Australian sugarcane production and the role of agricultural extension officers – Lesson 4 Experiment Instructions

Experiment 1 - Surface vs Sub-surface Fertiliser

Aim

This experiment aims to test the effect of applying sub-surface (~15cm) fertiliser versus surface fertiliser application to determine which application leads to the greatest nutrient loss following a surface water runoff event.

Background Information

- Two options are provided – one requires growing seedlings/plants to replicate a sugarcane crop. This approach will take several weeks of preparation to allow the plants to reach 30cm high. The second option doesn't require growing plants but uses bare soil to test the two application methods.
- When calculating the area of your plot, remember 1 hectare (ha) is 10,000 m^2
- 40 mm over 1m^2 is 40 L.
- If growing plants from seedlings, commercial practice is to place an initial proportion (~ 20%) of the recommended rate of nitrogen near, but never on, the sugarcane setts at planting. The remaining nitrogen is usually applied once the crop is established[1] .
- In the Australian sugarcane industry, the required fertiliser is calculated from a soil test and based on the "Six Easy Steps" method.
- For the purpose of this experiment 20kg of N/ha will be applied "at planting" and 120kg of N/ha "top dressed" at the "established" stage. However, you may change this based on advice from a local agronomist and/or soil test.
- In this experiment the fertiliser rate has been increased to 10 times this standard rate due to the standard ammonium test kits not being sensitive enough to pick up the fertiliser. If your school has access to more sensitive measurement tools, you may be able to use the standard rates.
- Talk to your local fertiliser reseller who can help you choose the appropriate fertiliser. DAP (diammonium phosphate) is a common plant starter fertiliser. You may choose to simply use urea as the top dress fertiliser, or if your soil is lacking other nutrients you may choose to use a fertiliser which also includes nutrients such as phosphorous and potassium. See this fact sheet from NSW DPI for help calculating the correct amount of fertiliser when establishing your plants: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/166153/fertiliser-calculations.pdf

[1] Australian Sugarcane Nutrition Manual https://sugarresearch.com.au/wp-content/uploads/2017/02/Australian-Sugarcane-Nutrition-Manual.pdf

Experiment 1 - Option 1

Materials

- 2 pots / containers (at least 30cm diameter)
- 2 buckets (to catch runoff water)
- 2 pieces of hose/pipe
- Silastic / tape
- Soil
- Sugarcane seedlings or billets
    - Or you can use any other seeds/seedlings or a piece of lawn
- Plant starter fertiliser
- Urea fertiliser
- Water
- Watering can
- Ammonium test kit (You can buy this from a local hardware or pet supplies store. The one tested in this experiment can be found here)

Method

1. Cut one hole, the same diameter as the hose, near the top of each pot.
2. Place hose into hole, securing with silastic or tape.
3. Place one bucket next to each pot, positioned so that any water exiting the hose will fall into the bucket.
4. Fill the pots with soil, pack soil down.
5. Dig a trench 200 mm deep along the middle of each pot.
6. Sprinkle plant starter fertiliser into trench at the required rate, cover with a small amount of soil.
7. Plant one sugarcane seedling in the middle of each pot, on top of fertiliser. Alternatively, you may plant a sugarcane “sett” or “billet”.
8. Continue to water as required, ensuring conditions are kept the same for each pot. Remove weeds. Ensure there is no runoff from any watering / rainfall. If rain is expected, move pots undercover to prevent runoff.
9. Once seedlings are approximately 30cm high:
    a. Treatment 1 - dig 2 trenches 150mm deep and 1cm wide on each side of the seedling, sprinkle urea fertiliser along each trench at the required rate. Fill in trench with soil.
    b. Treatment 2 - In the remaining pot sprinkle the required fertiliser on top of the soil in a band through the middle of the pot, around the seedling.
10. Water all pots with 20mm of water, ensure there is no runoff. Use a watering can and slowly water the pots over the entire lesson, simulating rainfall (20 L per 1 m^2 – the amount of water required will depend on how fast the water is applied and the soil type – ensure the amount and timing of water application is consistent across treatments). Over the next week continue to water pots as required.
11. One week later water all pots with 40mm of water in 30 minutes (40L per 1 m^2). This will generate runoff. Runoff will be collected into the buckets.
12. Using the ammonium test kit, take 3 readings from each bucket, record into the recording sheet.
13. Steps 11 and 12 can continue to be repeated to investigate the changes over time.
14. Analyse the results to determine the average ammonium concentration of the 2 treatments.

Experiment 1 - Option 2

Materials

- 2 pots / containers (at least 30cm diameter)
- 2 buckets (to catch runoff water)
- Urea fertiliser[2] – apply 1400 kg of N/ha. Urea is 46% N. This equates to approximately 3040kg of urea per ha. Convert this to the size of your pot.
- Water
- Watering can
- 2 pieces of lawn – cut to size of pot
- Soil – **do not** use potting mix that contains fertiliser
- Ammonium test kit (You can buy this from a local hardware or pet supplies store. The one tested in this experiment can be found here)

Method

1. Cut one hole, the same diameter as the hose, near the top of each pot.
2. Place hose into hole, securing with silastic or tape.
3. Place one bucket next to each pot, positioned so that any water exiting the hose will fall into the bucket.
4. Treatment 1 – partially fill pot with soil, sprinkle required fertiliser on top of soil, cover with 150mm of soil. Place lawn on top. Press down.
5. Treatment 2 - fill the pot with soil, place lawn on top, press down. Sprinkle required fertiliser on top of lawn.
6. Water all pots with 20mm of water, ensure there is no runoff. Use a watering can and slowly water the pots over the entire lesson, simulating rainfall. Over the next week continue to water pots as required.
7. One week later water all pots with 40mm of water in 30 minutes. This will generate runoff. Runoff will be collected into the buckets.
8. Using the ammonium test kit, take 3 readings from each bucket, record into the recording sheet.
9. Steps 11 and 12 can continue to be repeated to investigate the changes over time.
10. Analyse the results to determine the average ammonium concentration of the 2 treatments.

TIP

Fertiliser calculation examples

Note: these calculations are only relevant if using urea (46%N). You will need to adjust your calculations if a different fertiliser and N amount is used

Rectangle tub

- Measure the length (L) and width (W) to calculate area in meters^2; A = L x W
- Multiply area m^2 by fertiliser rate (300g) to calculate weight of urea required
- Example: 52L storage container area = 0.52m x 0.37m = 0.19m^2 x 300g = 57g/tub

Round pot

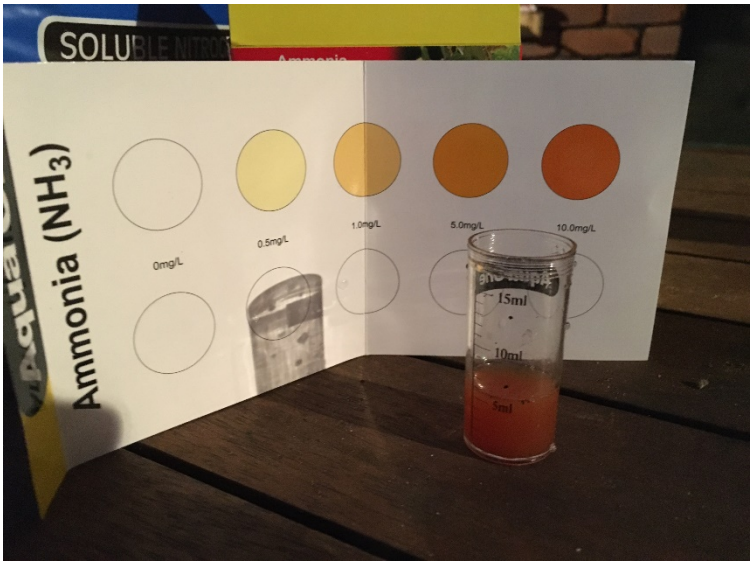
- Measure the diameter of the tub and divide by 2 to calculate radius (r), A = π x r^2
- Multiply area m^2 by fertiliser rate (300g) to calculate weight of urea required
- Example: 30cm pot = π x (0.15m)^2 = 0.07m^2 x 300g = 21g/pot

[2] Refer to 'Background Information' to determine the appropriate fertiliser rate depending on your chosen experimental set up

Fertiliser being applied subsurface (left) vs broadcast (right)

Plastic tubs used as pots, filled almost to the top with soil, raised on one side to create slope for water to drain.

Fertiliser applied subsurface (left) vs broadcast (right)



Above: Ammonium test kit used to test run-off water for ammonium.

Left: Tubs raised so that water runs to one corner, water spills over into bottle. You may also cut a hole near top of container and insert hose for water to drain out into a bucket

Experiment 2 - Band vs Blanket Herbicide

Aim

This experiment aims to test the effect of applying herbicide only in plant rows (band) versus all over plot (blanket) to determine which application leads to the greatest herbicide loss following a surface water runoff event.

Background Information

- Three options are provided:
  - Apply herbicide to areas of established grass
  - Apply herbicide to bare soil in containers
  - Apply herbicide to the seedlings grown in Experiment 1 – Option 1
- The experiment uses coloured dye to replicate herbicide
- The 'herbicide' solution should be sprayed at a rate of 400 L / ha which is equal to 40 mL per 1m2
- Remember 1 hectare (ha) is 10,000 m^2
- 40 mm over 1m^2 is 40 L.
- Make up dye solution as strong as possible, ensuring the same mix is used for both treatments
- Not all herbicides act the same way, however, research shows that many herbicides show a strong correlation between rate applied and runoff losses[3] - this experiment aims to test this correlation.

[3] Combining weed efficacy, economics and environmental considerations for improved herbicide management in the Great Barrier Reef catchment area. Emilie Fillols, Aaron M. Davis, Stephen E. Lewis, Andrew Ward https://www.sciencedirect.com/science/article/pii/S004896972030992X

Experiment 2 - Option 1

Materials

- Grassed area such as school oval. Some slope is required to collect runoff water more easily.
- Watering can
- Water
- Red dye
- Hand spray bottle
- Bucket/measuring jugs
- Spray paint / marker
- gloves

Method

1. Mark out 2 areas 1m^2 each. One area will be treatment 1, the other treatment 2.
2. For treatment 2 mark out 25cm strips across the metre. There will be 4 x 25cm strips in the metre.
3. Mix solution of red dye. Make up 60mL. Use enough dye for a dark solution. Wear gloves to prevent staining fingers with dye.
4. Apply 'herbicide' treatments
    a. Treatment 1 – apply 40 mL of 'herbicide' solution across the entire 1m^2 area.
    b. Treatment 2 – apply 20 mL of 'herbicide' solutions across the first and third marked out strips (half the area sprayed).
5. Wait for the 'herbicide' solution to dry
6. Using a watering can, simulate 40mm of rainfall over 30 minutes across both treatment (40 L per 1 m^2 – the amount of water required will depend on how fast the water is applied and the soil type – ensure the amount and timing of water application is consistent across treatments).
7. Collect run-off using measuring jugs and empty into a bucket, one for each treatment.
8. Compare the colour of the run-off from each treatment. Record in the record sheet.
9. Determine which treatment lost the most 'herbicide'.

Experiment 2 - Option 2

Materials

- Table/raised surface OR container/pots, hose, buckets, silastic/tape
- 2 buckets
- 2 pieces of lawn – 0.5m^2 each
- Watering can
- Water
- Red dye
- Hand spray bottle
- Gloves

Method

1. Lay lawn pieces on table / raised surface. Place bucket on ground at edge of table. Ensure there is some slope so that water will run off lawn into bucket.
2. OR place lawn pieces in pot/container filled almost to the top with soil. Cut one hole, the same diameter as the hose, near the top of each pot. Place hose into hole, securing with silastic or tape. Place one bucket next to each pot, positioned so that any water exiting the hose will fall into the bucket.
3. On the second piece of lawn (treatment 2) mark out 4 even strips.
4. Mix solution of red dye. Make up 30 mL. Use enough dye for a dark solution.
5. Apply 'herbicide' treatments
    a. Treatment 1 – apply 20 mL of 'herbicide' solution evenly across the 0.5 m^2
    b. Treatment 2 – apply 10 mL of 'herbicide' solution evenly across the first and second strips (half the piece)
6. Wait for the 'herbicide' solution to dry.
7. Using a watering can, simulate 40mm of rainfall over 30 minutes across both treatments.
8. Collect run-off into buckets
9. Compare the colour of the run-off from each treatment. Record in the record sheet.
10. Determine which treatment lost the most 'herbicide'.

Experiment 2 - Option 3

Materials

1. Seedlings grown in Experiment 1 – Option 1 (set up 6 pots as per treatment 1)
2. Watering can
3. Water
4. Red dye
5. Hand spray bottle
6. Gloves

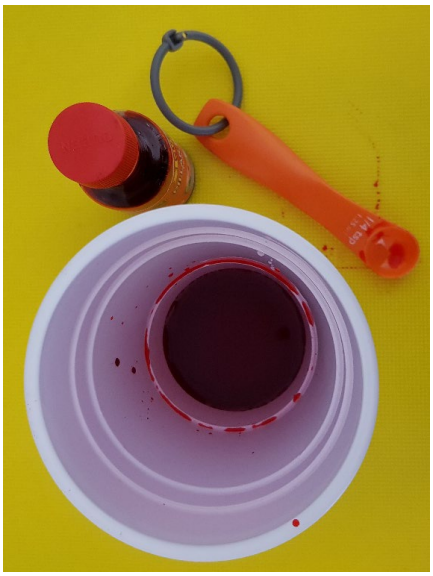
Method

1. After sugarcane has been established as per Experiment 1 Treatment 1, Experiment 2 can be conducted using the same pots. If you are going to replicate the trial, ensure enough pots were set up initially.
2. Mix solution of red dye. Make up solution according to size of pot/containers. Use enough dye for a dark solution. Wear gloves to prevent staining fingers with dye.
3. Apply 'herbicide' treatments

a. Treatment 1 – apply full rate (40ml/m^2) of 'herbicide' solution across the entire pot/container.

b. Treatment 2 – apply the full rate (40ml/m^2) only across the half of the pot (spray the middle area of the pot where the sugarcane is planted – there will be a strip either side of the sugarcane plant that is not sprayed). Effectively only half the amount of spray will be used.

4. Wait for the 'herbicide' solution to dry
5. Using a watering can, simulate 40mm of rainfall over 30 minutes across both treatments.
6. Collect run-off in buckets.
7. Compare the colour of the run-off from each treatment. Record in the record sheet.
8. Determine which treatment lost the most 'herbicide'.



Required volume of water placed in cup, teaspoon used to measure dye and place in cup.

Lawn after treatment

Treatment 1 (left) and treatment 2 (right). Spray paint used to mark boundaries. Treatments applied.

Sample of water collected after runoff, treatment 1 (right) and treatment 2 (left).

Experiment 3 - Minimal Tillage vs Full Cultivation

Aim

This experiment aims to test the effect that minimally disturbing the soil (minimal tillage) versus displacing all of the soil in a plot (full cultivation) disturbing the soil has on the amount of sediment lost from the plot following a surface water runoff event.

Background Information

- This experiment works best on soil that has not been disturbed for a long time.
- Create a way to compare the turbidity of the water. Search for turbidity tests for ideas.
- 40mm of rainfall over 1m^2 is 40 litres.

Materials

- Area of soil which can be dug up
- Shovel
- Water
- Bucket/measuring jug
- Spray paint / marker

Method

1. Mark out 2 areas 1m^2 each. One area will be treatment 1, the other treatment 2.
2. For treatment 1 (minimal tillage), using the shovel dig a slot 15cm wide and 15cm deep down the middle of the area, fill the hole back in and press the soil around the slot back in with foot. This is simulating a minimal tillage planter only moving the soil where required to plant the sugarcane billets.
3. For treatment 2 (full cultivation), using the shovel dig and turn over the soil, breaking it up as small as possible, across the whole treatment. This is simulating conventional tillage.
4. Using a watering can, simulate 40mm of rainfall over 30 minutes across both treatments.
5. Collect run-off using measuring jugs and empty into a bucket, one for each treatment. You may need to dig a 'channel' around your treatment for the water to run into to easily collect, or create a 'ledge' so the water can run into a measuring jug, etc.
6. Compare the colour of the run-off from each treatment. Record in the record sheet.
7. Determine which treatment lost the most soil.

Treatments marked out, treatment 2 (left) has been implemented. A channel was dug on the down side of the treatments to allow a jar to easily collect run off water.

Sample of runoff water indicating treatment 1 (bottom and left) had less soil loss than treatment 2 (top and right)