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Comparative evaluations of reproductive traits in a complete diallel cross of Aseel Peela, Kadaknath and CARI-Red

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Abstract
Two native chicken papulation, Aseel Peela, Kadaknath and one exotic papulation, CARI-Red maintained at 'Desi fowl' unit of CARI Izatnagar, were utilized for making full 3x3 diallel cross experiment. According to the mating plan, the hens of genetic groups were inseminated by deep intravaginal technique with the semen collected from the respective males by abdominal massage technique given by Burrows and Quinn, 1973. After two days of second insemination eggs were collected twice daily and marked with genetic group code. Total 1837 eggs were set for incubation and 1298 good chicks were obtained in single hatch comprising. Among the purebreds the higher fertility percentage was observed in AP (87.55%) followed by KN (80.55%) and CR (80%) while, in case of crossbred CR X KN had highest percentage of fertility (92%) followed by CR X AP (86.6%), KN X AP (85.89%), KN X CR (84.65%), AP X CR (81.61%) and AP X KN (80.71%). Among purebreds higher percentage of TES and FES were also observed in AP with value of 80.38 and 91.81 respectively. However, cross AP X KN had highest percentage of FES (92.04%) and cross CR X KN had highest percentage TES (77.91%).Cross CR X KN, KN X AP and CR X AP had positive percentage of heterosis and higher value were observed in case of CR X KN i.e. 22.44%, 6.49% and 15.04% for TES, FES and fertility percentage respectively.

Keywords: Hatchability %, fertility %, heterosis %, diallel cross, chicken breed

Introduction
Successful breeding in poultry sector is a continuous long term process of elimination and searching. Poultry Breeders exploit genetic disparity to maximize desired phenotypes. Specially, heterosis has become a routine practice for poultry breeders to bring out offspring that reveal more desirable attribute than parental line. Theoretically, heterosis is inversely related to the degree of genetic resemblance between parental populations (Willham and Pollak, 1985) [15] and is expected to be proportional to the degree of heterozygosity of the crosses (Sheridan, 1981) [14]; thus heterosis is a result of non-additive genetic effects and may be viewed as overall strength as well as expression of a specific trait. Heterosis is measured by crossing populations to producean F1generation, which is compared to the parental populations. Heterosis is usually greater for reproductive traits than for growth traits (Fairfull, 1990) [5], is influenced by maternal as well as dietary effects (Liu *et al*., 1995) [9], and may vary with regard to complex traits (Gram and Pirchner, 2001) [6].
Fertility and hatchability are vital variable that highly effect the supply of day-old chicks. Hatchability is the percentage of fertile eggs that hatch while Fertility refers to the percentage of incubated eggs that are fertile and hatchability include genetic make-up of the embryo, age, egg size and shell quality (King, Ori, 2011) [8]. Reproductive traits like fertility and hatchability determine the reproductive efficiency of the breeds. Indian breeds of chicken have special characteristics of adaptability, disease resistance and meat quality etc. Attempts are being made to utilize some of these good qualities of Indian breeds (desi) and cross breeding of desi breeds with suitable exotic breed evolving a more productive hybrid chicken. This may lead to economically viable unit of birds for backyard system of farming which is an instrument for the upliftment of present rural poor people. Therefore, the current study aimed to estimate the fertility and hatchability percent along with effect of heterosis from a complete 3x3 diallel experiment using Aseel Peela, Kadaknath and CARI-Red and to find out the best cross combination for given traits.

Materials and Methods

Experimental population

Two native chicken papulation, Aseel Peela, Kadaknath and one exotic population, CARI-Red maintained at 'Desi fowl' unit of Central Avian Research Institute, Izatnagar were used for making full 3x3 diallel cross experiment.

Mating plan

138, 96 and 120 females and 23, 16 and 20 male birds of Aseel Peela, CARI-Red and Kadaknath respectively were utilized in a 3x3 full diallel cross experiment which resulted into three crossbred, three reciprocal and three purebred genetic groups which are plotted as follows.

Table 1: Mating design and genetic groups

Male Female	AP	KN	CR
AP	AP x AP	KN x AP	CR x AP
KN	AP x KN	KN x KN	CR x KN
CR	AP x CR	KN x CR	CR x CR

*AP= Aseel Peela, KN = Kadaknath, CR= CARI-RED

According to the mating plan, the hens of genetic groups were inseminated by deep intravaginal technique with the semen collected from the respective males by abdominal massage technique given by Burrows and Quinn, 1973 [3] and insemination was following every five days till the required number of eggs were obtained from each genetic group.

Collection and incubation of eggs

Eggs were collected after two days of second insemination and marked with genetic group code with respective genetic groups. Collected eggs were stored in an egg cooler (10 ^{o}C) for a period of consecutive 10 days. Before setting the eggs for incubation in automatic incubator available at experimental hatchery, C.A.R.I., the cracked and grossly abnormal eggs were discarded. A total of 1837 eggs were set for incubation (table 2). The eggs were candled on 18th day of incubation and only the eggs with growing embryos were move to the hatcher. Eggs of each genetic group were placed in different hatching trays. The healthy chicks were taken out of the hatcher on 22 days. A total of 1298 good chicks were obtained in single (table 2).

Measurement of traits

The reproduction traits measured in the experiment were as follow

Fertility

$$\text{Fertility percent} = \frac{\text{No of fertile eggs}}{\text{Total no of eggs set}} \text{x } 100$$

Hatchability

Per cent hatchability in fertile eggs set (HFES)

$$= \frac{\text{No of chicks hatched}}{\text{Total no of fertile eggs set}} \text{x } 100$$

Per cent hatchability in total eggs set (HTES)

$$= \frac{\text{No of chicks hatched}}{\text{Total no of eggs set}} \text{x } 100$$

Estimation of Heterosis

The estimation of heterosis for each cross was calculated in terms of percent value over the performance of the purebreds.

Heterosis (absolute value) = Average of a crossbreds – Average of two purebreds

Heterosis % = 100 x Heterosis (absolute)/ Average of two purebreds.

Result and Discussion

Among the purebreds the higher fertility percentage was observed in AP (87.55%) followed by KN (80.55%) and CR (80%) while, in case of crossbred CR X KN had highest percentage of fertility (92%) followed by CR X AP (86.6%), KN X AP (85.89%), KN X CR (84.65%), AP X CR (81.61%) and AP X KN (80.71%). Among purebreds higher percentage of TES (Total egg set basis) were observed in AP with value of 80.38% followed by KN and CR with the value of 71.26% and 56% respectively. In case of crossbreds CR x KN showed highest percent of TES followed by KN x AP and least TES percent was reported in crossbred AP x CR (table 2). Again AP showed higher FES % (91.81%) followed by KN and exotic breed CR showed least FES % (70%). Among crossbreds AP x KN showed higher FES % followed by KN x AP (88.73%). Least FES % was reported in case of AP x CR (table2).

Table 2: Reproductive traits of different genetic groups

						Hatchability %	
	No of Egg	Infertile Egg	Fertile Egg	No of Chicks	Fertility %	HFES	HTES
	purebreds						
AP x AP	265	33	232	213	87.55	91.81	80.38
KN x KN	254	49	205	181	80.71	88.29	71.26
CR x CR	175	35	140	98	80.00	70.00	56.00
	crossbreds						
AP x CR	174	32	142	102	81.61	71.83	58.62
KN x CR	215	33	182	135	84.65	74.18	62.79
AP x KN	140	27	113	104	80.71	92.04	74.29
CR x KN	172	13	159	134	92.44	84.28	77.91
CR x AP	194	26	168	143	86.60	85.12	73.71
KN x AP	248	35	213	189	85.89	88.73	76.21

Bhardwaj *et al*., (2006) [2] reported the per cent hatchability in total egg set basis ranged from 35.54 to 64.91 and similarly in fertile egg set basis ranged 49.49 to 84.93 in all genetic groups. The corresponding per cent values of fertility were observed ranged from 62.65 to 76.39. Reddy *et al*., (1992) [13] reported higher estimates of hatchability on PES basis ranged from 84.0 to 93.5%. Similarly per cent fertility estimate ranged from 75.5 to 94.3 in different crosses. Permal *et al*., (2002) [12] obtained lower estimates of egg production from the present results in Kadaknath. The results of present study

indicated that fertility and hatchability was found higher in crossbred than their purebred whereas, purebred AP (Aseel Peela) showed higher percent of fertility and hatchability as compared to their crosses. Similar finding was also reported by Bhardwaj *et al*., (2006) [2].

Relationship between fertility and hatchability

The percentage of eggs fertility show embryo development, whether or not the eggs hatched from a number of eggs that were incubated (Bakar *et al*., 2005) [1]. By knowing fertility, it can be distinguished whether eggs germinate or not. This situation benefits the breeder, but fertility cannot be determined before the eggs are hatched. It is noted that high fertility is required to increase hatchability. Hatchability is the percent of eggs that hatch from number of fertile eggs. So the relationship between fertility and hatchability is that, high fertility is needed to produce high hatchability (Pagala *et al*., 2019) [11]. The figure showed the relationship between fertility and hatchability of all genetic groups.

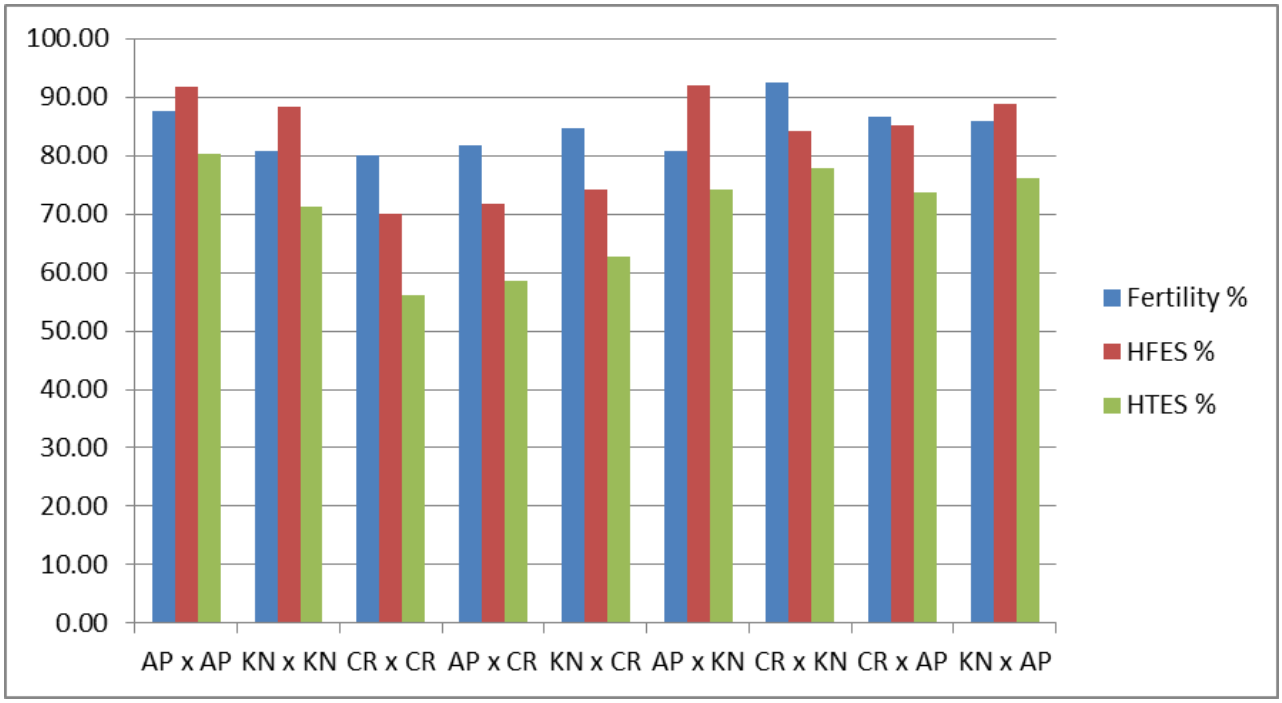

Fig 1: Relationship between fertility and hatchability

Heterosis of reproductive traits

Cross CR X AP, CR X KN and KN X AP had positive percentage of heterosis and higher values were observed in case of CR X KN i.e. 22.44%, 6.49% and 15.04% for TES, FES and fertility percentage respectively. Nadia M,(2014) [10] reported non-significant heterosis for fertility, hatchability from eggs set and fertile eggs. Deficit heterosis percent on fertility and hatchability of eggs were also reported by El-Gendy (2000) [4]. However Hossari and Dorgham (2000) [7] reported heterosis for egg fertility 2.73% in two-line and 3.04% in three-line crosses and define the presence of heterosis effect on hatchability in two-line crosses only.

Table 3: Heterosis of reproductive traits

	Heterosis (absolute value)			Heterosis %		
	Fertility %	**FES %**	**TES %**	**Fertility %**	**FES %**	**TES %**
AP x CR	-2.16	-9.07	-9.57	-2.58	-11.22	-14.03
KN x CR	4.30	-4.97	-0.84	5.35	-6.28	-1.32
AP x KN	-3.41	1.98	-1.53	-4.06	2.20	-2.02
CR x KN	12.09	5.13	14.28	15.04	6.48	22.44
CR x AP	2.82	4.21	5.52	3.37	5.21	8.10
KN x AP	1.76	-1.32	0.39	2.09	-1.46	0.52

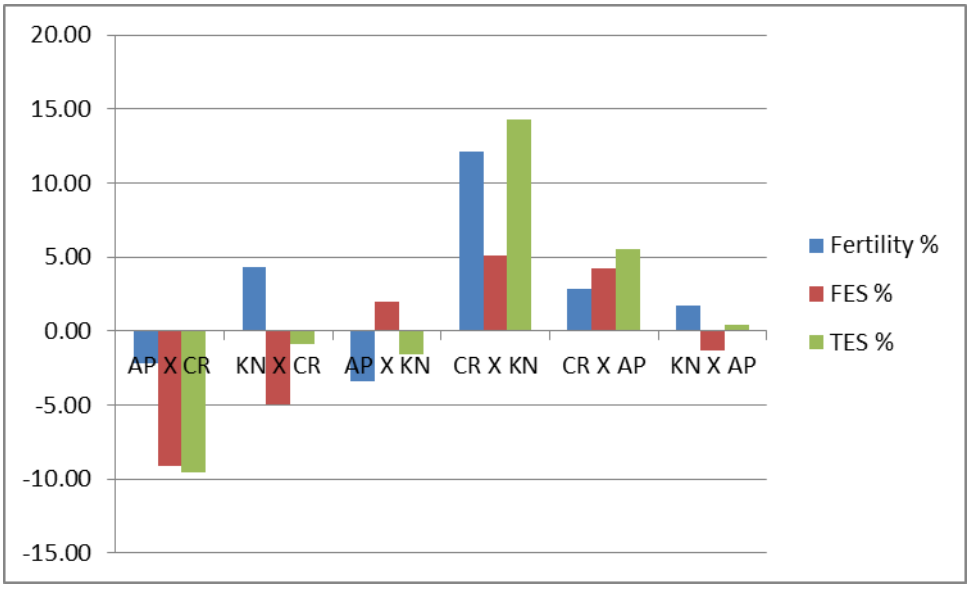

Fig 2: Heterosis (absolute value) of reproductive traits

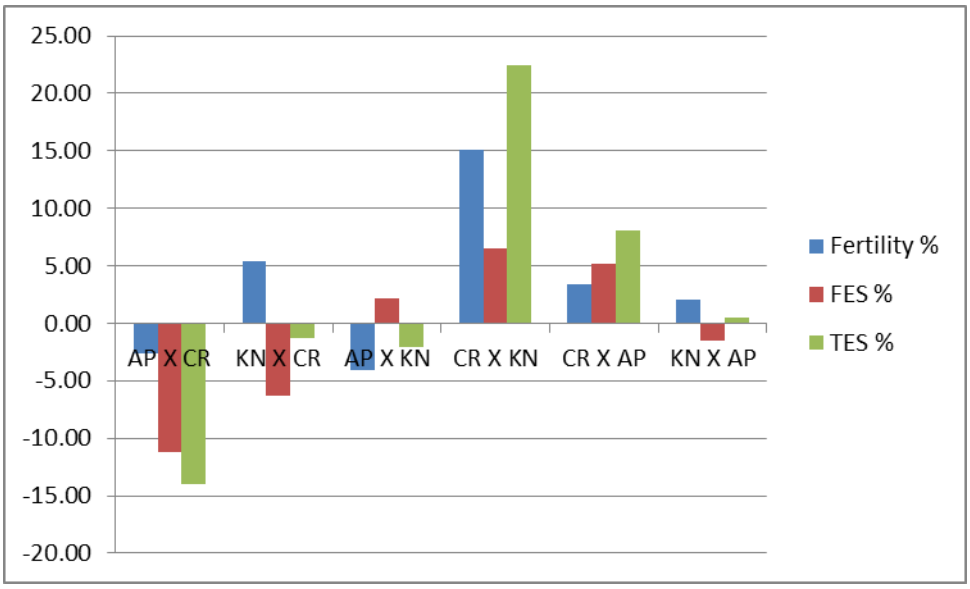

Fig 3: Heterosis percentage of reproductive traits

Conclusion

The crossbreds were superior to the purebreds for most of reproductive traits under experiment and positive heterosis percent were observed in most of the genetic groups under study.

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