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Local Slovenian quartz sands have low insecticidal activity against rice weevil (*Sitophilus oryzae* [L.], Coleoptera, Curculionidae) adults

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Abstract

The efficacy of Slovenian quartz sands admixed with stored wheat was tested against rice weevils (*Sitophilus oryzae*) in laboratory conditions. Five different samples of quartz sand of different ages were tested. Samples from the location Raka-Ravno (with admixture and clean) and the location Moravče (with admixture and clean) and commercially available cleaned quartz sand from the locality of Puconci (Plantella) each were used at six concentrations: 100, 300, 500, 900, 1200, and 1500 ppm. The amount of SiO_2 in all sand samples was high and varied from 91.52 to 99.24%. For each dose rate, the treated wheat grains were placed at four temperatures (20, 25, 30 and 35°C) and at 55 and 75% relative humidity level. After 7, 14 and 21 days of exposure dead adults were counted. All samples showed only a slight insecticidal effect on adults of rice weevil and are not appropriate for wider use against rice weevil adults in stored wheat. The highest mortality (15%) of rice weevil adults was confirmed 21 days after treatment at 900 ppm, 30°C and 55% RH level for quartz sand with admixture from the Moravče location.

Key words: Quartz sands, *Sitophilus oryzae*, sustainable control, stored wheat.

Introduction

Research on inert dusts as insecticides in grain storage facilities began in the 1920s [7, 8-11]. There are more groups of inert dusts with insecticidal properties: mineral dusts (rock phosphate, ground sulphur, lime, limestone, sodium chloride), diatomaceous earth, other earths and ashes (traditionally used powdered clay, sand, earth) and synthetic silica (SiO_2) [7]. Dusts have low mammalian toxicity, are effective for long durations, and they do not affect end use quality [12]. Their main disadvantages are that they are dusty to apply, do not work at high relative humidity and impede the flow of grain [11]. The silicon-dioxide-based inert dusts are thought to damage the cuticular waxes, and pests died because of dehydration [7]. The efficacy of five Slovenian local quartz sands against rice weevil *Sitophilus oryzae* was evaluated for the first time.

The rice weevil (*Sitophilus oryzae* [L.], Coleoptera, Curculionidae) is one of major pests of stored cereals, and the predominant pest of stored rice. The control of insect pests in storage is largely based on synthetic insecticides and fumigants, which have led to the development of insecticide resistant strains, the increasing cost of application and lethal effects on non-target organisms, not to mention its direct toxicity to users [4, 6-10].

Our previous study showed some insecticidal action of all five of the Slovenian quartz samples at 20 and 30°C and 55% RH level on rice weevil adults. The aim of this study was to discover if different temperatures, RH levels and the mineralogical composition of quartz sands tested had any influence on the mortality of rice weevil adults.

Material and Methods

Wheat and rice weevil adults: Wheat was produced in 2007 in and around Horjul (46°1'22.64''N, 14°17'53.28''E, altitude 339.8 m). The rice weevil adults (<21 d old) which were used for the study were taken from a population that was kept in the Laboratory for Entomology at the Chair of Phytomedicine, Agricultural Engineering, Crop Production, Grassland, and Pasture Management (Biotechnical Faculty, Slovenia) for several years at 25±1°C on wheat.

Quartz sands formulations: Two Slovenian local quartz sands and commercial available formulation were used in the test: the first and second samples were taken in the village Ravno (45°53'50.11''N, 15°22'27.68''E, altitude 159.5 m), while the third and fourth samples were from the village Moravče (46°8'11.97''N, 14°44'37.91''E, altitude 380.3 m). The second and fourth samples were purified with water filtration. The fifth sample was commercial quartz sand formulation "Plantella Izbrani kremenovi peski" (Unichem, Slovenia), which is cleaned quartz sand from Puconci (46°42'19.4''N, 16°9'13.06''E, altitude 205.7 m). Particle sizes of all quartz sands were approx. 12 μm.

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 "Plantella selected flint sands" (Unichem, Slovenia).

Laboratory bioassay: Exposure studies were carried out at 20, 25, 30 and 35°C, and at two relative humidity (RH) levels (55 and 75%). Six concentrations of each quartz sands were used (100, 300, 500, 900, 1200 and 1500 ppm). A single glass jar contained 1 kg wheat grain and an individual dose of quartz sand. An additional jar of untreated wheat was used as the control. All jars were shaken manually for approx. five minutes to achieve distribution of the dust throughout the entire grain mass. For each treatment, three samples of 50 g each were taken from each jar, and each sample was placed in a vial. Then, 30 rice weevil adults were introduced into each vial. The vials were closed with a slender net to prevent the insects from escaping, and were placed into a rearing chamber (RH-900 CH type, producer: Kambič, Semič, Slovenia) with a dark:light ratio of 24:0. The mortality of the exposed adults was measured after 7, 14 and 21 days of exposure. The entire procedure, which is a slightly modified method of Athanassiou [3] was repeated three times. The number of F1 individuals was counted after 60 days.

Data analysis and statistics: A multifactor analysis of variance (ANOVA) was conducted to determine differences in mortality rates (%) of rice weevil adults, reared under conditions of different treatments, at three different temperatures. Before the analysis, each variable was tested for homogeneity of treatment variances. Mortality rate data were corrected for control mortality using Abbotts formula [1], the arcsine square-root being transformed before analysis. Duncan's multiple range test ($P \leq 0.05$) was used to separate mean differences among the parameters in all the treatments [9]. All statistical analyses were performed with Statgraphics Plus for Windows 4.0 (Statistical Graphics Corp., Manugistics, Inc., Maryland, USA). The data are presented as untransformed means.

Results and Discussion

Table 1 shows mineralogical composition of quartz samples. It is evident, that Samples 1 and 3, which were not cleaned, had the lowest SiO_2 content, 91.74 and 91.52%, respectively. With the cleaning of these two samples we achieved 95.32 and 96.15% SiO_2 content and a lower amount of Al_2O_3. The amount of minor components such as MgO, CaO, Na_2O, Na_2O, K_2O, TiO_2, P_2O_5, MnO and Cr_2O_3 did not exceed 1%.

Rojht *et al*. (2009, unpubl.) showed that the cleaning process resulted in a higher mortality of rice weevils adults in the location Raka Ravno (Samples 1 and 2), but not in the location Moravče (Samples 3 and 4) at 25°C, where the mortality was lower at clean sample (Sample 4) than in the sample with the admixture (Sample 3). In this study the mortality after 7 days of treatment (Table 2) was in all samples negligible (0.00-5.24%), with the exception of one case where the mortality was 8.99±3.02% (Sample 3 at 30°C, 75% RH and at concentration of 300 ppm). Regarding to the very low mortality on rice weevils within this sample at concentration of 300 ppm and in all other conditions (0.00-3.34%), we believe that this result can be ignored. Because the mortality was very similar in all samples and in all treatments, we conclude that there is no influence of different geochemical compositions of analyzed quartz sands on the mortality of rice weevil adults.

The mortality of rice weevil adults was very low in all treatments. Most reached less than 10%, with some exceptions. The lowest mortality of the pests was seven days after treatment and did not exceed 5%, except in the already mentioned Sample 3, at a concentration 300 ppm, at the 30°C and 75% RH levels. In almost all cases there were no significant differences in the mortality of rice weevils between different concentrations within one sample of quartz sand. The mortality was in all cases slightly higher 14 days after treatment, but did not exceed 10%, except in the above example (Table 3). The highest mortality was recorded 21 days after treatment (900 ppm, 30°C and 55% RH level) in Sample 3. This sample also indicated low insecticidal activity where a mortality of 5% was determined in half of the cases. We noticed significant differences in the mortality among concentrations of quartz sand 14 and 21 days after treatment (Table 4). In all cases the mortality did not exceed 15%.

Until now quartz sand was not often used against the insects, but some results of the studies showed promising insecticidal efficacy. Owing to the very sensitive cuticle, the newly hatched larvae of potato tuber moth (*Phthorimaea operculella* [Zeller]) showed high susceptibility (almost 95% mortality) to the previously mentioned inert dust [13], while in other experiment quartz sand was less effective against 3rd instar larvae and adults of khapra beetle (*Trogoderma granarium* Everts) [2]. Also the mobile stages of southern corn rootworm (*Diabrotica undecimpunctata howardi* Barber) showed a certain susceptibility to quartz sand, since cuticle abrasion of the insect from the soil particles was confirmed as one of the most important factors of their mortality in soil [5].

Conclusions

At this point we can conclude that tested quartz sands in our research are not appropriate for controlling rice weevil adults in stored wheat, because all samples showed a negligible insecticidal effect. In the future we plan to test the efficacy of quartz sands against the larvae of stored-product lepidopteran pests, since the results of some previous researches indicated the potential activity of the sands against this developmental stage of insects.

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

Table 3. Mortality of rice weevil adults at 20, 25, 30 and 35°C, and at 55 and 75 % RH level after 14 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).

14 days		20°C		25°C		30°C		35°C	
Sam	Con	55%	75%	55%	75%	55%	75%	55%	75%
	100	2.28±2.43A	0.76±1.28A	0.00±0.00A	0.38±0.59A	0.00±0.00A	1.13±0.97A	1.13±1.09A	0.37±0.56B
	300	1.52±1.25A	0.38±0.59A	0.00±0.00A	1.13±0.79A	0.00±0.00A	2.99±0.94AB	3.38±1.14A	0.00±0.00A
1	500	3.80±1.20A	0.75±0.82A	0.00±0.00A	3.37±00.97A	0.00±0.00A	4.12±0.99AB	0.75±0.80A	0.00±0.00A
	900	3.42±1.37A	2.99±0.94B	0.76±0.57B	3.37±1.25A	1.11±.056B	5.25±1.81B	1.13±1.09A	0.00±0.00A
	1200	2.66±0.60A	3.33±1.11B	0.00±0.00A	1.50±0.94A	0.74±0.49AB	4.50±1.59AB	3.76±1.61A	1.12±0.81B
	1500	3.04±1.40A	3.81±1.33B	0.00±0.00A	0.75±1.27A	0.00±0.00A	3.75±0.82AB	3.38±1.14A	0.00±0.00A
	100	0.00±0.00A	0.74±0.49A	0.00±0.00A	0.00±0.79A	0.74±0.49A	2.99±0.94A	0.38±0.59A	0.00±0.00A
	300	1.90±0.99B	0.76±0.60A	0.00±0.00A	1.87±1.18A	3.33±1.11B	5.24±1.31A	1.88±097AB	1.12±0.82B
2	500	2.66±1.16B	1.85±0.58A	0.00±0.00A	1.13±1.12A	0.37±0.37A	5.24±1.63A	3.38±1.50AB	0.37±0.56B
	900	1.14±1.06B	0.75±1.27A	0.76±1.28B	0.75±0.82A	0.74±0.49A	4.87±1.57A	4.89±1.43B	1.12±0.81B
	1200	1.90±0.81B	1.87±0.88A	1.14±0.89B	2.25±1.25A	0.00±0.00A	5.62±1.59A	3.01±1.388AB	0.37±0.56B
	1500	0.76±1.40B	3.37±0.97B	0.00±0.00A	1.13±0.79A	0.74±0.49A	6.37±1.93A	4.51±1.76B	0.37±0.79B
	100	0.00±0.00A	0.76±0.57A	0.00±0.00A	2.25±1.86A	1.85±0.58A	7.12±3.03AB	2.96±1.58A	1.12±0.59A
	300	2.28±0.60B	1.13±0.97A	2.28±0.60B	0.00±0.56A	4.81±0.59B	10.11±3.02B	3.88±1.42A	4.10±0.59B
3	500	3.81±0.89B	2.25±1.86B	3.81±0.89B	1.87±1.18A	6.27±0.87B	6.37±1.84AB	3.55±1.33A	5.59±0.87B
	900	5.33±1.61B	1.87±1.18A	5.33±0.89B	1.87±0.67A	7.78±1.57B	4.50±1.37A	1.83±0.51A	7.09±1.58B
	1200	3.80±1.33B	0.74±0.49A	3.81±1.33B	1.87±0.88A	6.30±1.30B	3.37±0.97A	3.55±1.21A	5.60±1.31B
	1500	3.42±0.95B	1.87±1.18A	3.42±0.95B	1.50±0.94A	5.92±0.93B	5.62±1.12AB	1.25±0.31A	5.22±0.93B
	100	0.00±0.00A	0.38±0.57A	0.00±0.00A	2.62±1.42A	2.22±1.47A	0.37±0.49A	0.75±0.56A	0.00±0.00A
	300	0.00±0.00A	0.75±0.50A	0.00±0.00A	0.75±0.82A	1.11±0.56A	1.48±0.59B	1.13±0.75A	1.49±0.79B
4	500	2.66±1.29A	0.38±0.82A	0.00±0.00A	1.13±0.79A	0.74±0.74A	1.85±0.96B	1.13±0.94A	0.74±0.59B
	900	0.38±0.89A	2.62±1.42B	0.00±0.00A	2.62±0.88A	0.74±0.49A	1.49±0.81B	1.50±0.88A	0.00±0.00A
	1200	1.90±0.57A	2.62±0.88B	0.00±0.00A	2.62±1.18A	0.74±0.49A	1.86±0.79B	1.50±0.88A	0.00±0.00A
	1500	2.28±1.01A	0.75±0.82A	0.00±0.00A	1.87±1.18A	0.00±0.00A	2.60±2.04B	3.76±1.96A	0.00±0.00A
	100	0.76±0.99AB	0.74±0.49A	0.00±0.00A	0.84±0.33A	0.38±0.82B	4.64±2.03AB	2.92±1.08A	0.00±0.00A
	300	0.00±0.95A	1.59±0.93A	0.00±0.00A	1.59±0.93A	0.00±0.00A	2.38±0.95A	1.38±0.95A	0.00±0.00A
5	500	1.90±0.99AB	1.46±0.28B	0.00±0.00A	2.59±0.72A	0.00±0.00A	9.02±1.90B	4.09±1.11A	0.75±0.80A
	900	3.04±1.51AB	0.74±0.74A	0.75±0.80B	1.21±0.59A	0.00±0.00A	4.84±1.30AB	1.63±0.54A	0.00±0.00A
	1200	3.80±1.20B	0.74±0.49A	1.50±0.68B	1.46±0.28A	0.00±0.00A	3.34±1.38A	1.42±0.57A	1.13±1.10A
	1500	2.66±1.16AB	1.9±0.50B	0.00±0.00A	1.25±0.31A	0.00±0.00A	3.93±1.32A	3.30±1.47A	0.00±0.00A

Table 4. Mortality of rice weevil adults at 20, 25, 30 and 35°C, and at 55 and 75 % RH level after 21 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).

21 days		20°C		25°C		30°C		35°C	
Sam	Con	55%	75%	55%	75%	55%	75%	55%	75%
	100	3.90±2.55AB	0.76±0.74A	0.00±0.00A	2.27±1.10A	0.74±0.49AB	0.76±0.74A	2.67±1.28AB	0.74±0.81A
	300	2.34±2.06A	0.74±0.49A	0.00±0.00A	3.40±1.28A	2.22±1.11B	3.40±1.40AB	3.43±0.89AB	0.74±1.13A
1	500	3.51±1.56AB	1.89±1.19A	0.38±0.38A	5.66±1.58A	0.00±0.00A	3.77±0.98AB	-0.38±0.95A	1.12±0.81A
	900	5.06±1.48AB	3.77±1.38B	0.00±0.00A	3.77±1.38A	1.11±0.56AB	6.41±1.97B	1.53±1.28AB	0.74±0.59A
	1200	4.67±0.97AB	4.81±0.98B	4.21±1.26B	3.77±0.80A	1.11±0.56AB	5.28±1.54B	3.05±1.69AB	4.85±1.58B
	1500	8.95±1.94B	4.15±1.36B	3.83±1.76B	3.40±1.28A	0.74±0.49AB	5.28±0.88B	4.58±1.79B	1.49±0.56A
	100	0.00±1.03A	0.77±0.52A	0.00±0.99AB	0.76±1.09A	2.22±1.11A	5.29±1.83A	1.02±0.88A	-0.75±0.00A
	300	1.95±1.01AB	1.11±0.56A	0.00±0.00A	1.14±1.05A	4.81±1.13B	6.42±1.28A	2.91±0.60AB	2.61±0.79A
2	500	5.06±1.23B	1.87±1.18A	0.00±0.00A	1.51±1.26A	1.48±1.13A	6.79±1.51A	4.8±1.96AB	2.61±1.12A
	900	5.06±1.48B	1.25±0.31B	0.38±1.06B	1.14±1.19A	0.74±0.49A	7.92±1.64A	5.93±1.70AB	2.24±0.67A
	1200	10.51±2.11C	1.90±0.50B	0.00±0.81AB	1.89±1.19A	2.22±1.11A	7.17±1.13A	4.80±1.38AB	2.24±1.04B
	1500	1.95±1.30AB	4.64±2.03C	0.38±0.69B	1.89±0.68A	0.37±0.37A	9.06±2.32A	7.07±2.47B	2.98±0.67A
	100	0.00±1.18A	0.84±0.33A	1.53±1.16A	2.27±2.02B	4.81±1.13A	6.79±3.05AB	1.14±3.05A	4.10±1.13A
	300	1.56±0.70A	1.14±0.60A	3.07±0.69A	0.38±0.80A	6.29±0.67A	11.70±2.53B	3.05±1.88A	5.60±0.67A
3	500	6.23±1.82B	2.28±0.38B	7.66±1.79B	2.64±0.98B	10.74±1.74B	7.17±1.50AB	4.19±1.76A	10.07±1.75B
	900	11.68±2.00C	2.60±2.04B	13.03±1.97C	2.26±0.94B	15.93±1.91C	4.15±1.36A	2.29±1.16A	15.30±1.92C
	1200	6.61±1.43B	1.78±1.57A	8.04v1.41B	1.51±0.80A	11.11±1.36B	5.53±1.19A	3.82±1.51A	10.45±1.37B
	1500	6.23±1.82B	2.48±0.56B	7.66±1.79B	2.27±0.75B	10.74±1.74B	6.42±1.40AB	0.76±0.89A	10.07±1.75B
	100	2.73±1.13AB	1.50±0.94A	0.00±0.00A	3.02±1.51A	3.33±1.36A	3.33±1..36BC	0.38±0.99A	1.49±0.79BC
	300	1.56±1.36A	1.86±0.79A	0.00±0.00A	0.38±0.80A	4.81±0.98A	4.81±0.98BC	1.53±0.99A	1.86±0.49C
4	500	4.67±0.97ABC	1.21±0.59A	0.77±1.12B	0.76±0.94A	2.59±0.93A	2.59±0.93AB	1.91±1.01A	1.49±0.56BC
	900	5.06±1.36ABC	4.54±1.15B	6.13±1.70C	4.15±0.94A	1.48±0.58A	1.48±0.58A	1.91±0.83A	0.00±0.00A
	1200	8.17±1.40C	2.99±0.94B	1.53±1.01B	3.02±0.99A	7.04±1.41A	7.04±1.41C	2.29±1.41A	1.12±0.59BC
	1500	5.84±1.23BC	1.46±0.28A	2.68±1.12B	3.78±2.12A	2.22±1.11A	2.22±1.12AB	6.49±2.20B	0.00±0.00A
	100	2.51±1.07A	0.75±0.60A	0.00±0.00A	2.96±0.95A	2.26±1.04A	5.81±2.30A	4.63±1.59A	0.00±0.00A
	300	2.25±0.88A	1.85±0.96A	0.00±0.00A	2.76±1.00A	2.26±1.19A	4.30±1.03A	2.55±1.31A	1.13±0.75B
5	500	3.00±0.97AB	2.28±0.60A	0.00±0.00A	3.34±0.79A	1.88±1.13A	9.40±1.93A	5.05±1.08A	2.26±0.88B
	900	4.89±1.31AB	1.13±0.79A	0.75±0.80B	3.93±1.06A	3.76±0.82A	7.31±1.60A	3.17±0.89A	1.13±0.75AB
	1200	6.01±1.09B	1.50±0.68A	1.50±0.68B	3.55±0.90A	0.38±0.59A	4.84±1.42A	4.88±0.88A	1.50±0.68AB
	1500	4.51±1.09AB	3.34±1.38B	0.00±0.00A	4.30±1.30A	0.75±1.49A	6.01±1.47A	11.28±2.57B	0.38±0.59AB

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