Sklop 3:

Učinkovitost diatomejske zemlje in kremenovega peska za zatiranje žitnih žužkov, *Sitophilus* spp., in fižolarja, *Acanthoscelides obtectus*

Izvajalci:

Univerza v Ljubljani, Biotehniška fakulteta

Cilj:

- preučiti učinkovitost in za skladiščne razmere v naši državi optimizirati metodo uporabe diatomejske zemlje ali kremenovega peska (in dodatno eteričnih olj), ki predstavljajo okoljsko sprejemljive načine zatiranja skladiščnih hroščev

Materiali in metode

- Delovanje diatomejske zemlje
  - Preučevanje insekticidnega delovanja 4 različnih tipov diatomejske zemlje na riževega žužka (*Sitophilus oryzae)*
  - Preučevanje insekticidnega delovanja pripravka SilicoSec v primerjavi z zmletim prahom njivske preslice in prave sivke na fižolarja (*Acanthoscelides obtectus)*

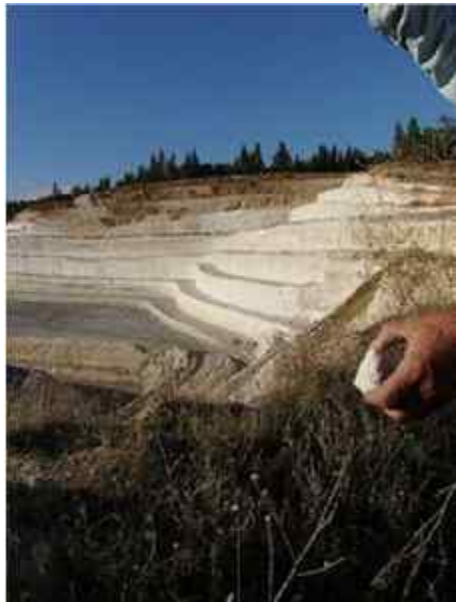
- Delovanje kremenovega peska
  - preučevanje insekticidnega delovanja 5 tipov kremenovega peska

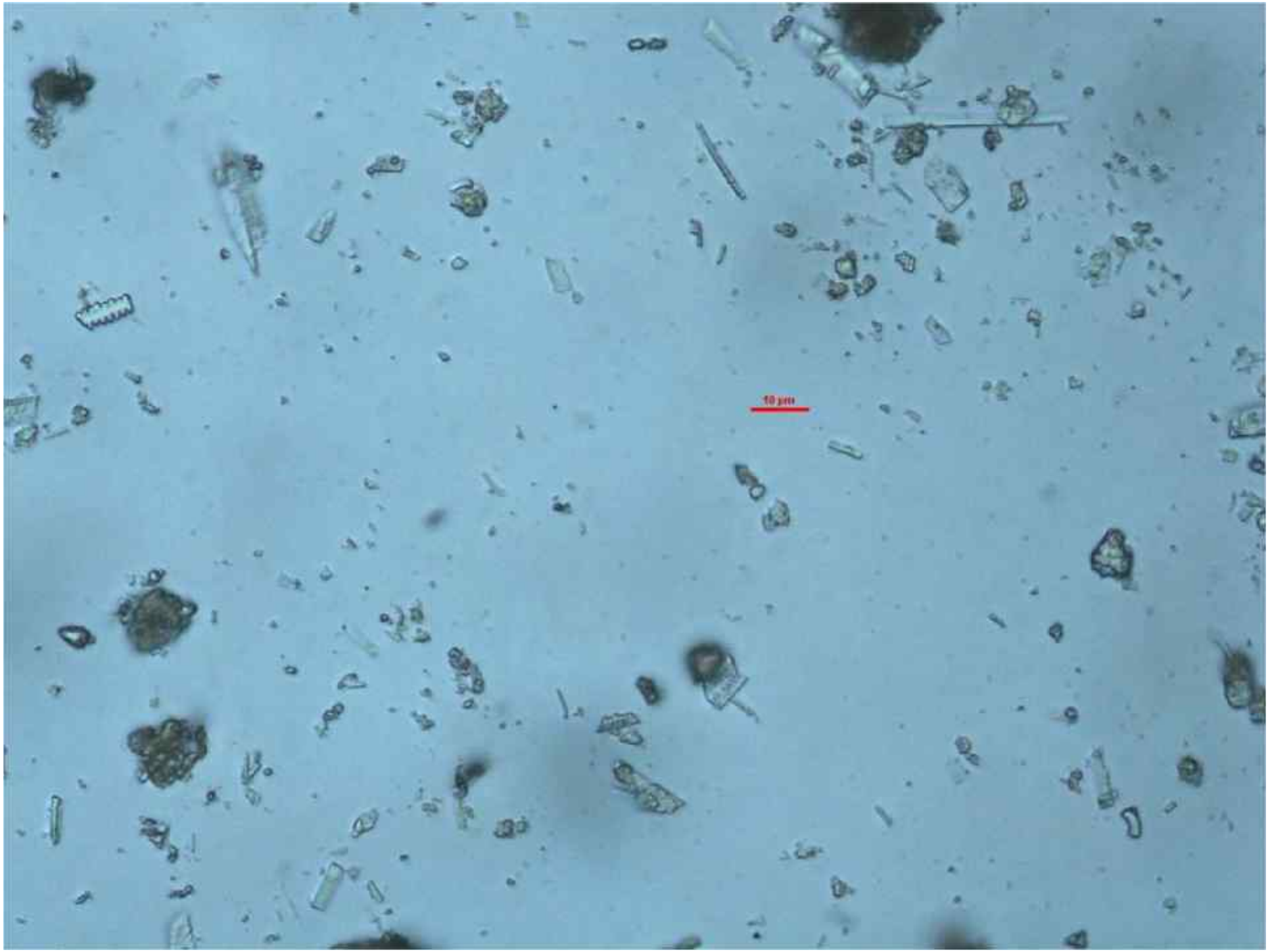
- Delovanje eteričnih olj
  - preučevanje insekticidnega delovanja petih komercialnih eteričnih olj

Diatomejska zemlja

Letni izkop: 1,5 milijona ton

- 40 % ZDA
- 15 % Rusija
- 15 % Francija
- Južna Koreja, Romunija, Mehika, Italija, Islandija…




10 µm

Bela Cerkev, 11. november 2007

Bela Cerkev, 11. november 2007

- prah – ostanki odmrlih (enoceličnih) kremenastih alg (celične stene vsebujejo kremen)

- Dodelava: sušenje → mletje

- Uporaba: 0,7 – 2 kg DE/t žita (~ 1 kg DE/ t žita = 0,1 % = 1000 ppm)
  10-20 g DE / m^2 tal ali stene (tretiranje praznih skladišč)

- Druge možnosti uporabe: - filtracijsko sredstvo za pripravo pijač
  - polnilo v industriji gum, papirja, zdravil, zobnih past

- Fizikalno delovanje na škodljivce:
  - absorbcija vodoodpornih lipidov → desikacija
  - poškodbe kutikule → desikacija
  - oslabitev prebavnega trakta

- Izguba 60 % vode oz. 30 % telesne mase → smrt žuželk!

- Dolgotrajna učinkovitost

Kremenov pesek

Moravče

Ravno pri Raki

- diatomejska zemlja, SilicoSec®

SiO_2!

- prah prave sivke (*Lavandula angustifolia* Mill.)

eterična olja:
- terpeni in ketoni!

- prah njivske preslice (*Equisetum arvense* L.) na fižolarja!

SiO, flavonoidi

Eterična olja

- So kapljevine oljnega videza in otipa z izrazitim vonjem
- Večinoma so rastlinskega izvora

– Po sestavu (mešanica terpenov,....)

- Nastajajo lahko v žleznih celicah na površju rastlinskih organov (rastline iz družine nebinovk, ustnatic,...) v oljnih celicah (npr. družina lovorovk), v sekretarnih votlinicah (npr. družina mirtovk) ali v sekretornih kanalčkih (npr. družina kobulnic)
- Značilnosti: hlapnost; močan, značilen vonj; topljivost v maščobah; manjša gostota kot pri vodi (izjema evgenol v nageljnovih žbicah),...
- Izhlapijo praviloma brez oljnega madeža

- Uporabnost eteričnih olj
  - Navadnega rožmarina (*Rosmarinus officinalis*)
  - Bergamot (*Citrus bergamia*)
  - Kafre (*Cinnamomum camphora*)
  - Navadnega lovorja (*Laurus nobilis*)
  - Žajblja (*Salvia officinalis*)

»Splošna uporaba«

Uporaba v varstvu rastlin




Eterična olja pri zatiranju skladiščnih škodljivcev

- Poskusne razmere:
  - Različne temperaturne vrednosti (10, 15, 20, 25, 30, 35 °C)
  - Vrednosti relativne zračne vlage: 55 in 75 %
  - 24 ur tema
  - Vsako obravnavanje 3-krat ponovljeno
  - Termin ocenjevanja: 1., 2., 4., 7., 14., 21. dan po nastavitvi

100 ppm	500 g zrnja	+	0,05 g
300 ppm	500 g zrnja	+	0,15 g
500 ppm	500 g zrnja	+	0,25 g
900 ppm	500 g zrnja	+	0,45 g
1200 ppm	500 g zrnja	+	0,6 g
1500 ppm	500 g zrnja	+	0,75 g

- Količina eteričnega olja – 25 µl in 100 µl (240 in 980 µl/l zraka pri fižolarju) ter 2,4 in 7,4 ml/l zraka pri preizkušanju insekticidnega delovanja na *S. granarius*
- Eterična olja v 1,5 ml mikrocentrifugirko

Rezultati

Kemična sestava 4 tipov diatomejske zemlje

Table 1 Content (%) of major oxides and opal-A for the analyzed DE samples originated from three different countries and commercial DE formulation SilicoSec®

Origin of DE samples	DE content (%)											
	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Cr_2O_3	opal-A
Slovenia	66.99	11.50	3.92	0.89	0.20	0.22	1.19	0.64	0.08	0.01	0.015	32.49
Greece	67.93	12.27	4.53	1.40	0.97	0.82	1.97	0.55	0.06	0.04	0.008	31.12
Serbia	80.96	6.20	0.66	0.26	0.16	0.05	0.72	0.16	0.02	0.01	0.005	62.36
SilicoSec®	84.47	3.79	1.21	0.25	0.33	0.15	0.07	0.07	0.02	0.02	0.002	73.10

opal-A content was calculated according to formula opal-A = $SiO_2 - 3xAl_2O_3$ (Boström et al. 1972)

Kemična sestava 5 tipov kremenčevega peska

Table 1. Geochemical composition (%) of analyzed quartz sand samples.

	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Cr_2O_3
1	91.74	3.17	0.84	0.04	0.02	0.02	0.13	0.60	<0.01	0.01	0.017
2	95.32	1.06	0.47	0.04	0.02	0.01	0.07	0.52	0.03	0.01	0.013
3	91.52	4.22	0.48	0.08	0.03	0.06	1.19	0.19	<0.01	<0.01	0.006
4	96.15	1.39	0.21	0.03	0.02	0.04	0.76	0.15	<0.01	<0.01	0.005
5	99.24	0.13	0.06	<0.01	0.02	<0.01	0.02	<0.01	<0.01	<0.01	0.006

1 Raka Ravno with admixture, 2 Raka Ravno clean, 3 Moravče with admixture, 4 Moravče clean, 5 Commercial quartz sand formulation "Plastella selected flint sands" (Unichem, Slovenia).

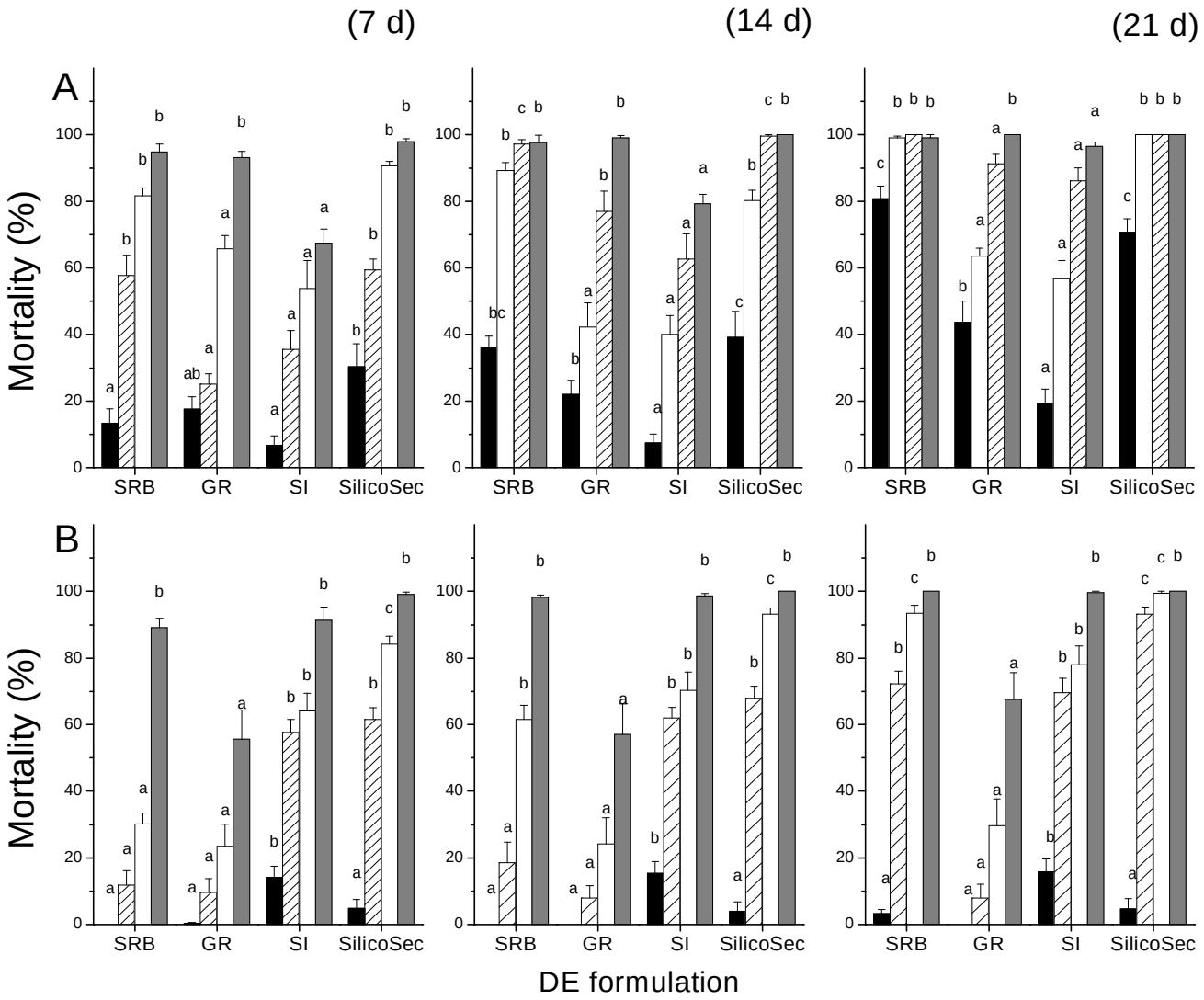


Figure 2: Mean ± SE mortality (%) of *S. oryzae* adults exposed for 7, 14 and 21 d on wheat treated with four DE formulations and at four concentrations (■ – 100, ▨ – 300, □ – 500, ■ – 900 ppm) in 55 % RH (A) and 75 % RH (B) at 25 °C (means at the same DE formulation and concentration followed by the same latter are not significantly different; Duncan test, at $P = 0.05$).

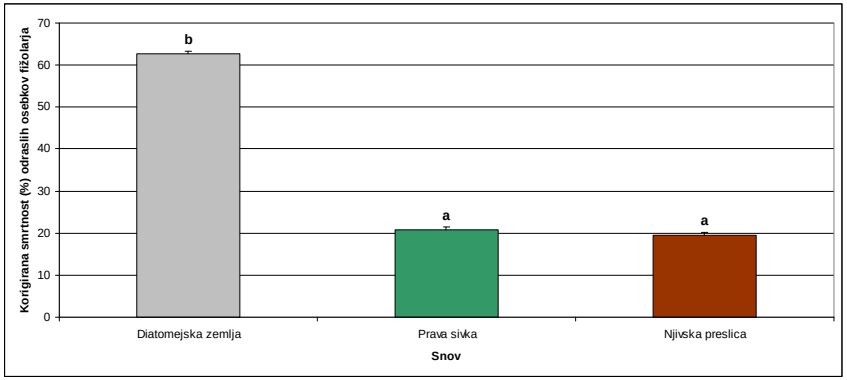
LD_{90} vrednosti 4 različnih tipov diatomej. Ciljni organizem: *Sitophilus oryzae*

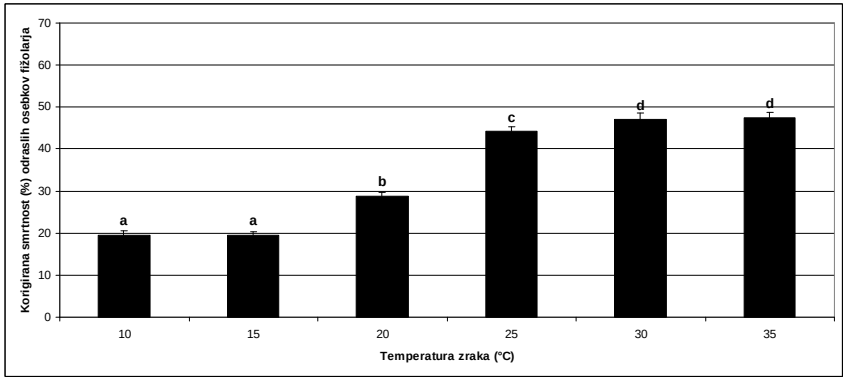
Table 3 LD_{90} (with 95% fiducial limits) values of the tested DE samples against *S. oryzae* 7, 14, and 21 days post-exposure on treated wheat at different temperature × relative humidity combinations

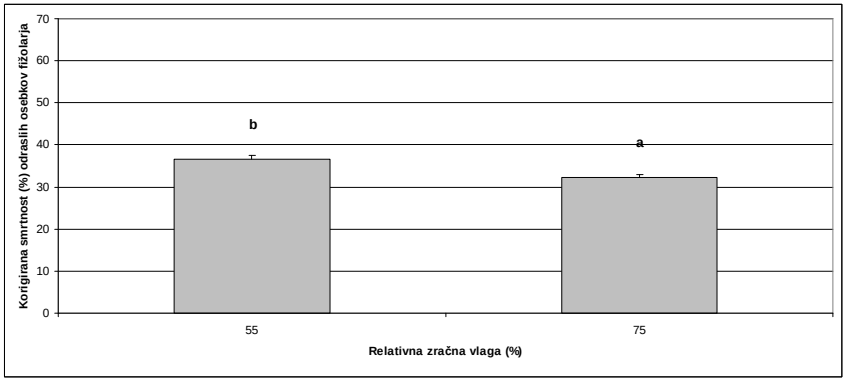
DE	55%			75%		
	20°C	25°C	30°C	20°C	25°C	30°C
7 days post-exposure						
Slovenia	1233 (959–1506) Aa*	854 (721–987) Aa	842 (602–1082) Aa	646 (555–738) Aa	731 (653–809) Ba	612 (530–774) Aa
Greece	551 (479–623) Bb	788 (727–849) Aa	844 (753–937)Aa*	525 (452–598) Ab	1029 (853–1206) Aa*	592 (515–668) Abb
Serbia	547 (477–617) Ba	667 (598–737) ABa	735 (668–803) Aa*	584 (520–648) Ab	921 (860–982) Aa*	546 (470–622) Abb
SilicoSec®	448 (372–524) Bb	626 (558–693) Ba	699 (636–762) Aa*	585 (511–658) Aab	646 (584–708) Ba	437 (349–525) Bb
14 days post-exposure						
Slovenia	1004 (864–1145) Aa*	794 (697–892) Aa	826 (684–967) Aa*	577 (497–657) Aa	685 (621–749) Ba	594 (511–678) Aa
Greece	514 (441–587) Bb	683 (616–750) Aa	543 (502–584) Bb	454 (375–533) Ab	995 (824–1167) Aa*	429 (345–513) Ab
Serbia	493 (419–567) Ba	530 (455–606) Ba	434 (354–515) Ba	519 (452–586) Ab	771 (722–821) Ba*	499 (421–578) Ab
SilicoSec®	379 (295–463) Ba	532 (459–606) Ba	546 (477–614) Ba	562 (487–636) Aa*	602 (535–669) Ba	426 (412–608) Aa
21 days post exposure						
Slovenia	908 (837–979) Aa*	649 (580–717) Ab	700 (606–793) Ab	551 (468–634) Aa	633 (564–703) Ba	578 (491–666) Aa
Greece	506 (431–581) Ba	606 (542–671) Aa	585 (519–651) Ba	432 (350–513) Ab	948 (817–1079) Aa*	527 (447–607) Ab
Serbia	452 (378–527) Ba	372 (276–467) Ba	457 (399–537) Ba	469 (396–542) Aa	591 (523–660) Ba*	422 (334–626) Aa
SilicoSec®	359 (267–450) Ba	415 (333–497) Ba	101 (0–283) Ca	551 (476–625) Aa	531 (454–609) Ba	409 (315–502) Aa*

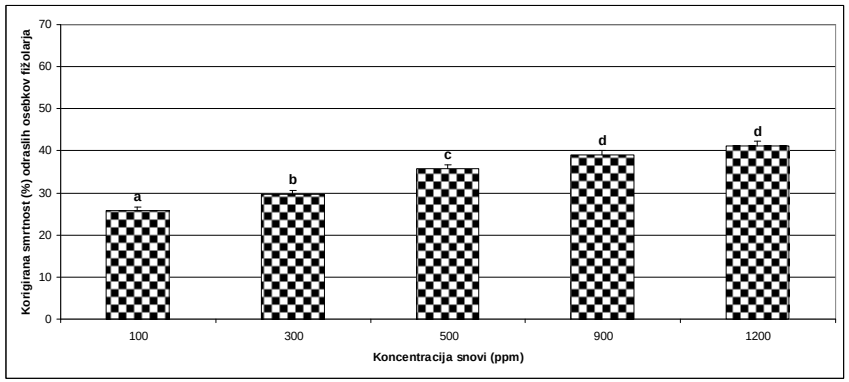
For a given exposure by temperature by RH combination, different *uppercase letters* show significant differences between LD_{90} values. For a given exposure by temperature by RH combination by DE combination, different *lowercase letters* show significant differences between LD_{90} values; for a given exposure by DE and temperature, *asterisk* (*) shows significant differences in LD_{90} values between the tested RH levels. (*uppercase letters* for DE, *lowercase* for temperatures; *asterisk* for RH; lethal dose ratio test of Robertson and Preisler 1992)

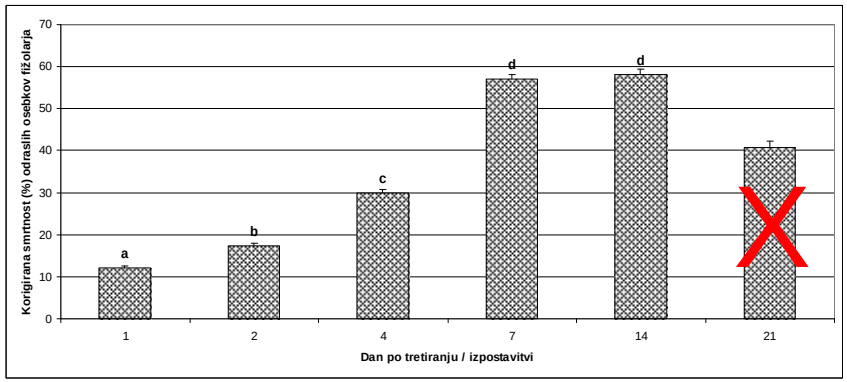
Rezultati generalne statistične analize



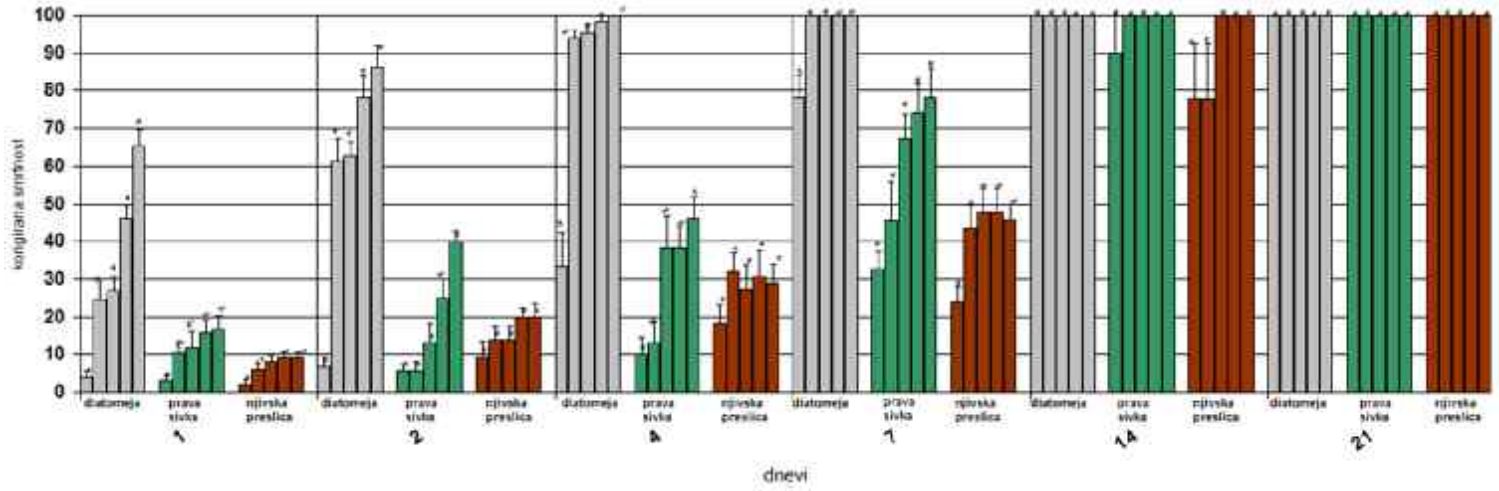




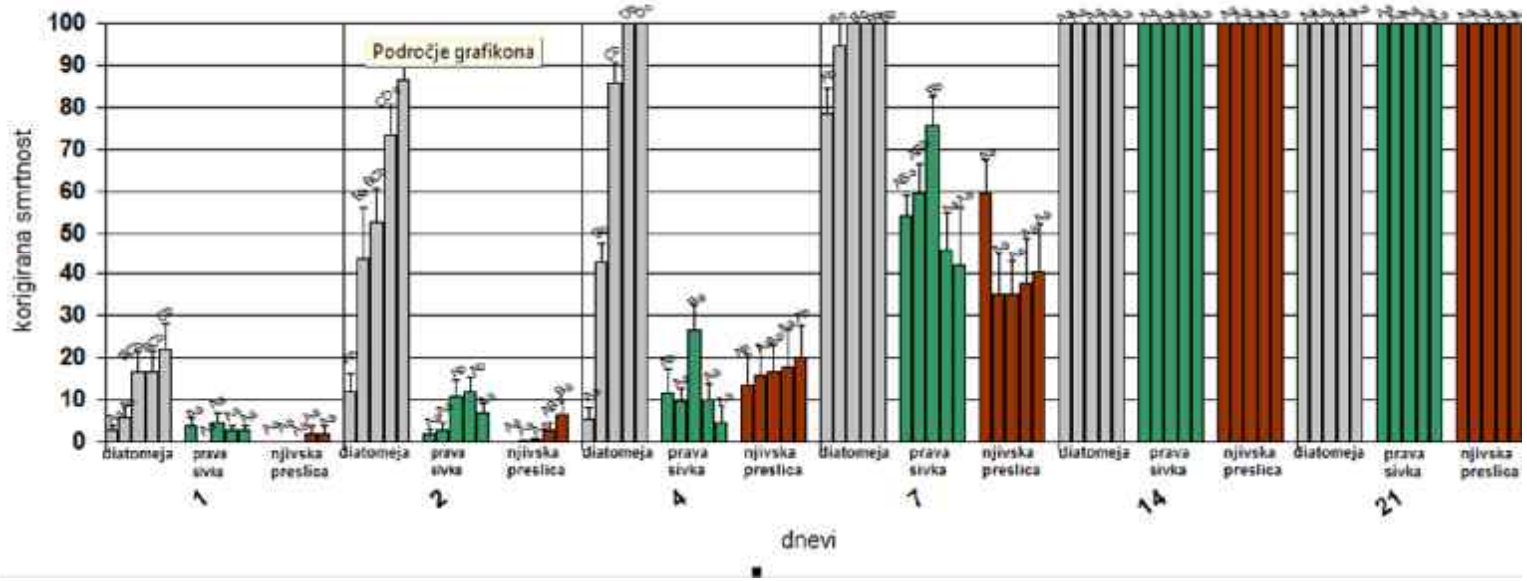




25°C,
55 % Rh



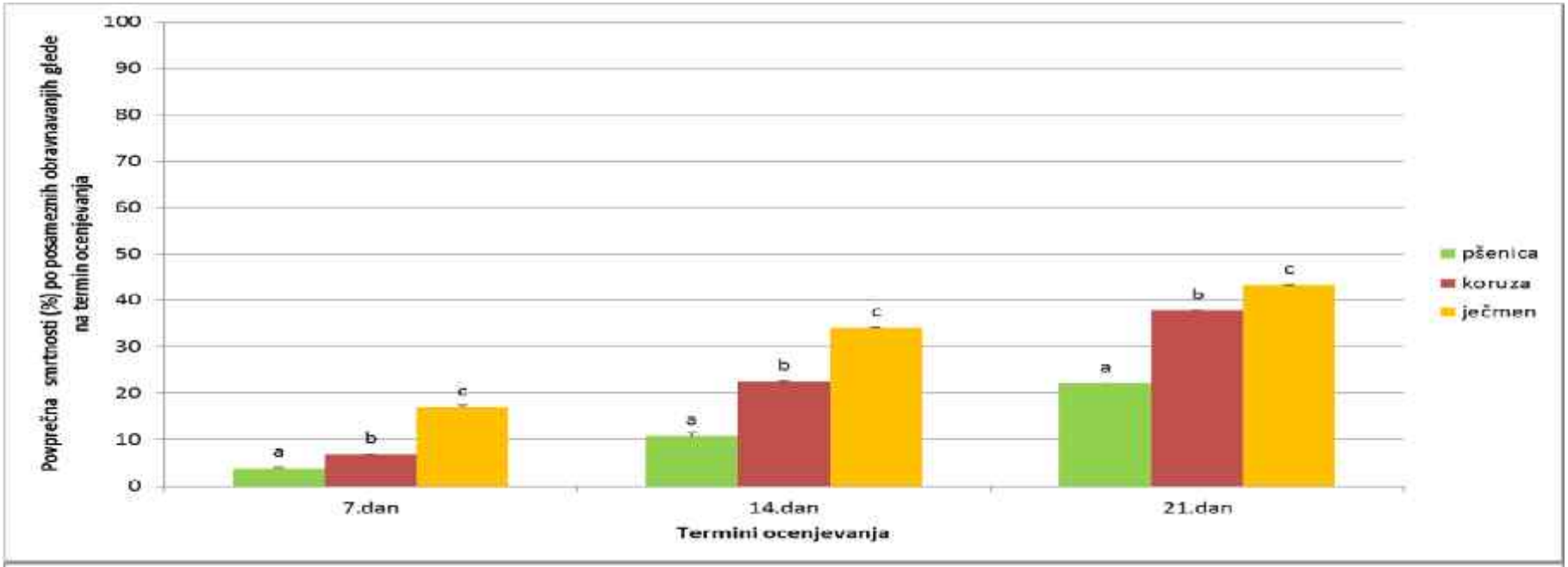
25°5C,
75 % Rh

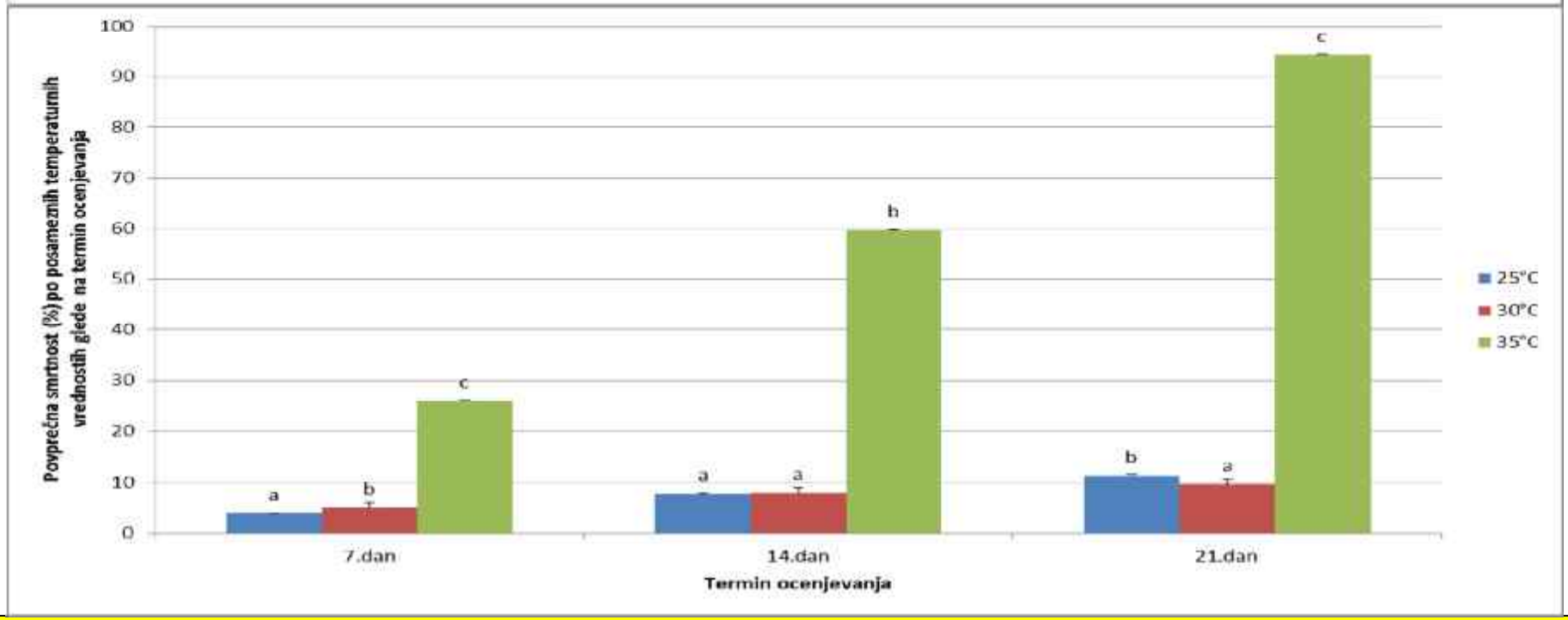


Insekticidno delovanje kremenovega peska na *Sitophilus oryzae*

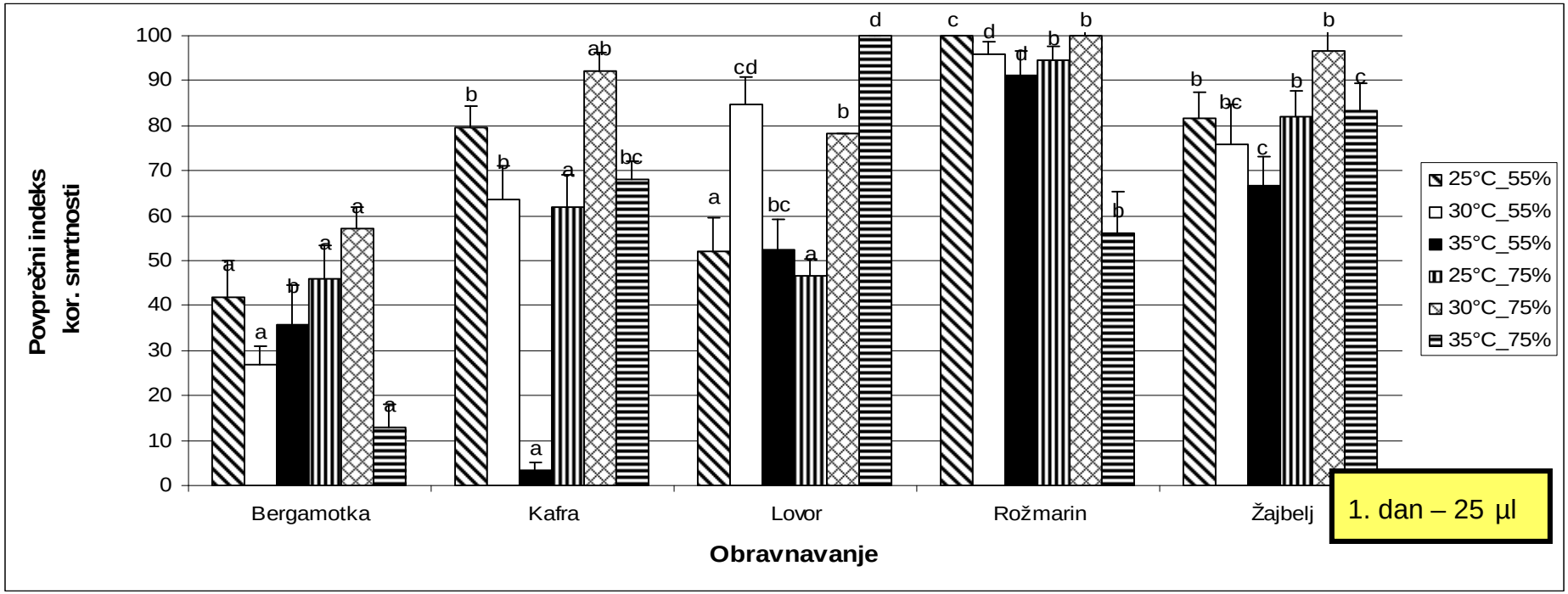
Table 2. Mortality of rice weevil adults at 20, 25, 30 and 35°C and at 55 and 75% RH level after 7 days of treatment. Different uppercase letters show significant differences between concentrations of quartz sand within one sample, temperature and RH level. 1 - Raka Ravno with admixture, 2 - Raka Ravno clean, 3 - Moravče with admixture, 4- Moravče clean, 5- Commercial quartz sand formulation "Plantella selected flint sands" (Unichem, Slovenia).

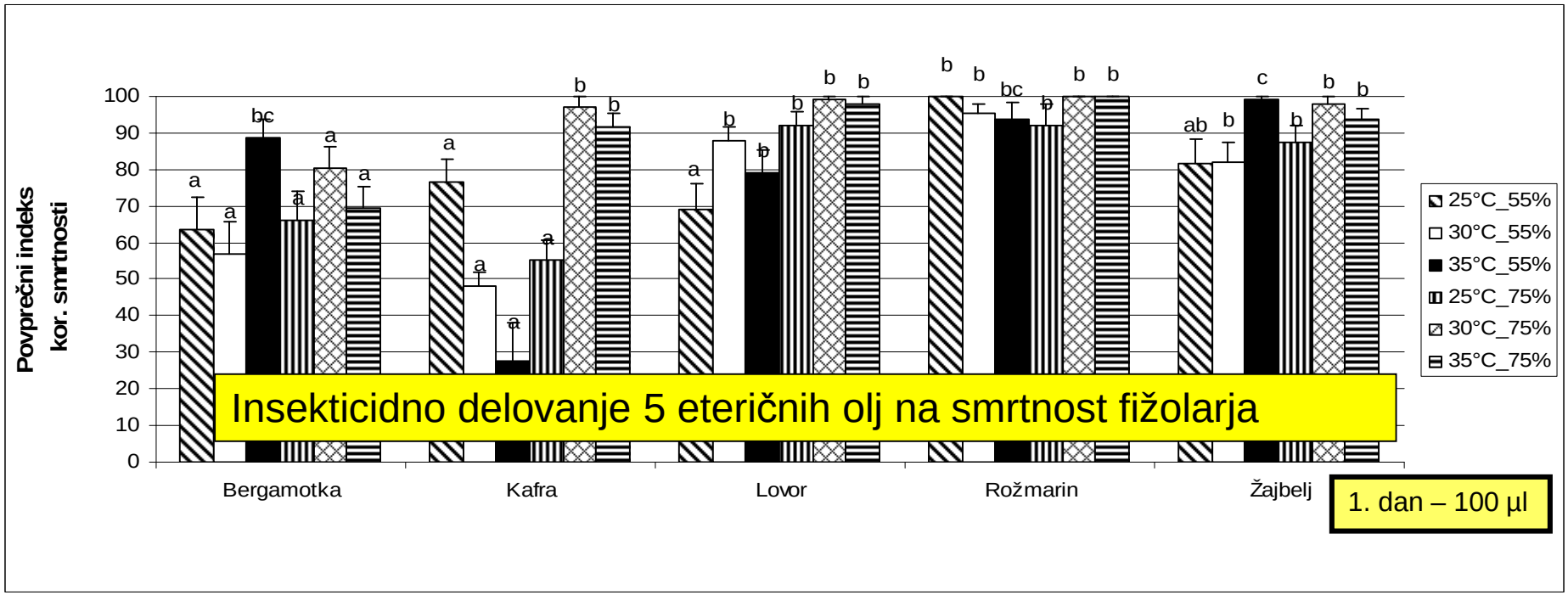
7 days		20°C		25°C		30°C		35°C	
Sam	Con	55%	75%	55%	75%	55%	75%	55%	75%
	100	2.23±1.21A	0.00±0.37A	0.00±0.00A	0.00±0.00A	0.00±0.00A	0.00±0.56A	0.00±0.00A	0.00±0.00A
	300	1.86±1.11A	0.37±0.74A	0.00±0.00A	0.00±0.00A	0.37±0.37A	1.87±0.88AB	0.49±0.82A	0.37±0.49A
1	500	1.86±0.79A	0.37±0.49A	0.00±0.00A	1.49±0.79B	0.00±0.00A	2.62±1.18AB	0.00±0.00A	0.37±0.00B
	900	2.60±1.03A	1.12±0.81A	0.00±0.00A	0.00±0.00A	0.37±0.37A	4.12±1.50B	0.00±0.00A	0.00±0.37A
	1200	2.23±0.49A	2.59±0.74A	0.00±0.00A	0.37±0.79A	0.37±0.37A	2.62±1.18AB	3.12±1.38B	0.00±0.37A
	1500	2.60±1.17A	2.59±0.93A	0.00±0.00A	0.00±0.00A	0.0±0.00A	2.62±1.04AB	1.24±0.94AB	0.00±0.37A
	100	0.74±0.56A	0.20±0.20A	0.00±0.00A	0.00±0.00A	0.37±0.37A	1.50±0.94A	0.00±0.37A	0.00±0.00A
	300	1.12±0.98A	0.74±0.56A	0.00±0.00A	1.12±0.81AB	0.74±0.49A	4.87±1.09B	1.86±0.79B	0.74±0.56B
2	500	1.12±0.81A	1.50±0.94A	0.00±0.00A	0.00±0.00A	0.00±0.00A	3.75±1.69B	2.94±1.25B	0.37±0.49B
	900	0.00±0.00A	0.37±0.79A	0.00±0.00A	0.37±0.79AB	1.48±0.81B	3.37±1.59B	3.71±1.34B	1.11±0.81B
	1200	1.12±0.81A	1.48±0.58A	0.00±0.56B	1.49±0.079B	0.00±0.00A	4.12±1.27B	2.97±1.11B	1.00±0.37B
	1500	0.74±0.56A	2.59±1.08A	0.00±0.00A	0.00±0.00A	0.00±0.00A	4.12±1.50B	4.46±1.59B	0.74±0.79A
	100	1.11±0.59A	0.37±0.49A	0.59±0.75A	2.24±1.53B	1.48±0.58A	4.87±1.93AB	1.12±1.49A	1.11±0.59A
	300	2.23±0.74A	0.74±0.81A	1.50±1.09A	0.00±0.00A	2.59±0.74A	8.99±3.02B	3.34±1.52A	2.23±0.74A
3	500	2.23±0.93A	2.22±1.11A	1.50±0.94A	0.74±0.81A	2.59±1.08A	4.50±1.69AB	2.60±1.41A	2.23±1.08A
	900	2.23±1.08A	1.48±0.58A	1.50±0.94A	0.00±0.00A	2.59±0.93A	2.99±1.35A	1.11±0.59A	2.23±0.93A
	1200	1.86±1.12A	0.37±0.37A	1.12±1.12A	0.74±0.81A	2.22±1.11A	2.25±1.12A	3.34±087A	1.86±1.11A
	1500	2.60±0.87A	1.42±0.57A	1.87±0.87A	0.37±056A	2.96±0.87A	5.24±0.88AB	0.74±0.56A	2.60±0.87A
	100	0.00±0.37A	0.00±0.00A	0.00±0.00A	0.74±0.81A	0.00±0.00A	1.87±1.04A	1.87±1.04A	0.37±0.49AB
	300	0.74±0.56B	0.74±0.49B	0.00±0.00A	0.00±0.00A	0.74±0.49A	1.87±0.87A	1.87±0.87A	1.49±0.81B
4	500	0.37±0.49A	0.37±0.37A	0.00±0.00A	0.00±0.00A	0.37±0.37A	1.87±1.53A	1.87±1.53A	0.37±0.49AB
	900	0.00±0.00A	2.60±1.17A	0.00±0.00A	1.11±0.81A	0.00±0.00A	1.12±1.12A	1.13±1.12A	0.00±0.00A
	1200	0.37±0.49A	2.23±1.08A	0.00±0.00A	0.37±0.79A	0.37±0.37A	2.25±0.79A	2.25±0.79A	0.00±0.37A
	1500	1.12±1.13A	0.37±0.37B	0.00±0.00A	0.00±0.00A	0.00±0.00A	4.12±1.95A	4.12±1.95A	0.00±0.00A
	100	0.37±0.49A	0.00±0.56A	0.00±0.00A	0.20±0.20A	0.00±0.00A	3.30±1.67A	1.38±0.76A	0.00±0.00A
	300	1.12±0.81A	1.48±0.58A	0.00±0.00A	0.00±0.00A	0.00±0.00A	1.42±0.57A	0.96±0.96A	0.00±0.00A
5	500	1.12±1.13A	1.42±0.57A	0.00±0.00A	0.42±0.28A	0.00±0.00A	5.22±1.59A	1.79±0.72A	0.00±0.00A
	900	0.74±0.56A	0.37±0.37A	0.00±0.00A	0.42±0.28A	0.00±0.00A	4.84±1.30A	1.04±0.33A	0.00±0.00A
	1200	0.37±0.74A	0.37±0.79A	0.00±0.00A	0.62±0.31A	0.00±0.00A	2.38±0.95A	1.21±0.59A	0.00±0.00A
	1500	0.37±0.49A	1.48±0.58A	0.00±0.00A	0.21±0.21A	0.00±0.00A	2.59±0.91A	2.88±1.55A	0.00±0.00A

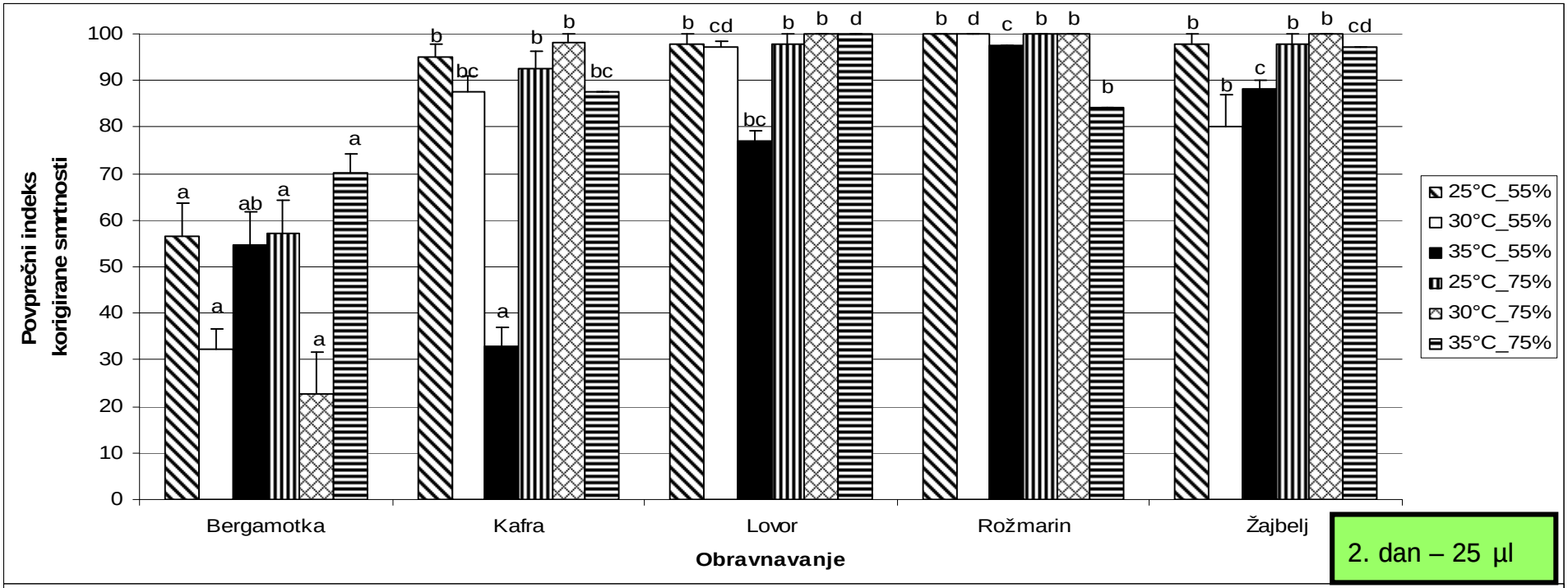


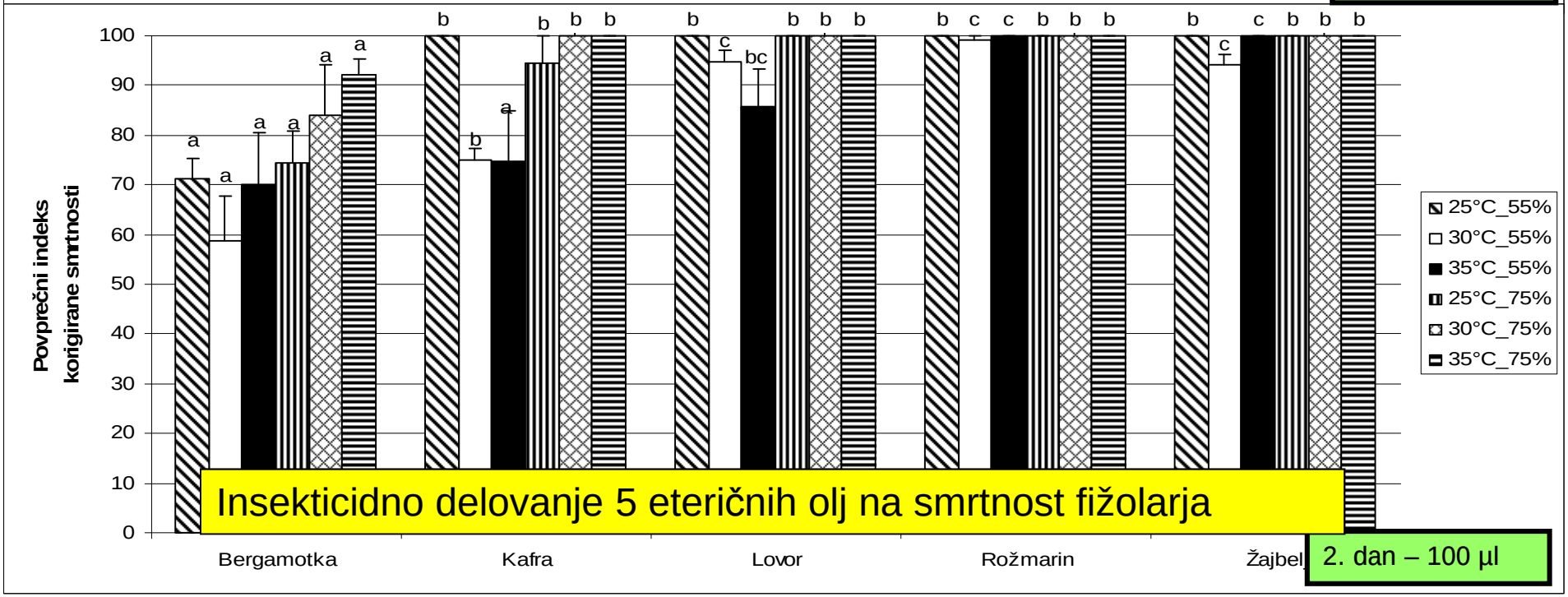


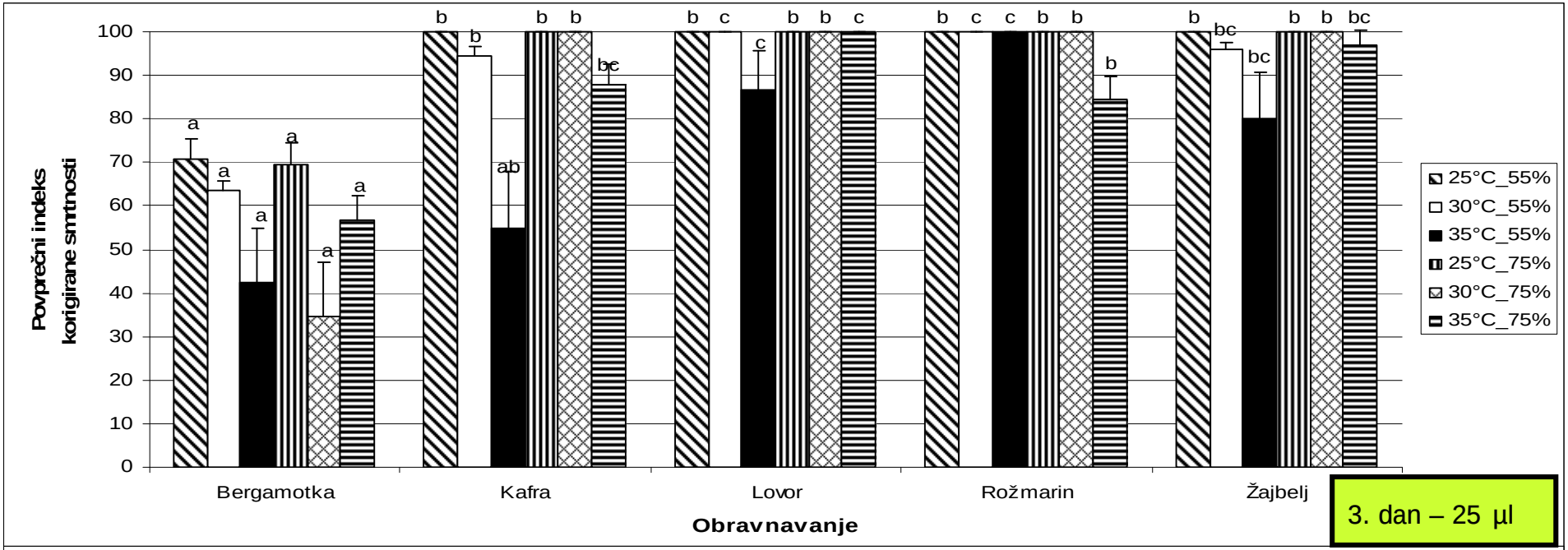
Povprečna smrtnost *S. oryzae* glede na vrsto žita (zgoraj) in temperaturno (spodaj)

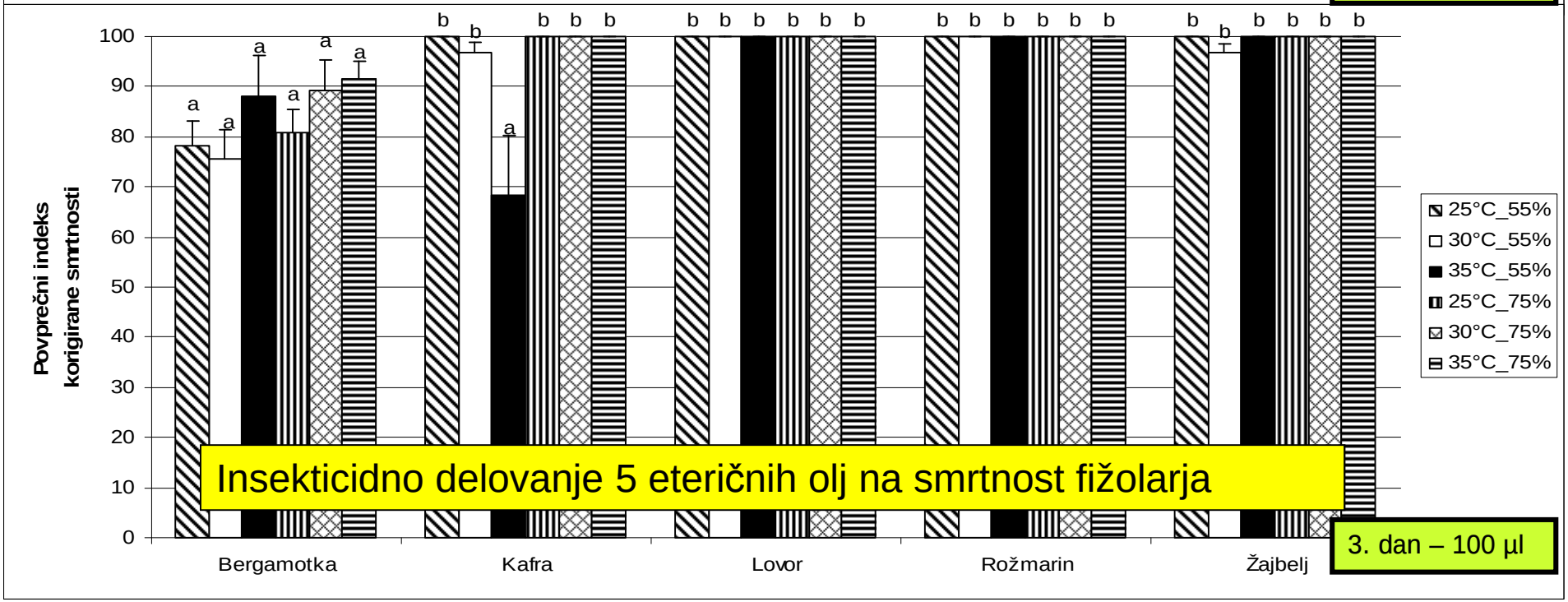

Povprečni indeks kor. smrtnosti
100
90
80
70
60
50
40
30
20
10
0
Bergamotka
Kafra
Lovor
Rožmarin
Žajbelj
Obravnavanje
25°C_55%
30°C_55%
35°C_55%
25°C_75%
30°C_75%
35°C_75%
1. dan – 25 µl


Povprečni indeks kor. smrtnosti
100
90
80
70
60
50
40
30
20
10
0
Bergamotka
Kafra
Lovor
Rožmarin
Žajbelj
25°C_55%
30°C_55%
35°C_55%
25°C_75%
30°C_75%
35°C_75%
Insekticidno delovanje 5 eteričnih olj na smrtnost fižolarja
1. dan – 100 µl


Povprečni indeks korigirane smrtnosti
Bergamotka
Kafra
Lovor
Rožmarin
Žajbelj
Obravnavanje
25°C_55%
30°C_55%
35°C_55%
25°C_75%
30°C_75%
35°C_75%
2. dan – 25 µl


Povprečni indeks korigirane smrtnosti
Bergamotka
Kafra
Lovor
Rožmarin
Žajbelj
25°C_55%
30°C_55%
35°C_55%
25°C_75%
30°C_75%
35°C_75%
Insekticidno delovanje 5 eteričnih olj na smrtnost fižolarja
2. dan – 100 µl





Insekticidno delovanje 5 eteričnih olj na smrtnost fižolarja

Sklepi

- najhitrejše delovanje in najboljša insekticidna učinkovitost diatomejske zemlje in eteričnih olj (zlasti rožmarina, lovorja in žajblja)

- insekticidna neučinkovitost kremenovega peska

- implementacija diatomejske zemlje in eteričnih olj v strategijo zatiranja skladiščnih škodljivcev

-0,25 l EO na 1000 l fižola! (50 ml EO ~ 20 EUR)

Bibliografija članov projektne skupine CRP projekta V4-1067, vezana na rezultate v okviru sklopa 3

1.01 Izvirni znanstveni članek: 3
1.02 Pregledni znanstveni članek: -
1.04 Strokovni članek: 1
1.05 Poljudni članek: -
1.08 Objavljeni znanstveni prispevki na konferenci: 2
1.12 Objavljeni povzetek znanstvenega prispevka na konferenci: 3
1.13 Objavljeni povzetek strokovnega prispevka na konferenci: 1
1.16 Samostojni znanstveni sestavek ali poglavje v monografski publikaciji: -
Urednik: 1
Mentor pri doktorskih disertacijah: 1
Mentor pri diplomskih delih: 1
Pisec recenzij: -
Drugo: -