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# Fast field drying as a method to maintain quality, increase shelf life and prevent post harvest infections on *Cucumis sativum* L.

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**Abstract**

A new drying technique consisting of adding a defined quantity of "drying beads" to seeds was developed recently. The objective of this experiment was to study the effects of this new drying technique on harvested cucumber seeds. The beads did reduce the air humidity in an extremely fast and very efficient way and as a result of this we did observe extreme fast drying curves. The seed moisture content dropped from 14% to 5% in less than one hour and a significant positive effect was seen on the seed quality; the germination increased significantly while the mean germination time was significantly reduced. After this, the beads and seeds were separated and the beads were re-dried for re-use.

**Keywords:** Drying, Seed, Quality, Cucumber

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## Introduction

Drying seeds has always been a very big issue in the seed world. Very basic systems and procedures (drying harvested seeds on a hardened surface in open air) to very sophisticated drying systems (fluidized bed systems with a closed dried air circuit as an example) are used globally.

It can be done with hot air, gentle processes with a very low efficiency factor, or in systems where the temperature and the relative humidity are controlled, using heating and or cooling. It can be done through different phases, where the first phase uses a higher temperature (higher

efficiency), but in a second phase with cooler temperatures (maintain seed quality) and even with a third phase where cooled air could be used (preventing cracks in delicate pelletings).
It can be done on fluidized bed systems, in continuous systems (belt dryers) or even on drying walls (box dryers for raw seeds). It can be done relatively mobile (drying containers, running on fuel) or completely fixed (drying rooms). Different systems can be added to measure the moisture content of the seeds (through direct systems such as conductivity, a heat source or even through NIR or through indirect systems by checking the temperature drop or the RH raise through the seed bed).

A fact is that drying seeds is one of the most difficult processes to master, and although everyone agrees that drying seeds is a very delicate process very little literature can be found concerning the ideal drying protocol. Whereas it is realized that any mishap can result in a reduced germination, vigor and/or shelf life of the seeds.

Most advanced seed technology systems (such as priming, seed coating and pelleting, our OptiPel and Multilevel Marker systems) are using drying within their processes. This drying part will often play a major role in the successes of failures of these systems.

A technology that could combine the precision with simplicity, the quality with efficiency and the mobility with capacity would bring a totally new dimension in the seed world. We developed a system based on the use of drying beads, a specific type of zeolite beads. The drying beads have an extremely high capacity to adsorb water, even at very low air humidity, making them optimal drying material. A second nature of the drying beads is the generation of heat during the process of water adsorption. The adsorption process is fully reversible and of purely physical nature. The beads can be regenerated indefinitely by heating to temperatures around 200 °C. Transport of the beads, in closed containers to prevent capacity loss by water adsorption from the air, and combining them with the (moist) seeds on the site of harvest, creates a versatile mobile drying system, which we called MobiDry®.

If we would dry through these drying beads, we could use the heat emission generated by the water adsorption, we could dry in direct or indirect contact with these drying beads, we could dry at low temperatures, the vapor pressure could be set, the drying would be very fast and would depend only on the water transport speed through the seed pericarp, we could set the final moisture content, resulting in a very homogeneous drying, and last but not least we could use complex drying protocols in an easy and precise way and all of this with an almost continuous control of all important parameters. These drying beads can be mixed with the seeds (figure 1), and after the drying separated through a sieving system. The system can be automated and easily adapted to the local and specific needs. We have tested the MobiDry® system with drying of cucumber seeds.

**Figure 1.** Mixture of rice seeds with drying beads.

## Materials and Methods

The cucumber seeds used for these tests were commercially produced seeds (by a major seed producer in Thailand) and extracted following their conventional system. Freshly extracted and therefore moist cucumber seeds were initially dried in the sun. In a first experiment (October 2008), after three hours of classical drying a sample was taken for determination of the seed moisture content (SMC, on fresh weight basis). At the same moment seven subsamples samples of 100 g seeds were homogeneously blended with an equal amount of drying beads similar to figure 1. The samples were stored in a closed container and set aside for 1, 2, 4, 6, 12, 18 and 24 h. After the desired time the container was opened and the seeds were separated from the drying beads through sieving (used bead size was 3 to 4 mm, and the used screen was a slot sieve of 2.2 mm). As control the seeds were further dried for eight h in the sun, according to the conventional treatment.

In a second experiment (June 2009), during conventional 'sun-drying' of a commercial seed batch, seed samples were taken after 7 hours. Four other samples were dried with the addition of 75 or 100% (seed weight basis) drying beads for one or two hours. During the bead drying the relative humidity (RH) and the temperature in the container were recorded. Samples that were further 'sun-dried' or dried with a classical dryer (fluidized bed, heated air) for five hours served as controls.

All seed samples have been tested by using the official ISTA methods. The SMC's were measured (ISTA oven method – high temperature) and germination behavior was analyzed (4 days and 8 days) as well as the mean germination time (MGT). This germination test was performed directly after the drying for the set period. Therefore the seeds differed in moisture level at the start the germination test. For estimation of the MGT counts were performed after 3, 4, 5, 6, 7 and 8 days. The MGT is a method that determines the time when 50% of the germinating seeds are germinated (Ranal & Santara, 2006) and is calculated as the weighted mean of the germination time. The number of seeds germinated in intervals of time established for data collection is used as weight.

## Results

*Experiment I*

Freshly extracted and therefore moist cucumber seeds were initially dried in the sun. After three hours of sun drying the SMC was 13.9%, to decrease till 6.1 % after a subsequent eight hours sun drying, giving a total of 11 h sun drying (Table 1). After mixing the seeds with the beads, their SMC dropped rapidly and reached a level of 6% between four and six hours of subsequent drying. Germination of the seeds additionally dried with the beads was better than for the sun-dried seeds, with regard to the early germination count (4 d), but total germination (8d) and MGT did not differ.

**Table 1:** Experiment I. Effect of drying cucumber seeds using drying beads, on seed moisture levels and germination behavior. Initial SMS after three h sun-drying was 13.9 %.

| Drying period with beads | SMC | germ 4d | germ 8d | MGT |
|---|---|---|---|---|
| 1 h | 9.5 | 57 | 100 | 3.7 |
| 2 h | 7.9 | 50 | 99 | 3.5 |
| 4 h | 6.4 | 62 | 100 | 4.2 |
| 6 h | 5.6 | 63 | 99 | 3.4 |
| 12 h | 5.1 | 58 | 98 | 4.1 |
| 18 h | 4.6 | 65 | 98 | 4.1 |
| 24 h | 4.6 | 61 | 100 | 3.7 |
| Control sun 8 h | 6.1 | 47 | 98 | 3.7 |

*Experiment II*

The effect of application of drying beads after 7 h of conventional ‘sun-drying’ was compared to continued sun drying or the use of subsequent fluidized bed drying. During the one or two h bead drying, the RH dropped to 0 or 1%, whereas the temperature reached a level between 36 and 41 °C (Table 2), only a few degrees above the ambient temperature during the experiment. The seeds that were only sun-dried had an initial SMC of 35.9%, which dropped till 7.5% after a total of 12 h conventional drying. The seeds used for fluidized bed drying had an initial moisture level of 14.6 %, which dropped till 4.9% after 5 hour under these drying conditions and which is lower compared to a similar period of subsequent sun-drying. Although the initial SMC at the start of bead drying was slightly less compared to that of the fluidized bed drying treatment, The SMC dropped till 5.3% within one h after mixing with 100% beads and 5.1% after 2 h. It seems that upon mixing with 75% beads the SMC drops less in one h, but after two h the same SMC is obtained as with 100% beads. As with the fluidized bed drying, the use of drying beads resulted in a faster drop in SMC compared to sun-drying. Early germination count (4d) of sun-dried seeds was slightly less compared to that of the other drying treatments, but no effect was observed on total germination (8 d) and MGT.

**Table 2:** Experiment II. Effect of drying cucumber seeds using sun-drying, a fluidized bed or drying beads, on seed moisture levels and germination behavior. The seed moisture content (SMS) was determined before and after drying.

| % beads | H | RH | Temp. min. | SMC max. | SMC before | Germ after | Germ 4 d | MGT 8 d | |
|---|---|---|---|---|---|---|---|---|---|
| sun drying | 0 | 5 | ? | ? | 35.9 | 7.5 | 26 | 91 | 6.1 |
| fluidized bed | 0 | 5 | ? | ? | 14.6 | 4.9 | 33 | 88 | 6.0 |
| beads 1 | 100 | 1 | 0 | 39 | 12.8 | 5.3 | 36 | 93 | 6.0 |
| beads 2 | 100 | 2 | 0 | 36 | 12.8 | 5.1 | 28 | 92 | 6.0 |
| beads 3 | 75 | 1 | 1 | 41 | 12.8 | 5.9 | 31 | 94 | 6.0 |

## Discussion

The relative humidity in the closed containers with the mixture of seeds and drying beads went down to or near 0%, maximizing the drying speed. This explains the observed very fast drop in seed moisture content. We also noticed that there seems a minimum moisture content where the beads / seeds mixture is equilibrating out. For cucumber we believe that this minimum lies around 4.5% SMC. There was definitely no negative impact on seed quality (early count, final count and mean germination time). The temperature increase due to the water absorption was very moderate (an increase of 2 to 6 °C was noticed) and did not harm seed quality. Separation of the seeds from the beads was easy to perform.

Drying seeds has always been a very big issue in the seed world. The major impact that drying conditions can have on the subsequent quality and longevity of the seeds is often underestimated. Faster drying can prevent seed born fungi to grow and thus minimize seed borne pathogens or saprophytes on certain seed lots. The search for new and better drying systems has often been focused on energy consumption and controllability of the drying process. But too often it takes a long time before the seeds can reach these drying points. Meanwhile, high humidity and temperature have already damaged the seeds. Sun drying is another option, but again, there is no or little control in such processes. The drying beads are providing a decent option in combining quality drying with speed, in flexibility combined with cost efficiency.

## References

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