Proc. 3rd All Africa Conf. Anim. Agric. & 11th Conf. Egyptian Soc. Anim. Prod., Alexandria, Egypt, 6-9 November 2000: 587-595

EFFECT OF VITAMIN E AND/OR SELENIUM INJECTION ON: I. REPRODUCTIVE PERFORMANCE OF NEW ZEALAND WHITE AND BALADI BLACK DOE RABBITS UNDER CLIMATE CONDITIONS OF MIDDLE EGYPT

Samia Z. Meshreky and G. H. Metry

Animal Production Research Institute, Agricultural Research Center, Giza, Egypt

SUMMARY

Throughout the period from April to October, 1999 at Seds Research Station, Bani-Suef Governorate (Middle Egypt), 20 of each of New Zealand White (NZW) and Baladi Black (BB) doe rabbits aged 9-10 months old housed in cages under open shed, were randomly divided into four equal groups (each of 5 NZW and 5 BB), maintained under normal nutritional status. The first group was injected subcutaneously with 100 IU/ head/week vitamin E (Vit E), while the second group was injected intramuscularly with 0.1 mg / kg body weight/week selenium (Se) as sodium selenite. The third group was injected with Vit E+Se at the same doses of the previous groups. The fourth group was kept as control. The treatments started two weeks before breeding and continued until the fourth parity. Weekly blood samples were collected from marginal ear vein in a heparinized tubes. Maximum and minimum ambient temperature and humidity were measured by digital max.-min. hygro-thermometer.

Temperature-humidity index indicated that the does were exposed to heat stress from April to October. Vitamin E level in peripheral plasma was higher ($P<0.001$) in Vit E and Vit E+Se groups. Selenium increased significantly ($P<0.001$) in plasma of does treated with Se and Vit E+Se. Does injected with Vit E or Vit E+Se had higher ($P<0.01$) rectal temperature and respiration rate before mating and during gestation period. Injection with Vit E in combination with Se improved ($P<0.01$) conception rate, litter size at birth, 21 and 28 days old and viability %, and improved ($P<0.05$) bunny weight at birth and 21 days old, while, decreased ($P<0.001$) abortion %. Does treated with Vit E or Vit E+Se had higher plasma level of progesterone and estradiol 17-ß hormones before mating and during gestation period. The NZW does had higher ($P<0.05$) conception rate and litter size at birth, 21 and 28 days old than BB does. The results suggested that injected NZW and BB doe rabbits with Vit E+Se could alleviate the harmful effect of hot months on their reproductive performance.

Keywords: Rabbit, vitamin E, selenium, reproductive performance

INTRODUCTION

Conception rate of the doe rabbits appears to be decreased under high ambient temperature (Matassino *et al.*, 1970) due to a complex set of events which expressed as reduction in litter size and increase of still birth. Severe sustained heat stress at 35 °C reduced the conception rate to 66% (Shafie *et al.*, 1984), which could be corrected with vitamin and mineral treatments (Marai *et al.*, 1999).

Vitamin E appears to be essential for the integrity and optimum function of the reproductive system (Sheffy and Schultz, 1979). Vitamin E deficiency causes reproductive failure in rabbit (Yamini and stein, 1989), while Vit. E supplementation causes favorable adaptive and better reproductive response of heat-stressed doe (Hassanein *et al.*, 1995).

The role of Se is similar to that of vitamin E as both are antioxidants (Close, 1999). It is biologically important because it is essential in animal metabolism (Mayland *et al.*, 1989). In addition, combination of Vit E and Se have a synergistic effect on enhancement of cell-mediated immunity in rabbit (Liu, 1988) and improved reproduction of the doe rabbit under the hot climate conditions (Abdel-Samee and El-Masry, 1997).

The objective of the present study was to investigate the effect of vitamin E and / or selenium injection on the reproductive performance of New Zealand White and Baladi Black doe rabbits under hot climate condition of Middle Egypt.

MATERIALS AND METHODS

This trial was carried out at Seds Research Station, Bani-Suef Governorate (Middle Egypt), belonging to Animal Production Research Institute, Ministry of Agriculture, during the period from April to October, 1999. Twenty of each of New Zealand White (NZW) and Baladi Black (BB) doe rabbits aged 9-10 months old were individually caged in cement pen (85 x 60 x 60 cm) under open shed with 6 meters height (the pens were built of two floors above the ground by 60 cm; each of 8 pens,). The does were randomly divided into four equal groups (each of 5 NZW and 5 BB does) maintained under normal nutritional status. The first group was injected subcutaneously with 100 IU vitamin E (Vit E)/ head/ week as dl-α tocopherol acetate (Cairo Company for Medicine, Egypt) dissolved in soybean oil. The second group was injected intramuscularly with 0.1 mg selenium (Se)/ kg body weight/ week as sodium selenite. The third group was injected with Vit E+Se at the same doses of the previous groups. The fourth group was kept without treatment as a control. The treatments started two weeks before breeding and continued for four consecutive parities. Palpation was performed 10 days after mating to detect pregnancy. Rectal temperature in °C (RT) and respiration rate as breath/min. (RR) were weekly measured between 12:00 and 15:00 hr.

Blood samples from marginal ear vein were collected weekly in a heparinized tubes, centrifuged at 3000 r.p.m. for 15 minutes. Blood plasma was separated and stored at -20 °C till analysis. Plasma Vit E concentration was determined using High Performance Liquid Chromatography (HPLC) and plasma Se concentration was determined using Unicam 929 Atomic Absorption Spectrometer under conditions previously mentioned by Samia-Meshreky and Abbas (2000). Blood plasma progesterone hormone concentration was determined by RIA kits (Diagnostic Systems Laboratories, Inc., USA) according to the manufacturer information. The antiserum had cross reaction values of 100% with progesterone, 2.5% with 11-deoxycorticosterone and 0.48% with 11-deoxycortisol. The standard curve ranged between 0.0 and 60 ng/ml and sensitivity value was reported to be 0.12 ng/ml. The intra and inter assay coefficients of variation were found to be 4.8 and 9.2%, respectively. Blood plasma estradiol 17-ß hormone concentration was determined by RIA kits (Diagnostic Systems Laboratories, Inc., USA) according to the manufacturer information. The antiserum had cross reaction values of 100% with estradiol and 0.57% with estriol. The standard curve ranged between 0.0 and 3000 pg/ml and sensitivity value was reported to be 6.5 pg/ml. The intra and inter assay coefficients of variation were found to be 5.3 and 4.9%, respectively.

Maximum and minimum air temperature (°C), relative humidity (%) under shed were measured using digital max.-min. hygro-thermometer during the experimental period (Table 1). The temperature-humidity index (THI) was estimated according to Livestock and Poultry Heat Stress Indices, Agricultural Engineering Technology Guide, Clemson University, Clemson, Sc 29634, USA, using the following formula: THI= db°F -(0.55 - 0.55 RH)(db°F - 58.00) where db°F = dry bulb temperature in Fahrenheit and RH = relative humidity (RH% ÷100). The obtained values of THI were classified as follows: less than 82 = absence of heat stress, 82 to < 84 = moderate heat stress, 84 to <86 = severe heat stress and those over 86 = very severe heat stress.

Table 1. Maximum and minimum values of ambient temperature (°C), relative humidity (%), and temperature-humidity index (THI) in the rabbitry during the experimental period under middle Egypt conditions

Month	Ambient temperature (°C)		Relative humidity (%)		Temperature humidity index (THI)	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
April	31.5±0.6	14.3±0.4	91.0±1.1	23.0±1.0	87.2	57.9
May	36.5±0.5	20.0±0.3	87.0±0.9	23.0±0.8	94.9	63.8
June	38.4±0.5	22.8±0.3	90.0±0.9	26.0±0.8	98.8	66.9
July	41.2±0.4	24.1±0.2	90.0±1.0	28.0±0.9	103.5	68.5
August	41.3±0.4	24.7±0.2	91.0±1.0	30.0±0.9	103.9	69.4
September	37.7±0.4	23.6±0.2	91.0±1.0	35.0±0.9	97.8	68.6
October	32.3±0.4	20.2±0.2	80.0±1.0	24.0±0.9	86.6	60.7

The data were analyzed using GLM procedure in SAS® program (1988). The significance of differences among means was evaluated by Duncan's New Multiple Range Test. The following model was used to analyze Vit E and Se concentrations in blood plasma.

$$Y_{ijklm} = \mu + T_i + C_j(T_i) + P_k + B_l + T_i * P_k + T_i * B_l + P_k * B_l + e_{ijklm}$$

Where:

Y_{ijklm} = An observation on the doe,

μ = Overall mean,

T_i = Fixed effect of the i^{th} treatment (i= 1, 2, 3 and 4),

$C_j(T_i)$ = The random effect of the j^{th} doe within the i^{th} treatment (j= 1 to 40),

P_k = Fixed effect of the k^{th} period (k= April-June, July-August and September-October),

B_l = Fixed effect of the l^{th} breed (l= 1 and 2),

$T_i * P_k$	=	Interaction between the i^{th} treatment and k^{th} period,
$T_I * B_l$	=	Interaction between the i^{th} treatment and l^{th} breed,
$P_k * B_l$	=	Interaction between the k^{th} period and l^{th} breed and
e_{ijklm}	=	The random error.

The following model was used to analyze rectal temperature, respiration rate, reproductive and productive traits, P4 and E2 concentrations in blood plasma.

$$Y_{ijkl} = \mu + T_i + P_j + B_k + T_i * P_j + T_i * B_k + P_j * B_k + e_{ijkl}$$

Where:

Y_{ijkl}	=	An observation on the doe,
μ	=	Overall mean,
T_I	=	Fixed effect of the i^{th} treatment (i= 1, 2, 3 and 4),
P_i	=	Fixed effect of the j^{th} period (j= April-June, July-August and September-October),
B_k	=	Fixed effect of the k^{th} breed (k= 1 and 2),
$T_I * P_j$	=	Interaction between the i^{th} treatment and j^{th} period,
$T_I * B_k$	=	Interaction between the i^{th} treatment and k^{th} breed,
$P_j * B_k$	=	Interaction between the j^{th} period and k^{th} breed and
e_{ijkl}	=	The random error.

RESULTS AND DISCUSSION

Temperature-humidity index values were estimated as 87.2 in April and 86.6 in October, indicating exposure of the does to a very severe heat stress (Table 1), with higher values during July and August (103.5 and 103.9). These findings are higher than those reported at East Delta region of Egypt (90.07 and 86.39 during July and August, respectively) by Zeidan *et al.* (1997).

Blood plasma Vit. E and Se concentrations

Plasma Vit. E concentration tended to increase (P<0.01) by advancing post-treatment period (Table 2). These results are within the range of 1.13 and 21.22 µg/ml reported by El-Manyalawi (1995) and higher than 3.67 and 8.21 µg/ml which reported by Castellini *et al.* (2000). Injection of Vit E+Se resulted in an increase (P<0.001) in plasma Vit E level than in the other groups (Table 2 and Figure 1). These findings agree with Verschuren *et al.* (1990), Lauridsen (1994) and Samia-Meshreky and Abbas (2000). Baladi Black does had higher (P<0.05) plasma Vit E level than NZW does (Table 2).

Plasma Se level increased (P<0.01) by advancing post-treatment period (Table 2), which is in consistent with Metry *et al.* (1998) in buffalo calves, and Samia-Meshreky and Abbas (2000) in rabbit bucks.

Table 2. Vitamin E (µg/ml) and Se (µg/ml) concentrations in blood plasma of rabbit does as affected by post-treatment period, treatment and breed (mean±SE)

	Post-treatment period			Treatment				Breed	
Item	Apr.-June	Jul.-Aug.	Sep.-Oct.	Vit	Se	Vit E+Se	Control	NZW	BB
		**			***			*	
Plasma Vit E (µg/ml)	7.30^c ±0.023	8.68^b ±0.023	10.53^a ±0.023	14.02^b ±0.024	2.80^c ±0.024	16.7^a ±0.024	1.82^d ±0.024	8.57^b ±0.017	9.10^a ±0.017
		**			***			NS	
Plasma Se (µg/ml)	0.032^c ±.0003	0.036^b ±.0003	0.042^a ±.0003	0.027^c ±.0003	0.044^b ±.0003	0.055^a ±.0003	0.021^d ±.0003	$.0368^a$ ±.0002	$.0363^a$ ±.0002

* (P<0.05). ** (P<0.01). *** (P<0.001). NS= Nonsignificant.

a,b,c,d Values with different superscripts within the same row are significantly different (P<0.05) .

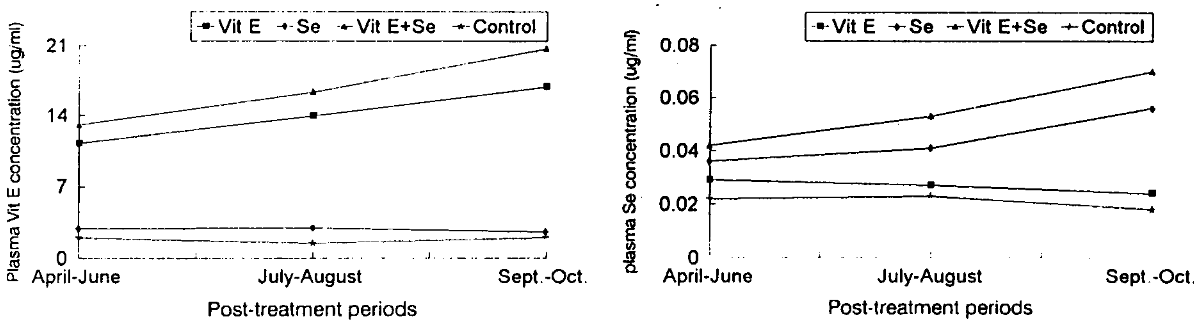

Figure 1. Plasma Vit E and Se concentration in rabbit does, during post-treatment period.

The does injected with Vit E+Se had higher (P<0.001) plasma Se level than those treated with Se alone (Table 2 and Figure 1). These results are in accordance with those reported by Stowe and Herdt (1992) and El-Gaafarawy *et al.* (2000).

Thermoregulatory responses

Increase in ambient temperature during the experimental periods (April-October) caused an increase in RT (P<0.05) and RR (P<0.01) before mating (BM), mid gestation (MG) and during the last week of gestation (LG) as shown in Table 3. These findings agree with Sedki (1999) and Habeeb *et al.* (1999). Does treated with Vit E and Vit E+Se had higher (P<0.01) RT and RR than the other groups during BM, MG and LG periods (Table 3). These results agree with Hassanein *et al.* (1995), reporting increase of RT and RR by advancing stages of gestation.

The NZW does had higher RT and RR than the BB does during gestation period (Table 3). The interaction between periods of the experiment and treatments was significant (P<0.01) for RT and RR. The does treated with Vit E or Vit E+Se had higher RT and RR during the different periods than the other groups. This might be due to the positive correlation between RT and plasma concentration of Vit E (Amici and Merendino, 1996). The interaction between treatment and breed was significant (P<0.05) for RT and RR at BM, MG and LG. Treated NZW does with Vit E or Vit E+Se had higher RT and RR than BB treated does. This might be due to that BB does are more adaptive to the hot climate than NZW does.

Table 3. Rectal temperature (RT) and respiration rate (RR) before mating (BM), mid gestation (MG) and last week of gestation (LG) of rabbit does as affected by post-treatment periods, treatment and breed (mean±SE).

Item	RT (°C)			RR (breath/min.)		
	BM	MG	LG	BM	MG	LG
Overall mean	39.4±.112	39.6±.114	39.9±.137	165.5±2.26	174.8±2.27	187.5±1.75
Period :	*	*	**	**	**	**
April-June	39.2±.023^{b}	39.5±.023^{b}	39.7±.028^{b}	152.8±.46^{c}	158.1±.46^{c}	173.5±.34^{c}
July-August	39.5±.023^{a}	39.7±.023^{a}	40.2±.028^{a}	169.0±.46^{b}	187.3±.46^{a}	200.8±.34^{a}
Sept.-October	39.4±.023^{a}	39.6±.023^{a}	39.8±.028^{b}	174.8±.46^{a}	179.1±.46^{b}	188.2±.34^{b}
Treatment:	**	**	**	**	**	**
Vit E	39.6±.026^{a}	39.8±.027^{a}	40.1±.032^{a}	169.8±.53^{b}	180.8±.54^{ab}	192.7±.54^{a}
Se	39.3±.026^{b}	39.4±.027^{b}	39.6±.032^{c}	160.2±.53^{b}	171.8±.54^{b}	177.2±.54^{b}
Vit E+Se	39.5±.026^{a}	39.7±.027^{a}	40.0±.032^{a}	183.7±.53^{a}	187.5±.54^{a}	198.8±.54^{a}
Control	39.2±.026^{b}	39.5±.027^{b}	39.8±.032^{b}	148.5±.53^{c}	159.2±.54^{c}	181.5±.54^{b}
Breed:	NS	*	**	*	*	*
NZW	39.5±.018^{a}	39.7±.019^{a}	40.1±.023^{a}	173.2±.38^{a}	181.2±.38^{a}	194.3±.29^{a}
BB	39.3±.018^{a}	39.4±.019^{b}	39.6±.023^{b}	157.9±.38^{b}	168.5±.38^{b}	180.9±.29^{b}

* (P<0.05). ** (P<0.01). NS=Nonsignificant.
a,b,c Values with different superscripts within the same column for each item are significantly different (P<0.05).

Reproductive traits

Periods of the experiment had a significant effect on conception rate, abortion % gestation length, litter size at birth, 21 and 28 days old, and bunny weight at 21 and 28 days old (Table 4). Armstrong *et al.* (1993) reported that reproduction of animals is impaired as a results of the drastic changes in biological functions caused by heat stress. In this study, viability (%) from birth to 21 and

28 days old was higher ($P<0.05$) for bunnies born in September-October than the other two periods (Table 4). Similar trend was reported by Sedki (1999).

The does injected with Vit. E+Se or Vit. E alone gave the best values for the most reproductive traits (Table 4). The higher litter size obtained at birth from the does injected with Vit. E+Se might be related to the increase in ovulation and fertilization rates (Abdel-Samee and El-Masry, 1997 and Shetaewi, 1998). The Vit. E+Se and Vit. E alone injection decreased ($P<0.001$) abortion (%). This finding is confirmed by Yamini and Stein (1989) who noticed that Vit. E deficiency caused an increase in abortion % in rabbits. Also, The Vit. E+Se and Vit E alone injection increased ($P<0.01$) viability (%) of the bunnies from birth to 21 and 28 days old (Table 4). This result agrees with Ismail (1993) and Hassanein *et al.* (1995). Reddy *et al.* (1987) attributed the reduction of mortality rate as a result of Vit. E treatment to the increase in immunity response. Does injected with Se alone improved slightly some reproductive traits than control group (Table 4).

New Zealand White does showed higher ($P<0.05$) conception rate, litter size at birth, 21 and 28 days old, higher ($P<0.01$) bunny weight at birth and 28 days old than Baladi Black does (Table 4). These results are in accordance with Marai (1999). However, Soad-Ahmed and Marai (1998) found that Baladi Black breed had higher litter size at birth and litter weight at 21 days old than NZW breed.

The interaction between periods of experiment and treatments was significant ($P<0.01$) for conception rate, abortion % and litter size at birth, 21 and 28 days old, and ($P<0.05$) for bunny weight at birth, 21 and 28 days old and viability % from birth to 21 and 28 days old. The interaction between treatments and breeds was significant ($P<0.05$) for reproductive and productive traits. Injected NZW does with Vit E or Vit E+Se resulted in an improve of reproductive and productive traits than BB treated does. This might be due to that NZW responded more efficiently to the treatment than BB does. The interaction between breed and experimental period was significant ($P<0.05$) for reproductive traits and ($P<0.01$) for bunny weight at birth, 21 and 28 days old.

Hormonal pattern secretion

Progesterone hormone (P4)

During April-June period, plasma P4 level was higher ($P<0.01$) before mating and during gestation period than in September-October, and the lowest P4 value was recorded during the hottest months (July-August), (Table 5). Bohr and Dial (1982) suggested that the lower P4 level in hot months might be due to indirect effect of increase ambient temperature that leads to fluctuation in LH level, which has primary stimulating effect on P4 secretion in domestic animals (Reeves, 1980).

Before mating and during gestation period, does injected with Vit E+Se maintained higher ($P<0.001$) or ($P<0.01$) P4 level followed by those injected with Vit E than Se and control groups (Table 5 and Figure 2). Such higher P4 values can be attributed to increase in ovulation rate (Habeeb and El-Masry, 1991). On day-7 of gestation, the plasma P4 level increased and continued till day-14, then declined towered day-21 and continued till day-28 of gestation (Figure 2). Karousa *et al.* (1999) found that P4 levels were 0.6 and 16.3 ng/ml at mating and day-10 after mating for NZW rabbits.

Baladi Black does maintained higher ($P<0.05$) P4 level on the day-14 and day-21 of gestation than NZW does (Table 5). Hassanein *et al.* (1995) found that Baladi Red does had higher P4 level than NZW. In this study the average P4 level for NZW does before mating (0.50 ng/ml) is higher than 0.38 ng/ml as reported by Khalil and El-Sharabassy (1987).

The interaction between periods of the experiment and treatments was significant ($P<0.01$) for P4 level. Vitamin E or Vit E+Se injection tended to increase P4 level during different periods of the experiment than the does treated with Se or control group. The interaction between periods and breeds was significant ($P<0.05$) for P4 level at BM and 28 days of gestation, and ($P<0.01$) at 7 and 14 days of gestation. Baladi Black does had higher P4 level than NZW does during April-June and September-October periods.

Estradiol 17-ß hormone (E2)

Plasma E2 levels were higher ($P<0.01$) during April-June followed by September-October and the lowest values were recorded in July-August (hottest months), before mating, at day-7 and day-28 of gestation (Table 5). This indicated that increased ambient temperature, decreased E2 hormone secretion.

Table 4. Some reproductive and productive traits of rabbit does as affected by post-treatment period, treatment and breed (mean±SE)

Item	Conception Rate (%)	Abortion (%)	Gestation length (day)	Litter size at: Birth	21 days	28 days	Bunny weight (gm) at: Birth	21 days	28 days	Viability% from birth to: 21 days	28 days
overall mean	55.8	8.5	30.7±.12	5.2±.180	4.6±.141	4.4±.130	54.1±1.3	277.8±7.4	364.1±4.2	88.3	85.0
Period :	***	***	**	**	**	**	*	**	**	*	*
April-June	71.7^{a}	2.1^{c}	31.2±.02^{a}	6.1±.036^{a}	5.3±.028^{a}	5.1±.026^{a}	56.0±.26^{a}	309.8±1.5^{a}	403.8±.85^{a}	87.6^{b}	84.9^{b}
July-August	43.0^{c}	15.1^{a}	30.5±.02^{b}	4.6±.036^{c}	4.0±.028^{b}	3.7±.026^{c}	52.6±.26^{c}	254.4±1.5^{c}	331.5±.85^{c}	86.8^{b}	81.4^{c}
September-October	52.8^{b}	8.3^{b}	30.5±.02^{b}	5.0±.036^{b}	4.5±.028^{c}	4.4±.026^{b}	53.7±.26^{b}	269.1±1.5^{b}	357.1±.85^{b}	90.7^{a}	88.5^{a}
Treatment :	**	***	*	**	**	**	*	*	**	**	**
Vit E	60.5^{b}	3.1^{c}	30.7±.03^{b}	5.7±.042^{b}	5.0±.033^{b}	4.8±.030^{b}	54.5±.30^{b}	280.7±1.7^{a}	390.3±.99^{b}	87.9^{b}	84.4^{b}
Se	49.2^{c}	11.4^{b}	30.8±.03^{a}	4.6±.042^{c}	4.0±.033^{c}	3.8±.030^{c}	52.9±.30^{c}	277.5±1.7^{a}	331.8±.99^{c}	85.8^{c}	83.2^{b}
Vit E+Se	66.9^{a}	3.2^{c}	30.6±.03^{b}	6.1±.042^{a}	5.7±.033^{a}	5.6±.030^{a}	56.5±.30^{a}	282.1±1.7^{a}	403.0±.99^{a}	93.1^{a}	91.4^{a}
Control	46.8^{d}	16.2^{a}	30.8±.03^{a}	4.4±.042^{d}	3.7±.033^{d}	3.5±.030^{d}	52.5±.30^{c}	270.8±1.7^{b}	331.4±.99^{c}	84.9^{c}	78.7^{c}
Breed :	*	**	*	*	*	*	**	*	**	NS	NS
NZW	59.1^{a}	10.5^{a}	30.6±.02^{b}	5.7±.021^{a}	5.0±.022^{a}	4.9±.021^{a}	61.6±.21^{a}	287.5±1.2^{a}	389.8±.70^{a}	88.0^{a}	85.5^{a}
BB	52.6^{b}	6.5^{b}	30.9±.02^{a}	4.7±.021^{b}	4.2±.022^{b}	4.0±.021^{b}	46.5±.21^{b}	268.1±1.2^{b}	338.5±.70^{b}	88.7^{a}	84.4^{a}

Table 5. Progesterone (P_4, ng/ml) and estradiol 17-ß (E_2, pg/ml) levels of rabbit does before mating (BM), 7, 14, 21and 28 days of gestation as affected by post-treatment period, treatment and breed (mean±SE)

Item	P_4 BM	7th	14th	21st	28th	E2 BM	7th	14th	21st	28th
Overall mean	0.50±.018	7.0±.157	13.6±.154	6.6±.121	3.9±.116	17.0±0.17	10.8±0.16	4.6±0.14	3.5±0.12	13.4±0.12
Period :	**	**	**	***	**	**	**	*	*	**
April-June	0.56±.004^{a}	7.4±.032^{a}	14.8±.031^{a}	8.1±.025^{a}	4.4±.024^{a}	18.9±.042^{a}	11.7±.041^{a}	5.1±.027^{a}	3.9±.022^{a}	14.9±.033^{a}
July-August	0.45±.004^{c}	6.4±.032^{c}	12.8±.031^{c}	5.3±.025^{c}	3.3±.024^{c}	15.6±.042^{c}	9.6±.041^{c}	4.0±.027^{c}	3.1±.022^{c}	11.5±.033^{c}
September-October	0.50±.004^{b}	6.8±.032^{b}	13.4±.031^{b}	6.2±.025^{b}	3.8±.024^{b}	16.6±.042^{b}	11.0±.041^{b}	4.7±.027^{b}	3.5±.022^{b}	13.9±.033^{b}
Treatment:	**	**	***	***	***	***	**	**	**	**
Vit E	0.57±.004^{b}	7.2±.037^{b}	15.3±.036^{b}	6.7±.029^{b}	4.1±.027^{b}	18.6±.047^{b}	11.6±.044^{b}	5.9±.033^{a}	4.0±.031^{b}	14.4±.036^{b}
Se	0.40±.004^{c}	6.8±.037^{c}	11.7±.036^{c}	5.8±.029^{d}	3.2±.027^{c}	15.1±.047^{c}	10.6±.044^{c}	3.7±.033^{b}	3.0±.031^{c}	12.5±.036^{c}
Vit E+Se	0.64±.004^{a}	7.9±.037^{a}	16.8±.036^{a}	7.7±.029^{a}	4.8±.027^{a}	20.3±.047^{a}	12.4±.044^{a}	6.0±.033^{a}	4.4±.031^{a}	15.4±.036^{a}
Control	0.40±.004^{c}	6.1±.037^{d}	10.7±.031^{d}	6.0±.029^{c}	3.2±.027^{c}	14.2±.047^{d}	8.4±.044^{d}	2.7±.033^{c}	2.9±.031^{c}	11.6±.036^{d}
Breed:	NS	**	*	*	NS	*	*	*	*	*
NZW	0.50±.003^{a}	6.8±.026^{b}	13.6±.021^{b}	6.5±.020^{b}	3.8±.019^{a}	17.7±.032^{a}	11.1±.031^{a}	4.8±.021^{a}	3.7±.014^{a}	13.5±.031^{a}
BB	0.51±.003^{a}	7.1±.026^{a}	13.7±.021^{a}	6.6±.020^{a}	3.9±.019^{a}	16.3±.032^{b}	10.4±.031^{b}	4.4±.021^{b}	3.4±.014^{b}	13.3±.031^{b}

* (P<0.05). ** (P<0.01). *** (P<0.001). NS= Non significant. a,b,c,d Values with different superscripts within the same column for each item are significantly different (P<.05).

Does injected with Vit. E+Se and Vit. E alone had higher (P<0.01) E2 level than Se and control groups. The pattern of E2 secretion was high before mating, on day-7 and day-28 of gestation (Table 5 and Figure 2). Stoufflet and Caillol (1988) and Kishk *et al.* (1999) reported that the pattern of E2 secretion shortly before mating as for receptive does. Karousa *et al.* (1999) found that E2 levels were 15.8 and 12.1 pg/ml at mating and day-10 after mating for NZW rabbits. Stormshak and Casida (1965) observed high level of E2 during the first seven days of pregnancy in order to maintain function of corpus luteum.

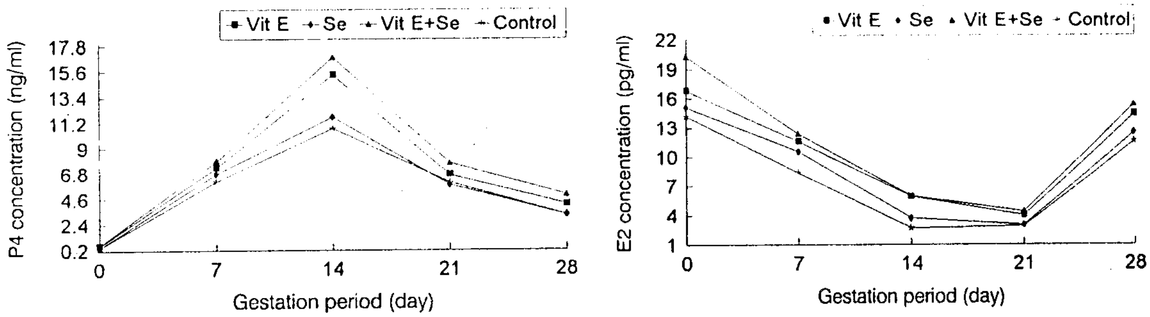

Figure 2. Patterns of circulating P4 and E2 concentration in peripheral plasma of does before mating and during gestation period.

The NZW does had higher (P<0.05) E2 levels before mating and during gestation period than Baladi Black does (Table 5). The interaction between periods of the experiment and treatments was significant (P<0.05) for E2 level. Vitamin E or Vit E+Se injection tended to increase E2 level during different periods of the experiment than the does treated with Se or control group. The interaction between treatments and breeds was significant (P<0.05) for E2 level. The NZW treated does had higher E2 level than BB treated does. This might be due to the effect of Vit E or Vit E+Se injection that increased the number of graafian follicles presented on the ovaries of NZW does.

CONCLUSION

It could be concluded that injected NZW and BB doe rabbits with Vit E+Se could alleviate the hurmful effect of severe hot months on their reproductive performance.

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