table). The combination treatment also resulted in highest leaf N content. Only one-half the amount of controlled release N was used on plants in the combination treatment as was used on plants where controlled release N was the only fertilization.

Soil tests did not show significant variation between treatments with regard to pH, salinity, P, K, Ca and Mg content. The pH ranged from 6.5 to 7.4 and the salinity was not high enough to adversely influence plant growth.

Temperature and microbial activity have been reported to influence the release of nitrogen from granules of sulfur-coated urea. The plants in this experiment were subjected to normal outdoor fluctuation in temperature which may account for some of the variation noted.

The length of the experiment probably was too short for a change in pH to be reflected as the sulfur was converted to sulfates. Even had this happened, the change would have been slight because a very small amount of sulfur was applied—6 to 12 grams per cubic ft of soil mix.

The reason for dilute applications of fertilizer at each irrigation (constant fertilization treatment) was to supply nitrogen as required. The procedure is based on the assumption that water use (evapotranspiration) and plant growth are closely correlated. While it is evident that the correlation is close enough for practical use, it is also evident that difficulties can arise from complete reliance on the procedure. The fluctuation in leaf N suggests that it may be below optimum levels at times. Also, changes in rate of evapotranspiration may not always be correlated with plant growth. Such environmental conditions as dry wind may increase evapotranspiration, without a corresponding increase in growth. Repeated applications of dilute fertilizer solution (under such conditions) may result in an injurious buildup of salt levels.

A combination of controlled release and constant fertilization overcame the difficulties of each treatment used separately, and resulted in greatest uniformity of N content. This was reflected in the uniform growth of the test plants.

Tok Furuta is Extension Ornamental Horticulturist; John Rible is Extension Technologist, Agricultural Extension Service, University of California, Riverside; and Lyle Pyeatt is Farm Advisor, Los Angeles County.

Effects of

SHALLOW VS. DEEP IN

AND SEMEN

ON TURKEY FERTILITY

F. X. OGASAWARA · J. P. SCHROEDER · R. A. ERNST

PREVIOUS RESEARCH has attributed a decline in turkey fertility to shallow insemination into the oviduct of the turkey hen. The study reported here was conducted to obtain more information on the effects of variations in depth of insemination, and/or dosage of semen during the artificial insemination (A.I.) process.

Small Bronze turkey hens were reared on the range of the poultry experimental farm at Davis until they were 24 weeks of age, and were then transferred to turkey cages. At 30 weeks of age, the hens were randomly divided into five groups (14 to 15 hens per group), and given 15 hours of light. Insemination was performed according to the experimental design (table 1) at biweekly intervals. Semen doses were measured as accurately as possible by aspiration into 4-inch sections of glass pipettes calibrated to read in .001 ml. The semen was expelled from plastic tubes by the exhalation technique at the predetermined depth. Eggs were gathered through the day, stored under standard conditions, and set weekly in the departmental hatchery. Fertility was determined by candling after seven days of incubation, and is reported in table 3 as the percentage of live embryos. Additional data from the five experimental groups of hens were obtained on rate of lay, number of days of fertility, and percentage of hatchability.

Two groups of 12 males were each grown under the same conditions as the hens until they were 24 weeks of age, after which they were confined in two floor pens. Semen quality was assessed by laboratory tests on alternate weeks, when semen was not being collected for A.I. Volume, concentration, motility, live-dead ratio, and methylene-blue reduction time were determined. The results of these tests indicated that the males were in normal reproductive condition throughout the 12-week trial. Although the confinement of turkey hens in cages usually results in decreased egg production, during the 12 weeks of this experiment, the hens were laying at a normal rate (table 2).

TABLE 1. DESIGN OF EXPERIMENT

Groups	No. Hens	Procedure
A	16	.03 ml semen; Deep* A.I.
B	14	.005 ml semen; Deep A.I.
C	14	.03 ml semen; Shallow† A.I.
D	14	.01 ml semen; Shallow A.I.
E	16	.005 ml semen; Shallow A.I.

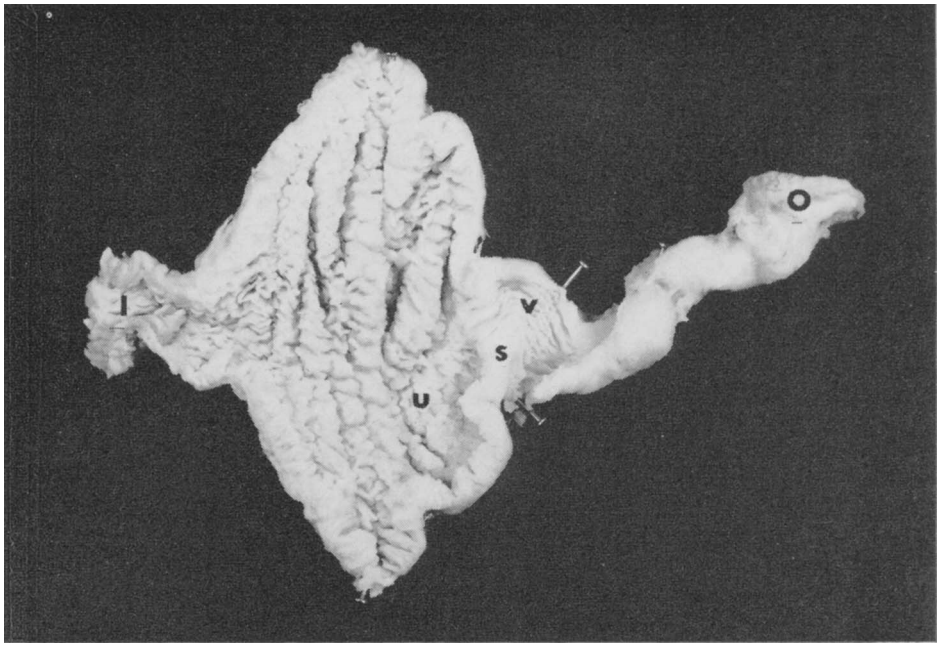
* A.I. at least 2 inches into oviduct.
† A.I. into orifice oviduct.

TABLE 2. PERCENTAGE OF TURKEY EGG PRODUCTION

Group*	Week of lay 1–2	3–4	5–6	7–8	9–10	11–1
	Deep insemination					
A (control)	70.9	64.3	68.2	66.5	62.0	58.1
B	64.3	58.1	65.1	60.7	54.1	52.0
	Shallow insemination					
C	67.7	71.4	61.2	58.7	56.6	53.8
D	67.3	67.3	68.4	63.3	57.1	58.2
E	62.8	57.6	58.9	56.7	54.2	49.5

* No. of hens per group: 14 or 16.

SEMINATION DOSE



Dissected uterus (u) and vagina (v) of a hen showing the orifice (o) of the vagina, the sphincter (s) region which contains the sperm storage tubules, and the isthmus (i), the adjacent component of the oviduct from the uterus. The vagina is a hostile environment for the survival of spermatozoa. The spermatozoa must move rapidly from o to s by their own flagellar processes. This emphasizes the importance of depositing the semen dose during artificial insemination as close to the storage tubules as possible.

Where the depth of insemination was optimum (group A and B, table 3), the percentage of live embryos was the highest and the expected decline in post-insemination fertility was the lowest. On the other hand, it was evident that the combination of minimal depth of insemination (shallow) and smallest semen dosage (.005 ml), as represented by group E, resulted in the lowest fertility—typical of the fertility in problem flocks under California field conditions.

Group A, which received the optimum dose of semen inseminated at the optimum depth, showed a maximum fertility duration of 14 days (table 4). Furthermore, deep insemination of the lowest semen dose (.005 ml) gave a longer duration of fertility than any of the shallow treatments. Hens in group E, inseminated with the lowest dose of semen, had the shortest duration of fertility. This suggests that the interaction of these two factors had the greatest negative effect on the duration of fertility. The fertility (candled eggs) in the experimental groups differed according to the experimental treatment; however, the hatchability of fertile eggs was not influenced by treatment, and embryonic development was normal in all groups.

Present knowledge of sperm transport in the turkey oviduct indicates that spermatozoa move by their own flagellar processes through the vaginal region of the oviduct. Generally, they find their way into the storage tubules of the uterovaginal tissue. They are released from the storage tubules by an unknown oviducal transport system. The photo of the dissected tissue of the vagina and uterus of a hen's oviduct illustrates the relationship between the depth of insemination and subsequent fertility in a hen.

Results

Results of this experiment support this sperm-transport theory, because fertility was higher when the spermatozoa were placed closest to the storage tubules of the uterovaginal region. Conversely, shallow A.I. resulted in a lower level of fertility, which was correlated with the dosage of semen introduced into the vagina. The lowest level, and shortest duration of fertility, resulted when the minimum semen dosage (.005 ml) was inseminated at a shallow depth.

Previous research has shown that many spermatozoa must be present before a single spermatozoon can fertilize the egg. This suggests that the oviduct of the hen requires the presence of a certain minimum number of spermatozoa to insure maximum fertility for the desired period. The duration of fertility is shortened when the required number of spermatozoa are not present. Further information is needed on how spermatozoa enter and leave the storage tubules, how they are nourished in the tubules, and how they are transported to the site of fertilization in the upper region of the oviduct.

Frank X. Ogasawara is Associate Professor, Poultry Department and Animal Physiology Department, University of California, Davis; J. Price Schroeder is Area Farm Advisor in Turkeys, Agricultural Extension Service, Kearney Field Station, Reedley; and Ralph A. Ernst is Extension Poultry Specialist, U. C., Davis.

TABLE 3. SEVEN DAY CANDLE FERTILITY—PERCENTAGE OF LIVE EMBRYOS

Week of lay	A*	B	C	D	E
1	87.9%	75.5%	64.6%	63.6%	55.9%
2	93.2	78.5	68.2	54.5	52.4
3	88.9	83.0	77.5	73.8	45.3
4	85.7	73.0	66.7	66.2	46.2
5	93.5	76.7	73.3	71.6	56.1
6	84.1	77.8	70.0	62.7	40.9
7	83.9	74.1	73.7	70.5	44.1
8	84.2	77.0	61.1	54.0	30.0
9	89.8	85.4	70.0	74.6	67.8
10	86.0	76.5	46.7	61.0	51.8
11	93.0	85.8	60.9	77.3	70.9
12	76.1	70.8	64.8	66.7	43.2

* Control group.

TABLE 4. DURATION OF FERTILITY IN DAYS

Groups	Week of lay 1–2	3–4	5–6	7–8	9–10	11–12
A*	14.0	14.0	14.0	14.0	13.8	13.0
B	12.9	13.0	12.7	12.8	12.5	12.8
C	12.8	13.2	12.2	12.3	11.0	10.0
D	9.3	11.8	11.2	11.4	11.4	11.6
E	11.3	10.2	8.5	7.6	10.9	9.5

* Control group.