From Seed to Plant – Factors affecting Germination

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Introduction

Germination of non-dormant seeds requires the proper environment, with some specific factors being temperature, water and oxygen (Fimball, 2003). In some circumstances, germination will only occur after a period of dormancy, or once an inhibitant has been degraded away.

After seeds have been dispersed to a variety of unpredictable locations there is reliance on the survival strategies and adaptations of the seed so that seeds can germinate under the most favourable conditions available.

This extended experimental investigation is focused on the *Ocimum basilicum,* which is more commonly known as 'Sweet Genovese' Basil. The purpose of this investigation is to identify some of the primary survival strategies utilized by the Sweet Genovese Basil and further determine the recommended conditions to produce the optimum yields if growing as a crop. It will also be investigated as to whether environmental pressures have influenced these adaptations over time.

Five factors pertaining to effective germination were determined and will be used throughout the investigation. These factors are; sunlight exposure, drainage, pH level, germination medium, frequency of water and seed depth.

Alternate Hypotheses (H_1)

Sunlight

The optimum sunlight exposure for germination is full sunlight.

Drainage

Full drainage provides better conditions than no drainage.

pH level

A neutral pH level is ideal.

Germination Medium

Vermiculite provides the best sterile medium to observe germination.

Frequency of Watering

Watering should occur once a day.

Seed Depth

Optimum depth when planting the seed is 5 mm.

Null Hypotheses (H_0)

Sunlight

The optimum sunlight exposure for germination is full shade.

Drainage

No drainage provides better conditions than full drainage.

pH Level

A strong basic pH level is ideal.

Germination Medium

Soil provides the best medium to observe germination.

Frequency of Watering

Watering should not occur.

Seed Depth

Optimum depth when planting the seed is 5cm.

Materials

- 33 Germination pots (at least)
- Vermiculite
- Packet of Sweet Genovese Basil seeds
- Bag of Mc Fothergill's seed raiser mix
- Regular earth (dirt) from garden
- Water
- Materials for recording results (i.e. camera and writing equipment)

Method

Sunlight Exposure

1) Using nine germination pots fill each with vermiculite leaving approximately 1cm of space to the top of the pot.
2) Place 3-5 seeds in each pot. *
3) Cover with 5mm of vermiculite
4) Lightly water until all vermiculite in the pot is moist. **
5) Situate three pots in an area with full sun exposure as the control
6) Situate three pots in an area with part sun/ part shade exposure
7) Situate three pots in an area with no sun exposure
8) Maintain by watering daily and make regular observations

(Please note that the 3 pots that are situated in the full sunlight have the optimum of each control factor and therefore will be used as the control for all variable factors.)

* This is because not all of the seeds will germinate successfully and planting multiple seeds works to ensure that at least one will germinate.

** Attention must be given to the fact that due to the tiny size of the seeds watering must be done is such a manner that it does not interfere with the positioning of the seeds.

Drainage

1) Using three germination pots fill each with vermiculite leaving approximately 1cm of space to the top of the pot.
2) Place 3-5 seeds in each pot. This is because not all of the seeds will germinate successfully and planting multiple seeds works to ensure that at least one will germinate
3) Cover with 5mm of vermiculite
4) Lightly water until all vermiculite in the pot is moist
5) Place the three pots in a watertight container where the pots will be continuously waterlogged
6) Maintain by watering daily

pH level

1) Prepare six germination pots
2) Take one lemon and juice is so that the juice of the whole lemon is collected
3) Place juice in a small bowl
4) Add to the bowl enough vermiculite to adequately soak up all the lemon juice hence creating acidic vermiculite
5) Fill three germination pots with this vermiculite leaving 1cm space at the top
6) Place 3-5 seeds in each pot
7) Cover with 5mm of the acidic vermiculite
8) Place in a full sunlight area
9) Lightly water until all vermiculite in the pot is moist
10) In a cup combine one tablespoon of bi-carbonate soda with a quarter to a half cup of water
11) Mix well to create a basic solution
12) Pour solution into a small bowl
13) Add enough vermiculite to adequately soak up the liquid
14) Fill three germination pots with this basic vermiculite leaving 1cm space at the top
15) Place 3-5 seeds in each pot
16) Cover with 5mm of the basic vermiculite
17) Place in a full sunlight area
18) Lightly water until all vermiculite in the pot is moist

Medium

1) Prepare six germination pots
2) Fill three pots with Mc Fothergill's brand seed raiser mix leaving 1cm space at the top
3) Place 3-5 seeds in each pot
4) Cover with 5mm of the seed raiser mix
5) Place in a full sunlight area
6) Lightly water until all seed raiser mix in the pot is moist
7) Using a shovel dig up some ordinary dirt from the ground
8) Fill three pots with dirt leaving 1cm space at the top
9) Place 3-5 seeds in each pot
10) Cover with 5mm of the dirt
11) Place in a full sunlight area
12) Lightly water until all dirt in the pot is moist

Frequency of watering

1) Prepare nine germination pots
2) Using the nine germination pots fill each with vermiculite leaving approximately 1cm of space to the top of the pot.
3) Place 3-5 seeds in each pot.
4) Cover with 5mm of vermiculite
5) Situate in full sunlight
6) Lightly water until all vermiculite in the pot is moist.
7) Isolate three pots and water them three times a day
8) Isolate three pots and water them twice a day
9) Isolate three pots and water them once every three days

Safety aspects

Avoid direct contact with biological material
Disinfect hands before and after handling biological materials
Keep area well ventilated and avoid inhaling biohazardous materials (particularly when handling seed raiser mix)
Ensure that germination pots are not disturbed or damaged (e.g. by animals)
In the case of rain germination pots should be taken to a sheltered location

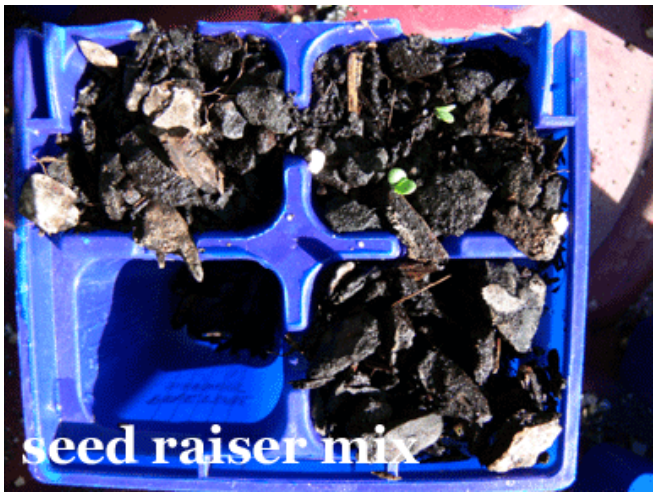
Results

Refer to table and pictures attached.

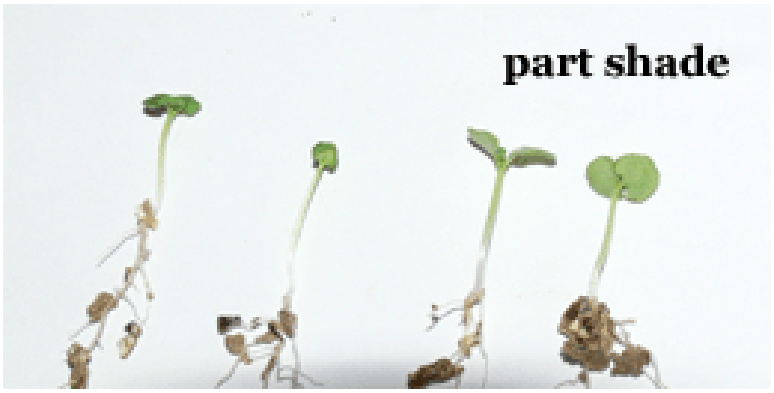

part sunlight


no sunlight


no drainage
(waterlogged)


seed raiser mix


optimum


part shade


no sunlight


seed raiser mix

Discussion

Ocimum Basilicum belongs to the family '*Lamiaceae*' and is an annual herb (Simon, 1998). It is thought to have originated from the tropics of Asia and in particular India (Floridata, 2007). Basil is now cultivated worldwide and there are many different types of basil such as lettuce-leaf, lemon, cinnamon, Thai and of course the Sweet Genovese (Davis, 1997). Due to cross-pollination there have been many sub-species created that are now classified under the name of *O. Basilicum.*

Sweet Genovese Basil is commonly thought to be the best basil that can be used for pesto and this aromatic herb has culinary value for use in other Mediterranean style dishes (The Pool Room, 2007). It is also of cultural significance; it is a symbol of love in Italy and in is considered sacred in traditional Indian culture (Superb Herbs, 2007).

For a species of plant to survive, effective germination of seeds is essential. If a seed drops directly below a plant it may eventually have to compete for light, water and nutrients with its parent plant and therefore it is beneficial for the seed to have structural adaptations. An example of this is miniscule hooks in the seeds to latch of on the hair/clothing of any bypassing animals/humans to be taken to another location for germination.

After seeds are dispersed to these unpredictable locations through the use of their structural adaptations they must then be readily equipped so that they can successfully germinate and continue to develop.

One way that this is done is through the use of germination triggers. Sometimes germination is triggers by an environmental factor such as light, or after a preceding period of dormancy. Sometimes inhibitants are used by the seed to ensure that the germination will occur at the most suitable time. One example of this is the use of abscisic acid, a chemical which works to induce dormancy in the seed (Koning, 2007). Gradually the enzymes present during winter will leach away the acid leaving the seed ready to germinate in spring, which is likely to bring favourable conditions.

This investigation examines five variables of the seeds environment during the germination process. The first variable is the exposure to sunlight, being either; full sunlight exposure, part sun/part shade, and no exposure to sunlight. The second was whether the soil was drained or not and the third variable tested was the pH level of the soil – acidic, basic or neutral. The fourth factor tested was frequency of watering, being either; three times a day, two times a day, daily and once every 3 days. The final variable was the depth at which the seed was planted with the optimum being 5mm and the two alternatives being 5cm and that the seed was simply left on top of the vermiculite.

There was little difference between the results of the full sunlight and part sunlight but it was observed that in the case of the seed germinated which no sunlight there was a significant difference in the way that the seeds developed in the lack of sunlight. After the two seedlings emerged from the vermiculite it can be observed that all energy expenditure was directing towards lengthening the stem of the seedling in an attempt to reach a source of sunlight. The roots were very basic and it seems minimal energy was spent on developing these roots and the two primary leaves on the shoots did not open as the dominant necessity was to find sunlight. The alternate hypothesis is to be accepted – the optimum sunlight exposure for germination is full sunlight but part sunlight is also acceptable.

In regards to drainage, it has been observed that well-drained soil is important because otherwise it will become waterlogged and cause the seeds to rot hence the alternate hypothesis is being accepted – full drainage provides better results than no drainage.

In neither the acidic or basic vermiculite did the seeds successfully germinate so therefore a neutral pH level is ideal, proving the alternate hypothesis.

In order to provide the most suitable, neutral, sterile environment for observing the germination process vermiculite was used but it must be noted that the seedlings that were planted in seed raiser mix grew at a slightly faster rate than the vermiculite, the alternate hypothesis is still correct however because the vermiculite served the purposes required for the investigation.

It seems that where watering occurred 3 times daily and 2 times daily it simply made it impossible for the seeds to germinate due to over-watering but it must also be considered that the additional force from the extra watering may have caused the small seeds to be taken further down in the vermiculate also making it harder to germinate. The pots that were watered once every 3 days did not successfully germinate either due to under-watering hence proving the alternate hypothesis to be correct.

The seeds planted at 5cm and 0cm both did not successfully germinate proving the alternate hypothesis to be correct – the optimum depth for planting seeds in 5mm.

When using the Sweet Genovese Basil as a crop plant it is important to effectively research the optimum conditions of the growing environment in order to produce optimum yields. Some of the factors which should be considered are the climatic conditions such as season and temperature as well as soil quality, soil pH level, nutrients, drainage and irrigation.

One of the main dangers when planting basil is the threat of damage as a result of frost hence the optimum season for planting is around late spring (Simon, 1998).

When sowing seeds the agricultural climate is of utmost importance. The temperature should be between 7 and 27 degrees Celsius and the soil pH is optimum when between 5.5 and 6.5 (Smith, 2007).

Because the seeds are quite small the optimum depth for sowing is 5mm (Superb Herbs, 2007). One common method of sowing the seeds with relation to the spacing of plants is a 15cm gap for seeds sown in rows and a 60-90cm space in between rows (Simon, 1998). The emergence of the seedlings should occur within 7-14 days of sowing the seeds (Simon, 1998).

Regular daily watering is necessary and one recommended system is trickle irrigation throughout the rows. The soil must be well-drained and aerated and care must be taken no to over-water to prevent the seeds from rotting.

If the soil is to be fertilized any past treatments of the soil and the current condition, with specific regards to nutrients, must be given extensive consideration before an appropriate fertilizer can be selected and applied.

Weed control must also be considered as the presence of weeds in the product of harvest will decrease the quality of the product and it is recommended that crops are monitored for pests or diseases.

Generally it is the basil leaves that are harvested but this will vary according to the expected use of the harvest. If harvesting for leaves to be dried it is recommended that this takes place just before the flowering occurs whereas if the leaves are going to be distilled for use as an essential oil harvest is recommended during full flower.

Environmental pressures have caused a need for genetic variance within the species and especially because basil is cultivated worldwide these plants will be exposed to a variety of conditions. It is due to cross-pollination that several ‘sub-species’ can be formed which have the ability to adapt themselves to their climate.

Some problems experienced when carrying out the investigation included rainy weather which required for the germination pots taken to shelter, possibly interfering with the outcomes of the experiment. Another problem encountered was what was suspected to be a bird knocking over a set of germination pots spilling out the vermiculite and seeds – this particular part of the experiment had to be redone.

If the EEI was to be completed again it would be better if more levels of the variation could have been researched and also time of monitoring after germination was extended from one week to at least 14 days so that survival rates could be further observed.

Conclusion

Germination is an extremely important process relating to the survival of the plant species and therefore it must be considered for this to be possible a seed can develop adaptations and germination triggers.

The Sweet Genovese is a variety of basil (*Ocimum basilicum*) and if this plant is to be considered for a crop it is important that research is done into its optimum environmental conditions. This report investigated five specific factors and after doing extensive research to support the results and give further elaboration it was then possible to outline some guidelines in order to produce an optimum yield.

A future outcome that may be possible within this species is the possible development of more sub-species through cross-pollination and with relation to crops, the development of new pesticides or disease control methods.

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