

Rhizobox assembly instructions

This document contains diagrams to aid assembly of a rhizobox. This rhizobox is a container for soil and a growing root system that is visible due one side of the rhizobox being transparent. Assembly of the rhizobox is shown in figures 1-17 while the parts required are shown in Table 1. As rhizoboxes take time to assemble, this document is split into 3 sections: Preparation – Rhizobox (1-4), Preparation – Soil (5), Preparation – Seeds (6-9), Soil loading/Assembly (10-16) and Planting (17-22). A table of the equipment required is included at the beginning of the sections. Tips and a timeline are included at the end to help with experiment planning. Before starting it is advisable to read the whole of this document.

Safety

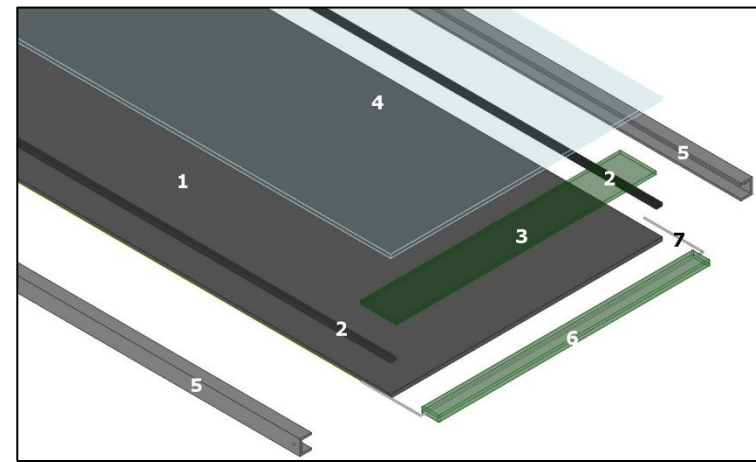
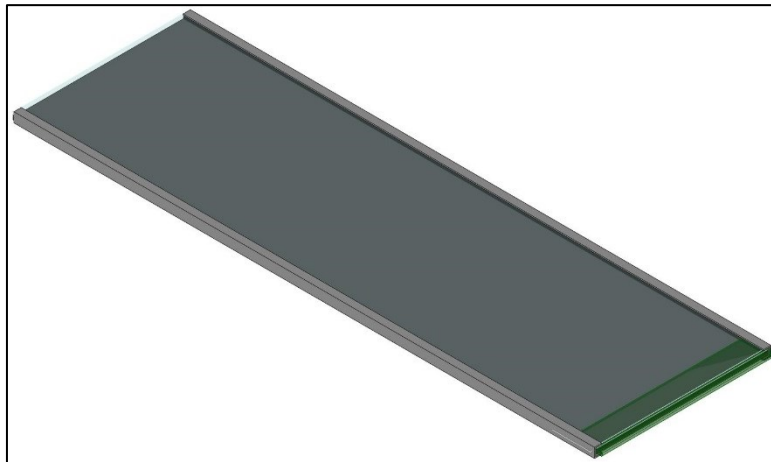
This document suggests the use of power tools, hand tools and adhesives. Follow all safety instructions which is provided or appropriate for any equipment used. Appropriate personal protective equipment should be used at all times such as gloves, eye protection etc. Work with tools should only be carried out by competent persons. Tools and materials can become hot when cut or filed and should be left to cool before handling.

Some of the components in this document are heavy. These components should be handled carefully and following manual handling guidelines. Further to this glass can be damaged and contain sharp edges. Glass should be handled with care using gloves and any broken glass should be disposed of appropriately.

Any work which uses tools or requires lifting is best carried out with two or more people.

Table 1

Part	Size	Properties	Number	Example part source, country
PVC sheet	150 x 45 x 0.6cm	Opaque, water and light resistant	1	Direct Plastics, UK
Silicon strip	150 x 1 x 0.6cm (x2)	Water resistant	2	Silex Silicones, UK
Inner mesh	43 x 6cm (made of 8 folded layers)	1mm aperture, water resistant	3	Buzzstop, UK
Glass sheet	150 x 45 x 0.6cm	Polished edges	4	Alba Glass & Glazing, UK
U-channel	Outer dimensions - 150 x 2.5 x 1.9, inner dimensions – 150 x 1.9 x 1.6, 0.3cm diameter hole drilled 0.5cm from one end (x2)	Aluminium	5	Aluminium Warehouse, UK
Outer mesh	45 x 3cm (made of 8 folder layers of 1mm aperture mesh)	1mm aperture, water resistant	6	Buzzstop, UK
Wire	57 x 0.24cm	Welding steel rod	7	Jac Tools, UK



Preparation - Rhizobox

Equipment	Description
Sealant gun	To hold chosen cartridges
Silicone sealant or grab adhesive cartridge	Heavy-duty , waterproof
Wire cutters	Suitable to cut 0.24cm steel rod
Drill + drill bit	Suitable to drill into 0.3cm thick aluminium with a diameter of 0.3cm
Cloth tape	Waterproof, 25mm wide, 0.03mm thick

1



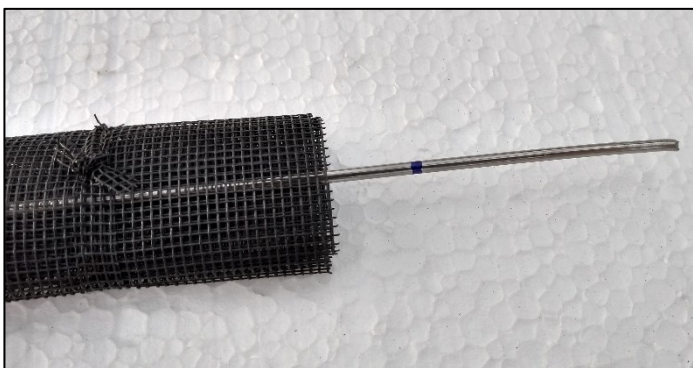
Silicon strips should be glued to the PVC sheet ideally using a silicone sealant or grab adhesive. These generally take at least 24h to dry so this step should be done a few days before use.

2



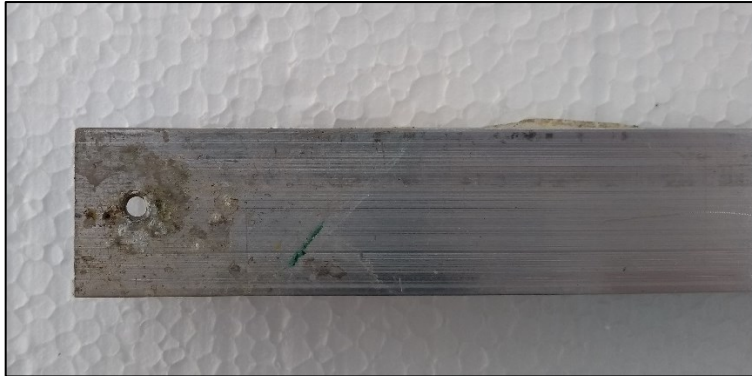
The inner mesh is made by folding an approx. 43x48cm piece of mesh eight times to produce a 43x6cm piece. The outer mesh is made by folding an approx. 45x24cm piece of mesh eight times to produce a 45x3cm piece. After folding a mesh, it should be tied around the outside.

3



The wire to fit with the outer mesh should be cut to length (if necessary) and inserted. Mark 5cm from each end to show approx. where the wire will be bent.

4



Aluminium u-channels require an approx. 3mm hole drilled approx. 5mm from one end.

Aluminium u-channels often require a layer of cloth tape to line the inner surface. This ensures the frames fit tightly on the rhizobox and can prevent the frames damaging the glass. A 0.03mm thick tape is suggested but the thickness should be tailored to fit the system.

Preparation – Soil

Equipment	Description
Sieve	Suitable for dry soil, 2mm aperture mesh
Trays	To dry soil
Storage boxes	To hold soil

5



Drying soil



Dried and sieved soil

Soil preparation may depend on soil type and the experimental requirements.

Commonly soil is air dried and sieved to 2mm to remove large objects.

Preparation - Seeds

6



Chickpea seeds need to be imbibed with water before germination. In our work, this was done by an initial soak in water for several hours (2-3) before being rinsed and then left to soak overnight.

Seeds will increase in size (See inset images: left dry seeds, right soaked).

7



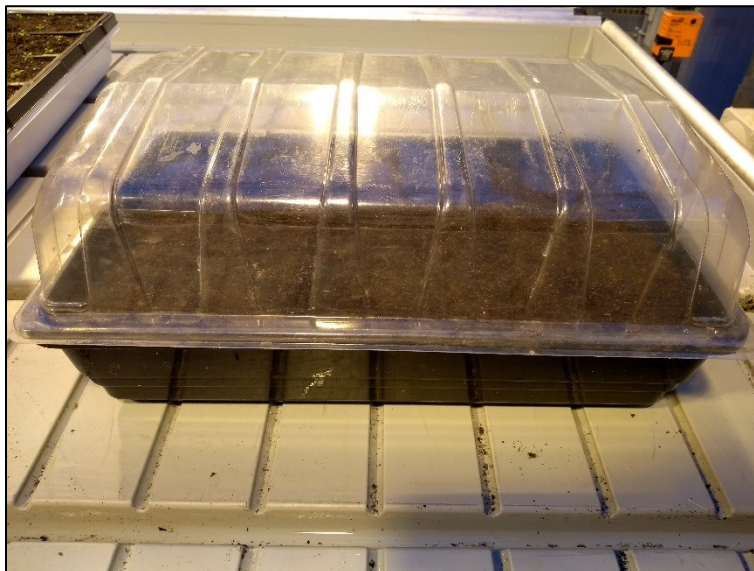
The next day seeds are ready to be sown into soil. For optimal growth seeds should be sown approximately 3cm apart in seedling compost or the same soil which will be used for the experiment. Soil should only be lightly compressed: this ensures the roots grow straight and are easier to transplant into rhizoboxes. Seeds should be sown with the point of root emergence facing downwards.

8



Seeds should be sown in a container which allows unrestricted growth of the root. As a guide, in approximately 2 days roots grow 3-4cm (this could vary with variety and growth conditions). Either pre-moistened compost should be used or the soil should be watered after covering the seeds with soil.

9



Germinating seeds should be kept in a well-lit area at approx. 20-25C with a transparent cover to maintain humidity. Seeds should be germinated so that the root is large enough to assess for growth and suitability for transplant but not so large that it can be damaged during transplanting.

Soil loading/ Assembly

Equipment	Description
Balance	Suitable for weight of soil
Rotary sieve	Suitable for wet soil, approx. 5mm aperture mesh
Storage boxes	To hold and weigh soil
Rhizobox components	See Table 1 & Figures 1-4

10



Soil after mixing dry soil with water and sieving

Wet soil preparation depends on soil type and experimental requirements. Dry soil is weighed and mixed with water. Wet soil should then be sieved with a rotary sieve. This produces a homogenous and fine textured soil which can be used to fill a rhizobox.

11



A PVC sheet should be laid flat with silicon strips facing upwards. An inner mesh should be placed at the bottom of the PVC sheet.

12

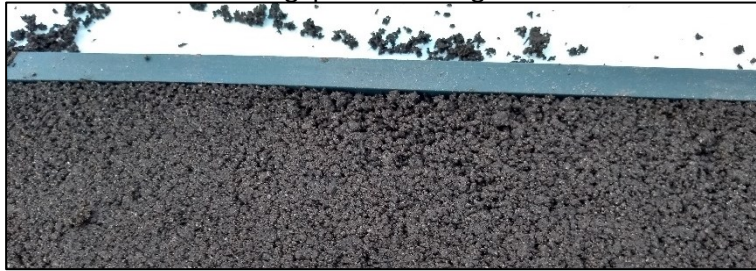
Soil spread in rhizobox



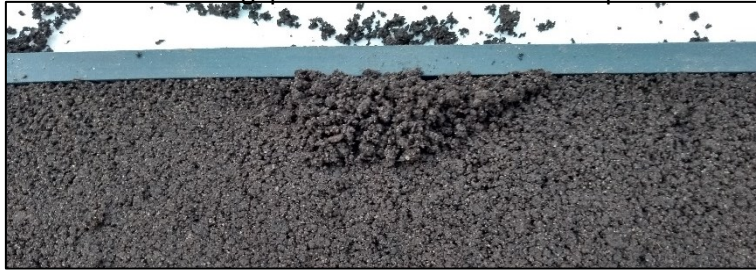
The prepared wet soil should be weighed for the required bulk density. The soil should then be spread evenly across the PVC sheet. After spreading, the soil should be compressed (using a rolling pin/plastic cylinder).

13

Small gap in soil at edge of rhizobox



Soil added to gap which should then be compressed



Soil fills the rhizobox evenly



Any gaps in the soil should be filled with soil and compressed. This should be repeated until the rhizobox is filled evenly and the required weight of soil is used.

14

The glass is then placed on top of the soil.



15



The aluminium u-channel frames are added to each side of the rhizobox. Ensure the frames fit tightly.

16

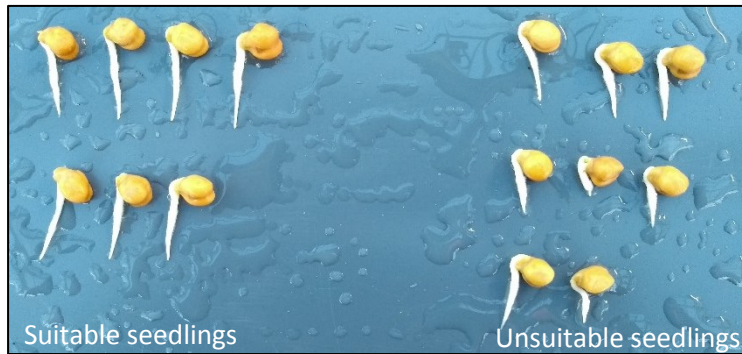


Place the wire and mesh through the holes at the bottom of the frames. Bend the wire towards the top of the rhizobox at the points marked on the wire (5cm from each end). The frames may need to be pushed up the sides of the rhizobox after the wire is added.

The rhizobox is then ready to be used.

Planting

17



Germinated seedlings should be carefully removed from the soil and kept moist. The ideal seedlings have undamaged and straight roots and are of similar length to ensure growth in an experiment is not affected by different starting points.

18



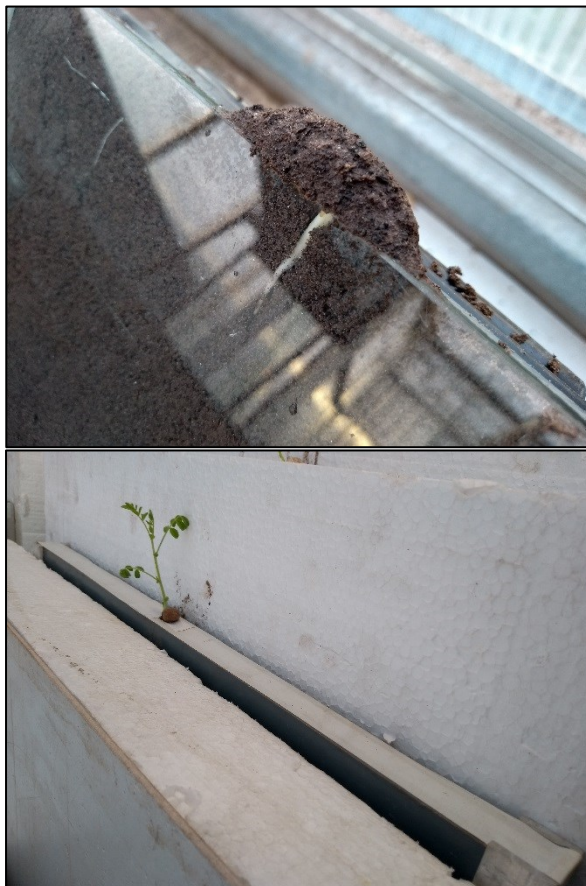
Make a hole in the soil at the centre and top of the rhizobox. This hole should have the approximate dimensions to fit a seedling root without leaving any large air gaps which could dry the root.

19



Insert the seedling root into the hole being careful not to damage the root, in particular the tip.

20



Two different methods can be used to stop the young root drying out:

1) Soil can be packed around the seed. The seed may not fit into the rhizobox so should be kept just above the soil level and soil packed around here outside the rhizobox.

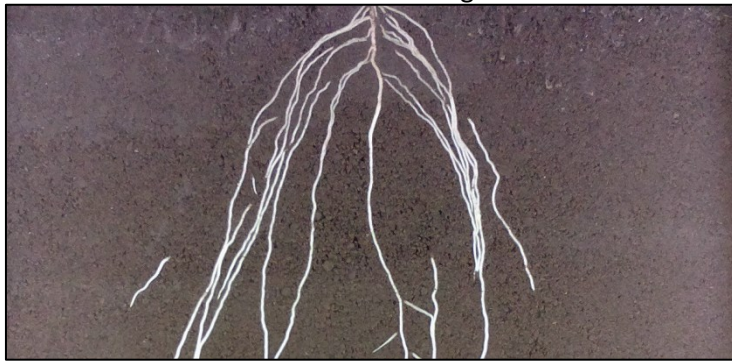
2) Tape can be added to the top of the rhizobox covering the exposed soil. A hole should be left to allow the seedling shoot to emerge.

21

Roots obscured by soil washed onto glass



No soil washed onto glass



Water can be added to the top of the rhizobox if necessary. This should be done carefully to avoid soil being washed down the glass surface which can decrease image quality.

22



The rhizobox is ready to be placed in a support. Rhizoboxes should be placed in a support with the glass side facing downwards. The last rhizobox should be covered to stop heating if the rhizobox is dark in colour. Further to this, the support & rhizoboxes can be wrapped in white plastic sheeting to stop the rhizoboxes becoming too hot.

Tips

- Depending on the condition of seeds, they may require surface sterilisation prior to germination. The health of germinating seeds should be tested prior to an experiment to assess the need for surface sterilisation.
- All items should be clean before being used to make a rhizobox, however, the glass sheet is particularly important especially if it has been used before. Clean glass helps to improve image quality. Soap and water should be enough but solvents can be used for tougher stains.
- This document assumes that rhizoboxes will be held in a purpose built support (see file 'Support assembly instructions'). This may not be possible, especially at initial stages of experiments. In this case, a rhizobox or several can be placed against a suitable strong structure such as a table or shelving unit, however, it is important to properly assess that the structure can safely support the rhizobox/es.
- It is ideal to build an extra support or half-width support which can be used to place rhizoboxes when they are being moved.

Timeline

Preparation – Rhizobox & Preparation - Soil

This can be done **in advance**. Soil drying may take time and so should be done several weeks in advance. The other tasks can be done, at the latest, in the week before the start of an experiment.



Preparation – Seeds

This should be done **several days before** the start of an experiment. This time depends on the germination time for the seeds used in an experiment and can vary with species, variety and germination conditions. Make sure this is tested before designing an experiment.



Soil loading / assembly

This should be done as soon as possible to the **start of an experiment**. It is possible for 2 people with some experience to make approx. 10 rhizoboxes in a day. Larger experiments will therefore take several days.



Planting

This is the **start of an experiment**! Adding seeds to assembled rhizoboxes should be done on the day of soil loading and assembly if possible or as soon after as possible. Very large experiments can be staggered if assembled rhizoboxes would be left for too long.