TURF TROUBLES

A science investigation pack for teachers of 7-9 year olds

CENTRE for INDUSTRY EDUCATION COLLABORATION

Supported by the Gatsby Charitable Foundation

Contents

Introduction

AGE RANGE

The activities in this book provide opportunities for primary children to investigate various conditions of growth of plants, to discover which will produce the best crop.

CONTEXT

The context is that of a sports company who wish to provide a turf surface at a sports ground that is suitable for a range of sports and activities[1]. They need information on suitable types of grass and the best conditions for growth. They also need to apply for a water abstraction licence from the Environment Agency, and need to know how much water will be needed by the grass, as well as the effect of the ground type on water absorption.

The context is closely related to actual problems facing companies. The Sports Turf Research Institute (STRI) in West Yorkshire was set up in 1929 to undertake research and provide advice for golf clubs, but it has subsequently become the market leader in turf grass research and agronomy. It now advises golf and sports clubs, local authorities, stadium venues, and amenity grasslands throughout the world. Thus, any company wishing to build a new golf course or sports ground will almost certainly refer to the STRI for information on types of grass, and the conditions required to grow it successfully.

Similarly, should anyone not on the mains water supply want to take water from the environment, a water abstraction licence must be obtained from the Environment Agency if a stream, river, pond or well is to be the source of water. The licence holder is charged by the 1000 cubic metres of water, and the licence can be quite expensive, so the calculations for the amount of water needed have to reasonably accurate! In the case of farmers wishing to irrigate crops, the calculations involve the size of the field, the soil type, the soil water deficit (how good the soil is at retaining water) and the crop type. In these activities the children are able to investigate two of these, the soil type and the soil water deficit. Appendices 1-3 give further background information on grasses.

ACTIVITIES

The activities take approximately 3-4 hours, and can be completed over a 3 week period. Appendices 4-5 provide lesson plans, as well as a sample assessment grid for one investigation.

Activity sheets are included to help children record their ideas, measurements and findings. At Lower Key Stage 2 children are expected to '*...record findings using simple scientific language, drawings, labelled diagrams, keys, bar charts and tables*'. It is hoped that the formats provided will increase the children's enjoyment of science by appreciating the variety of ways in which they can record their work. The formats are also intended to support differentiated teaching in the classroom.

1 Although the context is that of turf growing for sports grounds, the teacher may prefer to grow a different plant, or 'crop' to link with a specific school visit or topic. See the teaching notes for Activity 2 for further suggestions.

ACTIVITY SUMMARY

Title	Description	Timing
1a **Top turf** (Years 3-4)	A newspaper article stimulates an investigation into the factors required for healthy plant growth (light, temperature, water and air). The investigative focus is on developing skills of prediction, measuring, recording and considering the evidence.	2 hours and 10 mins per day
1b **Turf troubles: which liquid?** (Years 3-4)	A letter from a company that grows turf sets the context in which children investigate the effects of different liquids (drinks) on plant growth.	1 hour 45 mins and 10 mins per day
2 **Which soil holds the most water?** (Years 3-6)	Experiments are set up to discover which type of soil best retains sufficient water to help the plant growth. Years 5-6 children are set an investigation to make up different soil types from mixtures of sand, compost and soil.	1 hour 40 mins

1a. Top turf

2 hours and 10 mins per day

A newspaper article stimulates an investigation into the variables required for healthy plant growth (light, temperature, water and air). The investigative focus enables children to work scientifically in a variety of ways.

OBJECTIVES

- Setting up simple practical enquiries, comparative and fair tests
- Making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers
- Explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant

APPROXIMATE DURATION

90 minutes, split by 3 weeks of 10 minutes daily recording.

RESOURCES

- Activity sheet 1a
- Activity sheets 2-4 (ability-dependent)
- Packets of grass seed
- Data-logging equipment (optional)
- 8 seed trays
- 8 thermometers
- Water
- Coir
- Cooking oil
- Seed compost
- Soil
- Sand

INTRODUCING THE ACTIVITY (30 minutes)

Read the newspaper article on Activity sheet 1a (based on a real article) to introduce the problem. An American company wishes to buy English turf for new housing estates, in both the United States and England. The article should provide some ideas as to what it is about English turf that makes it so desirable. Questions to encourage the children to think about this could include:

- *What might be different about growing grass in England rather than America? (Rainfall? Amount of sunlight? Temperature? Type of soil?)*

- *What might the Americans mean by the quality of the grass growing in England? (Green colour? Thickness of growth? Rate of growth?)*

The children will no doubt suggest some of the important conditions for healthy growth, but probably not all of them. The teacher can introduce the conditions missing from the discussion, and ask the children whether they might be important, and worth testing.

Now share the planned activity with the children, presenting the 8 sets of growing conditions as shown in this table:

Seed tray								
Growing condition	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Soil	✓	✓	×	×	×	✓	✓	✓
Warmth[1]	✓	✓	✓	✓	✓	×	✓	✓
Light	✓	×	✓	✓	✓	✓	✓	✓
Water	✓	✓	✓	✓	✓	✓	×	✓
Air	✓	✓	✓	✓	✓	✓	✓	×

Subsequent discussion can include:

- *How have we made sure that the test is fair?*
  Ensure that all conditions are kept the same, except for the one changed. The teacher can discuss, or decide beforehand, what the quantities should be (e.g. of soil etc., seeds, and water for each watering).
- *How shall we keep the watering the same for all?*
  Use the same measured quantity (this may be in spoonfuls, pipettefuls or millilitres) and water at the same time, not necessarily using the same time interval, but when the soil is feeling dry.
- *How should we measure the growth of the grass? Can we measure just one grass plant? What would be a fair way of measuring?*
  Select a method from the list below, depending on the ability of the children. Measure:
  - the tallest blade each day
  - the tallest and shortest and divide by 2 to find the mean
  - 10 blades of grass and choose the 'common' height
  - several blades of grass e.g. 10, and find the average.
- *What do you think will happen to the seeds in each tray?*
  Ask once trays have been set up. Children can make predictions for up to 8 trays, using drawings, writing or a table.

Activity sheets 2-4 provide recording opportunities for a range of abilities.

1 Data-logging equipment can be used to measure temperature and light, if desirable. The sensors and computer can be kept running continuously for the 3-week growth period, resulting in a graphical output of any change in temperature, and any effect of changing light levels on temperature. The air temperature should only show significant change in the 'cold' location.

MAIN ACTIVITY (30 minutes)**:**

Children work in 8 groups, each being responsible for one seed tray, and the associated growing conditions. Each group can be given a list of their test's growing conditions and 5 minutes to think about how it might be achieved. Follow the children's ideas, if suitable. If not, suggest those listed below, and ask each group to set up their test.

The seeds can be planted in rows or scattered, or each method used in half the tray (it is easier to measure the height when grown in rows).

Tray 1: Use all conditions for healthy growth.

Tray 2: A black bin liner can be used to provide darkness. Trays 3, 4 and 5: Use sand, seed compost and coir (a coconut derivative, available from garden centres) as alternative growing media.

Tray 6: An outside, protected area is ideal. Do not use a refrigerator, as it will also be dark.

Tray 7: Best kept next to tray 1, but not watered. All other trays should be watered equally as the soil, etc. dries out.

Tray 8: Keep this tray in a transparent plastic bag, with the air removed using a straw (place the straw to the side of the tray, to prevent sucking up the compost). The air will need to be removed after each watering. Water with cooled, boiled water, as this removes dissolved air.

OBSERVATIONAL RECORDING (10 minutes per day)

Carry out observations every 2 to 3 days, at roughly the same time, using the choice of Activity sheets 2-4.

Seed growth will not be observed for several days, and possibly up to a week after planting, but temperature records can still be maintained. However, the apparent lack of growth can be used to reinforce the notion that living things do take time to grow and develop. Some, like humans, take years to reach full size, while others like grass, take just weeks to develop fully.

PLENARY (30 minutes)

Once the results have been recorded, and graphs produced, encourage the children to discuss what they have learned from the investigation. The discussion can begin by considering what is meant by healthy growth, and how the children would recognise a healthy plant. Questions might include:

- *What colour are the leaves of the grass in the tray 1?*
  This tray has all conditions for healthy growth, and tells us what happens to the seeds and plants when nothing is deliberately changed. It is called a 'control' by scientists.
- *Are the blades of grass strong and upright? What about the grass in the other trays?*
- *Is there a difference in the breadth of the blades of grass in the control tray, compared to the others?*
- *Is there evidence of a difference in the rate of growth?*

In contrast, what does an unhealthy plant look like:

- *Have the leaves withered?*
- *Are they yellowing?*
- *Is growth slow or has there been no growth at all?*

Can the children suggest what effect the various changes to conditions have had on the growing grass? They should consider:

- *What has happened to the grass growing without light, or water?* Yellowing leaves, thin and straggling, or even dead.
- *What has happened to the grass growing in the cold conditions?* The grass has probably grown more slowly, and it will be less vigorous, than that in the control tray.
- *What has happened to the grass growing in the sand, compost and coir?* Grass grown in the sand will show signs of unhealthy growth due to the lack of nutrients, whereas the compost and perhaps even the coir will have encouraged strong growth.
- *What has happened to the grass growth away from air?* This will similarly show very unhealthy growth, if there is any sign of growth at all.

News Post

Thursday *48p*

English grass is the best, say Americans!

A new export market set to open

Turf grower's bonanza!

Turf growers in England have been discovered by the Americans. Apparently they envy our typical English green lawns of smooth, well-mown grass which grow in our gardens, and surround so many of our housing estates. As a result, a firm in Florida, GreenGrass Inc., has decided to import English grass.

The Director of GreenGrass Inc., Howard Johnson Jr., explained that he had had the idea as he flew in to England for a meeting one morning. As his plane waited to land he noticed how green the countryside was, compared to America. As the plane got lower, he could see all the green lawns in the gardens. "*I suddenly realised that there would be a market for good English grass in America*," he said. "*My neighbour had just been complaining to me before I left home about the lawn behind his house. It was yellow and patchy, instead of the lush green you have here in England.*"

Great conditions

Mr. Johnson went on to explain that the conditions in England were suited to growing grass. In America, the summers can be very hot and dry, while winters become very cold indeed, often with lots of snow.

A market for grass

Mr. Johnson visited turf growers all round the country, and has now got a contract to buy English turf for export to America. It will be grown here, and then transported in rolls, similar to the way we can buy it here.

"*I have already arranged to sell all my first batch to a landscape gardening company in Florida, who have a contract to make the lawns for a new group of houses being built*," explained Mr. Johnson.

Another company who landscape new housing estates all over America has also asked to buy stocks of the English turf. It is becoming very popular now to provide turf surrounds to the houses, because it looks much nicer than bare concrete and tarmac.

If the idea becomes as popular as Mr. Johnson thinks, then turf growers in this country have cause to thank our English weather for providing the ideal conditions for grass growing! So next time you complain about the mild but wet spring and summer weather, spare a thought for the turf growers, who will be helping fund a major new export market!

Activity 2: Growth record sheet

Tray number ☐

Put a circle round each growing condition in your test:

warm dark coir water light

cold air soil sand seed compost

What we predict will happen to our seeds:

We have cut strips of paper the same length as the longest plant every 3 days, and stuck them on this chart.

Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 21	Day 24

Activity 3: Growth record sheet

We are growing our plant with the following conditions : _____

_____

_____

We predict that our plants will _____

_____

We will measure the longest plant and the shortest. We will find the average height.

Day	Longest	Shortest	Average
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

Activity 4: Growth record sheet

We are growing our plant with the following conditions : _____

_____

_____

_____

We predict that our plants will _____

_____

_____

_____

Every 3 days we will measure the height of 10 plants, and work out the average height.

Day	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7	Plant 8	Plant 9	Plant 10	Plant Average
3											
6											
9											
12											
15											
18											
21											
24											
27											

1b Turf troubles - which liquid?

1 hour 45 mins and 10 mins per day

A letter from a company that grows turf sets the context in which children investigate the effects of different liquids (drinks) on plant growth.

OBJECTIVES

- Setting up simple practical enquiries, comparative and fair tests
- Reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions
- Explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant

APPROXIMATE DURATION

1 hour 25 minutes (split by 2 weeks of 10 minutes daily recording).

RESOURCES

(Per group of 4)

- Activity sheet 1b, 5-7
- 2 seed trays with previously germinated grass seed[1]
- Packets of grass seed
- Labels (plant labels will be ideal)
- 50 ml measuring cylinder
- 2 small screw top pop bottles (280 ml/330 ml size)
- Range of liquids e.g.:
    - salt water
    - cola
    - sugar water
    - tea
    - white vinegar
    - coffee
    - lemonade

1 The trays of grass seed will need to be prepared 10-14 days in advance, by either the teacher or children. The seed is then allowed to germinate normally, so that there is a crop of grass to test and observe.

INTRODUCING THE ACTIVITY (10 minutes)

Read the letter on Activity sheet 1b to set the scene. The discussion can then begin by looking at types of grass in general. Brainstorm suggestions about where grasses grow and the characteristics of the grasses that grow in different places. Questions to encourage ideas can include:

- *Where does grass grow?*
  They can be found almost anywhere there is a place for their roots to hold.
- *Are all grasses the same?*
  No. There are lots of different types.
- *Can you describe different types of grass?*
  Tall, short, flowering, broad leaves, narrow leaves, soft leaves, hard leaves, short leaves, etc.
- *Are there differences between the grass on a lawn, and on a bowling green? What about a football pitch, or a cricket pitch?*
  Grass sold for lawns is usually 'hard-wearing' rye grass, while that for bowling greens is much finer and susceptible to wear.
- *What sorts of grass characteristics might be needed for particular sports?*

The detail found on the backs and sides of grass seed packets can be used to help develop and inform their ideas.

Children are now reminded of the conditions plants require for healthy growth, and that water is one of these. You may choose to discuss some of the reasons why plants need water, in simple terms. You could include:

- Seeds will not germinate without water.
- Water carries dissolved materials from the roots to the leaves.
- Water is used up during photosynthesis, when the plant makes starch, etc. from carbon dioxide, air and water, using the energy from the sun.
- Water provides support for leaves and stems of plants like tulips, which do not have a 'skeleton'.
- Water in the leaves evaporates during hot weather, and so cools them, stopping the leaves from being scorched by the sun.

The question to be investigated asks whether other liquids might stimulate growth in plants like grass.

Safety note

- Keep the liquids in clearly labelled screw top bottles.
- Use commercial compost rather than garden soil in the seed trays.
- Children should always wash their hands after handling the soil and the liquids.

MAIN ACTIVITY (45 minutes, and 2 weeks of 10 minutes daily recording)

Using the Investigation planner on Activity sheet 5, the groups of 4 children spend about 15 minutes planning their investigation. The teacher may stimulate discussion to help this by asking questions such as the following:

- *Should groups have a control experiment?*
  Since no two experiments are likely to be identical, there should be individual controls for each group.
- *Which liquid(s) should you use?*
  If they run a control, one liquid will be ordinary water. Since there are several groups, each group can investigate one other liquid.
- *How much liquid should you use?*
  25 ml would be a good starting point, and this could be varied as the test proceeds, as long as the amount is kept the same for the control as well.
- *What equipment will we need?*
  This is partially answered for them on the Planner, but they will need to add some items to this.
- *How can we make sure we have a fair test?*
  Decide what are the important variables to keep the same (e.g. it does not have to be the same person pouring the liquid on each time, or how quickly it is poured on, but the quantity is important) and what that 'sameness' should be (e.g. continuing to pour 25 ml of liquid onto water-logged plants is not a good strategy! Perhaps the amount and frequency of adding should be reconsidered).
- *How can we record our findings?*
  Select a method from the list below, depending on the ability of the children.
  Measure:
  - the tallest and shortest and divide by 2 for the mean
  - 10 blades of grass and choose most 'common' height
  - several blades of grass e.g. 10, and find the average
  - using a grid (Activity sheet 8) and counting squares coverage
  - using a grid, and converting squares of coverage to percentages.

Once the teacher is satisfied with a group's plan, they set up their investigation. The trays should be labelled clearly with the liquid used for watering, and then placed in the same area near the windows, so that all other conditions remain the same.

The following two weeks are spent watering and recording the effects on Activity sheet 6. Some will undoubtedly wilt, change colour or die during the recording period. The recording sessions will take about 10 minutes, and should be done at roughly the same time of day.

Groups plot charts of the growth (or otherwise) of the grass, showing the rate at which the liquids have stimulated, or harmed growth.

Ideas can be developed as to dealing with missing data from weekends. For example, a space can be left on the recording sheet, the results plotted, and the missing results *interpolated* into the graph (that is, the missing results of coverage can be estimated and placed on the graph perhaps in a different colour to show that they are not measured, but merely estimated).

PLENARY (30 minutes)

The final session should draw together the results from all the groups, so that discussions can identify the effects of the different liquids. The final record sheet can either be filled in individually or by the groups, or a flip-chart sheet or similar can be prepared from Activity sheet 7. Once all the results have been collated, they can be used to draw final conclusions. For instance:

- *Have any liquids caused damage to the grass?*
- *Have any liquids killed the grass?*
- *Have any liquids increased the growth of the grass?*
- *What has happened to the control experiments? Have different groups' control experiments grown in a similar way?*

The children can note any surprising results; for instance, it is often suggested that lemonade is added to cut flowers in a vase to keep them fresh for longer. Is there any evidence that this has helped the grass grow?

- *What effect does lemonade or cola have on grass growth?*
- *Are there any hints which ground staff or gardeners might find useful if they want to avoid harming their grass?*
- *Is there any information which ground staff and gardeners might find helpful to enhance the growth of their grass?*

Finally, the children can write a letter to gardeners/ground staff explaining their findings, and explain how they could make use of them.

Sports Turf Ltd

Keighley, West Yorkshire

Dear Scientists,

We are a firm that lays grass turf for sports grounds around the country. We have been asked to grow some grass for a new community sports ground. The ground will be used for playing football, rounders, tennis, hockey and cricket. We need to grow a type of grass that will not wear away easily from all the different sports. As users and spectators will bring drinks into the ground, we also want to select a grass that will not be damaged by any spillage of these drinks.

Finally, we need to know how much watering the grass will need to keep it healthy. We have to get permission to take water from the nearby river to water the sports ground. The more water we take, the more expensive it is, so we want to apply for the right amount of water. Can you investigate the amount of water the grass needs, and how much is soaked up by different types of ground? The usual three sorts of soil we find are sandy, fine soil and heavy clay types.

Therefore, in summary, we would like your help to find out:

- whether grasses are damaged by spilled drinks
- the wear on different grasses
- how much watering the grass will need, depending on the soil type.

Any information you can give us will be useful.

Yours faithfully,

Ruth Petera

Research Director

Activity 5: Scientist's investigation planner

We will have: seed trays, grass seed, compost, liquids, containers, window sill

The question we will investigate is _____

_____

_____

The liquids we could investigate are _____

_____

_____

We predict that _____

_____

_____

_____

This is because _____

_____

_____

We will record our ideas by _____

_____

_____

Activity 6: Which liquid? Record Sheet

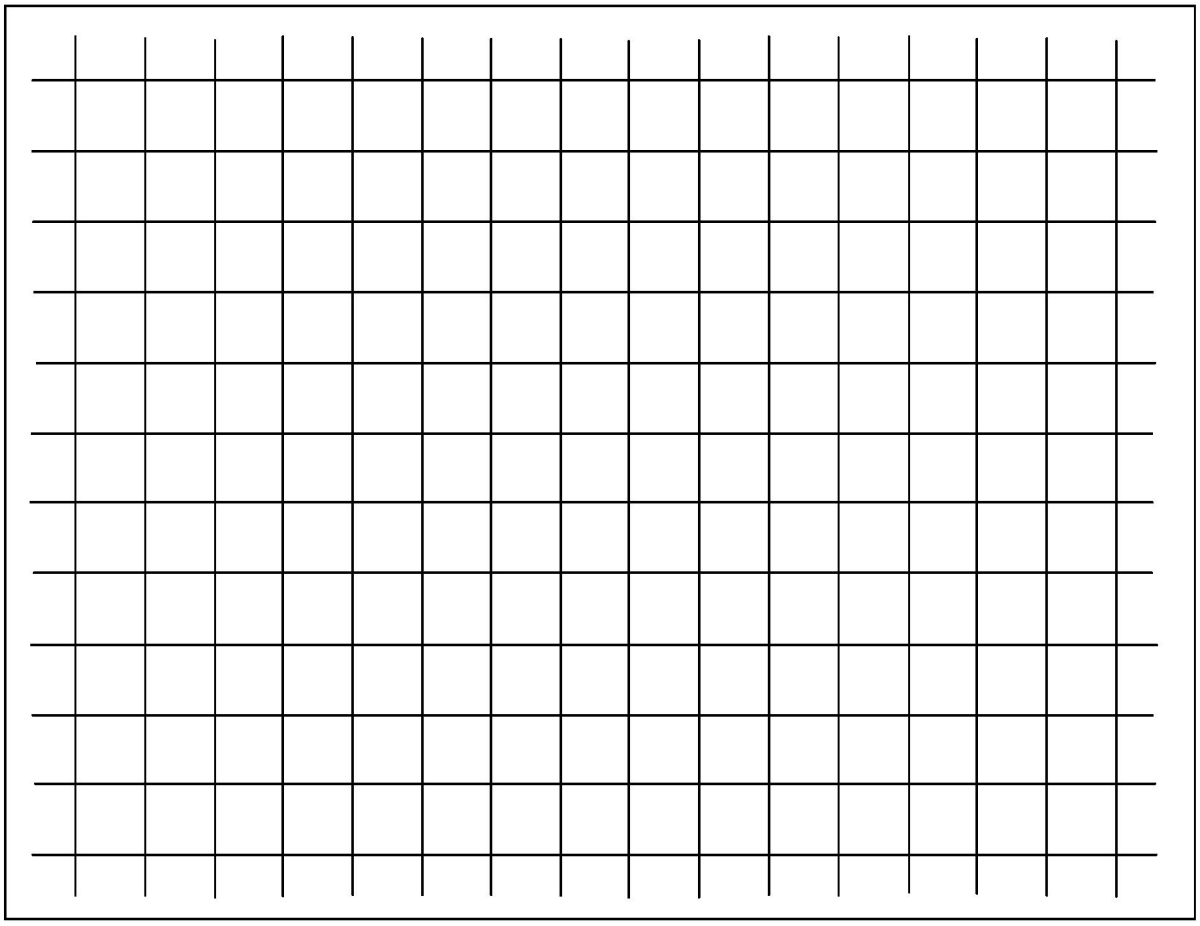
We measured the longest and shortest blades of grass, and found the average length for our control experiment, and for our different liquid.

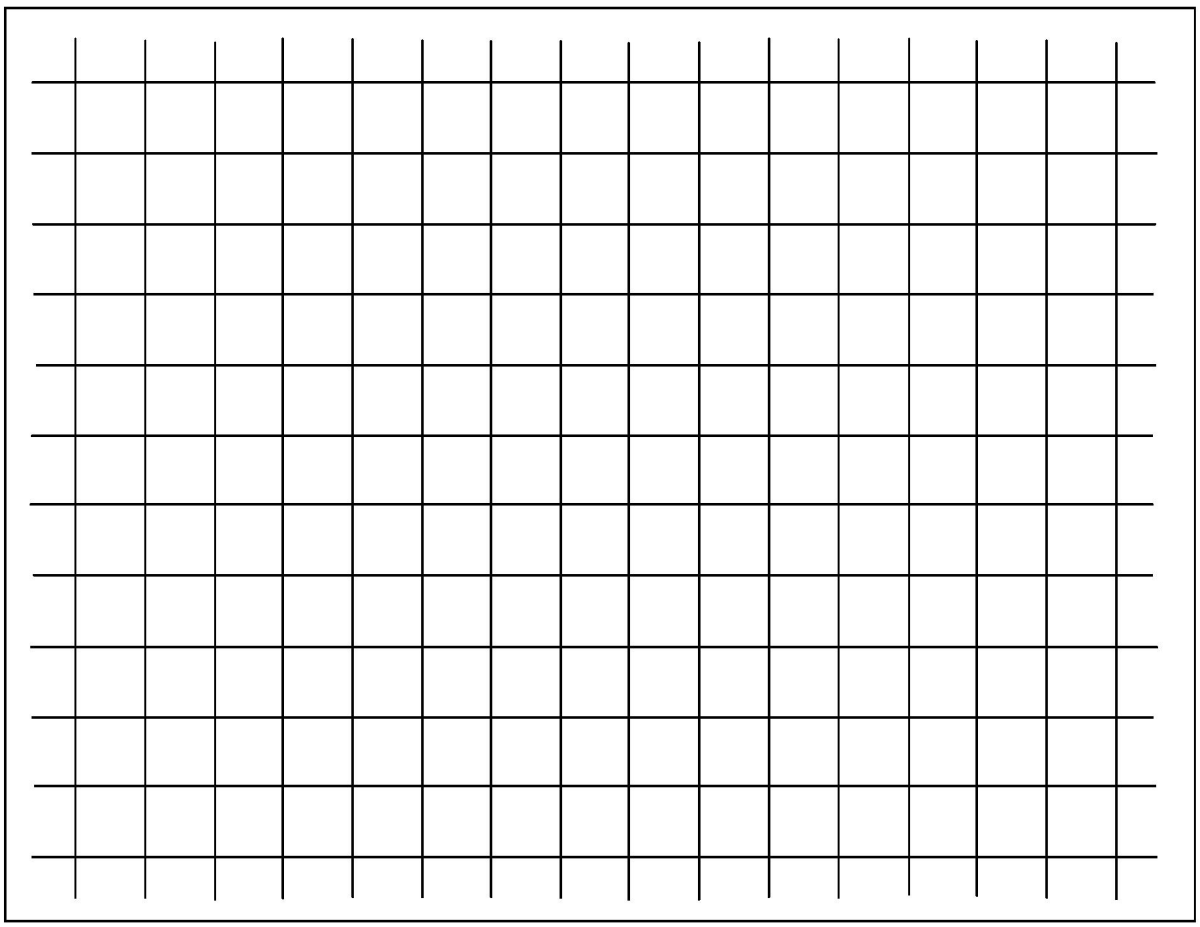
We also recorded the colour and shape (thick, thin, bent over) of the grass.

	Control tray Liquid: water				Test Tray Liquid: _____			
Day	Longest	Shortest	Average	Appearance	Longest	Shortest	Average	Appearance
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								

Activity 7: Final results sheet

Sample	Final Result	Conclusion
Control		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		





2. Which soil holds the most water?

1 hour
40 mins

Experiments are set up to discover which type of soil best retains sufficient water to help the plant growth. There is an extension opportunity to investigate different soil types from mixtures of sand, compost and soil.

OBJECTIVES

- Setting up simple practical enquiries, comparative and fair tests
- Reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions
- Recognise that soils are made from rocks and organic matter

APPROXIMATE DURATION

1 hr 40 minutes (and 60 minutes optional extension activity).

RESOURCES

(Per group of 4)

- Activity sheet 2b (Years 5-6) or sheet 9 (Years 3-4)
- 2 x 100 ml measuring cylinders
- 2 beakers (100 ml or 250 ml)
- 2 funnels
- 2 filter papers
- Large yogurt pot full of each: compost, sand, gravel, garden soil and peat
- Large yogurt pot

ADVANCE PREPARATION

Two soil samples are prepared as follows (a plant pot or yogurt pot being a 'unit'):

- Sample 1 (sandy)
    - 2 units compost
    - 1 unit sand
    - 1 unit gravel
- Sample 2 (loam)
    - 2 units compost
    - 1 unit peat
    - 1 unit garden soil

INTRODUCING THE ACTIVITY (10 minutes)

Years 5-6 refer to Activity sheet 1b and Years 3-4 to Activity sheet 9. Both contain a letter from the Sports Turf company, asking for information about the amount of water needed by both the grass and the amount of water retained by different types of soil. As the company points out, the licence from the Environment Agency is expensive, and therefore need as much accuracy as possible.

Begin by discussing the types of soil commonly found. The letter lists three types of soil. In what way might these soils hold onto the water? Questions to encourage ideas could include:

- What happens when the tide comes and goes on sandy beaches?
- What happens to water on pebbly, gravelly beaches?
- If the ground was very sandy, how might water soak into it?
- What happens to rain water on the school field/garden?
- Does it lie on the surface after heavy rain?

MAIN ACTIVITY (1 hour)

The groups are provided with the two samples of soil, sandy and loam.

When planning their investigation, encourage the children to think carefully about the design of the work. They need to consider aspects such as:

- Whether to use the same amount of soil and water
- Should the soil be pressed down?
- Should the water be added at the same time?
- Should they measure how much water comes through in a certain period of time?
- Should they record the amount of water coming through after certain intervals of time?

Younger or less able children can be provided with a structured test, if felt appropriate:

1. Place a piece of filter paper in a funnel and fill it with the soil sample.
2. Place the funnel on top of a measuring cylinder.
3. 100 ml of water is poured carefully onto the sample, and the water running through the soil is collected in the cylinder.
4. The quantity collected is subtracted from the original 100 ml to calculate how much has been retained by the soil.

PLENARY (30 minutes)

The results of the investigations should be collated, and the children asked to suggest which types of soil retain water, and which allow it to soak through quickly. Discussion can highlight various points.

- *Why is this information important to the Sports Turf company?*
- *Could ground staff alter the characteristics of the soil on the sports ground?*
- *What could they do to achieve this?*
- *Would it be worth doing, bearing in mind the cost of water licences?*

EXTENSION ACTIVITIES (1 hour each)

1. 1. Some children could be encouraged to investigate the type of soil in the school grounds, or from their own garden. The investigation can be set up as above, using a sample of the soil. The results can be compared to the results from the samples used in the main activity, so that the children can suggest what sort of soil is present locally. The children could then try to alter the characteristics of the soil by adding compost and/or sand to achieve a particular water retention.
2. 2. Children can plot the data from one of the tables shown in Appendix 3 (either manually or using a computer spreadsheet) to decide on the most hard-wearing, disease- resistant grass types. This data has been obtained by professional researchers. Appendices 1-2 provide additional data to compliment the research of enthusiastic Year 5 or 6 scientists!

Sports Turf Ltd

Keighley, West Yorkshire

Dear Scientists,

We are a firm that lays grass turf for sports grounds around the country. We have been asked to grow some grass for a new community sports ground. The ground will be used for playing football, rounders, tennis, hockey and cricket. We need to grow a type of grass that will not wear away easily from all the different sports. As users and spectators will bring drinks into the ground, we also want to select a grass that will not be damaged by any spillage of these drinks.

Finally, we need to know how much watering the grass will need to keep it healthy. We have to get permission to take water from the nearby river to water the sports ground. The more water we take, the more expensive it is, so we want to apply for the right amount of water. Can you investigate the amount of water the grass needs, and how much is soaked up by different types of ground? The usual three sorts of soil we find are sandy, fine soil and heavy clay types.

Therefore, in summary, we would like your help to find out:

- whether grasses are damaged by spilled drinks
- the wear on different grasses
- how much watering the grass will need, depending on the soil type.

Any information you can give us will be useful.

Yours faithfully,

Ruth Petera

Research Director

Sports Turf Ltd

Keighley, West Yorkshire

Dear Scientists,

We are a firm that lays turf for sports grounds around the country. We have been asked to prepare the surface of a new ground with turf. The ground will be used for playing football, rounders, tennis, hockey and cricket.

We understand that your group is investigating types of grass, and the conditions in which they grow.

We need to know how much watering the grass will need to keep it healthy. We have to get permission to take water from the nearby river to water the sports ground. The more water we take, the more expensive it is, so we want to apply for the right amount of water. Can you investigate the amount of water the grass needs, and how much is soaked up by different types of ground? The usual three sorts of soil we find are sandy, fine soil and heavy clay types.

Any information you can give us will be useful.

Yours faithfully,

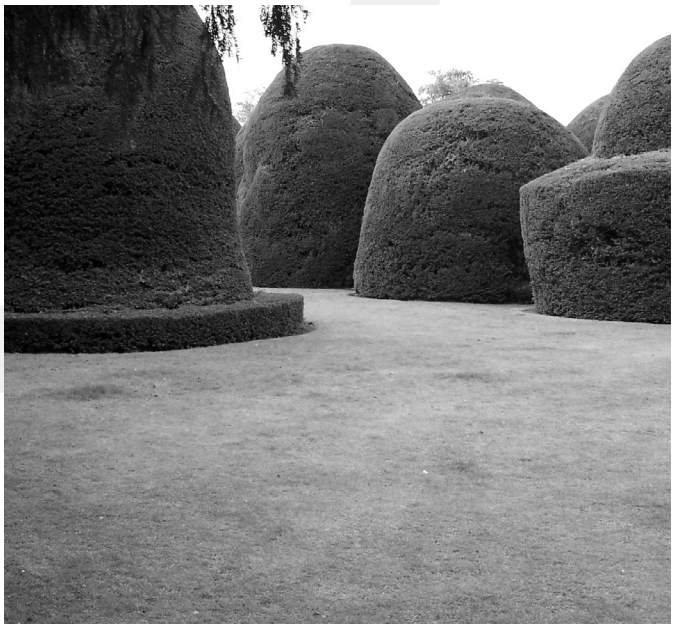
Ruth Petera

Research Director

Appendix 1

TYPES OF GRASSES

The grasses used for luxury lawns, with the bowling green look, are fine-leaved compact types. These are the Bent grasses and Fescues, which are slow growing. However, it does not stand up to very hard wear, such as children playing on it or people constantly walking along the same track on it. Some common examples are Bents such as Brown top and Creeping Bent, and Fescues like Chewings Fescue and Creeping Red Fescue. This last type is widely used in the production of sports turf.



The classic English luxury lawn using Bent and Fescue grasses

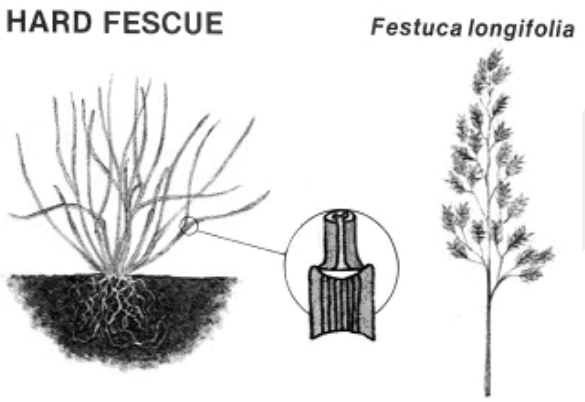
Harder wearing grasses are usually broad leaved types such as perennial ryegrass. These grow quickly in late spring and summer and need frequent cutting. They will stand children playing games on them, people walking over them and even cycling on them. Common examples of these grasses include meadow grasses, ryegrass and grasses such as Timothy.

Harder wearing grasses like Ryegrass and Meadow grasses

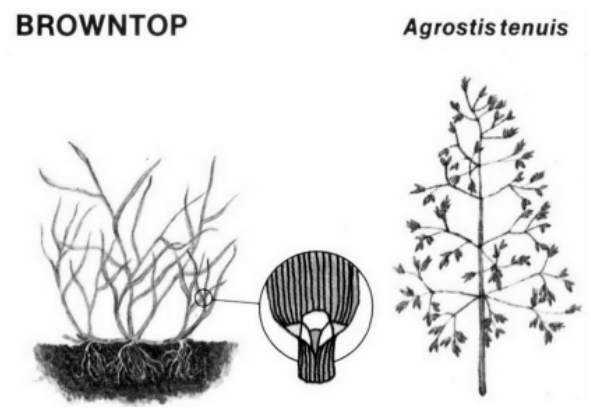
Appendix 2

GRASS IDENTIFICATION PICTURES AND DETAILS

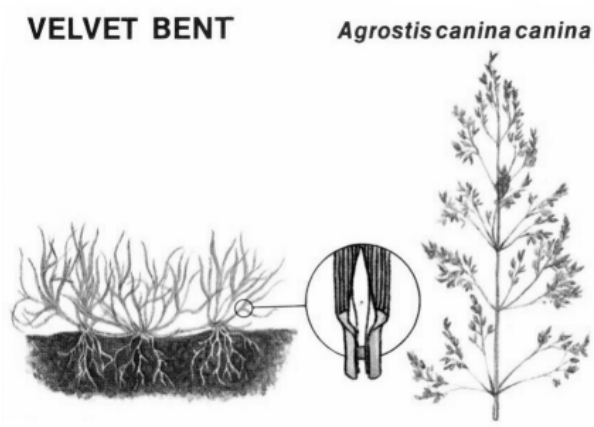
The following grasses are used in sowing high quality lawns and sports turfs. They are slow growing and fine leafed varieties:



Grows in all soils, apart from heavy clays. Succeeds in dry areas.

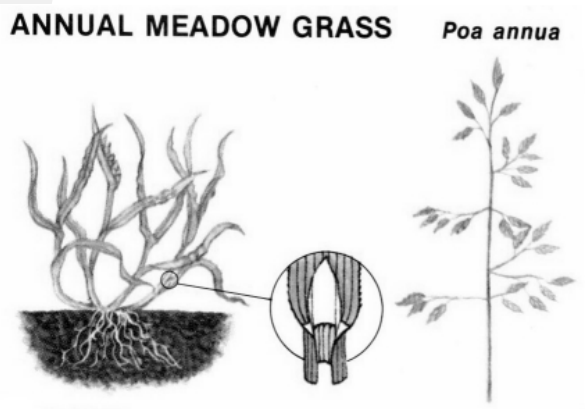


Grows in all soils and is well suited to dry and acid soils.

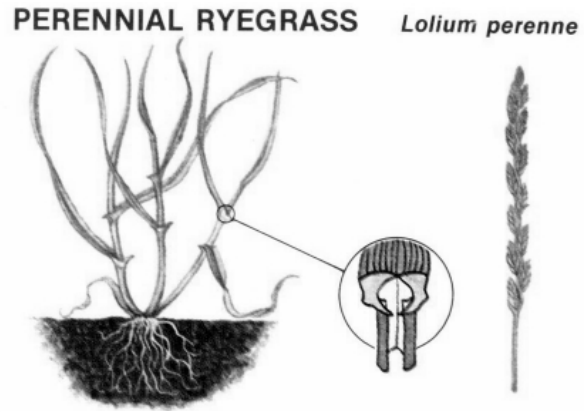


This grass favours damp conditions and will tolerate shade.

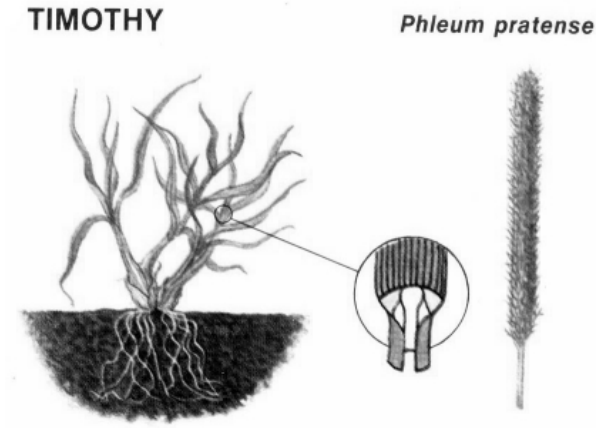
The following grasses are called utility lawn grasses, and are broad leafed, quick growing varieties:



Grows in all soil types.



This grass grows in all soil types, thriving in moist fertile land.



Succeeds in heavy wet soils. It is shallow rooting and is not suitable for thin dry land

Appendix 3

GRASS TESTING DATA

Taken from the Sports Turf Research Institute 'Turfgrass Seed 2002' Data book, STRI, Bingley, West Yorkshire BD16 1AU.

The STRI was set up in 1929 to undertake research and provide advisory services to golf clubs. This work has now expanded to include all other sports and amenity grass areas, and STRI is recognised as a world centre for research into grass surfaces.

The Institute has developed tests to evaluate various types of turf grasses. The fine turf grasses are evaluated for use in close mown turf for golf and bowling greens, ornamental lawns, golf fairways and for low maintenance uses. Course turf grasses are tested for use in football and rugby pitches, lawns and low maintenance situations.

The data given here is condensed (for use by children) from the STRI to facilitate the use of the numerical information as part of their data handling work. In Extension Activity 1, the children should identify the particular properties that are important for the situation, and choose grasses which score well for those characteristics.

TABLE 1: Perennial ryegrass for winter pitches (In order of how well they withstand wear)

In the tables the bigger numbers are better, so that a grass with a score of 8.0 for shoot density would produce thicker turf with lots of grass shoots than those with a score of 7.0. There are two tables for perennial ryegrass, the first one in order of wear tolerance (how well it will stand lots of people running on it), and the second one in order of shoot density and slow regrowth under frequent cutting. A grass which stands up to lots of running about on it would be good for football and rugby pitches used a lot in the winter, and a high number for slow regrowth would mean that the grass would not need to be mowed so often to keep the grass at a reasonable height. You should not choose grasses just because they are at the top of the list - look at other properties as well. For instance, football and rugby pitches may be better if the grass seed used is a type which does not easily get diseases like red thread disease, but still stands up to heavy wear. You should look for the particular things that are important for the sports ground, and choose grasses which score well for those characteristics. For instance, you might decide that your football pitch should be planted with Ritmo grass seed, because it will resist disease well (7.4) but will still stand up to wear quite well too (7.0). It will also produce quite a lot of shoots to make the turf fairly thick (6.7).

You can choose the greenness of the grass as well if you wish, but this does not affect the way it grows!

TABLE 1 (Continued)

Grass type	Wear (mean)	Shoot density	Leaf fineness	Slow growth	Disease resistance	Greenness
Aberimp	7.4	6.4	6.3	7.9	5.0	M
Barlinda	7.2	5.5	6.1	5.7	5.4	D
Verdi	7.2	6.5	5.2	7.1	5.4	M
Essence	7.1	7.5	7.0	6.4	5.3	M
AberElf	7.1	7.0	6.7	5.9	6.2	D
Eden	7.0	5.3	4.8	5.7	5.8	D
Ritmo	7.0	6.7	6.8	6.7	7.4	D
Concerto	6.8	7.3	5.6	6.7	6.0	D
Greenstar	6.8	6.5	6.1	5.4	5.3	M
Disco	6.7	6.4	5.9	5.7	5.3	M
Bardessa	6.7	6.0	6.4	6.1	6.9	M
Darius	6.6	7.4	7.3	6.9	5.2	D
Claudius	6.6	5.4	5.1	6.2	6.6	M
Troubadour	6.5	5.7	6.4	5.9	5.6	D
Lex 86	6.4	7.4	6.8	6.7	5.2	M
Evita	6.4	6.7	7.9	6.0	7.4	D
Ballet	6.3	6.9	6.5	6.9	5.8	D
Lorettanova	6.2	6.0	6.9	6.1	7.3	M
Barmona	6.2	6.9	6.6	6.3	5.2	D
Superstar	6.0	6.9	6.4	5.7	5.7	M
Sauvignon	5.9	7.9	8.4	6.2	4.2	D
Queens	5.8	6.2	5.6	6.3	6.0	M
Capri	5.8	6.2	6.4	5.9	7.0	M
Lorina	5.7	6.2	6.8	6.8	5.0	M
Dali	5.6	7.9	7.5	5.9	5.6	M
Juwel	5.0	4.8	4.5	5.9	5.3	M
Barcredo	4.9	6.0	6.4	5.6	5.8	M

The final column refers to the winter colour: L - Light Green; M - Mid-Green; D - Dark Green

TABLE 2: Perennial ryegrass for lawns, cricket fields etc. (In order of shoot density, fineness of leaf, and slow regrowth)

A high number in the first column indicates that the grass will stand being cut short (cs), has a good shoot density (sd), finer leaves (fl)and a slow growth (sg) between regular mowing. The number is the average of all four things. The second column shows how cleanly the grass will cut. The third column gives a number for short growth. Choosing a shorter growing grass like AberImp (7.5) which also has a high score for slow regrowth (average 8.3) will help the groundsman if they cannot mow the grass frequently.

The last two columns let you choose the colour of grass you would like to see in summer and winter, but this does not affect the growing of the grass!

Grass type	Average (cs, sd, fl, sg)	Cleanness of cut	Short growth	Summer greenness	Winter greenness
AberImp	8.3	7.0	7.5	M	M
Sauvignon	8.0	6.8	6.8	M	D
Evita	7.6	5.2	5.9	D	D
AberElf	7.4	6.8	7.7	D	D
Darius	7.2	7.0	7.9	D	D
Dali	7.1	6.8	6.7	M	M
Lorina	7.1	7.6	7.9	M	M
Ritmo	7.0	7.0	5.6	D	D
Ballet	6.8	6.6	7.4	M	D
Lex 86	6.7	6.6	6.6	M	M
Lorettanova	6.6	6.3	6.4	M	M
Barmona	6.5	5.8	5.9	L	D
Bardessa	6.5	6.3	6.1	M	M
Essence	6.4	6.5	5.6	L	M
Superstar	6.4	3.9	6.0	M	M
Concerto	6.3	6.9	5.2	D	D
Greenstar	6.1	5.8	6.4	D	M
Disco	6.1	6.4	5.8	D	M
Queens	6.1	6.0	6.0	M	M
Capri	6.0	5.9	5.0	D	M
Verdi	6.0	6.2	6.2	L	M
Barcredo	6.0	6.9	6.0	D	M
Troubadour	6.0	5.8	5.6	M	D
Eden	5.9	6.1	7.7	M	M
Barlinda	5.8	5.2	6.3	M	D
Claudius	5.6	5.0	7.3	M	M

Colour code: L - Light Green; M - Mid-Green; D - Dark Green

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or contact:

Centre for Industry Education Collaboration
CIEC Department of Chemistry
University of York
York
YO10 5DD

01904 322523

ciec@york.ac.uk

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Author – Bryan Jackson

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