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Malaria Research Lead Programme

**Syngenta**

**Field Evaluation Of Residual Activity Of Icon 10 CS**  
**(25mg/m<sup>2</sup>) For The Control Of Malaria Vectors**  
**(February 2007-November 2007)**

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**Medical Research Council**

The work described in this report is being carried out in the Durban laboratories of the Malaria Research Programme of the Medical Research Council and was commissioned for Syngenta.

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## Introduction

Indoor residual spraying has been the most widely used method of controlling malaria by the application of long lasting insecticides on the interior walls of homes in a malaria endemic area. This practice targets the endophilic vector and reduces the number of mosquitoes entering the sprayed areas, thus minimizing the risk of malaria transmission.

Although DDT has proven to have the longest residual efficacy ranging between six to twelve months (WHO,2007), there is a constant need to find alternative insecticides which are cost effective and have the ability to maintain residual efficacy for the entire malaria transmission season and therefore only require a minimum of two spray rounds per year.

During the phase one laboratory trials conducted on four different substrates, Icon 10 CS had maintained its residual efficacy for a period of twelve months (Maharaj et al, 2005). The substrates used were representative of those found in structures in the field, i.e. mud daub, cement, painted cement plaster, and reeds.

The aim of this study was to assess the long term efficacy of Icon 10 CS when applied to houses of different construction types for control of *Anopheles arabiensis*, the primary malaria vector in southern Africa.

*An. arabiensis* is a primary vector of malaria in numerous parts of Africa (White, 1974) and is the predominant malaria vector species in South Africa (Sharp and le Sueur, 1991), making it an obvious choice as test species.

## **Materials**

### **House selection**

Suitable houses from the Swaziland area was used in the study. Only houses that were previously unsprayed and represented typical construction types in the area had been applicable for this trial. A selection of forty houses comprising of ten houses each of mud daub, cement, reed and painted cement plaster were chosen.

### **Test mosquitoes**

Blood fed adult female *Anopheles arabiensis* KGB (Kanyemba Gambiae spB, Zimbabwe) from the colony maintained at the Malaria Research Lead Programme was used in the bioassays.

The houses representing each of the four substrates had undergone bioassays at monthly intervals. All structures including daub, reed, cement and PVA was sprayed with Icon 10 CS to give coverage of 25mg active ingredient/m<sup>2</sup>

## **Methods**

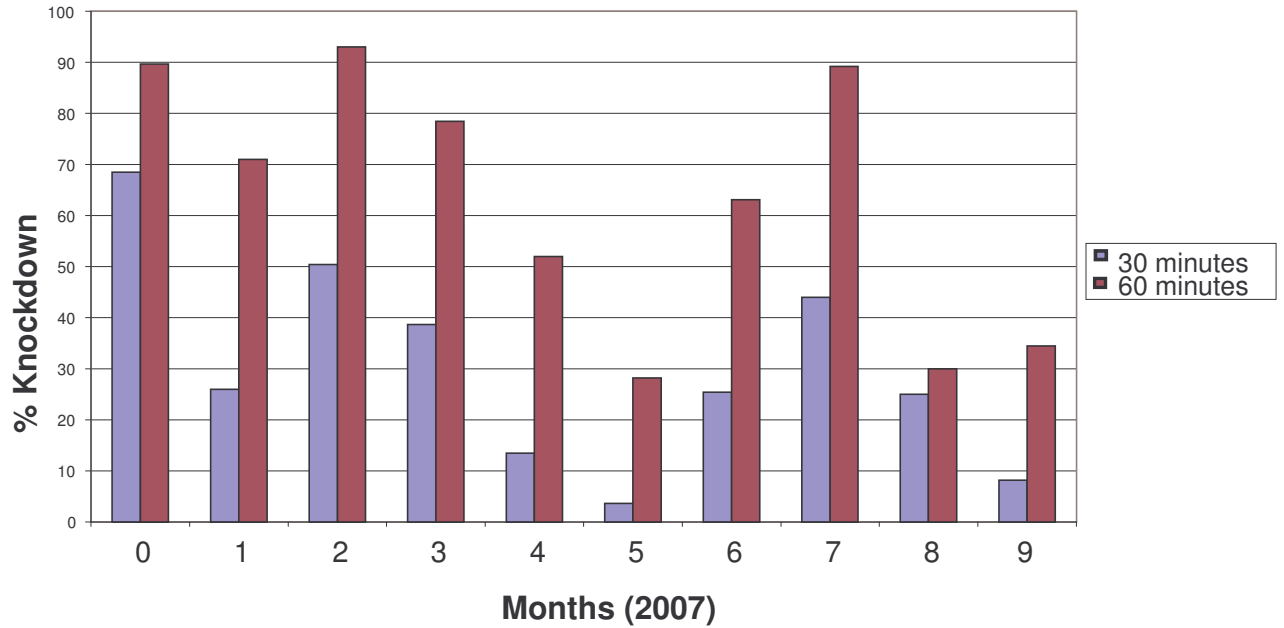
### **Bio-Assays**

Bio-assays were carried out every month in each of the structures using 30 *Anopheles arabiensis* mosquitoes per assay. The mosquitoes used had been approximately 4 day old blood-fed females. The standard WHO bio-assay test procedure was adhered to as outlined in the WHO manual of practical entomology (WHO, 1975). Cones had been fixed to the inner wall surfaces of each house. Negative control trials had been conducted in each non-sprayed structure.

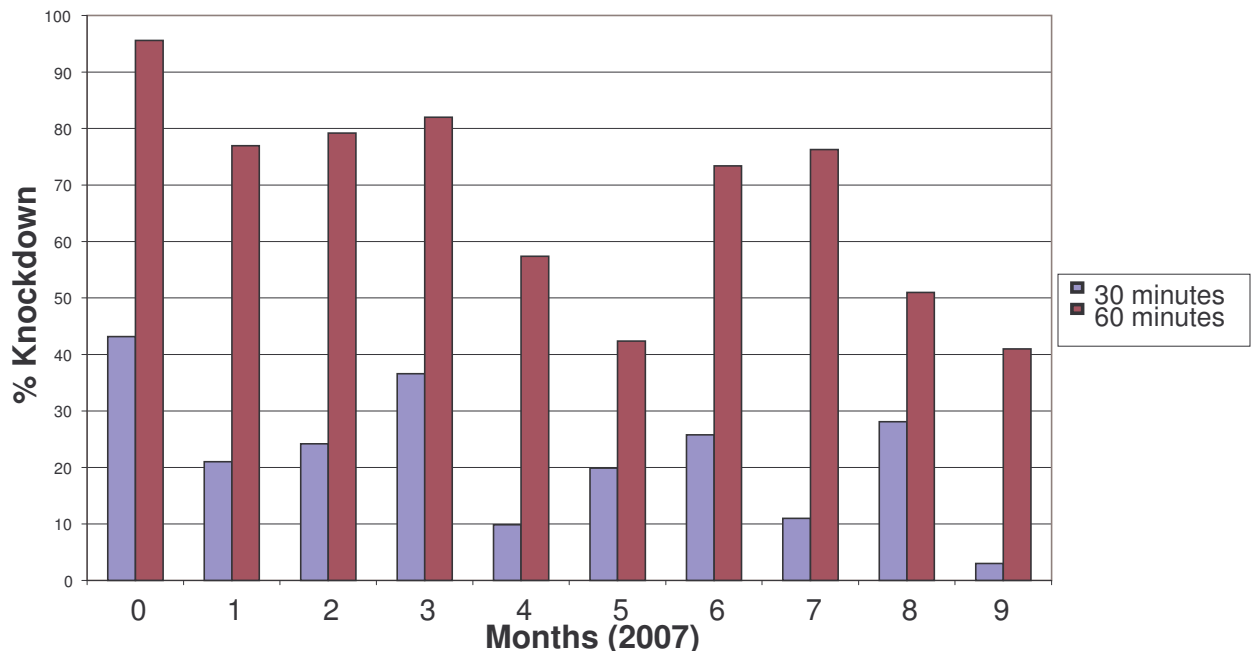
### **Data Analysis**

Mortality data obtained during the ten month trial had been statistically analyzed by comparison between substrate and post-spraying time using Generalized Estimating Equations (GEE). The mean and standard deviation were calculated using STATA software.

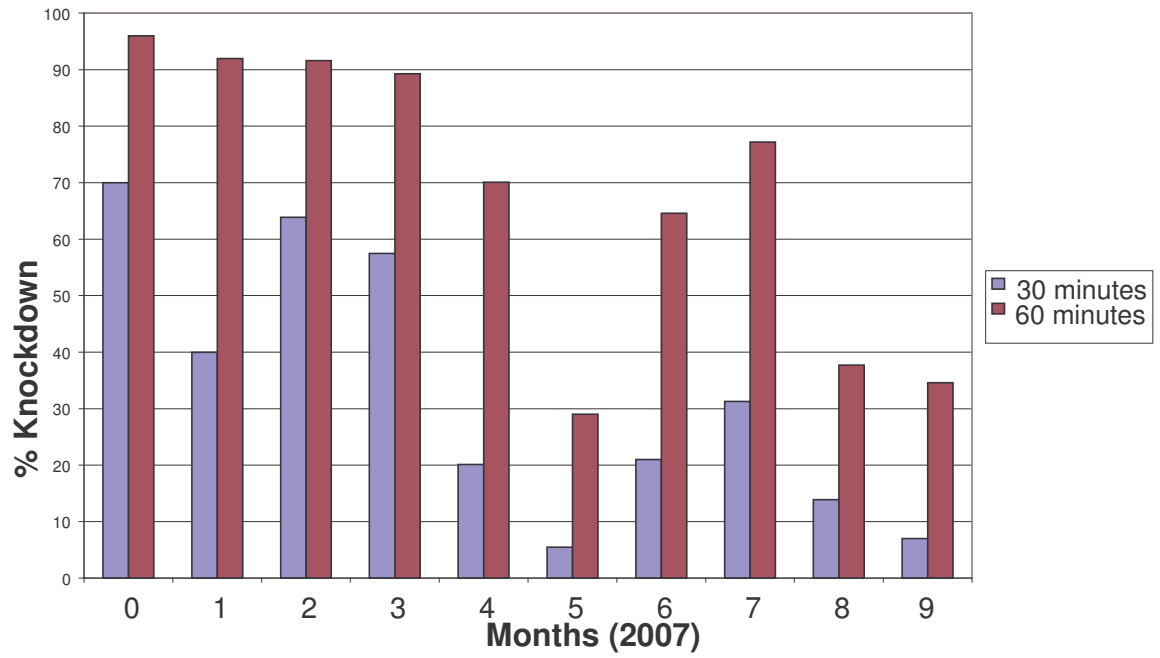
## Results



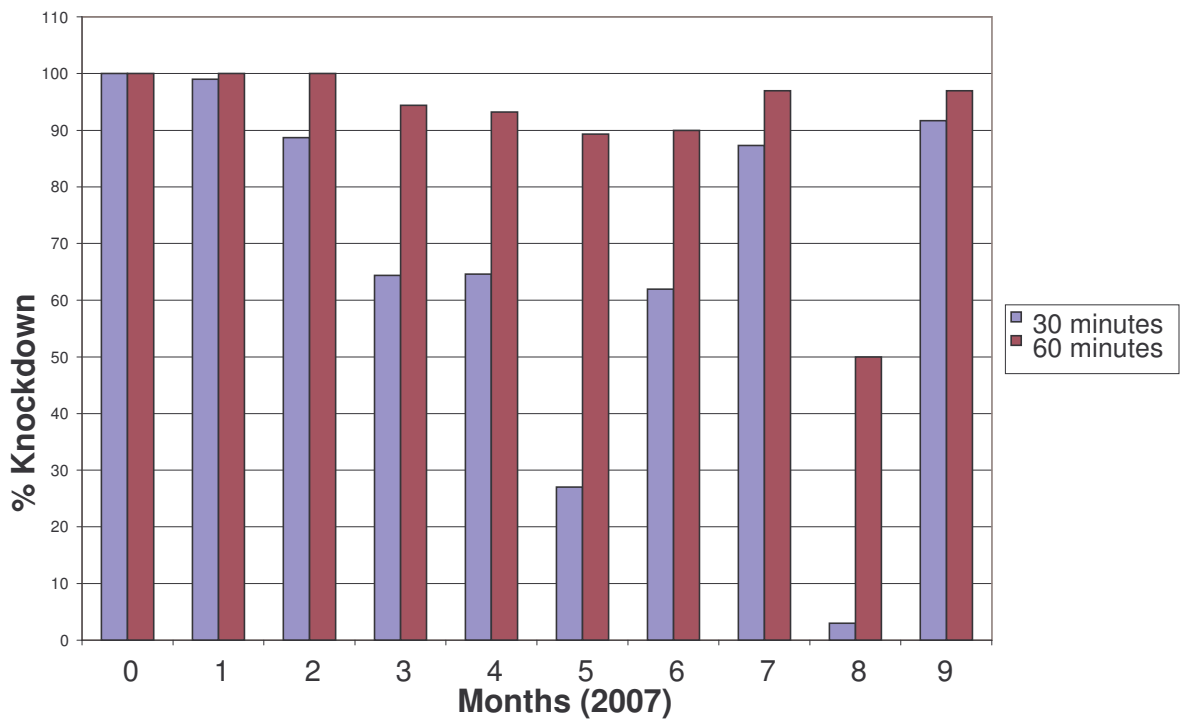
**Figure one:** Knockdown rates for bioassays conducted on painted cement



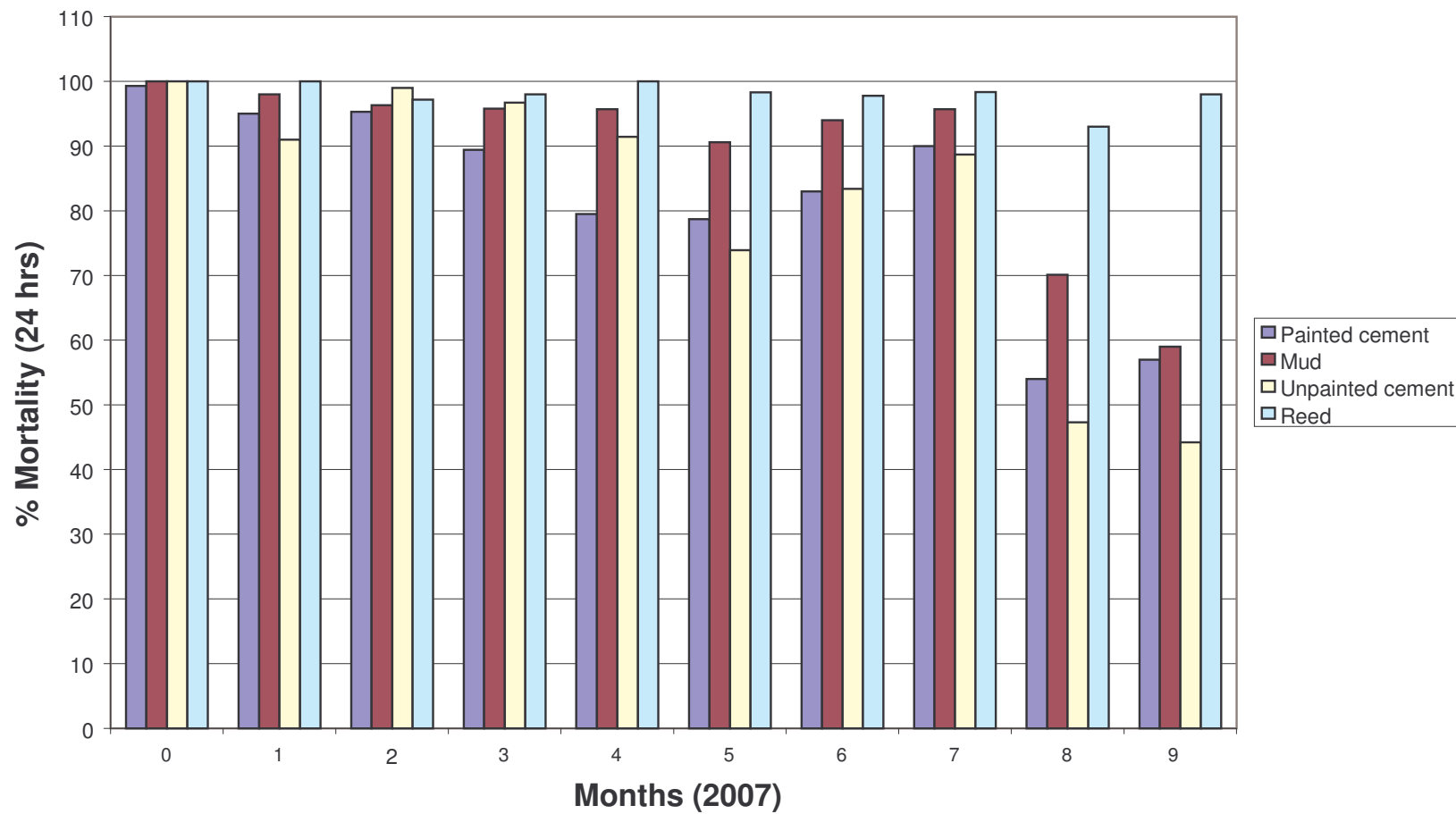
**Figure Two:** Knockdown rates for bioassays conducted on mud surface



**Figure Three:** Knockdown rates for bioassays conducted on unpainted cement



**Figure Four:** Knockdown rates for bioassays conducted on reed



**Figure five:** Mortality rates after 24 hours on the four substrates

**Table one:** Statistical analysis indicating mean and standard deviation results of substrates over time

Month	Substrate							
	Painted Cement		Mud		Unpainted Cement		Reed	
	Mean	± SD	Mean	± SD	Mean	± SD	Mean	± SD
0	99.29	2.26	100.00	0.00	100.00	0.00	100.00	0.00
1	95.28	6.88	98.13	4.86	91.33	25.10	100.00	0.00
2	95.39	10.05	96.49	6.28	99.09	2.87	97.22	4.43
3	88.70	18.84	95.71	5.87	96.67	5.88	97.78	2.72
4	79.76	23.13	95.67	5.68	91.46	9.86	100.00	0.00
5	78.69	18.76	82.50	20.91	74.05	17.25	98.39	3.95
6	83.68	20.93	93.61	5.67	83.33	11.90	98.00	4.47
7	95.33	7.89	95.56	6.24	90.36	21.82	99.33	1.49
8	95.33	7.89	95.56	6.24	90.36	21.82	99.33	1.49
9	57.36	35.81	58.89	27.64	44.39	34.40	97.55	3.10
<b>Total</b>	87.08	20.64	91.45	16.01	86.56	23.20	98.73	2.79

**SD:** standard deviation      **Mean:** Average mortality (24hrs)

**Table two:** p values for mortality results

	<b>IRR</b>			
	<b>PVA</b>	<b>MUD</b>	<b>UNPAINTED CEMENT</b>	<b>REED</b>
<b>PVA</b>	X	0.954 (p<0.05)	1.004 (p>0.05)	0.883 (p<0.05)
<b>MUD</b>	1.048 (p<0.05)	X	1.053 (p<0.05)	0.926 (p<0.05)
<b>UNPAINTED CEMENT</b>	0.996 (p>0.05)	0.950 (p<0.05)	X	0.880 (p<0.05)
<b>REED</b>	1.132 (p<0.05)	1.080 (p<0.05)	1.137 (p<0.05)	X

**IRR:** Incidence rate ratio

## **Discussion**

Efficacy testing of Icon 10 CS had been conducted in the field for a period of ten months (February 2007 to November 2007) using laboratory strain susceptible mosquitoes (Annexure A).

To ensure that the trial has been performed under controlled conditions a negative control assay had been included. Since the results were calculated relative to the negative control, Abbott's formula was used if control mortality exceeded 5%.

The control mortality observed may have been due to injury caused by transferring mosquitoes between the substrate cones and the holding cage.

Referring to figure four, knockdown values for the substrate reed has shown consistent results for a period of seven months with a decrease observed in the ninth month. For the remaining three substrates, high knockdown rates had been produced for the first four months post spraying, and subsequently have exhibited a loss in activity and variation in results during the following months.

Figure five indicates the mortality rate after 24 hours of conducting the bioassays. The substrate, PVA has displayed high mortality for the first five months of trials however inconsistent results were achieved in the following months and finally a steep decline in activity was observed after eight months.

Trials conducted on Mud (Figure five) shows consistency in results for eight months of Icon 10 CS efficacy testing on Mud; however a decrease in mortality has been observed after eight months.

Trials conducted on Unpainted cement (Figure five) has shown mortality ranging between ninety to one hundred percent for the first five months post spraying and thereafter a loss in activity was observed by the inconsistent results produced.

Reed (Figure five) has continued to maintain a high mortality ranging between ninety to one hundred percent for a period of nine months.

Trials have been terminated after the 9<sup>th</sup> month of testing due the drastic decrease in activity in three substrates, with the lowest mortality observed with unpainted cement reaching 44.2% mortality after 24 hours of testing (Figure five).

Table one indicates the effect of Icon 10 CS on all four substrates measured as percentage mortality per month during the ten month field trial.

Referring to Table two, statistical analysis of each substrate has indicated that painted cement compared to unpainted cement had a greater p value ( $p > 0.05$ ) indicating less significance. Thus for the remaining surfaces Icon has significantly different residual efficacies.

Limitations to the trial had been the decrease in the number of structures tested each month. This is due to factors such as houses being demolished, walls washed or re-sprayed.

## **Conclusion**

Icon 10 CS has shown high activity in the Reed and Mud substrates for a period of eight months however a decline in activity has been observed with the latter.

Long term activity testing conducted on painted and unpainted cement has shown that the product had indicated high mortality for a period of five months and had thereafter experienced a loss in activity much earlier compared to the other two substrates.

Comparing the results of both laboratory (Maharaj et al, 2005) and field trials conducted, it is apparent that environmental and other factors lead to degradation of the insecticide and consequently a loss in residual activity.

**References:**

Maharaj R, Gayaram R, Sharp B. (2005) Laboratory evaluation of residual activity of Icon 10 CS (25mg/m<sup>2</sup>) applied on various surfaces for the control of malaria vectors. South African Medical Research Council, Durban, South Africa.

Sharp, B L and Le Seur D 1991. Behavioral variation of *Anopheles arabiensis* populations in Natal, South Africa. *Bulletin of Entomological Research*. 81:107

White, G B 1974. *Anopheles gambiae* complex and disease transmission in Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 68:278

World Health Organization (1975) Manual on practical entomology. WHO, Geneva

World Health Organization (2007) The Use of DDT in Malaria Vector Control. WHO/HTM/GMP/2007,

<http://www.who.int/malaria/ddtandmalariavectorcontrol.htm>

**Annexure A: Results of trials conducted over the 10 month period**

Month	Substrate	% Knockdown		% Mortality
		30 minutes	60 minutes	24 hrs
0	Painted cement	68.5	89.7	99.3
0	Mud	43.2	95.6	100
0	Unpainted cement	70.03	96	100
0	Reed	100	100	100
1	Painted cement	26	71	95
1	Mud	21	77	98
1	Unpainted Cement	40	92	91
1	Reed	99	100	100
2	Painted cement	50.4	93	95.3
2	Mud	24.2	79.2	96.3
2	Unpainted Cement	63.9	91.6	99
2	Reed	88.7	100	97.2
3	Painted cement	38.7	78.5	89.4
3	Mud	36.6	82	95.8
3	Unpainted Cement	57.5	89.3	96.7
3	Reed	64.4	94.4	98
4	Painted cement	13.5	52	79.5
4	Mud	9.9	57.4	95.7
4	Unpainted Cement	20.1	70.1	91.4
4	Reed	64.6	93.2	100
5	Painted cement	3.65	28.2	78.7
5	Mud	19.9	42.4	90.6
5	Unpainted cement	5.5	29	73.9
5	Reed	27	89.3	98.3
6	Painted cement	25.4	63.1	83
6	Mud	25.8	73.4	94
6	Unpainted cement	21	64.6	83.4
6	Reed	62	90	97.78
7	Painted cement	44	89.2	90
7	Mud	11	76.3	95.7
7	Unpainted cement	31.3	77.2	88.7
7	Reed	87.3	97	98.33
8	Painted cement	25	30	54
8	Mud	28.1	51	70.1
8	Unpainted cement	13.9	37.7	47.3
8	Reed	3	50	93
9	Painted cement	8.2	34.5	57
9	Mud	3	41	59
9	Unpainted cement	7	34.6	44.2
9	Reed	91.7	97	98