Pureline selection of Jinyang Ⅲ strain in late-feathering Leghorn

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Received December 8,1992

Summary Jinyang Ⅲ strain of late-feathering Leghorn chicken has been successively selected with comprehensive index for 7 generations by family breeding method of mass-first and closing-late. As compared with the control,the selection result is average 7 days earlier at first laying for every generation,more than 13 of egg number at age of 300 days and higher than 0.63% for survival rate in laying period. Main laying performances are as follows:age at first laying 156±10.4 days;egg number at age of 300 days 99±26.0;egg number and egg weight at 72 weeks of age 226±38.8 and 58.2±4.6g respectively. Through cross breeding selection,a series of white-shell autosexing chicken has been developed. More than 5.1 million commercial sex-identified chicken have been released as well.

Key words chicken,Jinyang white Leghorn,late feathering,selection

Material and method

Original flock

In 1978－1979,nine chicken in which primaries noteworthily was shorter than primaries covert were found in Starcross 288 Leghorn in experimental chicken farm of Shanxi Animal Husbandry and Veterinary Institute and kept for observation and breeding. Two cocks and seven hens have been got from this flock. These nine were utilized to close-selfing expansion in 1979—1980 and 83 late-feathering cocks have been got. From 1980 to 1981,Romania No. 7 and No. 8 strains of early-feathering Leghorn hens and available late-feathering hens in Experimental Chicken Farm were utilized to test cross genotype heredity of these 83 phenotype late-feathering cocks(sercurity probability 99.99%). 27 cocks of homozygous late-feathering had been got. The original flock was composed of these 27 cocks and 425 late-feathering hens with genetype of Starcross 288,Romania No. 7 and No. 8 Leghorn kept by selfing expansion and cross-mating(Liu Zhanshou,1984). Having rejected chicken of bacillary white diarrhea and pleuro-pneumonia-like organism positive, uncomplete record,inferior performance and aged hens,we primarily selected 103 hens and 9 cocks as zero generation flock and then closed it to start selection. To examine and compare selective effect, control group was established through random sampling from the original flock. From the consideration of actual finicial ability and effective population closing flock ($Ne=4M\times F/M+F$)(Mukaikimi,1984),inbreeding coefficient increment per generation $\Delta Fx\leqslant 0.03$ was assumed. Initial control group was made up of 60 hens and 8 cocks.

Selection method

For th test flock,family breeding was employed and early identification was made at age of 300 days. Three preselections were made for cocks in test-flock during growing stage. At the age of 6 weeks,the cocks having no sibs and over/under weight,surplus one (total full-sib was not more than 3), those unhealthy/handicapted and marklost were all eliminated. At age of 18 weeks, the flock was once again regulated according to the individual growth and chicken of bacillary white diarrhea positive were eliminated. The last regulation was carried out during the process of artificial insemination training. Young cocks failing to react after many times of training, aspermia and semen of inferior quality were eliminated, and full-sib cocks were maintained no more than 2.

First hatched and identified cocks were only kept for control group. At the age of 6 and 18 weeks, except for those of extrem under developed bacillary white diarrhea positive, unhealthy/handicapted and mark-lost, all had been kept.

After the test at age of 300 days, adult chicken were selected with comprehensive index based mainly on individual triat phenotypic value and average family group value. Outstanding cocks from superior families through half-sib family seletion have been kept as breeder, while breder hens were selected mainly from superior families with supplyment of outstanding individuals from standard families. New families were organized randomly with an essential prequisite to avoid completely, or as much as possible, full-sib and half-sib inbreeding. Sex ratio(♂ : ♀)were 1:10—13. A formula of comprehensive selection index for test flock is:

$$I = \sum_{i=1}^{n} ai \cdot \frac{Pi}{\overline{Pi}}$$

where, I, comprehensive index; Pi, individual phenotypic value of trait i; $\overline{Pi}$, average colony phenotypic value of trait i; $ai = Wi \cdot hi^2 \cdot a$; Wi, weighted coefficient of trait i; hi^2 heritability of trait i;

$$a = \frac{100}{\sum_{i=1}^{n} Wi \cdot hi^2}$$

The main selection traits were egg performance, egg weight at age of 300 days and the age at first laying. According to the progresses of every generation and requirements for selection, we corrected trait weighted value Wi; Beginning with the second generation, heritability had been tested and quoted in selection formula.

The test flock was coded with 6 digits, of which first two represented paternal family, middle two, maternal, and the last two, individual chicken. Actual housing amount per generation was 30—50 young hens. Average selection pressure of cock for 7 generations was 10.5%, and of hen 33.3%.

For hens in control flock, only individual statistics but no selection was made. During hatching, groups were devided randomly according to number of survived cocks. Artificial insemenation was carried out indiviually. Offsprings were coded with ordinal number. The ratio of control flock to test flock was about 4—4.5:1.

Results

Results of selection

After 7 generations closing selection, late-feathering Jinyang Ⅲ strain of Leghorn showed extremely remarkable improvement in age at first laying, egg number and survival rate (Dalton, 1980). The improved values of main traits(vs. control group)and trait phenotypic values are shown in Table 1 and 2.

Table 1. The improved values of main traits for every generation

Generation	Year	Age at first laying (day)	Egg no. 300 days	Egg wt (g)	Egg no. 72 weeks	Egg wt 72 weeks (g)	Survival rate 300 days (%)
1	1982	+7	−4	+1.3	−7.1	+0.8	−1.0
2	1983	−4	+8	−2.5**	+12	−2.0**	−0.6
3	1985	−3	+4**	−1.4	—	—	−7.3
4	1986	−5**	+9**	−1.1*	+22**	−0.9	+2.7
5	1988	−11**	+27**	−0.7	+47**	−2.3**	+3.3
6	1989	−14**	+14**	−1.6**	—	—	+5.4
7	1990	−21**	+33**	−0.1	—	—	+1.9

Note: * $P<0.05$, ** $P<0.01$

Table 2. Trait phenotypic values of Jinyang Ⅲ strain

Item	Test group	Control group
Age at first laying (days)	159±10.4	180±35.0
Body weight at first laying (g)	1434±126.6	1440±92.6
Egg weight at first laying (g)	39.0±4.3	39.6±3.8
Egg number, 300 days	99±26.0	66±40.7
Egg weight, 300 days	52.1±3.5	52.2±5.0
Body weight, 300 days (g)	1584±224.9	1477±209.7
Egg number, 72 weeks	226±38.8	179±47.7
Egg weight, 72 weeks (g)	58.2±4.6	60.5±4.5
Body weight, 72 weeks (g)	1641±208.7	1559±169.5
Body weight, 6 weeks (g)	413±56.7	376±33.3
Body weight, 18 weeks (g)	1236±132.4	1072±100.9
Brooding rate (%)	94.7	94.0
Grower rate (%)	92.4	68.9
Fertility rate (%)	93.1	80.3
Survival rate, 300 days laying period (%)	96.9	95.0

The data of Table 1 and 2 show that age at first laying, egg number and surival rate increased signiflcantly beginning with the 4th generation ($P<0.01$) after selection. Average age at first laying per generation are about 7 days earlier; egg number at age of 300 days are 13 more and survival rate increases 0.63%. All production target for the 7th generation are higher than that previously planned, and survival rate and fertility rate maintain in a high level in all periods.

Egg weight decrease averaged 0.68g per generation in the tendency towards rapid significant increase of egg number. Beginning with 3rd generation, value of egg weight was corrected and attention had been paid to individual selection for egg weight, the decreasing speed was kept under control and stoped even completely up to 7th generation ($P>0.05$).

Inbreeding was avoided among full-sib and half-sibs due to using audio-visual 6 digits code in selection. Attention was paid to the selection of semen quality trait, to a relative higher degree, homozygosity of inferior lethal recessive gene of late-feathering chicken was avoided, and breeder cocks were ensured to maintain higher fertility and survival rates. Mortality rate of embryo hatched in the same box and at the same time did not differ significantly was avoided in comparision to that of other early-feathering strains of Babcock, Hisexwhite and Hisexbrown.

Effect of cross-breeding

Since 1983, Jinyang Ⅲ strain was utilized as maternal parent in 2 ways cross-breeding and as paternal line of maternal parent in 3 and 4 ways cross-breeding to cross with domestic-bred or external superior strains. A series of high-yield breeder laying autosexing white-shell egg has been obtained. It is characterized by highly precise sexing, full vigor and high survival rate. It is feed easily, and total egg weight laid in 300 days per hen is more than 15kg. Its comprehensive economic benefit is remarkably higher than that of the introduced strains under the same feeding condition(Table 3).

Table 3. The traits for commercial generation of layer in Jinyang strain

Item	Jinyang No. 1	Jinyang No. 4
Bred year	1983	1991
Sexing rate of pullet chick(%)	99.2	99.6
Survival rate, 300 days laying period(%)	96.4	98.1
Survival rate, 72 weeks(%)	96.4	96.2
Age at first laying(d.)	166±11.9	147.6±1.7
Body weight at first laying(g)	1600±12.0	1378.5±18.5
Egg weight at first laying(g)	45.3±3.8	39.4±0.6
Egg number, 300 days	99.2±15.9	110.7±3.8
Brooding rate(%)	98.3	95.0
Grower rate(%)	100	93.0
Egg weight, 300 days(g)	62.1±4.0	59.9±3.8
Body weight, 300 days(g)	1768±15.1	1503.8±19.7
Egg number, 72 weeks	234.2±30.9	247.4±8.7
Egg weight, 72 weeks(g)	64.4±4.7	61.8±2.83
Ttatol egg weight(kg)	15.0	15.1
Egg-feed ratio	1:2.82	1:2.55

Cross-breeding of Hisexwhite as peternal line with Jinyang Ⅲ strain shows a very good compatibility. Egg number of the cross-breeding system is considerably higher than that of the original Hisexwhite cross-breeding system($P<0.01$) and its sex diagnosis can be made automatically.

Table 4. Egg performance of cross-breeding system and Hisexwhite system at the age of 300 days

Strains	Age, first laying(d)	Egg no., 300 days	Egg wt, 300 days(g)	Total egg wt(kg)	Grower rate (%)	Survival rate in laying period(%)
Crorss-breeding	153±11.68**	106±18.08**	57.1±2.74	6.05	94.74	100
Hisexwhite	161±22.16	91±36.49	58.6±3.81	5.33	91.51	91.7

Table 5. Comparision of improved starcross 288 with original starcross 288

Strains	Age, first laying(d)	Egg no., 300 days	Egg wt., 300 days(g)	Total egg wt(kg)	Grower rate (%)	Survival rate in laying period(%)
Improved 288	161±8.76**	98±24.87**	56.7±3.39	5.55	94.1	93.3
original 288	170±15.7	75±35.63	56.3±3.50	4.22	88.3	84.6

At the same time, line C of introduced Starcross 288 was replaced by Jinyang Ⅲ strain, as a result, the trait of commercial generation was improved and chicken autosexing was realized. Under the same feeding condition, egg number increased significantly (Table 5).

Since 1985, 3. 24 million of the newly bred system chicken and 1. 9 million chicken of improved cross-breeding system have been released in Shanxi province which has created a great social benefit of 50 million yuan (RMB). Commercial chicken feathering-speed sexing precision is 99. 8% and speed of autosexing per hundred chicken is 2. 6 min.

Conclusion

1. The method of crossbreeding followed by closing selection can combine superior traits from several strains and expand genetic foundation, so it is good to selection. At the same time of test, available superior strains of Romania No. 7 and 8 were crossed with 3 strains of Starcross 288 to improve traits of egg number and survival rate. The method of comprehensive index selection was used for family selection and resulted in considerable improvement in survival rate, egg number and age at first laying ($P<0.01$) from the 4th generation. Up to the 8th generation, laying rate of pureline is about 82% and can maintain for 7 weeks.

Using vedio-visual 6 digits code can avoid inbreeding and homozygosity of inferior lethal recessive gene and maintain a relative high fertility and survival rates.

2. When testing genetype for sex-linked heredity gene, reactor gene is usually used to test genetype for the male. Because avian sex chromosome is different from animal's, hens carrying dominant gene can be used to test genetype for cocks.

3. Separated eliminative selection for individual egg weight has been carried out on the basis of comprehensive selection. Breeder hens were selected with prerequisite of certain egg weight, though some high-index hens have been eliminated by use of the selection method, the increase of egg number effectively slowed down the speed of reduction of egg weight.

4. By use of introduced external superior breeder, Jinyang Ⅲ strain late-feathering chicken has been successfully crossed and our high-yield new crossbreeding system was obtained. The new strain possesses adaptibility of local bred breeder and shows very good effect of cross-breeding. The method not only speeds up the development of local high-yield new strain, but also overcomes the difficulty of autosexing for introduced Leghorn has cross breeding system. It is an investment-saving, rapid-effect breeding method suitabl for the situation in our country.

5 Hybrid strains in white Leghorn has realized feathering-speed autosexing through crossbreeding. Autosexing speed per hundred newly-born chicken has increased 1—1. 5 times as compared with ventsexing and chicken cann't be injured. Feathering speed autosexing method is simple and easy to be mastered. Therefore it is an effective way to increase speed and precision of sex diagnoisis in large hatchery.

References

Dalton DC. (1980) An Introduction to Practical Animal Breeding. London: Granada Publishing Limited, Technical Books Division, 126—128

Liu Zhanshou, Zhao Deyan et al. (1984a) Production performance and combining ability determination of hybrid strains. *J Shanxi Agri Sci*, 2:17—20

Liu Zhanshou, Zhao Deyan et al. (1984b) Selection of late-featheing strain. *J Shanxi Agri Sci*, 8:7—11 (in Chinese)

Mukaikimi. (1984) Effetive Population Size. In: Population Genetics. Changchun: Jilin Science & Technology Publishing House, 49—51 (in Chinese)

Zhao Deyan, Li Wen et al. (1992) Economic benefit comparison of Shanxi Home-bred layer strains with cross-breeding ones. *J Shanxi Agri Sci*, 3:26—29 (in Chinese)