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Drying and storage of seeds

General remarks;

When we speak about the moisture levels of seeds it's important to know what is meant by this therefore first of all some facts regarding moisture levels.

We try to explain this with the following examples;

1 A wet grain of sand

2 A wet piece of polystyrene

3 A wet grain seed

1. A wet grain of sand is only wet at the outside of the grain, in this case we are dealing with free water (the possibility of having Cristal water we leave out of this example).
2. Polystyrene is a porous material polystyrene on itself does not get wet the little canals act like capillary and pull the moisture into the piece of polystyrene.
3. A wet grain seed is not only wet at the outside but also in the seed itself. Inside the moisture is no longer free water but is contained inside the seed in a very special way. The water is bounded to a diversity of compounds in the seed. This can be a physical binding or a chemical binding. Both exist in a seed side by side. Removing this kind of bonded water from a seed is difficult and requires a lot of time and surprisingly it is not possible to remove all the water from the seed. There always stay's a little bit bonded water behind although in very low amounts!

In situation 1 and 2 all the water is relatively easy removed but with 3 there is always a bit left after drying.

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Equilibrium moisture content

Dried seeds are subject to equilibrium moisture content. This means that in time the seeds return to an equilibrium with the surrounding air you can predict very accurately the moisture level of seeds when you know the percentage RH (Relative Humidity) of the surrounding air.

This is different for different species in example an onion seed lot at a RH of 55% eventually will have a moisture level of 10,2% absolute but a grass seed lot under the same conditions will eventually have an absolute moisture level of 11,2!

This is called the equilibrium moisture content which is an important part of post drying behaviour of seeds after coating. Starting with a seed lot of onion dried to a moisture level of 6% absolute. The moisture level will go up as soon as the room where it is stored is not conditioned the moisture level can go up very fast. (Table 7 until 12)

In our research we found after 90 minutes already an increase of 1% absolute with an air RH of only 35%. (Table 1 until 6)

With a RH of 55% the take up speed is shockingly fast, in the onion seed sample after only 30 minutes the absolute moisture level went from 6,4 % absolute to a staggering 8,63% absolute!

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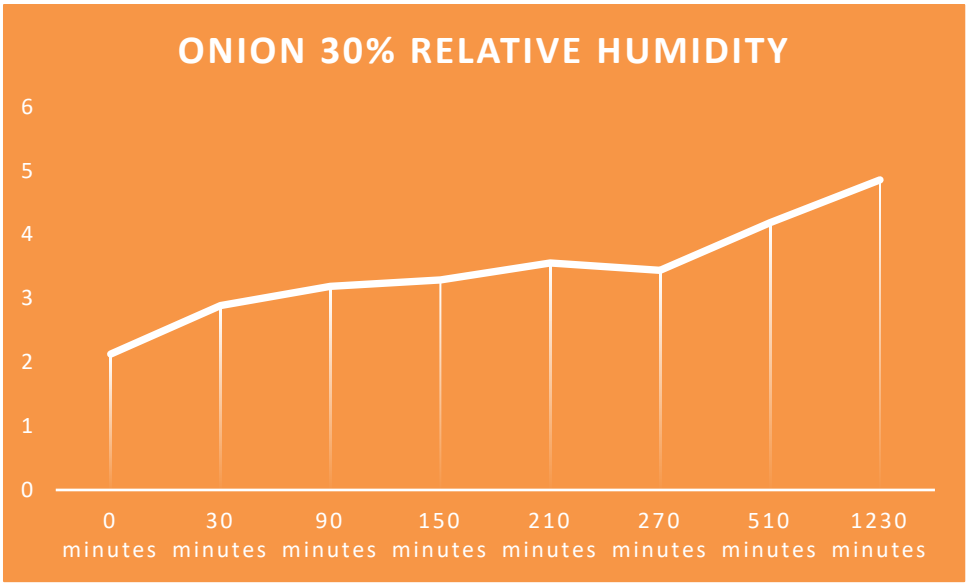

Table 1 Percentage absolute moisture level of the seed

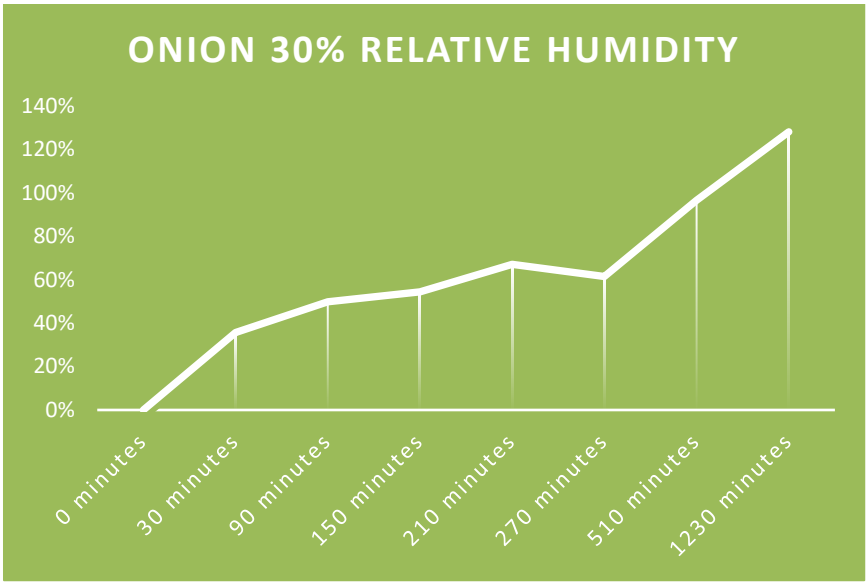

Table 2 Percentage Increase of absolute moisture level

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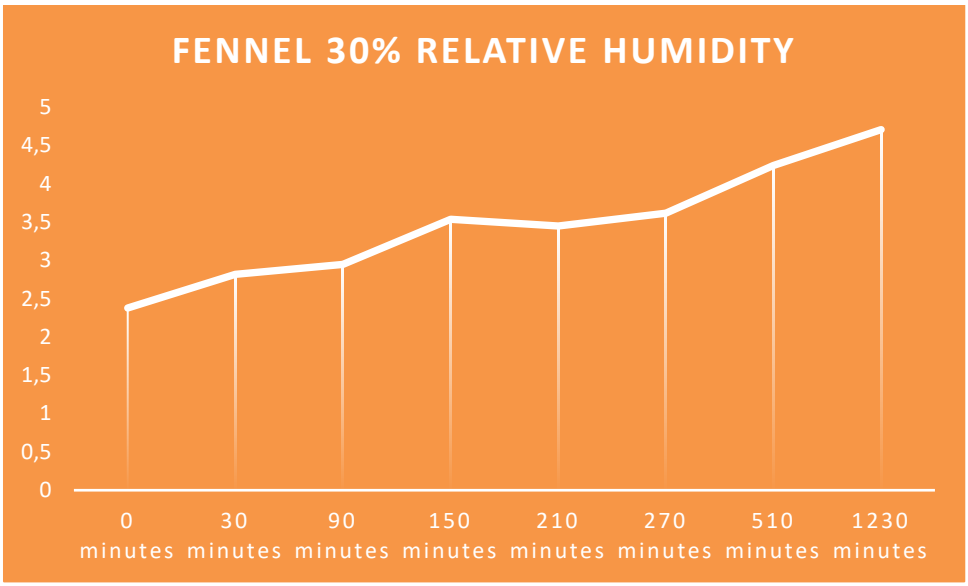

Table 3 Percentage absolute moisture level of the seed

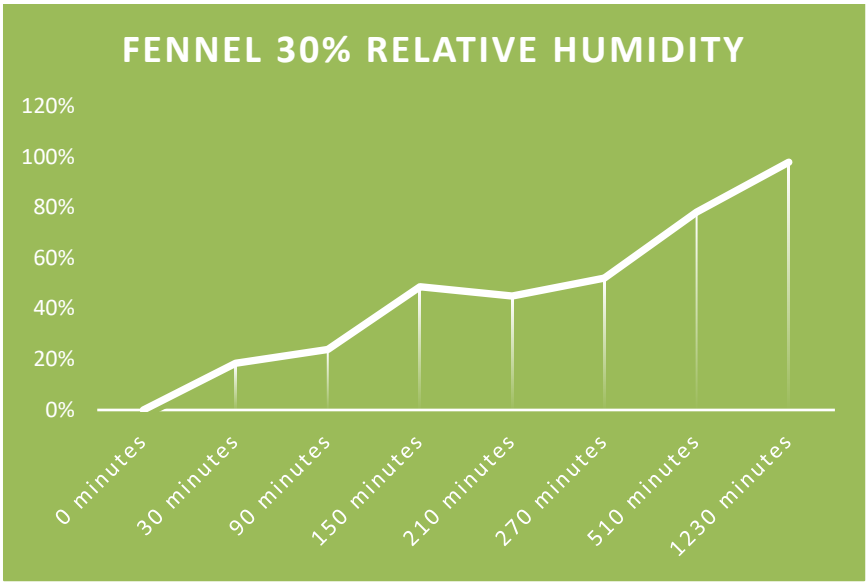

Table 4 Percentage Increase of absolute moisture level

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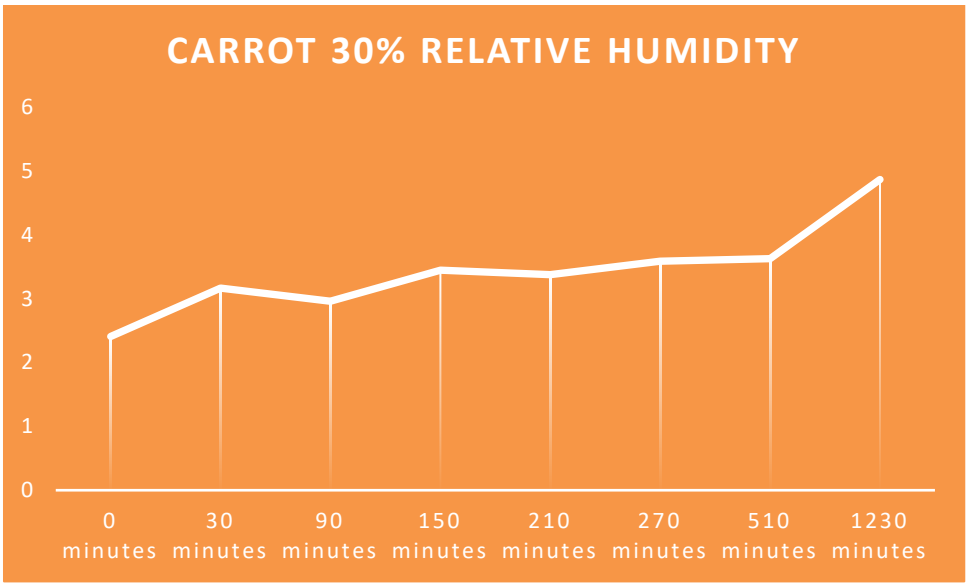

Table 5 Percentage absolute moisture level of the seed

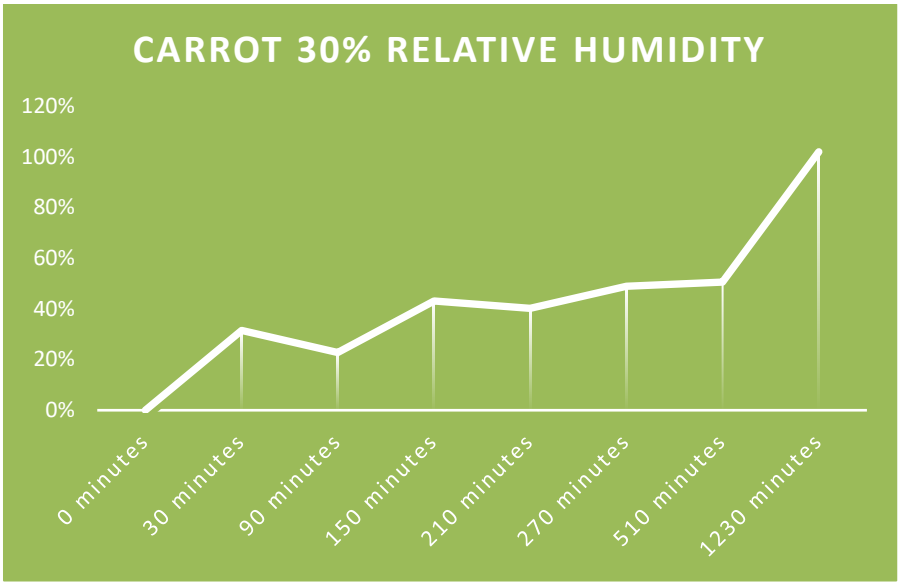

Table 6 Percentage Increase of absolute moisture level

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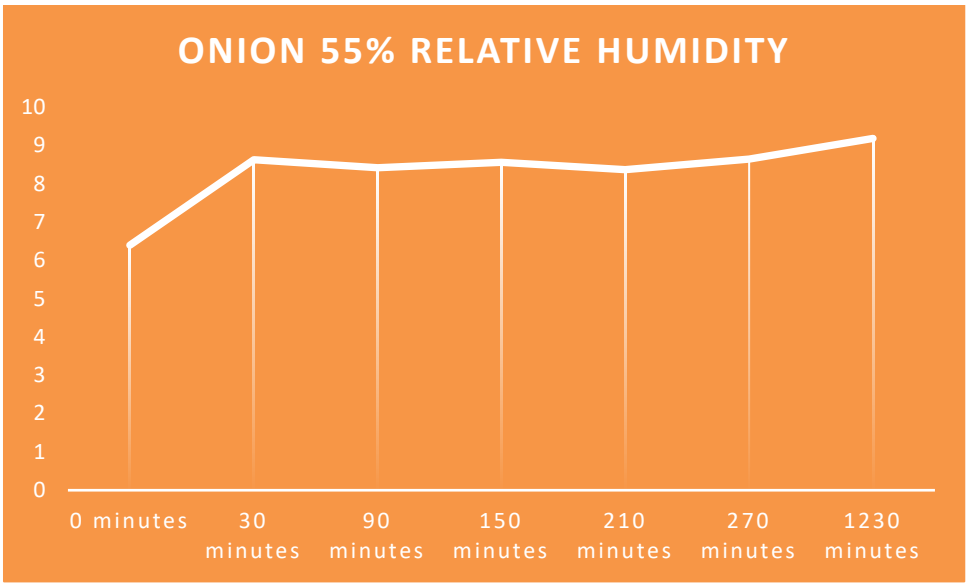

Table 7 Percentage absolute moisture level of the seed

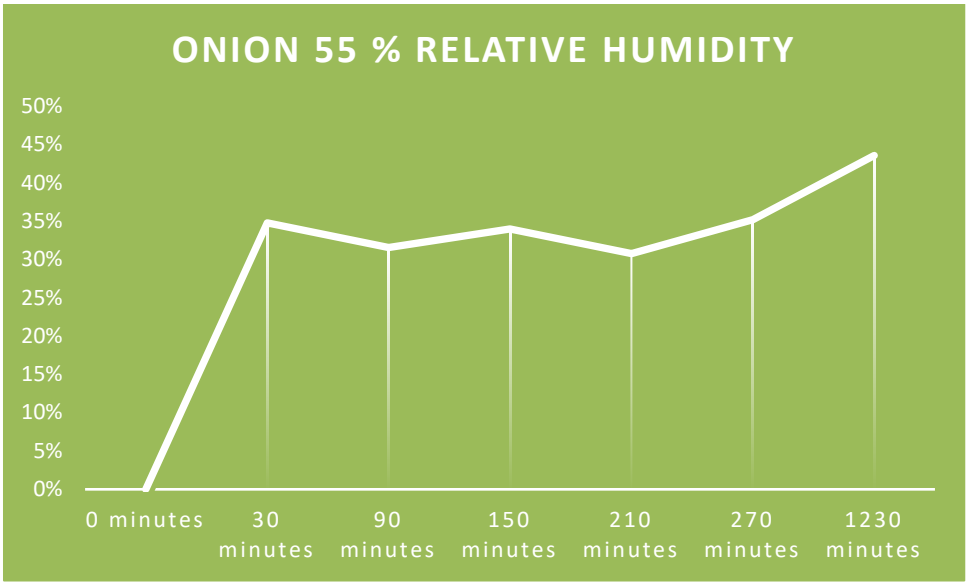

Table 8 Percentage Increase of absolute moisture level

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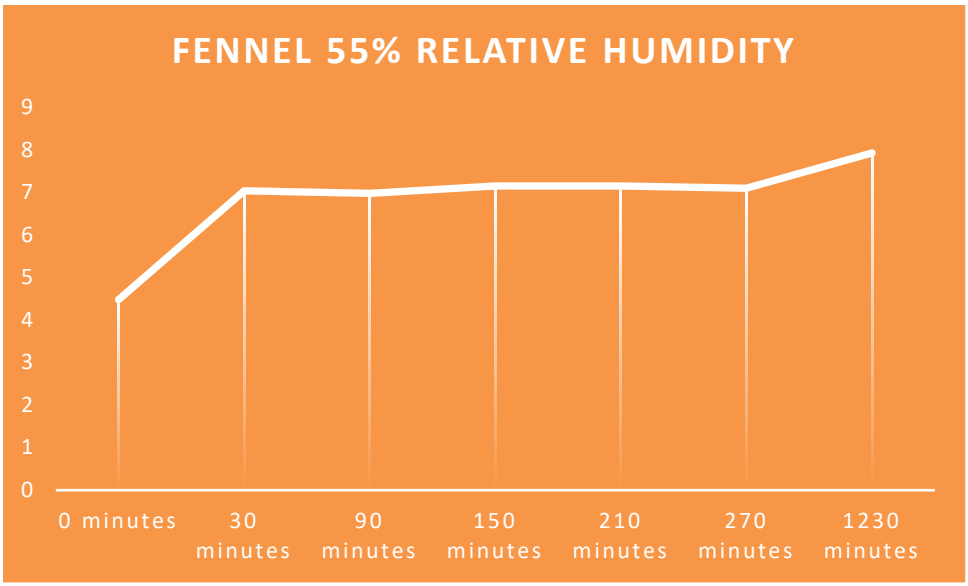

Table 9 Percentage absolute moisture level of the seed

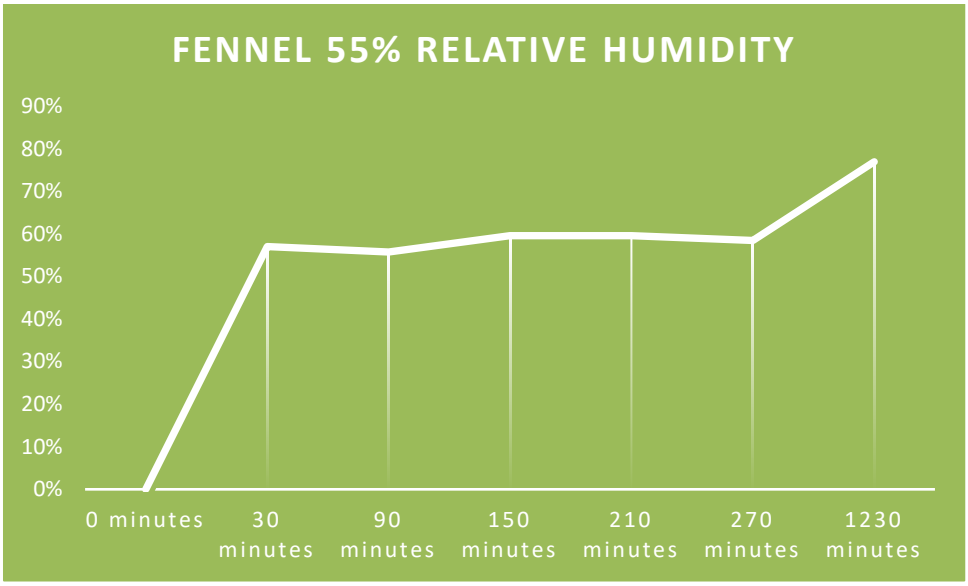

Table 10 Percentage Increase of absolute moisture level

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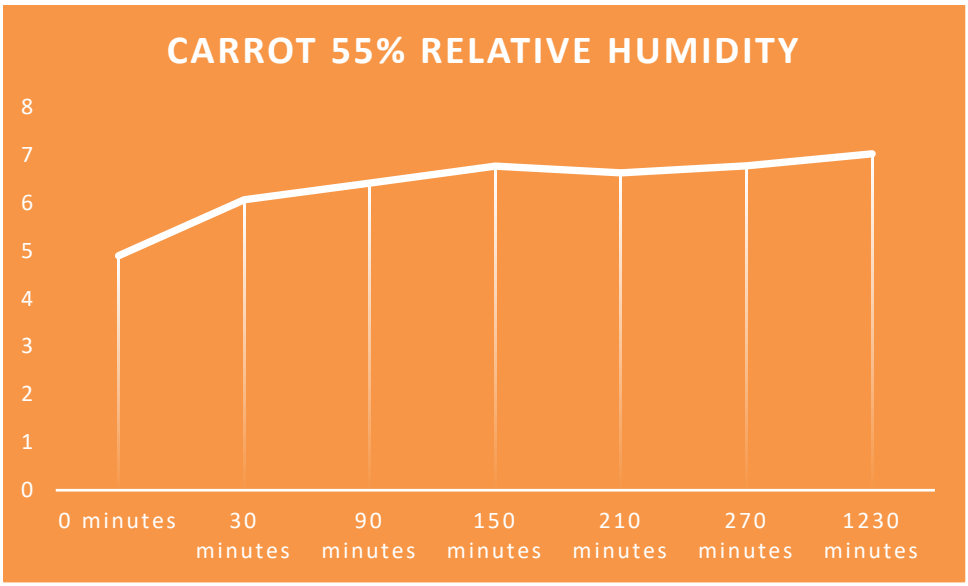

Table 11 Percentage absolute moisture level of the seed

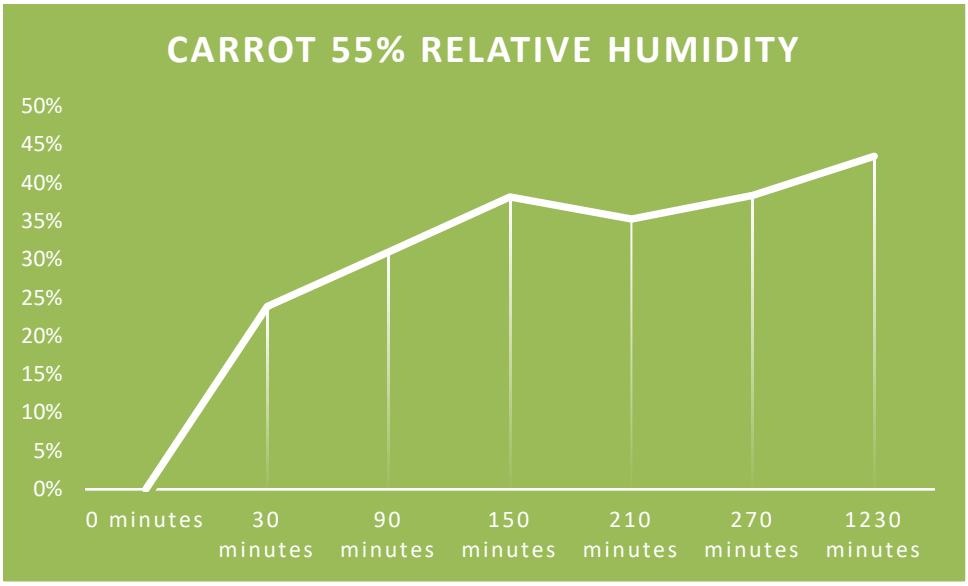

Table 12 Percentage Increase of absolute moisture level

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Over time (measuring with first intervals of one hour) we see clearly the behaviour of the different species; this was also found in the research of the Wageningen University.

This is very important to know when you are storing seeds at a relatively low humidity.

Clearly when you are processing the seeds it takes approximately an hour to get it done in that hour the seeds have absorbed already a lot of moisture. This means that whenever you are going to coat your seeds it is the best to do this right before shipment and use of the seeds.

Species	Percentage relative humidity					
	15	30	45	60	75	90
Barley (*Hordeum*)	6.0	8.4	10.0	12.1	14.4	19.5
Beet (*Beta*)		5.8	7.6	9.4	11.2	
Buckwheat (*Fagopyrum*)	6.7	9.1	10.8	12.7	15.0	19.1
Cabbage (*Brassica*)		5.4	6.4	7.6	9.6	
Carrot (*Daucus*)		6.8	7.9	9.2	11.6	
Cucumber (*Cucumis*)		5.6	7.1	8.4	10.1	
Egg plant (*Solanum*)		6.3	8.0	9.8	11.9	
Flax (*Linum*)	4.4	5.6	6.3	7.9	10.0	15.2
Groundnut (*Arachis*)	2.6	4.2	5.6		9.8	13.0
Lettuce (*Lactuca*)		5.1	5.9	7.1	9.6	
Lima bean (*Phaseolus*)		7.7	9.2	11.0	13.8	
Maize (*Zea*)	6.6	8.4	10.2	12.7	14.4	18.8
Mustard (*Brassica*)		4.6	6.3	7.8	9.4	
Oat (*Avena*)	5.7	8.0	9.6	11.8	13.8	18.5
Okra (*Abelmoschus*)		8.3	10.0	11.2	13.1	
Onion (*Allium*)		8.0	9.5	11.2	13.4	
Radish (*Raphanus*)		5.1	6.8	8.3	10.2	
Rice (*Oryza*)	5.6	7.9	9.8	11.8	14.0	17.6
Rye (*Secale*)	7.0	8.7	10.5	12.2	14.8	20.6
Sorghum (*Sorghum*)	6.4	8.6	10.5	12.0	15.2	18.8
Soyabean (*Glycine*)	4.3	6.5	7.4	9.3	13.1	18.8
Tomato (*Lycopersicon*)		6.3	7.8	9.2	11.1	
Turnip (*Brassica*)		5.1	6.3	7.4	9.0	
Watermelon (*Citrullus*)		5.1	6.3	7.4	9.0	
Wheat (*Triticum*)	6.5	8.5	10.4	12.1	14.6	19.8
Winter squash (*Cucurbita*)		5.6	7.4	9.0	10.8	

Table 13 Equilibrium moisture contents of some common crop seeds at 25°C1 (M, P, & R, 2007)

When you want to preserve the moisture level there is no other way to do this than to physically treat the seeds under the same conditions as were the seeds are kept for storage.

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In this way a short period of drying is enough to get the seed lot back to the starting point in relation with the absolute moisture.

If you dry your seeds back to the moisture level of storage after treating the seeds in an unconditioned space you will always **over dry** the coated seeds and therefore applying a relative high stress level to the seeds.

At Ad Terram we use for the day to day measurement of absolute moisture levels an infrared moisture analyser from Mettler Toledo.

We calibrate this machine with standard stove measurements in order to keep it accurate.

In the research of the WUR it's stated that after the stove methodology this infrared method is the closest to the stove method. Measuring RH with a stick is considered very inaccurate and not suitable for measuring moisture levels in seed lots only as an indicative method this should be used.

Ad Terram also sends out twice a year samples for a ring test so our customers can find out if their apparatus is still accurate.

We use seed samples which are on a moisture level using the equilibrium table so no changes take place after the samples are send out.

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Willingness to release moisture

Seeds from different species have different abilities to release the moisture from the seeds. The circumstances during drying also has an impact on the release of moisture from seeds and differ between species. The capacity of releasing moisture is depending on the way the water is stored in the seeds also there is a big difference between seed containing a relative low percentage of water and seeds containing a high level of water. In short, the higher the level the easier the seed releases the water in the dryer.

Different ways of drying gives different times to extract a specific amount of moisture from the seed. Seeds with a higher oil content or seeds with a higher starch level all need different time to release X % moisture.

TEAL has developed a new way of drying the treated seeds.

Instead using a fixed time with a fixed temperature and fixed RH we use the previous science and dry the treated seed lots as soon as possible after drying and use a potential difference of 5 degrees Celsius between the air used in the dryer and reduce the RH to a stable 25 % RH. The moment that ingoing and outgoing RH levels are the same for a determined period of time the dryer will release the seeds and will eliminate the factors which are specie specific.

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General relationship between willingness to release moisture and absolute moisture level.

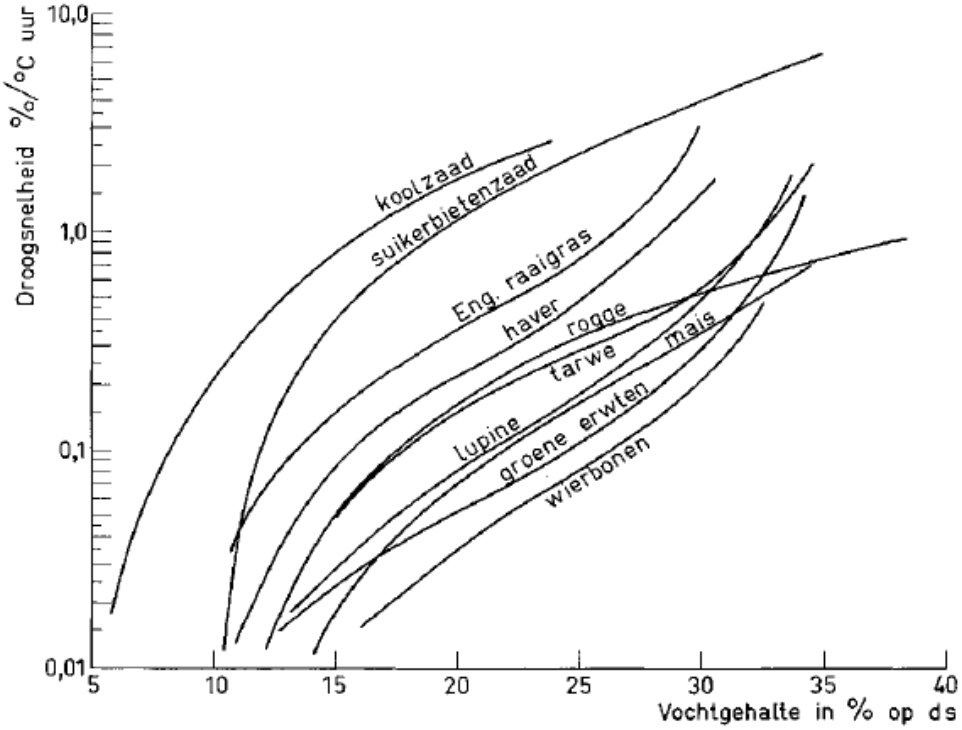

Figure 1 General relationship between willingness to release moisture and absolute moisture level (Sparenberg, 1964)

Diary Figure 1
Koolzaad = Oilrape seed
Suikerbietenzaad = Sugerbeet seed
Eng. Raaigras = English Ryegrass
Haver = Oat
Rogge = Rye
Tarwe = Wheat
Lupine = Lupine
Mais = Corn
Groene erwten = Green pea
Wierbonen = Beans

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