COBISS: 1.01
Agris category code: L01

GROWTH AND MORTALITY OF SIKA SUCKLING RABBITS IN SLOVENIA

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Received September 05, 2011; accepted November 15, 2011.
Delo je prispelo 05. septembra 2011, sprejeto 15. novembra 2011.

Growth and mortality of SIKA suckling rabbits in Slovenia

The aim of the study was to estimate some effects on mortality and growth in rabbits. The study was carried out in Slovenian SIKA sire line. In total, 1028 kits of 80 does were included. In the analyses the effects of parity, number of liveborn kits, number of teats, and season of kits birth were analysed. Birth weight was included in the model for mortality, while age was included in the model for growth. Parity, litter size, teat number and season affected the body weights. Body weight varied also according to age. Mortality has changes by litter size, season and initial weight. An average litter size was 8.77 kits born, 8.15 kits born alive and 7.00 kits weaned. The birth to weaning mortality was 14.4% and mortality has steadily declined with age. Average weight up to age 3 days was 72 g and at weaning 959 g. Kits in smaller litters and kits from does with more teats had a higher growth rate. Also kits grow faster in the colder months.

Key words: rabbits / breeds / SIKA / reproduction / growth / mortality / litter size / Slovenia

Rast in izgube sesnih kuncev SIKA linije v Sloveniji

Namen študije je bil oceniti možne vplive na rast in izgube v času laktacije pri kuncih. Študija je bila narejena pri kuncih slovenske SIKA pasme terminalne linije. Analizirani so bili podatki 1028 kuncev 80 mater. V model smo vključili zaporedno laktacijo, število živorojenih kuncev, število seskov pri materah in sezono rojstva mladičev. Masa ob prvem tehtanju je bila vključena v model za izgube. Starost smo vključili v model za telesne mase. Na telesno maso so vplivali zaporedna laktacija, velikost gnezda, število seskov, sezona in starost. Izgube so se razlikovale glede na velikost gnezda, sezono in telesno maso ob prvem tehtanju. Povprečno število rojenih kuncev je bilo 8.77, 8.15 živorojenih in 7.00 odstavljenih. Izgube so v času laktacije znašale 14.4 % in so se s starostjo zmanjševale. Telesna masa mladičev do starosti 3 dni je bila 72 g , masa od odstavitvi pa je v povprečju znašala 959 g. Kunci v manjših gnezdih in kunci mater z več seski so rasli hitreje. Prav tako kunci hitreje rastejo v hladnejših mesecih.

Ključne besede: kunci / pasme / SIKA / reprodukcija / rast / izgube / velikost gnezda / Slovenija

1 INTRODUCTION

Reproductive performance of rabbit does, as well as growth rate and mortality, are the factors that define the productive potential of rabbit farm (Rebollar *et al.*, 2009). Effects, such as genotype of the animal, litter size, season of birth, birth weight, and chance of individual kit to find an available teat during lactation, quality and management of the nest in addition to the climate conditions, affect mortality and growth in suckling rabbits (Harris *et al.,* 1982; Krogmeier and Dzapo, 1991; Poigner *et al.,* 2000). The early postnatal days are critical to survival of kits (Rödel *et al.*, 2009). Within large litters, there is an intensive competition among littermates for milk. In smaller litters, there are more teats than kits available. With increasing litter size the individual milk share is reduced (Ferguson *et al.,* 1997). In smaller litters, kits have more chance to suckle more teats or spent more time to switch searching for the most productive one (Hudson *et al.*, 1996). When the number of the liveborn exceeds the number of functional teats for three or more, there is not enough time for kits to suckle during the allotted

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time. The smallest one became weak and eventually died of hunger (Moce *et al.*, 2000). Litter size in rabbits is often equalized. Generally the number of kits is equals the number of teats plus two. All this could mean that kits from the nests of does with more teats have more chance to survive to weaning.

Rabbit producers must take especial care of nests first week of age (Rosell, 2005). When the hygienic conditions are satisfied, a large part of the mortality before weaning is more related to a biological weakness than to a specific pathology (Farougou *et al.*, 2006). The control of pre-weaning mortality increased the number and weight of rabbits weaned per doe per year (Rashwan and Marai, 2000).

Selection of sire lines to be used in terminal crosses is a common practice in meat rabbit production. In Slovenia, a selection line SIKA for meat was formed in Rabbit centre of Biotechnical Faculty. Male SIKA line for meat production exists from 1995.

The purpose of study was to determine the impact of parity, litter size at birth, number of teats, season on growth and mortality in Slovenian SIKA sire line rabbits. In addition, the effect of birth weight on mortality was focused upon.

2 MATERIAL AND METHODS

2.1 ANIMALS AND HOUSING

Rabbits of Slovenian SIKA terminal sire line were kept on the experimental farm at the University of Ljubljana. Litters were born between December 2010 and May 2011. The study started with 1028 kits from 80 does. There were 1.7 litters per dam on average.

The rabbits were housed in a heated, closed building in wire-net cages. Three days before expected parturition, nests were filled with hay and were removed when kits were about 28 days old. The minimum daily light period was 16 hours. Does were fed commercial diet *ad libitum*, and had unlimited access to water. All liveborn kits were individually identified by ear notching and weighed for the first time between birth and age of 2 days. Later, kits were weighed once a week until weaning at around 35 days. Additionally, kits lost during observational period were weighted within the day after death.

2.2 STATISTICAL ANALYSIS

Statistical model (Eq. 1) for body weights at different ages and mortality contained parity, litter size expressed by number of liveborn kits, teats number, and season as class effects. Season represented a month of kits birth. Body weights were adjusted to the average age at each weight assessment by linear regression. The model for mortality comprised weight at the start as covariate.

$$y_{ijklm} = \mu + P_i + L_j + T_k + S_l + b\, x_{ijklm} + e_{ijklm} \quad (1)$$

where:

y_{ijklm} = weights at different ages / mortality
μ = intercept
P_i = parity (1, …, 6)
L_j = litter size (1, …, 7)
T_k = number of teats (1,2,3)
S_l = season of kits birth (1, …, 7)
b = regression coefficient
x_{ijklm} = age at each weight assessment (for weights) or initial weight (for mortality)
e_{ijklm} = random error

Litters with no kits alive on the day of first weighing were excluded. Because the number of litters with less than 4 kits born alive was low, they were combined into one group designated as group "3-". Litters with more than 10 liveborn kits appeared seldom and were joined into group "11+". Maximum age differences were three days at the first and four days at later stages of experiment. Cross fostering was recorded.

Data were analysed with GLM procedure in statistical package SAS/STAT (SAS User's Guide, 2002).

3 RESULTS AND DISCUSSION

The average litter size at birth (Fig. 1) was of 8.77 born kits per litter. The number of stillbirths together with kits lost up to the first recording was 0.62 kits per litter, resulting in 8.15 kits born alive. A litter without liveborn kits was excluded, thus, litter size varied between 1 and 13 kits per litter. Two thirds of rabbit does had 7 to 10 kits born per litter, while close to 80% of litters had 6 to 10 kits born alive. There were 14.4% losses from birth to weaning, having 1028 kits on the starts 888 kits at the end of experiment. Therefore, 7.00 kits were weaned per litter on the average. At most, 6, 7 and 9 kits per litter were raised up to weaning. Larger litters with six or more kits weaned per litter appeared 3-times more frequent than smaller ones.

Cumulative mortality during observed period was 14.4 % (Table 1). Mortality was the highest in the first week with 6.8% kits dead, and has steadily declined with age. Some litters were checked one of two days after birth, losses before the first assessments were treated as stillbirth. Thus, mortality in the first week was most probably even higher. Average cumulative mortality in the first three week was about 12.1%, which is less than in the

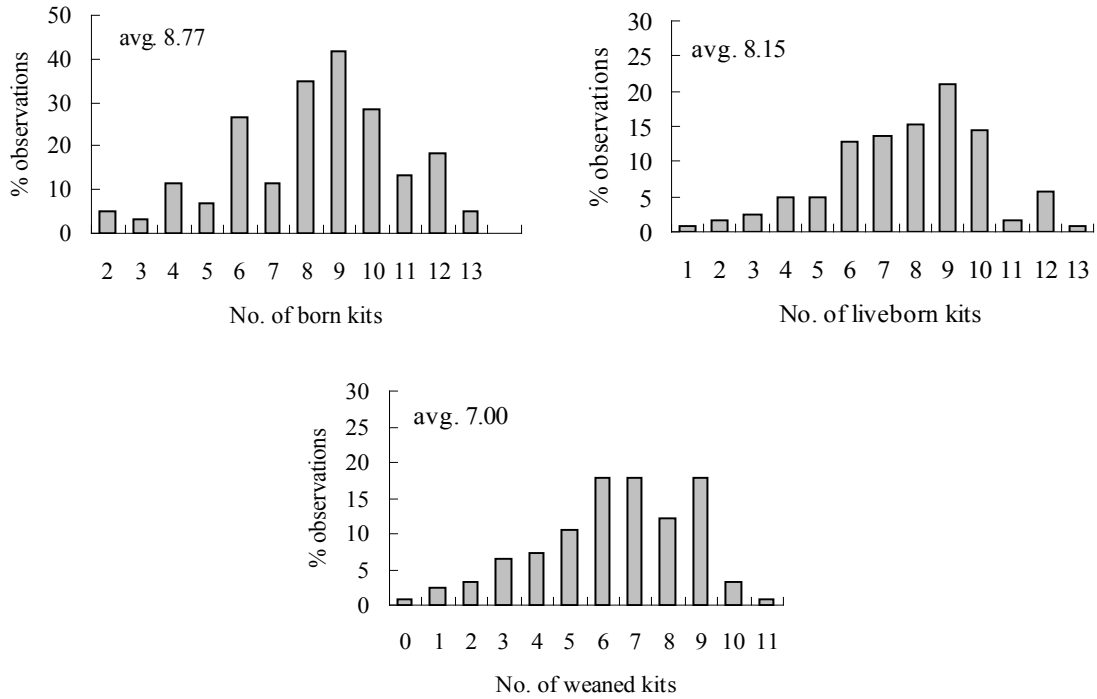

Figure 1: *Litters size distribution*
Slika 1: *Porazdelitve za velikost gnezda*

experiment of Poigner *et al.* (2000), where in first three week 13.3% of kits died. Losses in the last two weeks before weaning were relatively low, less then 1.8%.

Body weight increased rapidly in rabbits (Table 1). One week old kits weighed twice as much as at birth. They gained around 100 g per week before 21 days of age and thus, increased birth weight 3-times. Growth rate was practically doubled in the last two weeks of lactation while kits started to consume solid food. During the first week after birth, kits grew with the average rate of 11 g/d and the rate remained similar as long as the kits were on milk only. Just before weaning, kits gained almost 44 g/d.

Body weights (Table 2) were affected by parity, litter size, teat number of the dam, season of birth, as well as age within each recording. Expectedly teats number did not affect on 5th and 6th body weight, when kits started to consume solid food. Mortality depended on parity, litter size, season and initial weight ($P < 0.05$). Teats number did not prove to be an important factor affecting losses in lactation ($P > 0.05$). Expectedly, the initial weight showed effect on mortality. It is believed that lighter kits at birth are less competitive at suckling, obtaining less milk. Thus, they often become malnourished and even die due to starvation. Due to rapid growth of rabbit kits after birth, it is needed to define starting point in the future experiment more precisely.

Body weights increased by parity (Table 3). Kits were lighter in the first parity from day one to wean-

Table 1: *Mortality of kits between birth and weaning, average body weight and daily gain*
Preglednica 1: *Izgube kuncev v času laktacije, povprečna telesna masa in dnevni prirasti*

Age (week)	Mortality per week		Cumulative mortality		Body weight (g)	Daily gain (g/day)
	No.	%	No.	%		
1st	70	6.8	70	6.8	95	11
2nd	29	3.0	99	9.8	214	15
3rd	21	2.3	120	12.1	312	15
4th	16	1.8	136	13.9	493	25
5th	4	0.5	140	14.4	858	44

Table 2: *Levels of significantly for effect included in the model for body weights and mortality in rabbit kits*
Preglednica 2: *Statistična značilnost posameznih vplivov na telesne mase in izgube kuncev*

	Parity	Litter size	Teat number	Season	Age	Initial weight
BW1	< 0.0001	< 0.0001	0.0007	< 0.0001	< 0.0001	/
BW2	< 0.0001	< 0.0001	0.4094	0.0329	< 0.0001	/
BW3	< 0.0001	< 0.0001	0.0004	0.0013	< 0.0001	/
BW4	< 0.0001	< 0.0001	0.0004	0.0018	< 0.0001	/
BW5	< 0.0001	< 0.0001	0.1390	< 0.0001	< 0.0001	/
BW6	< 0.0001	< 0.0001	0.3678	< 0.0001	0.0290	/
Mortality	0.0051	< 0.0001	0.1347	< 0.0001	/	< 0.0001

* BW – body weight

ing. The udder of primiparous does are still developing during first lactation and produce less milk. The initial weight as well as the weights at later stages, were better in the second parity. Nevertheless, the kits grow slower and the weaning weight is the lowest in first parity. Initial as well as weaning weights were higher for kits born in sixth litter which were smaller. The milk supply with elderly rabbit does was sufficient for their litters. Similar trends were observed by Rebollar *et al.* (2009) who reported kits in the first litter were lighter than kits from later parities. Weight of kits at age of 35 days was 932 g for first parity and 1061 g for third party.

Initial body weight of suckling rabbits as well as weights at later ages (Table 4) was affected by litter size. Average initial weight was decreasing from 88 g in litters with fife kits to 64 g in litters with more than 10 kits. The differences were clear already at the initial weight and were increasing at all successive events up to weaning. At weaning, weight was increased faster in smaller than in larger litters. The initial weight was lower for about 30%. Kits from smaller litters were heavier because of better nourishment in both prenatal and postnatal phases. Therefore, the results are expected, while kits in smaller litters have better starting weight, get more milk and consume more solid food in the last two weeks before weaning.

Average weaning weight of kits in litters with 8 or more kits did not exceed 940 g in comparison with kits form smaller litters, where weaning weight was between 1016 g and 1191 g. Results were comparable to that of Poigner *et al.* (2000). Similar trend of higher growth rate in small litters was also observed in Farougou *et al.* (2006).

All rabbit does have either 8, 9 or 10 teats, counted after the first parturition (Table 5). If dam had 9 or 10 functional teats, kits were heavier at birth and during suckling period than kits of dams with eight teats. At weaning there were no differences between kits suckling 8, 9 or 10 teats. Teats number in Fayeye and Ayorinde (2008, 2010) did not affect litter weight.

Season affected the body weight of the kits (Table 6). At weaning, the lowest value was recorded in the warmer months (season 5, 6 and 7). Since kit's growth between birth and 21 days depends mainly on the doe's milk production, these results imply that doe milk production was affected by season. Kits started to eat solid food at the age 21 days. During warmer months kits consumed

Table 3: *LSMeans for live body weight (± SEE, g) of rabbit kits by parity*
Preglednica 3: *Ocene srednjih vrednosti telesnih mas (± SEE, g) kuncev po zaporedni laktaciji*

	Body weight (g)					
Parity	1	2	3	4	5	6
1	$67^{a} \pm 1.2$	$156^{a} \pm 2.7$	$263^{a} \pm 4.3$	$370^{a} \pm 6.1$	$615^{a} \pm 9.7$	$939^{a} \pm 13.0$
2	$79^{b} \pm 1.2$	$179^{b} \pm 2.9$	$300^{b} \pm 4.5$	$419^{b} \pm 6.4$	$677^{b} \pm 10.1$	$1028^{b} \pm 12.9$
3	$77^{bc} \pm 1.1$	$179^{b} \pm 2.6$	$297^{bc} \pm 4.1$	$420^{bc} \pm 5.7$	$687^{b} \pm 9.1$	$1041^{b} \pm 11.5$
4	$76^{bc} \pm 1.2$	$168^{bc} \pm 2.8$	$282^{cd} \pm 4.4$	$404^{bc} \pm 6.2$	$675^{b} \pm 10.0$	$1020^{bc} \pm 12.3$
5	$72^{b} \pm 1.4$	$162^{bc} \pm 3.5$	$273^{d} \pm 5.6$	$392^{c} \pm 7.8$	$661^{b} \pm 12.4$	$990^{ac} \pm 15.6$
6	$73^{c} \pm 1.8$	$165^{c} \pm 4.3$	$274^{d} \pm 6.7$	$410^{bc} \pm 9.4$	$669^{b} \pm 14.5$	$1011^{b} \pm 19.5$

Different letters in the same column indicate sign. ($p<0.05$) differences

Table 4: *LSMeans for live body weight (± SEE, g) of rabbits kits by litter size*
Preglednica 4: *Ocene srednjih vrednosti telesnih mas (± SEE, g) kuncev po velikosti gnezda*

Litter Size	Body weight (g)					
	1	2	3	4	5	6
3–	74 ^{cb} ± 3.0	175 ^{b} ± 7.3	317 ^{b} ± 11.3	457 ^{b} ± 15.7	703 ^{a} ± 24.6	1055 ^{bc} ± 32.6
4	79 ^{a} ± 2.8	198 ^{a} ± 6.2	351 ^{a} ± 9.7	503 ^{a} ± 13.4	809 ^{b} ± 21.4	1191 ^{a} ± 29.4
5	88 ^{b} ± 2.0	190 ^{b} ± 4.9	310 ^{c} ± 7.9	461 ^{c} ± 11.3	720 ^{c} ± 17.7	1102 ^{c} ± 23.8
6	78 ^{c} ± 1.5	178 ^{b} ± 3.4	298 ^{c} ± 5.4	429 ^{c} ± 7.6	708 ^{bc} ± 12.0	1076 ^{b} ± 15.8
7	75 ^{d} ± 1.3	169 ^{c} ± 3.1	276 ^{d} ± 4.9	397 ^{d} ± 7.0	664 ^{d} ± 11.3	1016 ^{d} ± 14.0
8	71 ^{ef} ± 1.4	163 ^{d} ± 3.2	253 ^{ef} ± 5.0	358 ^{ef} ± 7.0	625 ^{e} ± 11.2	938 ^{e} ± 14.7
9	70 ^{e} ± 1.0	152 ^{d} ± 2.5	254 ^{e} ± 3.9	354 ^{e} ± 5.4	609 ^{e} ± 8.6	925 ^{de} ± 11.5
10	68 ^{ef} ± 1.1	149 ^{d} ± 2.8	243 ^{ef} ± 4.4	334 ^{ef} ± 6.3	573 ^{e} ± 10.0	887 ^{e} ± 12.8
11+	64 ^{f} ± 1.4	139 ^{e} ± 3.3	233 ^{f} ± 5.3	329 ^{f} ± 7.6	564 ^{f} ± 11.8	867 ^{f} ± 15.6

Different letters in the same column indicate sign. (p<0.05) differences

Table 5: *LSMeans for live body weight (± SEE, g) of rabbit kits by teat number*
Preglednica 5: *Ocene srednjih vrednosti telesnih mas (± SEE, g) kuncev po številu seskov*

Teat Number	Body weight (g)					
	1	2	3	4	5	6
8	72 ^{c} ± 0.9	166 ^{b} ± 2.3	273 ^{b} ± 3.6	389 ^{c} ± 5.0	655 ^{a} ± 8.1	996 ^{a} ± 10.0
9	74 ^{a} ± 1.2	170 ^{a} ± 2.6	292 ^{a} ± 4.1	413 ^{a} ± 5.8	676 ^{a} ± 9.2	1015 ^{a} ± 11.8
10	76 ^{b} ± 0.9	168 ^{ab} ± 2.3	280 ^{b} ± 3.6	405 ^{b} ± 5.0	661 ^{a} ± 8.0	1008 ^{a} ± 9.5

Different letters in the same column indicate sign. (p<0.05) differences

less, therefore, the differences in body weight between seasons increased.

Contrary to our results, Zerrouki *et al.* (2007) did not observed any effect of the summer season on body weight of the kits at birth and during the first three weeks of lactation. However, at weaning they recorded the lowest values in the summer. On the other hand, Ayyat *et al.* (1995) working in Egypt did not observe any effect of the kindling season on the kit's weight.

Mortality changed by parity and litter size. Mortality increased from the third to the sixeth litter (Fig. 2a) and declined from first to third parity. The highest mortality (18.5%) was in the first litter.

Mortality was expectedly highest in large (+11) litters. In larger litters, the losses were almost 23% (Fig. 2b). Kits died usually due to small birth weight and malnutrition. In smallest litters there were 13.6% losses. The losses were then increased up to 20% in litters with fife

Table 6: *LSMeans for live body weight (± SEE, g) of rabbit kits by season*
Preglednica 6: *Ocene srednjih vrednosti telesnih mas (± SEE, g) kuncev po sezoni*

Parity	Body weight (g)					
	1	2	3	4	5	6
1	75 ^{c} ± 1.3	164 ^{b} ± 3.6	276 ^{bc} ± 5.7	405 ^{c} ± 7.4	689 ^{a} ± 12.8	1096 ^{a} ± 30.7
2	83 ^{a} ± 1.3	185 ^{a} ± 5.7	300 ^{a} ± 8.9	433 ^{a} ± 12.1	733 ^{b} ± 20.2	1100 ^{b} ± 31.9
3	78 ^{b} ± 1.4	165 ^{b} ± 3.6	272 ^{b} ± 5.7	385 ^{b} ± 11.6	653 ^{bc} ± 13.2	985 ^{c} ± 16.9
4	73 ^{c} ± 1.5	166 ^{b} ± 3.9	284 ^{b} ± 6.1	409 ^{c} ± 8.1	657 ^{c} ± 13.7	1000 ^{c} ± 17.7
5	72 ^{d} ± 0.9	163 ^{d} ± 2.8	291 ^{d} ± 4.4	410 ^{d} ± 6.4	651 ^{d} ± 10.0	961 ^{d} ± 17.6
6	60 ^{b} ± 2.9	167 ^{b} ± 4.2	262 ^{c} ± 6.6	380 ^{c} ± 8.8	629 ^{c} ± 14.7	980 ^{c} ± 19.4
7	74 ^{d} ± 1.5	167 ^{c} ± 3.5	287 ^{d} ± 5.5	396 ^{d} ± 7.9	636 ^{d} ± 12.3	921 ^{d} ± 19.3

Different letters in the same column indicate sign. (p<0.05) differences

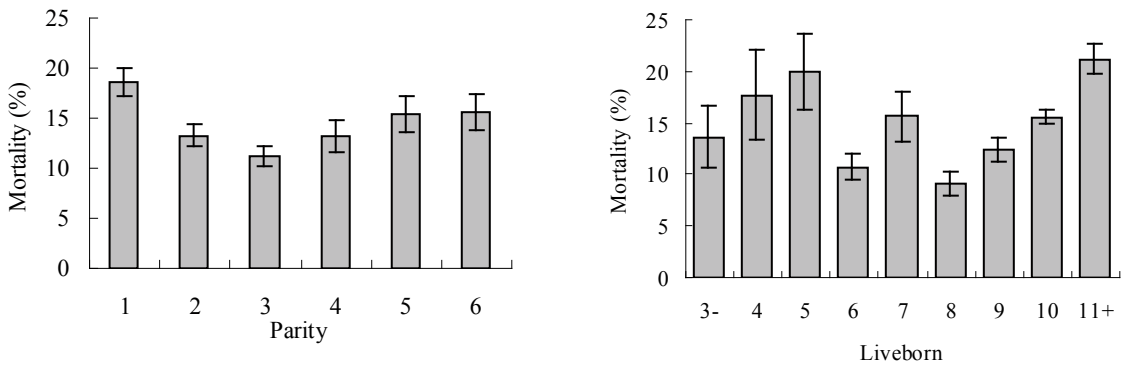

Figure 2: *Mortality of kits by a) parity and b) litter size*
Slika 2: *Izgube kuncev po a) zaporedni laktaciji in b) velikosti gnezda*

kits. Mortality was around 10% in litters with six kits. Mortality also increased from the litters with 8 liveborn to the litters with 10 or more liveborn kits. Poigner *et al.* (2000) checked mortality in standardized litters to 6 or 10 kits in two experiments. In the first experiment, losses were higher than in the second one. They reported much higher losses between birth to age of 21 days in larger litters (35.2% and 18.0%) than in smaller litters with 6 kits (8.1% and 5.6%). Higher preweaning mortality in larger litters has been recorded elsewhere (Elmaghraby and Elkhoya, 2010).

The effect of litter size on kits mortality is connected also with the chance of individual kit to find an available teat during lactation (Poigner *et al.*, 2000). With increasing litter size, the milk consumed by a kit is reduced (Ferguson *et al.*, 1997). The result is higher mortality, which was confirmed in our experiment.

The dead kits were on the average much lighter then kits alive at the same age (Fig. 3). The difference in weight between dead and alive kits was increasing with age. All rabbits which died within the first week of life, were lighter than 60 g. Mortality of about 50% or 70% occurred in the young rabbits between 35 and 45g, while above this birth weight mortality was reduced to 7% (Szendrö and Barna, 1984; Rashwan and Marai, 2000).

4 CONCLUSIONS

Relationship between parity, litter size, season and mortality was confirmed in Slovenian SIKA rabbit terminal line. Litter size affected growth and mortality, particularly at birth and during the weaning. Kits grow faster during the warmer months. Mortality during the first week postnatal accounts for most of kits losses until weaning. The difference in weight between dead and alive kits was increasing with age. Further research is required in scopes related with selection, health, care and survival of suckling rabbits.

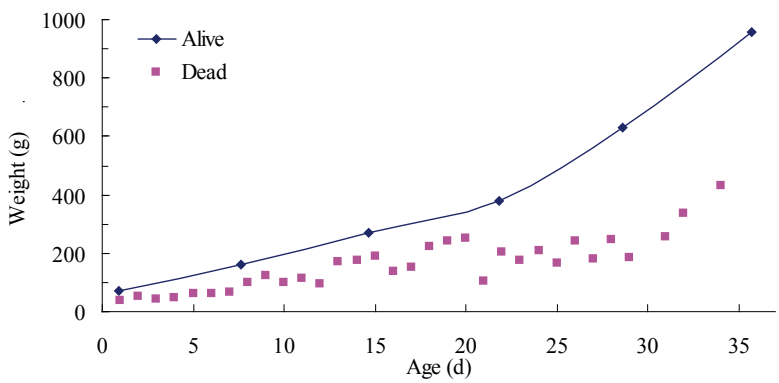

Figure 3: *Comparison between the average weight of kits and weight of kits that died*
Slika 3: *Primerjava povprečnih telesnih mas živih in poginulih kuncev*

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