Five ways to increase your seed germination rates

When you start plants from seeds one of the most important things you want to achieve is a very high and fast germination rate. However if you try to do seed germination without any additional effort you will most likely reach sub-optimal results since there are some natural factors that hinder seed germination that need to be eliminated in order to achieve the best possible results. Today we are going to talk about five things you can do in order to provide the best conditions for the germination of your seeds.

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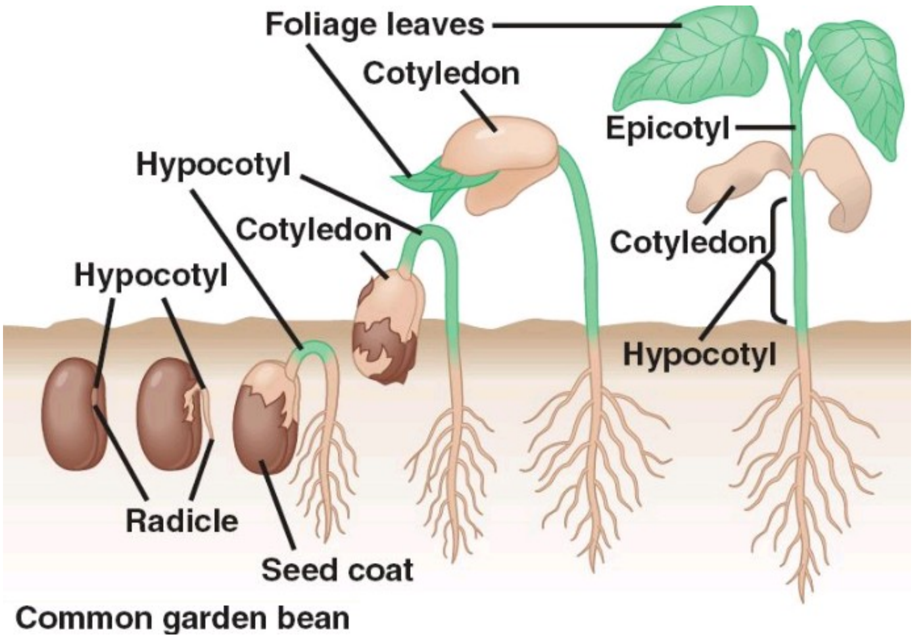

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Temperature is very important. When doing seed germination one of the most critical factors is seed temperature. Some plants require cold temperatures to germinate – for example spinach's germination rate drops to about half when you go from 15 to 25°C – while other plants require higher temperature – for coriander it's basically the opposite. For your seedling emergence rate to be as high as possible ensure that you are giving them the temperature they ideally want, which depends on the plant species. Below you can see a table with germination temperatures for several plant species.

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Vegetable	Min (°F)	Optimum Range (°F)	Optimum (°F)	Max (°F)
Asparagus	50	60-85	75	95
Bean	60	60-85	80	95
Bean, Lima	60	65-85	85	85
Beet	40	50-85	85	85
Cabbage	40	45-95	85	100
Carrot	40	45-85	80	95
Cauliflower	40	45-85	80	100
Celery	40	60-70	70	85
Chard, Swiss	40	50-85	85	95
Corn	50	60-95	95	105
Cucumber	60	60-95	95	105
Eggplant	60	75-90	85	95
Lettuce	35	40-80	75	85
Muskmelon	60	75-95	90	100
Okra	60	70-95	95	105
Onion	35	50-95	75	95
Parsley	40	50-85	75	90
Parsnip	35	50-70	65	85
Pea	40	40-75	75	85
Pepper	60	65-95	85	95
Pumpkin	60	70-90	90	100
Radish	40	45-90	85	95
Spinach	35	45-75	70	85
Squash	60	70-95	95	100
Tomato	50	70-95	85	95
Turnip	40	60-105	85	105
Watermelon	60	70-95	95	105

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Pretreat seeds with PEG-6000. Polyethylene glycol treatments can dramatically increase seed germination rates (see here). We have known this since the mid 1970's and we have also known that the optimum treatment duration and air-drying effects change according to plant species. Applying a general PEG-6000 treatment, as a I described here a few years ago, might or might not work depending on the plant you're trying to work with. For best results you need to search the scientific literature for the best PEG-6000 treatment or – if this information is not present – design your own experiments to figure this out.

Seed disinfection. Seeds are usually covered in microorganisms that can seriously impair seed germination rates. In order to eliminate this issue seeds need to be disinfected prior to germination with a chemical agent (most commonly either hydrogen peroxide or sodium hypochlorite solutions). For this purpose solutions in the order of 0.1-2% NaClO are generally used with different soaking times varying between different papers. You can read more about this sort of process here. Treatments are usually quick with disinfection lasting only a few minutes with subsequent plain water baths to eliminate any excess oxidant.

Introduce some good guys. In the same way that there are pathogens that can hinder seed germination there are some "good guys" that can stimulate seed germination. In particular there are *trichoderma* species that have been known to increase germination rates for some plant species. For example in this paper using okra (see here) there was an important increase in germination rates when using *T. harzianum* as a beneficial fungi. You should look for some scientific literature surrounding the species that interest you or – if that's not available – apply a product that contains a few tr*ichoderma* species.

Using GA_3 for stimulation. The final trick in your arsenal to increase germination rates is to use Gibberellic acid to stimulate your seed germination. Optimum concentration of gibberelic acid, treatment lengths and effects depend fundamentally on the plant species used but this is acknowledged to be a quite universal stimulant for seed germination rates in the general scientific literature. You can read this paper to see the effects of gibberelic acid on a wide variety of species found in western Australia (so that you can grasp how different its action can be). For particular species you can find articles like this one – for tomatoes – where different GA_3 concentrations are tested to figure out the best application rate. The effect can be quite dramatic as in the image below (taken from [this paper]).

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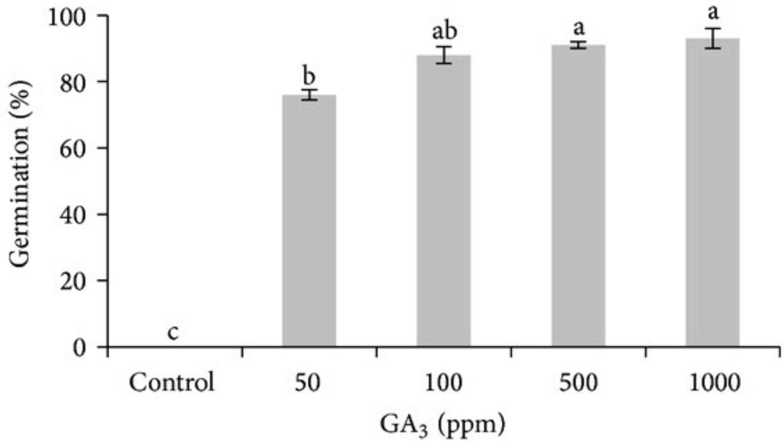

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In the end there are many things we can do to improve seed germination and the above is by no means an exhaustive list. For particular plant species there can be other tricks – for example things like scarification – which can lead to important improvements in germination rates as well. However the above advice is quite general and can probably help you increase germination rates for a wide variety of plant species.

Making your own DIY plant rooting gel

Cloning is a very common technique used by a large variety of plant growers. When growing plants from seeds there is an important unpredictability factor in what you might get so cloning ensures that you get a clear genetic copy of the parent and therefore removes a lot of the variability inherent to the growing process when starting from seed. To perform the cloning process most growers use the aid of rooting hormones which are usually sold in the form of a gel at high prices. Today we are going to learn how to make our own DIY plant rooting gel using ingredients that can be easily bought online for a fraction of the cost.

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Rooting gels have basically four ingredients. A rooting hormone (active ingredient), a gelling agent (usually an acrylic acid polymer), a base (needed to increase the viscosity given by the gelling agent) and a preservative (because fungi eat anything). Today we are going to talk about making a rooting gel without any preservative – which is simpler – so don't make very large quantities because it can spoil after some time (probably will last for a month or so). To make this you will need the following:

- Distilled or RO water
- Indole-3-butyric acid (you can get it here) 0.69 USD/g
- Carbopol 940 (you can get it here) 0.09 USD/g
- Potassium hydroxide (you can get it here) 0.02 USD/g
- Two containers for mixing (one around 60% of the volume you want to make, the other around 120%)

- A scale that can weight with enough precision according to the amount you want to prepare (for 1L you will need a +/- 0.1g scale).

Warning: Potassium hydroxide is a very strong base. Handle with a lot of care wearing protective eye wear and nitrile or PVC gloves. Do not agitate it before opening it since KOH powder is very caustic.

Once you get these ingredients the process is quite simple. For a one liter preparation add 500 mL of water to one container (we will call this one A) and 500mL to another container (which we will call B). Add 3.0g of the Indole-3-butyric acid to the A container along with 0.6g of potassium hydroxide and mix until both are dissolved. Heat the water in container B to 120-140F (48-60°C), stop heating and add 9.0g of Carbopol 940. Mix the water in container B thoroughly, the Carbopol 940 might take a long time to get hydrated and get into solution, stir it until there are no visible clumps (this can take around 15-60 minutes).

Once this process is done wait for B to cool to ambient temperature, then mix A and B slowly (in whichever has the largest container). When you do this the viscosity of the mixture will start to increase exponentially and you will have your rooting gel preparation. The amount of money it takes to prepare 1L is around 3 USD while the most popular rooting gel products online are charging you around 16 USD for 100mL of basically the same thing. This means that you will be saving 98% of your rooting gel costs if you make your own.

There are some other additives – including preservatives and biostimulants – that we could add to make a better product, but that’s a topic for another blog post.

Building your own DIY high power LED lamp: Part One

It is no mystery that LED technology has evolved greatly during the past several years. We are now up to the point where anyone can buy LED lamps to replace HPS fixtures, with full spectrum LED configurations that have showed to be just as good – or sometimes even better – at growing crops (see here for a post about LED lights Vs HPS). However these lamps are often very expensive – most commonly around thousands of dollars to adequately replace a 1000W HPS. Within these series of posts I am going to talk about how you can build your own LED lighting to replace HPS lights for pennies on the dollar compared to commercial LED fixtures.

WARNING: Mains voltages (110-220V) can be extremely dangerous. Please make sure that you know what you're doing if you're going to follow these instructions. All of this information is provided "as-is" with educational purposes only. Make sure you follow all safety precautions when working on mains electricity.

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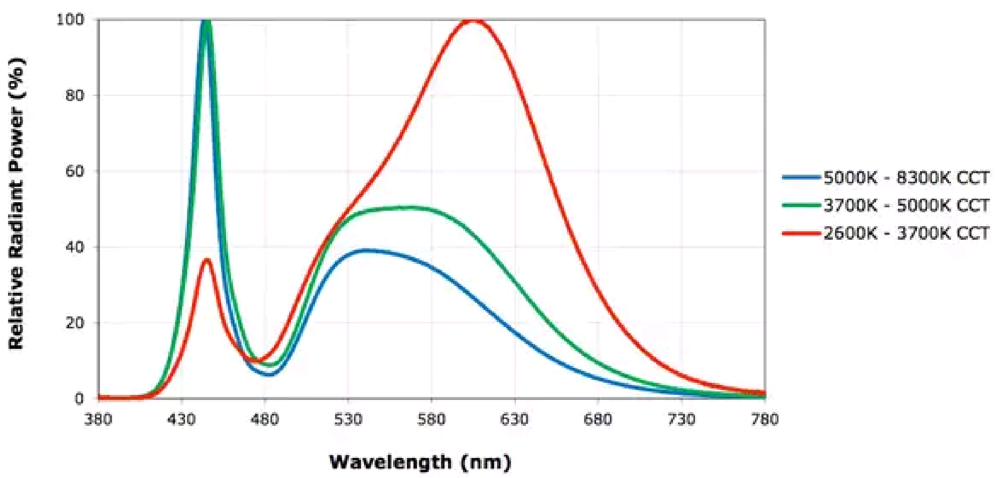

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There are several ways in which you could build your own LED lamps. This usually involves building an aluminium case with fans, putting an LED driver inside and then using that driver to power rows of different light emitting diodes. A driver is basically a transformer not unlike a computer PSU that takes voltage from the mains and dials it back down to a lower voltage that you can use across a row of diodes. Most commonly commercial lamps use combinations of 3W diodes with narrow focusing elements with sometimes higher wattage elements with wider focusing elements. Building a configuration like this can be done but it is a laborious that we can avoid using some of the latest advances in LED technology.

To make a simple high power LED lamp we should absolutely forget about putting together LED elements of different colors. This involves a lot of wiring and makes the lamp fundamentally more expensive. To replace them we can use white diodes instead which although far less efficient – as they are basically blue diodes whose light is absorbed and re-emitted by a phosphor – can give us all the different colors we need in the proportions we need them. The image above shows you the spectrum of different white diodes, as you can see we don’t want the 5000-8000K or 3700-5000K LEDs – which emit a lot of blue light we don’t need – but we need the much “warmer” 2600-3700K diodes which produce a lot of light in the red region of the spectra, with enough blue to provide us with close to a 1:3 ratio. Although this light spectra is still not ideal compared to what plants absorb it will easily able to replace a 1000W HPS.

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To make things very simple and avoid using a separate driver we can use 150W LED cobs that include their own driver and are fed directly with 120/240V electricity (like the ones here). As I mentioned we want the lower temperature spectra white diodes so go for the “Warm white” and make sure the temperature description says it is at least 3200K or lower (if you’re looking at another source). The publication above contains 150W cobs that can do 2500-3200K so they can be considered ideal for this application. For every 150W cob you install you should also install a 2A AC fuse for that cob only to ensure that if anything bad happens the power will be cut almost instantly. *Since these cobs are wired directly to mains electricity you should be specially careful with having proper safety precautions (proper soldering of the wires, solders protected with isolating material (like silicon) fuses for each cob, etc).*

Of course the cobs are only half the setup. We need to place these cobs on top of an appropriate heatsink and then also ensure we have fans for it. You can buy a properly sized aluminium heat sink here. Since cobs measure 16×40 we can comfortably glue two cobs to the bottom of a heat sink of profile A (146x22mm) with a length of 400mm. To glue the cobs to the heatsink you should use proper arctic silver thermal adhesive (you can find it here). For fans you can place 2 12cm Fans on top of the above. There are several fans that work with 120-240AC that you can use, for example these fans work with 120V. This setup will give us a 300W LED lamp, with 2 fans that should be able to keep the heatsink temperatures in check. All of this for a total of around 83 USD, let’s call it 100 USD after adding fuses, cable and other parts you might require.

The above lamp will not replace a 1000W HPS on its own, for this you will need at least 4 cobs – meaning two of the above lamps – which should give you 600W of LED power that should be close to the PAR of a 1000W HPS light. This for the cost of only 200 USD (far less than the commercial LED replacement lights). I am in the process of making my own so I will be able to give you some additional details as soon as I get the parts and finish building my own setup. In part No.2 of this series of posts I’ll show you the results of my work and what it does in terms of photon flux and PAR.