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Title: REPRODUCTIVE CHARACTERISTICS OF TWO BREEDS OF SWINE FED DICHLORVOS

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Thirty-six gilts were used in an experiment of 2^3 factorial design. The experiment consisted of two breeds (Yorkshire-Berkshire and Yorkshire), two feeding regimens (pre-breeding and post-breeding) and two levels of dichlorvos (2, 2-dichlorovinyl dimethyl phosphate, 0 and 800 mg. per gilt per day). Pre-breeding treatment consisted of feeding dichlorvos to gilts for the duration of the estrous cycle prior to mating. Post-breeding treatment was initiated on the day of last mating and was continued until 48 hours prior to slaughter. All gilts were slaughtered on day 25 ± 1 of gestation.

There was no effect of treatment or breed on number of corpora lutea, or number of viable embryos. Treatment of gilts with dichlorvos prior to breeding caused an increase in total and average luteal weight ($P < .025$, for each characteristic). Dichlorvos fed to gilts prior to breeding increased the number of ovarian follicles

$\geq$ 4 mm. diameter ($P < .005$) and follicular fluid weight ($P < .025$). Pre-breeding treatment caused a greater increase in follicle size in Yorkshire than in Yorkshire-Berkshire gilts (pre-breeding x breed interaction $P < .025$).

The anterior pituitary was heavier in gilts of Yorkshire-Berkshire breeding than in Yorkshire gilts ($P < .005$) but the stalk median eminence tended to be heavier in Yorkshire gilts ($P \cong .08$).

Reproductive Characteristics of Two Breeds of Swine Fed Dichlorvos

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REPRODUCTIVE CHARACTERISTICS OF TWO BREEDS OF SWINE FED DICHLORVOS

INTRODUCTION AND REVIEW OF LITERATURE

Recent results of scientific investigations suggest that the addition of the dehelminthic dichlorvos (2, 2-dichlorovinyl dimethyl phosphate) to the ration of pregnant gilts or sows increases the post-natal growth and survival of the young. Batte et al. (1969) reported that treated sows tend to produce more live and fewer stillborn pigs, which result in an increased number of young weaned. Pigs from sows treated with dichlorvos gain more rapidly from birth to weaning (Singh et al., 1968). The advantages of dichlorvos in increasing the number of live pigs farrowed, decreasing the number of stillborn per litter and increasing litter weights at birth and at four weeks of age were reported to be greater in gilts than in sows (Foster, 1968). Treatment of sows with dichlorvos causes a reduction in post-natal mortality and in number of young weighing two pounds or less at birth (England, 1969a). Dichlorvos may affect ovulation rate of swine. Bazer et al. (1969) reported that sows treated with dichlorvos had a significantly greater number of corpora lutea and an increased number of embryos present at day 25 ± 3 of gestation. On the other hand, sows receiving dichlorvos after breeding that were allowed to farrow had a reduced number of viable young.

Increasing the energy level of the feed prior to and after breeding causes an increase in ovulation rate and early embryonic survival in gilts and sows (Robertson et al., 1951; Self et al., 1955; Sorensen et al., 1964; Mead et al., 1964; Kirkpatrick et al., 1967). On the other hand, a high energy ration prior to breeding has been reported to not only increase the ovulation rate of gilts or sows but also increases embryonic mortality (Robertson et al., 1951; Self et al., 1955; Goode et al., 1965; O'Bannon et al., 1966). Batte et al. (1968) and England (1969b) observed that offspring from dichlorvos-treated sows had higher blood glucose, and liver and muscle glycogen than offspring from control sows. These authors postulated that dichlorvos fed to pregnant gilts and sows may act, at least in part, to increase the level of available energy in the animal.

Feeding dichlorvos to gilts or sows may increase the number of ovulations and improve the possibilities of farrowing a larger number of pigs per litter. In addition, the heavier birth weight and fewer stillbirths per litter, which result when gilts and sows are treated with dichlorvos, seem to indicate an improved uterine environment.

The present experiment was conducted to study the effect of feeding of dichlorvos prior to and following breeding on early embryo survival, number and weight of corpora lutea, size and follicular fluid weight of ovarian follicles, weight of the anterior pituitary gland and weight of the stalk median eminence in two breeds of gilts.

MATERIALS AND METHODS

Animals used in this experiment were part of a larger study in which 80 Yorkshire-Berkshire and Yorkshire gilts were assigned randomly in equal numbers within breed to one of eight subgroups in an experiment of 2^3 factorial design. The experiment consisted of two breeds (Yorkshire-Berkshire and Yorkshire), two feeding regimens (pre-breeding and post-breeding) and two levels of dichlorvos (0 and 800 mg. per gilt per day). The first five pregnant animals from each subgroup which were slaughtered were used for the present study. The gilts were approximately 9-10 months of age at the beginning of the study and weighed between 240 and 370 pounds at the time of slaughter. All gilts were allowed to complete at least one estrous cycle before being assigned to the experiment. Pre-breeding treatment was initiated on day one of the estrous cycle (first day of detected estrous = day 1 of the cycle). Upon the recurrence of estrous, each gilt was bred on two consecutive days to a sire whose inbreeding coefficient was such that all embryos within the experiment would have approximately equal inbreeding coefficients. After breeding, the gilts were changed to the post-breeding treatment regimen.

The same basic ration was fed to all gilts (Table 1). Treated gilts received 800 mg. of dichlorvos daily mixed with the basic ration. All gilts were individually fed the same amount of ration

which was six pounds per gilt per day. Gilts that failed to return to estrus after breeding were slaughtered at day 25 ± 1 of gestation. Dichlorvos was withheld from gilts 48 hours prior to slaughter.

Table 1. Basic experimental ration

Ingredients	Percent of Ration
Barley	39.2
Corn	39.2
Alfalfa	5.0
Fishmeal	5.0
Soybean Oil Meal	5.0
Tankage or Meat and Bone Scraps	5.0
Salt	0.5
Ground Limestone or Oyster Shell Flour	1.0
Zinc Sulphate	12 oz./ton
Irradiated Yeast	.05 lb./ton

As soon as possible after slaughter, the reproductive tract was removed from the carcass. The ovaries were removed and placed on crushed ice for transport to the laboratory. The embryos were exposed by cutting the antimesometrial wall of each uterine horn from the uterotubual junction to the cervix. Embryos were examined to determine whether they were viable or dead. An embryo was considered to be viable if a heart beat could be detected. The percent viable embryos for each gilt was determined by dividing the number of viable embryos by the number of corpora lutea present at slaughter.

The stalk median eminence was removed by severing its connections with the pituitary gland and hypothalamus. The anterior lobe of the pituitary gland was dissected free from the posterior lobe and adhering tissue. Both the stalk median eminence and the anterior pituitary gland were weighed to the nearest tenth of a milligram.

Each ovary was freed of extraneous tissue, and individually weighed. The diameter of the largest visible ovarian follicles was measured with a vernier calipher and the size recorded. Corpora lutea were counted, enucleated from the ovarian stroma and weighed. The ovarian stroma was then minced with a blade and blotted dry. Ovarian follicular fluid weight was determined by obtaining the difference between initial ovarian weight and the weight of the corpora lutea and minced ovarian stroma.

Number of corpora lutea in swine is positively correlated with total weight and negatively correlated with average weight of corpora lutea (Loy et al., 1958). Hence, in this study total luteal weight and average luteal weight were adjusted for number of corpora lutea by linear regression after testing for homogenity of within-treatment regression. Data were analyzed statistically by unweighted means analysis of variance as described by Snedecor (1956).

RESULTS

General

Only 52 of the original 80 gilts assigned to the experiment conceived and were pregnant at day 25 ± 1 post-breeding. Consequently, there were disproportionate numbers of animals in the subgroups of the study. As shown in Table 2, the subgroups in which there were animals missing were of Yorkshire breeding.

Table 2. Design of the Experiment

Treatment		Breed[a]	No. of Gilts
Pre-breeding	Post-breeding		
None	None	Y-B	5
		Y	4
	Dichlorvos	Y-B	5
		Y	3
Dichlorvos	None	Y-B	5
		Y	4
	Dichlorvos	Y-B	5
		Y	5

[a] Y-B = Yorkshire-Berkshire, Y = Yorkshire.

The effects of breed and the feeding of dichlorvos prior to and following breeding on ovarian characteristics of pregnant gilts are given in Table 3. Neither breed nor feeding regimen had an effect on number of ovulations.

Table 3. Ovarian characteristics (mean ± S.E.) §

Treatment							
Pre-breeding	Post-breeding	Breed	No. of C.L.	Total C.L. Wt. [a] (mg.)	Average C.L. Wt. [a] (mg.)	Fol. Fluid Wt. [a] (gm.)	No. of Fol ≥ 4mm [b]
None	None	Y-B	15.60 ± 2.15	4668.4 ± 454.0	319.8 ± 24.44	3.09 ± 0.17	18.4 ± 9.0
		Y	16.25 ± 2.95	4771.6 ± 574.0	321.8 ± 46.00	3.47 ± 1.20	18.5 ± 10.9
	Dichlorvos	Y-B	15.60 ± 1.85	5039.1 ± 796.6	341.9 ± 48.24	3.52 ± 0.39	18.8 ± 2.1
		Y	14.33 ± 1.25	4774.0 ± 284.1	322.8 ± 19.38	2.84 ± 0.27	7.3 ± 2.6
Dichlorvos	None	Y-B	15.20 ± 1.33	5592.3 ± 536.7	377.4 ± 34.63	3.92 ± 0.53	20.4 ± 9.4
		Y	14.50 ± 2.29	5549.9 ± 876.6	374.2 ± 48.07	4.09 ± 0.98	27.8 ± 8.4
	Dichlorvos	Y-B	14.20 ± 1.95	5124.9 ± 341.8	351.4 ± 30.82	3.60 ± 0.52	21.4 ± 2.6
		Y	13.20 ± 1.72	5415.9 ± 938.3	371.9 ± 80.50	3.98 ± 0.91	31.4 ± 4.4

§ Luteal weights were adjusted for number of corpora lutea by linear regression.

[a] Pre-breeding $P < .025$.

[b] Pre-breeding x breed interaction, $P < .025$, Pre-breeding, $P < .005$.

Corpora Lutea

Treatment of gilts with dichlorvos prior to breeding increased the total and average weight of corpora lutea ($P < .025$, for each characteristic). Breed was without effect on number of corpora lutea although the Yorkshires tended to have heavier corpora lutea than the Yorkshire-Berkshire gilts, but the difference was not significant statistically.

Ovarian Follicles

The weight of ovarian follicular fluid was affected by the pre-breeding treatment. Pre-breeding treatment with dichlorvos caused an increase in the follicular fluid present at day 25 ± 1 of gestation ($P < .025$). The post-breeding treatment or the breed of the gilt had no effect on weight of follicular fluid.

The number of follicles $\geq$ 4 mm. in diameter was increased by the addition of dichlorvos to the pre-breeding ration ($P < .005$). Pre-breeding treatment with dichlorvos increased the number of follicles $\geq$ 4 mm. in Yorkshires but not in Yorkshire-Berkshire gilts (pre-breeding x breed interaction, $P < .025$).

Embryos

One of the basic objectives of the study was to determine the effect of dichlorvos on the number of viable embryos present in

treated gilts. There was, however, no significant effect of treatment or breed on percent viable embryos present.

Table 4. Percent of corpora lutea represented by viable embryos (mean ± S. E.).

Treatment		Breed	Percent Viable Embryos[a]
Pre-breeding	Post-breeding		
None	None	Y-B	78.3 ± 4.3
		Y	76.9 ± 2.8
	Dichlorvos	Y-B	63.9 ± 21.5
		Y	72.7 ± 15.2
Dichlorvos	None	Y-B	72.9 ± 25.0
		Y	65.5 ± 19.0
	Dichlorvos	Y-B	74.8 ± 14.5
		Y	84.5 ± 11.4

[a] Percent viable embryos = $\frac{\text{Number of viable embryos}}{\text{Number of corpora lutea}} \times 100$

Anterior Pituitary and Stalk Median Eminence

The anterior pituitaries in gilts of Yorkshire-Berkshire breeding averaged 218.9 mg. in weight which was heavier ($P < .005$) than anterior pituitaries from gilts of Yorkshire breeding, which averaged 187.7 mg. in weight.

The stalk median eminence of Yorkshire gilts (average 49.6 mg.) was heavier ($P \cong .08$) than the stalk median eminence of Yorkshire-Berkshire gilts (average 41.8 mg.) as shown in Table 5.

Table 5. Pituitary and stalk median eminence weights as affected by treatment and breed (mean ± S. E.).

Treatment		Breed	Ant. Pit. Wt.[a] (mg.)	SME Wt.[b] (mg.)
Pre-breeding	Post-breeding			
None	None	Y-B	226.7 ± 26.0	37.0 ± 7.2
		Y	181.7 ± 14.4	51.2 ± 3.1
	Dichlorvos	Y-B	221.0 ± 17.7	47.4 ± 13.8
		Y	190.2 ± 12.8	51.5 ± 14.1
Dichlorvos	None	Y-B	221.0 ± 26.6	39.8 ± 9.8
		Y	206.8 ± 24.0	48.2 ± 11.0
	Dichlorvos	Y-B	199.7 ± 28.7	46.8 ± 7.7
		Y	181.5 ± 17.3	48.7 ± 6.7

[a] Breed $P < .005$

[b] Breed $P \tilde{=} .08$

DISCUSSION AND CONCLUSIONS

Rigor et al. (1963) reported the effect of high and low energy feed intake on the weight of ovarian follicular fluid in gilts. High energy rations increased the weight of ovarian follicular fluid. In addition, weight of ovarian follicular fluid was greater in Chester White than Poland China gilts. The fact that these investigators observed an effect of breed on follicular fluid and none was observed in the present study was more than likely due to the Yorkshire-Berkshire and Yorkshire gilts being much more closely related than were gilts in their study. Similarly, Kirkpatrick et al. (1967) observed no effect of increased energy level on number of follicles greater than 5 mm. in diameter or follicular fluid weight in Chester White or Poland China gilts. A breed difference, however, did exist in number of follicles greater than 1 mm. in diameter and follicular fluid weight. Feeding ewes on a high nutritional plane (grain vs. hay) has also been reported to cause an increase in ovarian follicular fluid (Howland et al., 1966). In addition, grain feeding of ewes resulted in an increase in number of large follicles. Nonpregnant gilts receiving a basal ration plus glucose at the rate of 1.72% of body weight per day had heavier corpora lutea than those on a basal ration alone (Kirkpatrick et al., 1967). The ration was fed for 14 days prior to slaughter which was at various stages of the estrous cycle.

In the present study, dichlorvos fed to gilts prior to breeding increased the number of ovarian follicles $\geq$ 4 mm. in diameter and follicular fluid weight. The increase in number of large follicles was greater in Yorkshire than in Yorkshire-Berkshire gilts suggesting a difference between breeds in the response to treatment. Similarly, pre-breeding treatment with dichlorvos increased the weight of corpora lutea during the ensuing pregnancy.

The primary effect of dichlorvos is unknown. These data, however, suggest that dichlorvos when fed prior to breeding may act, either directly or indirectly, to increase the levels of energy available to the gilt. Presumably an increase in available energy could stimulate pituitary gonadotropin activity which would be reflected by increased number and weight of ovarian follicles and weight of corpora lutea. Indirectly, dichlorvos, by removing any intestinal parasites, may have a beneficial effect by making more nutrients available to the gilt. This also could be the explanation for the fact that the ration after breeding had no effect on the traits measured. Presumably there would not be sufficient time within 25 days post-breeding for the number of intestinal parasites to increase to the point where there would be competition for available energy.

Bazer et al. (1969) reported that 800 mg. of dichlorvos fed daily to sows for 21 days prior to breeding significantly increased the number of corpora lutea found at slaughter on day 25 ± 3 of

gestation. In the present study dichlorvos fed at the same level and given for approximately the same number of days prior to breeding had no significant effect on the number of corpora lutea. In fact, there was a slight depression in number of corpora lutea in those gilts receiving dichlorvos prior to breeding. England et al. (1969c) reported a significant decrease in the average number of corpora lutea from gilts fed dichlorvos prior to breeding. If feeding dichlorvos to swine stimulates pituitary function then an increase in ovulation rate might be expected. Perhaps the feeding of dichlorvos to gilts acts to stimulate the synthesis and release the pituitary follicle stimulating hormone (FSH) but not pituitary luteinizing hormone (LH). Consequently, although follicular development would be increased, the hormone (LH) needed to cause ovulation would be limited.

Rigor et al. (1963) reported a highly significant difference in ovulation rate between Chester White and Poland China gilts. In their study, the number of mature follicles were combined with the number of corpora lutea in order to get an estimate of ovulation rate. In the present study there was a difference in the number of corpora lutea between breeds, 15.2 for the Yorkshire-Berkshire gilts as compared to 14.5 for the Yorkshire gilts, but the difference was not significant. The breeding of the gilt had no effect on the

total or average weight of the luteal tissue or weight of the follicular fluid.

The anterior pituitaries of Yorkshire-Berkshire gilts were heavier than those from gilts of Yorkshire breeding ($P < .005$). Kirkpatrick et al. (1967) reported that there was no difference in the weight of the anterior pituitary gland of Poland China and Chester White gilts. Hollandbeck et al. (1956), however, reported that the anterior pituitary of Hampshire sows weighed less but contained more gonadotropin per unit weight than pituitary glands of Duroc sows. In contrast to the breed difference in weight of the anterior pituitary, Yorkshire gilts in the present experiment had heavier stalk median eminence than did those of Yorkshire-Berkshire breeding ($P \tilde{=} .08$). The reason for this difference is not known.

A high fiber ration fed to gilts causes an increase in embryo survival (Spies et al., 1959). Mayrose et al. (1964) observed that low energy rations compared with high energy rations fed to gilts prior to breeding significantly increased the number of pigs born. There was no effect of the energy level of the ration after breeding on the number of pigs farrowed. Haines et al. (1957) reported that ration had no effect on number of viable embryos at days 25 and 40, and number of live pigs farrowed. In the present study neither pre-breeding nor post-breeding treatment of gilts with dichlorvos had an effect on embryo survival during the first 25 days of gestation.

Likewise, there was no effect of breed on embryo survival.

It may be concluded that dichlorvos, when fed prior to breeding at 800 mg. per head per day either directly or indirectly acts on ovarian components (corpora lutea and follicles) in such a way as to give the same results as a high energy ration fed prior to breeding. The mechanism by which dichlorvos acts to elicit these responses in ovarian characteristics was not determined.

SUMMARY

Thirty-six gilts were used in an experiment of 2^3 factorial design. The experiment consisted of two breeds (Yorkshire-Berkshire and Yorkshire), two feeding regimens (pre-breeding and post-breeding) and two levels of dichlorvos (2, 2-dichlorovinyl dimethyl phosphate, 0 and 800 mg. per gilt per day). Pre-breeding treatment consisted of feeding dichlorvos to gilts for the duration of the estrous cycle prior to mating. Post-breeding treatment was initiated on the day of last mating and was continued until 48 hours prior to slaughter. All gilts were slaughtered on day 25 ± 1 of gestation.

There was no effect of treatment or breed on number of corpora lutea, or number of viable embryos. Treatment of gilts with dichlorovos prior to breeding caused an increase in total and average luteal weight ($P < .025$, for each characteristic). Dichlorvos fed to gilts prior to breeding increased the number of ovarian follicles $\geq$ 4mm, diameter ($P < .005$) and follicular fluid weight ($P < .025$). Pre-breeding treatment caused a greater increase in follicle size in Yorkshire than in Yorkshire-Berkshire gilts (pre-breeding x breed interaction $P < .025$).

The anterior pituitary was heavier in gilts of Yorkshire-Berkshire breeding than in Yorkshire gilts ($P < .005$) but the stalk median eminence tended to be heavier in Yorkshire gilts ($P \cong .08$)

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