 and T4 were Rs. 1868, 2039, 2085 and 1891, respectively.

The total cost of production was Rs. 7125 in T1, Rs. 7560 in T2, Rs.7374 in T3 and Rs. 6536 in T4.

The return by the sale of chicks in the treatment groups T1, T2, T3 and T4 were Rs.16095, 17265, 17530 and 16025, respectively.

The total return by the sale of meat of 16 weeks old quails in the treatment groups T1, T2, T3 and T4 were Rs. 1834, 1921, 1834 and1604, respectively.

The cost of production per chicks in the treatment groups T1, T2, T3 and T4 was estimated as Rs. 2.21, 2.19, 2.10 and 2.04, respectively.

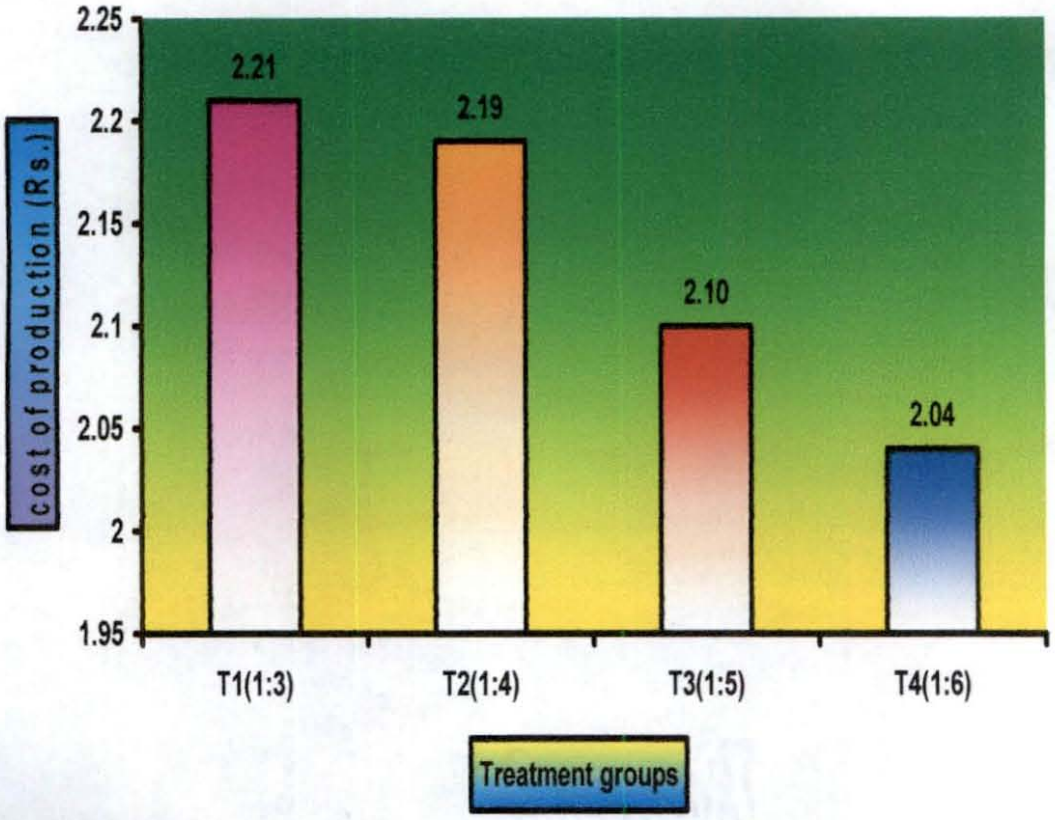
The margin per breeder quail (Male + Female) in the treatment groups T1, T2, T3 and T4 was calculated as Rs. 113, 117, 125 and 132, respectively.

Table 12. Cost and return of quail rearing in cages from 9 to 16 weeks of age as influenced by different mating ratio in the experimental groups.

Sl. No.	Particulars	Unit cost	Treatments							
			T1 (1:3)		T2 (1:4)		T3 (1:5)		T4 (1:6)	
			Quantity	Cost(Rs.)	Quantity	Cost(Rs.)	Quantity	Cost(Rs.)	Quantity	Cost(Rs.)
A	Cost									
1	Quails	Rs. 20 /F Rs.16 / M	F72+M24=96	1824	F80+M20= 100	1920	F80+M16 =96	1856	F72+M12 =84	1632
2	Feed	Rs.16.5 / kg	204 kg	3366	214 kg	3531	204 kg	3366	179 kg	2954
3	Electricity	70 p. / bird	96 quails	67	100 quails	70	96 quails	67	84 quails	59
4	Incubation	50 p. / Egg	3737 egg	1868	4079 egg	2039	4170egg	2085	3783 egg	1891
	Total			7125		7560		7374		6536
B	Return									
1	Chicks	Rs.5 / day old chick	3219	16095	3453	17265	3506	17530	3205	16025
2	Meat Value at 16 weeks	Rs. 90 / kg	20.38 kg	1834	21.35 kg	1921	20.38 kg	1834	17.83 kg	1604
3	Manure	50 p. / kg	66 kg	33	68 kg	34	66 kg	33	58kg	29
	Total			17962		19220		19397		17658
C	Margin			10837		11660		12023		11122
	Margin / quail housed			113		117		125		132
	Cost of prod. per chick,			2.21		2.19		2.10		2.04

Cost of housing and labour were not included.

Fig.10. Cost of production per chick



4.9 METEOROLOGICAL OBSERVATIONS

The mean maximum and minimum temperature (° C) and the mean per cent relative humidity (R.H.) in the F.N. and A.N. at monthly interval from August to December, 2008 are presented in Table13. The maximum temperature averaged 29.8, 30.6, 31.7, 32.2 and 31.6 ° C during the period I, II, III, IV and V, respectively with an overall mean of 31.18 ° C. During the above periods, the minimum temperature averaged 23.6, 23.2, 23.4, 23.1 and 22.5 ° C with an overall mean of 23.16 ° C during the entire period of experiment.

During experimental period the Relative humidity per cent was 93, 92, 87, 84 and 73 in the forenoon and 71, 68, 64, 56 and 47 in the afternoon in the period I, II, III, IV and V, respectively. The overall mean relative humidity from day old to 16 weeks of age was 80.85 per cent in forenoon and 61.20 per cent in the afternoon.

Table13. Mean maximum and minimum temperatures (° C) and per cent R.H. during the period from August to December, 2008.

Month	Temperature (° C)		Relative Humidity (%)	
	Maximum	Minimum	F.N.	A.N.
I (August)	29.8	23.6	93	71
II(September)	30.6	23.2	92	68
III(October)	31.7	23.4	87	64
IV(November)	32.2	23.1	84	56
V(December)	31.6	22.5	73	47
Mean	31.18	23.16	80.80	61.20

Discussion

5. DISCUSSION

The results of a study on the influence of mating ratio on fertility, hatchability and other production traits in Japanese quails are discussed in this chapter.

5.1 BODY WEIGHT

The mean body weight at 6 weeks of age obtained in the present study (Table 3 and Figure 1) ranged from 175.86 (T2) to 187.51 (T4) g in the treatment groups. The mean values obtained in the different replicates ranged from 167.82 (T2 R2) to 189.50 (T4 R4) g. The body weights indicated that the growth was optimum during the growing period. Moreover the variation in the body weight was to the tune of 11 per cent only, indicating uniformity in the experimental flock.

A body weight range of 166.96 to 174.50 g at 6 weeks of age was reported by Sheena (2005) in the same line of quails, whereas Raseena (2006) observed a range of 185.01 to 186.56 g for the same trait in the same line. Preethymol (2006) recorded a mean body weight of 180 g at 6 weeks of age in an earlier study with the same line of quails. The results obtained in the earlier studies supports the results obtained in the present study. However statistical analysis on treatment means revealed that although T1, T2 and T3 groups were similar in 6^{th} week body weight the group T4 was significantly different from all others. This experimental group had widest sex ratio and therefore this might have resulted in a higher mean values, since the females are heavier than males.

A perusal of the mean body weight of the different treatment groups also indicated a gradation in the mean 6^{th} week body weight from T1 to T4. This was the influence of the sex ratio which was getting wider from T1 through T2, T3 to T4.

The body weight at 16 weeks of age in the experimental groups (Table 3 and Figure1) ranged from 206.43 g in T1 to 222.34 g in T4 showing an increasing trend from T1 to T4. In this trait also, the mean value of T1, T2 and T3 were statistically similar but the group T4 was different from the rest of the groups. This trend was similar to that observed for body weight at 6th week. The difference had occurred due to larger proportion of females in T4 than other groups.

The minimum mean body weight recorded was 198.67 g (T1 R2) and the maximum mean body weight recorded was 225.10 g (T4 R1). Therefore the variability in the flock was only 11 per cent indicating uniformity among different treatment and replicate groups. This indicated that body weight at 16 weeks was not influenced by different mating ratio employed in the present study. The report of the earlier research work on body weight at 16 weeks of breeder quails in the same line could not be located. However Lekshmi (2005) reported a mean body weight ranging from 199.43 to 204.77 g and Sheena (2005) reported a mean body weight ranging from 196.20 to 205.16 g at 26 weeks of age in the same line of quails. However Preethymol (2006) reported a higher mean body weight of 225.83 g at 26 weeks of age and Raseena (2006) reported a range of 220.52 to 223.31 g at 26 weeks of age in the same line of quails. It may be observed that mean body weight at 16 weeks of age recorded in the present study is very close to the body weight at 26 weeks of age reported in the same line in the earlier studies. This indicated that quails attain mature body size by 16 weeks of age and body weight increases only marginally afterwards.

5.2 AGE AT FIRST EGG AND AT 10 AND 50 PER CENT PRODUCTION

Age at first egg recorded (AFE) in the present study (Table 4 and Figure 2) revealed very similar figures in all the treatments. The AFE was 41 days in T1, T3 and T4 whereas it was 42 days in T2. Therefore the mating ratio does not seem to have any effect on this trait. The AFE obtained in this study was in agreement

with those reported by Preethymol (2006), Raseena (2006) and Preeta (2007). However the AFE was lower than the values reported by Padmakumar (1993), Lekshmi (2005), Sheena (2005) and Bhadra (2008).

The data on age at 10 per cent and 50 per cent production as presented in Table 4 and Figure 2 revealed that they were very similar among all the treatments for each of the trait. While the treatment group T1 could attain 50 per cent production from 10 per cent production in four days time, it was 6 days in T2, 3 days in T3 and 5 days in T4. The performance of the different treatment groups was similar in this regard also.

It was also observed that while T1 group recorded 50 per cent production in 9 days from the age of AFE, the same was 9 days in T2, 8 days in T3 and 9 days in T4. The four treatment groups were similar in this regard also. It appeared that the mating ratio did not affect the expression of this trait.

5.3 WEEKLY MEAN EGG NUMBER AND MEAN PER CENT EGG PRODUCTION

The data on the weekly mean egg number and per cent production from 7 to 16 weeks of age (Table 5 and 6 & Figure 3 and 4) brought out the egg production pattern in the treatment groups.

The data presented in Table 5 and 6 revealed that initial egg production ranged from 21.23 (T1) to 29.46 (T3) per cent. All the experimental groups attained around 90 per cent production or more by 9 weeks of age. The peak production was attained at 12 weeks of age in T1, T3 and T4 whereas the same was attained at 11 weeks in T2. The egg production was maintained close to 90 per cent or above at 16 weeks of age in all the groups. However it may be mentioned that the T4 group maintained egg production above 90 per cent from 9 weeks of age till the end of experiment at 16 weeks of age. The highest overall egg production of 60.24 eggs (86.05 per cent) was recorded in T4 (1:6) whereas

the lowest egg number 57.95 egg (82.78 per cent) was recorded in T2 (1:4). However the difference was only 2.29 eggs.

The per cent egg production recorded in the present study is comparable to the report of Yamane *et al.* (1979), but higher than those reported by Johri and Vohra (1977), Arscott and Goeger (1981) and Soares *et al.* (2003). The variation in egg production might be due to strain differences. The earlier workers in the same line have reported egg production from 6 to 26 weeks of age and so a meaningful comparison was not possible.

The overall picture of the egg production (number, per cent and pattern) showed a little difference among treatment groups and statistical analysis also revealed that the mean differences were not significant. This revealed that the mating ratio did not influence egg production trait in quails in the present study.

5.4 MEAN EGG WEIGHT

The egg weight (Table 7 and Fig. 5) recorded in all treatment groups at 8 weeks of age did not reveal any pattern. Since the data is only on initial egg weight, the effect of mating ratio might not be pronounced.

The egg weight recorded at 12 weeks of age in the experimental group was comparable and no profound influence of mating ratio could be noticed in this trait. The egg weight being a trait related to body size; it might not be influenced by the presence or absence of males.

The mean egg weight was around 11 g at 16 weeks of age, though the values were marginally lower when compared with the egg weight at 12 weeks of age in all the treatment groups. The trends for egg weight at 16 weeks of age clearly proved that the mating ratio had no influence on this trait.

The mean egg weight recorded in the present study is in agreement with those reported by Ross and Dominy (1990) and Shukla (1993). Further Lekshmi

(2005), Sheena (2005), Preethymol (2006), Raseena (2006), Preeta (2007) and Bhadra (2008) had also reported results similar to the present study. Therefore the egg weight might be considered optimum in the present study.

5.5 FERTILITY OF EGG

The percentage of fertile eggs in the four treatment groups was the main trait evaluated in the present study. The ideal mating ratio 1: 3 was suggested by Shanaway (1994), Baser *et al.* (2002), Seker *et al.* (2004) in Japanese quails. In other species of poultry, a sex ratio of 1: 8 in ducks (Wyeld and Wyeld, 1979), 1:10 in turkey (Lake *et al.* 1985) and 1: 10 in chicken (North and Bell, 1990) has been reported as optimum. Therefore a wider sex ratio was tested in quails in the present study. The sex ratio was progressively increased from 1: 3 to 1: 4, 5 and 6 in the four experimental groups of T1, T2, T3 and T4, respectively. It may be noted that double the number of females of T1 was allotted per male in T4. When more females were allotted, the males should be were able to mate and fertilize the female breeders. The fertility was evaluated in eight weekly batches of eggs obtained from 9 to 16 weeks of age (Table 8). Since candling is not accurate in evaluating fertility, the unhatched eggs in each setting were break opened after each hatch and the infertiles were recorded. Although the quails started laying by the end of six weeks of age, the egg produced in the 7^{th} and 8^{th} weeks were not set for the incubation since the egg production in the 7^{th} week was only to tune 21 to 29 per cent and the production reached up to 85 per cent by 8^{th} week only.

The fertility of the 1^{st} batch of eggs (Table 8) ranged from 87.24 (T2) to 89.77 (T1) per cent and the same was 88.93 in 1: 6 mating group. Therefore it could be observed that the fertility per cent was very close in all the treatment groups and the magnitude could be termed as satisfactory. This level of fertility was maintained in the subsequent batches from 10 to 16 weeks of age. The fertility reached its peak during 12 to 13 weeks of age in all the treatment groups. Since the overall fertility was above 90 per cent, it could be termed as good. The

decrease in mean fertility in T4 (1:6) group compared to T1 (1:3) group was only 1.94 per cent. Since only half number of males were used in T4 compared to T1 (Para. 3.2), the economic disadvantage in T4 by lower fertility will be offset by savings in cost of males and feed. In the present study, though T2 (1:4) and T3 (1:5) groups were equally good in fertility, the economical advantage was maximum in T4 (1:6) group. Any sex ratio from 3, 4, 5 or 6 may be practiced in quail breeder units but the maximum returns could be obtained in 1:6 ratio.

Woodard and Abplanalp (1967) could attain a maximum fertility of 49.6 in the mating ratio of 1:4 and 53.7 per cent in 1:6 sex ratios which is lower than the present study. The fertility observed by Shanaway (1994), Shrivastav *et al.* (1993) and Erensayn (2002) was also lower than all the treatment groups in the present study. Asasi and Jaafar (2000) could attain a fertility of 62 and 94.5 per cent in mating ratios of 1:3 and 1:4, respectively. The fertility attained in the present study was higher in 1:3 mating ratio compared to above study, but lower in 1:4 mating ratio.

Since the mating ratio groups of 1: 3, 4, 5 and 6 were equally high and similar in fertility, it could be concluded that each quail male is capable of fertilizing double the number of females compared to the conventional ratio of 1:3. Therefore any ratio from 3 to 6 could be successfully used in quail breeder units for attaining good fertility. But the widest ratio of 1:6 requires only the half number of males compared to the narrowest ratio of 1:3 evaluated in this study. A saving could be attained in the cost of breeder males and the feed required for maintaining them throughout the breeding period. Therefore, a sex ratio of 1 male for every 6 females is recommended for the quail line maintained in University Poultry Farm, Mannuthy, in a flock mating system.

5.6 HATCHABILITY ON TOTAL EGGS SET

The percentage of eggs hatched out in the different treatment groups was another important trait evaluated in the present study. Although the fertility is primary requirement for hatching of eggs, the hatchability on total eggs set (HTES) directly influence the returns in a breeder and hatchery enterprises. A good hatchability of over 80 per cent assures a margin in quail breeder and hatchery units. Therefore, when different mating ratios are tested, a good hatchability must be assured for a profitable venture. The hatchability on total eggs was evaluated weekly from 9 to 16 weeks of age in the present study in different mating ratios of 1:3, 4, 5 and 6. The HTES in first batch of incubation (Table 9) ranged from 79 to 80 per cent in the four treatment groups. The HTES increased to above 80 per cent at 10 to 11 weeks of age in all the mating groups and it was maintained at that level up to 16 weeks of age. The HTES even reached 90 per cent at 12 weeks of age in T4 (1:6) and at 14 weeks of age in T1 (1:3). The overall mean hatchability per cent was also in close range of 83.86 (T3) to 86.22 (T1) per cent, the difference being 2.56 per cent only. The T4 (1:6) group was lower only by 1.44 per cent in HTES compared to T1 (1:3) group.

Asasi and Jaafar (2000) recorded hatchability of 60 and 88 per cent in mating ratio of 1:3 and 1:4 respectively. The hatchability in the present study was higher in 1:3 mating ratio but lower in 1:4 ratio compared to the above study. The hatchability obtained in the present study was higher than those reported by Erensayn (2002). The differences in the line utilized might have caused the variations.

The result indicated that hatchability was not adversely affected by widening the sex ratio from 1:3 to 1:4, 5 and 6. The female quails were successfully fertilized by the varying male ratios and the eggs laid could hatch out equally well. The differences in the HTES have been caused by the differences in fertility rates. Since the ratios of 3, 4, 5, and 6 are very similar and comparable for HTES, any one of the ratios could be applied in the breeder unit. But 1:6 ratio has

obvious advantages like lower bird, feed and space, which affect the overall returns from the unit. The shortfall of the income caused by a marginally lower percentage of HTES could be overcomed by the higher return in T4 group. Therefore a sex ratio of 1:6 is recommended in flock mating system for the quail line maintained in University Poultry Farm, Mannuthy.

5.7 HATCHABILITY ON FERTILE EGGS SET

The hatchability on fertile eggs set (HFES) indicates efficiency of incubation in a hatchery. Though all the fertile eggs are capable of hatching out, some losses do occur during incubation. A minimum loss during incubation will result in a higher hatchability and in turn a higher return for the hatchery man. Therefore this trait attains economic importance. Though the initial HFES was from 88.61 (T1) to 91.11 (T2) per cent, the values generally increased to 95 per cent by 12 weeks of age and it was maintained above 90 per cent till the end of the experiment. The overall mean values for this trait could be termed as good in all the treatment groups which ranged from 91.95 (T3) to 93.43 (T4) per cent. The results revealed that the performance of all the mating ratio groups was equally good for this trait.

The HFES attained in the present study was higher than those reported by Woodard and Abplanalb (1967) in similar mating ratios and those of Shrivastav *et al.* (1993) and Erensayn (2002) in Japanese quails. The higher values obtained in this study might be due to line differences.

Since HFES was similar and comparable among mating ratios of 1: 3, 4, 5 and 6 in the present study, it could be concluded that the mating ratio did not exert any influence for this trait. Since 1: 6 ratio is more economical compared to 1: 3, 4 and 5, it could be applied in Japanese quail line maintained at University Poultry Farm, Mannuthy.

5.8 CHICK PRODUCTION

The data on weekly number of chicks produced (Table 11) in the four treatment groups revealed that a total of 13383 quail chicks were obtained in the four treatment groups in the present study. The variations in the number of chicks obtained in each treatment was due to variation in the number of eggs obtained which was caused by variation in the number of females utilized in each treatment groups.

The maximum number of chicks was obtained in the 12 weeks of age in T3 (474 Nos.). The average number of quail chicks obtained per female housed was maximum in T1 (44.71 Nos.) and minimum was in T2 (43.16 Nos.). However the difference was only 1.55 chicks which can not be considered as substantial. The number of chicks in T4 group was lower by 0.20 chicks per female. This reduction cannot be considered as significant. Therefore it could be concluded that the female in 1:3 and 1:6 mating groups were equally efficient in producing chicks and so the wider mating ratio of 1:6 can be utilized in this quail line.

5.9 COST AND RETURN

The data presented in Table 12 details the expenditure incurred for various items and returns obtained. The margin per quail housed and cost of production per quail chick are also presented.

A reduction in the number of male breeder resulted in a resultant reduction in the cost of male breeders. A male breeder quail aged 5 weeks of age costs Rs. 16 in the farm. In T1 group, one male was required for every 3 females and therefore the cost of male breeder worked out to Rs. 5.33 per female. Similarly the cost of male breeder in T2 (1:4), T3 (1:5) and T4 (1:6) worked out to Rs. 4, 3.2 and 2.67 per female breeder, respectively. It could be observed that a progressive reduction in male cost per female occurred from T1 to T4 and that the cost is

halved in T4 compared to T1. This reduction of initial investment in the quail breeder enterprise will be of advantage to the investor.

The quantity of feed utilized per female breeder (males excluded) also progressively decreased as the mating ratio got wider from 1: 3 to 1: 4, 5 and 6. A total of 204 kg feed was required in the T1 group which had 72 females which averaged to 2.83 kg per female. Similarly in T2, T3 and T4 average quantity of feed per female was worked out to 2.68, 2.55, and 2.48 kg, respectively. The economy attained by the reduction in the feed requirement in large breeder units will be substantial considering the cost of feed saved.

It is evident from the Table 12 that the total margin was on the positive side and there was a progressive increase in margin per quail housed from T1 to T2, T3 and T4. A higher margin to the tune of Rs. 20, 16 and 8 per quail housed was attained in T4 compared to T1, T2 and T3, respectively. The reduction in the cost of production also helped to bring down the cost per chick from Rs. 2.21 in T1 to 2.19 in T2, 2.10 in T3 and 2.04 in T4.

Therefore, taking into consideration all the aspects of cost and return, it was evident that reducing the number of males allotted to female quail breeder from 1 per 3 females to 1 per 6 female was helpful in reducing the cost of production and increasing the margin over expenditure.

5.10 METEOROLOGICAL OBSERVATIONS

The data presented in Table 13 showed that the range of temperature and humidity was normal during the period of study and that the quails were not exposed to any extreme climate. Therefore it was concluded that weather did not cause any adverse effect on the performance of the quail breeder.

The mean maximum and minimum temperatures and relative humidity in forenoon and afternoon were comparable with the reports of Somanathan (1980), Narayanankutty (1987), Padmakumar (1993) and Bhadra (2008).

Based on the above findings, it could be concluded that the mating ratios from 1: 3 to 1: 6 did not influence fertility, hatchability and other production traits in Japanese quails. The wider mating ratio would be helpful to the breeder because it requires lesser number of males and the reduction in the number of males would result in a subsequent reduction in the feed requirement. This would be helpful in reducing cost of production per quail chick. Therefore a male-female ratio of 1: 6 is recommended for the quail line maintained in the University Poultry Farm, Mannuthy. Further study is required to assess whether a still wider ratio could be practiced without affecting fertility and hatchability.

Summary

6. SUMMARY

An experiment was carried out at the Department of Poultry Science, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, to study the influence of mating ratio on fertility, hatchability and other production traits in Japanese quails.

The experiment was carried out during the period from August, 2008 to December, 2008. Three hundred seventy six (376) breeder Japanese quails were weighed at six weeks of age and allocated randomly to four groups with a male female ratio of 1: 3 (T1), 1: 4 (T2), 1: 5 (T3) and 1: 6 (T4) with four replicate each. In T1 treatment group, each replicate consisted of 6 males and 18 females. In treatment group T2, each replicate consisted of 5 males and 20 females. In T3 treatment group, each replicate consisted of 4 males and 20 females. In treatment group T4, each replicate consisted of 3 males and 18 females. Standard managemental practices were followed uniformly. Quail breeder ration which contained 22.75 per cent crude protein and 2650 Kcal metabolizable energy per Kg feed was fed for all the mating groups.

The data were collected from 6 to 16 weeks of age. Body weight was recorded at 6 week and 16 week of age. The age at first egg and 10 and 50 per cent production was recorded. The egg weight was recorded at 8, 12 and 16 weeks of age. The egg production was recorded daily and expressed as weekly mean egg number and mean per cent egg production from 7 to 16 weeks of age. The eggs obtained were set for incubation replicate wise and treatment wise in weekly batches from 9 to 16 weeks of age and hatches were obtained. Fertility was recorded from 9 to 16 weeks of age by breaking open the unhatched eggs. Hatchability on total eggs and hatchability on fertile eggs were recorded from 9 to 16 week of age.

The salient finding in the study are presented below.

1. The average body weight of the quails were 176.43 ± 3.00, 175.86 ± 2.87 , 179.72 ± 2.11 and 187.51 ± 1.08 g at 6 weeks of age and 206.43 ± 3.79 , 210.90 ± 2.94, 210.52 ± 2.22 and 222.34 ± 1.58 g at 16 weeks of age in groups T1, T2, T3 and T4, respectively. The body weight in T4 group at both these ages was significantly different ($P < 0.05$) from other groups.

2. The absolute age at first egg was 41, 42 , 41 and 41 days and the mean age at 10 per cent production were 46, 45, 46 and 45 days and the mean age at 50 per cent production were 50, 51, 49 and 50 days in treatment groups T1, T2 , T3 and T4, respectively.

3. The cumulative egg number per quail during the period from 7 to 16 weeks of age was 58.05, 57.95, 59.39 and 60.24 in groups T1, T2, T3 and T4, respectively and the corresponding percentage were 82.92, 82.78, 84.04 and 86.05. Statistical analysis revealed no significant differences among the treatment groups.

4. The overall mean egg weight was 10.90 ± 0.056, 10.83 ± 0.052, 10.86 ± 0.113 and 10.97 ± 0.089 g at 8 weeks of age, 11.40 ± 0.074, 11.55 ± 0.122, 11.53 ± 0.081 and 11.32 ± 0.128 g at 12 weeks of age and 11.17 ± 0.832, 10.99 ± 0.469, 11.00 ± 0.073 and 11.19 ± 0.109 g at 16 weeks of age in the groups T1, T2, T3 and T4, respectively and the differences between mean values at different ages were non significant.

5. The overall mean fertility of egg from 9 to 16 weeks of age was 92.65 ± 0.75, 90.45 ± 0.81, 91.21 ± 0.72 and 90.71 ± 1.09 per cent in groups T1, T2, T3 and T4, respectively. Statistical analysis revealed that no significant difference existed between treatment groups.

6. The overall mean hatchability on total eggs from 9 to 16 weeks of age was 86.22 ± 1.42, 84.71 ± 1.20, 83.86 ± 1.21 and 84.78 ± 1.40 per cent in groups T1, T2,

T3 and T4, respectively and the differences between the mean values were non significant.

7. The overall mean hatchability on fertile egg from 9 to 16 weeks of age was 93.04 ±1.15, 93.62 ± 1.81, 91.95 ± 0.82 and 93.43 ±1.06 per cent in groups T1, T2, T3 and T4, respectively and statistical analysis revealed no significant difference between treatment groups.

8. The total number of chicks obtained from 9 to 16 weeks of age was 3219, 3453, 3506 and 3205 in groups T1, T2, T3 and T4, respectively.

9. The average number of quail chicks per female was 44.71, 43.16, 43.83 and 44.51 in groups T1, T2, T3 and T4, respectively.

10. The cost of production per chick in the treatment groups T1, T2, T3 and T4 was estimated as Rs. 2.21, 2.19, 2.10 and 2.04, respectively.

11. The margin per breeder quail (Female + Male) in the treatment groups T1, T2, T3 and T4 was calculated as Rs. 113, 117, 125 and 132, respectively.

12. The overall mean maximum temperature was 31.18^{0}C, minimum temperature was 23.16^{0}C and the relative humidity was 80.85 per cent in the forenoon and 61.20 per cent in the afternoon from August to December 2008.

The results of this study revealed that modifying the mating ratio (male: female) from 1: 3 to 1: 4, 5 and 6 did not adversely affect body weight, egg production and egg weight in Japanese quails. The fertility and hatchability was equally high in all the mating groups. The margin of return per quail housed was highest and chick production cost was the lowest in 1:6 mating ratio. The overall evaluations of the study indicated that though the mating ratios of 1: 3, 4, 5 and 6 were equally good in egg production, fertility and hatchability, the widest ratio of 1: 6 results in a lower production cost and higher margin. It is recommended that 1: 6 sex ration can be safely practiced in breeding units for the Japanese quail line maintained at the University Poultry Farm, Mannuthy.

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INFLUENCE OF MATING RATIO ON FERTILITY AND HATCHABILITY IN JAPANESE QUAILS

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ABSTRACT

An experiment was carried out to study the influence of mating ratio on fertility, hatchability and other productive traits in Japanese quails maintained at University Poultry Farm, Mannuthy. A total of 376 breeder Japanese quails at 6 weeks of age were allotted randomly to four groups with a male female ratio of 1: 3 (T1), 1: 4 (T2), 1: 5 (T3) and 1: 6 (T4) with four replicate each. The number of male and female breeders employed in the treatment groups T1, T2, T3 and T4 were 24 & 72, 20 & 80, 16 & 80 and 12 & 72, respectively. Standard managemental practices were followed uniformly. Quail breeder ration which contained 22.75 per cent crude protein and 2650 kcal metabolizable energy per kg feed was fed to all mating groups.

The T1, T2 and T3 treatment groups were similar but a T4 group differed significantly from the other groups for 6 weeks and 16 weeks body weight. The age at first egg, 10 and 50 per cent production was similar ($p < 0.05$) in all the treatment groups. The results revealed that mean egg number and mean per cent production did not differ significantly in all the treatment groups. Statistical analysis of the mean data on egg weight revealed no significant difference between treatment means at 8, 12 and 16 weeks of age. The overall mean fertility in the treatment groups T1, T2, T3 and T4 were 92.65, 90.45, 91.21 and 90.71 per cent, respectively and statistical analysis revealed no significant difference between treatment groups. The overall mean hatchability on total egg in the treatment groups T1, T2, T3 and T4 were 86.22, 84.71, 83.86 and 84.78 per cent, respectively and statistical analysis did not reveal any significant difference ($p<0.05$) between treatment groups. The overall mean hatchability on fertile egg in treatment groups T1, T2, T3 and T4 were 93.04, 93.62, 91.95 and 93.43 per cent, respectively and the means were statistically similar ($P<0.05$). The total number of chicks obtained from 9 to 16 weeks of age was similar in all treatment groups. Margin per quail housed in the treatment groups T1, T2, T3 and T4 were Rs. 113, 117, 125 and 132, respectively. The T4 treatment group had

highest margin than other treatment groups. Cost of production per chick in the treatment groups T1, T2, T3 and T4 were Rs. 2.21, 2.19, 2.10 and 2.04, respectively. The T4 treatment group had lowest cost of production per chick as compared to other treatment groups.

The critical evaluation of the result revealed that changing the mating ratio from 1: 3 to 1: 6 did not affect fertility, hatchability and other production traits. Therefore a sex ratio of 1: 6 is recommended in the quail line since it is more economical compared to other sex ratios of 1: 3, 4 & 5.