



## **Turf submersion study**

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## Turf submersion study v1.0

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**Front cover:** Day 6 of submersion for a Santa Ana couch paddock at Pitt Town Bottoms in April 2024.

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## Executive summary

Turf NSW engaged Agenviro Solutions to undertake this study which examines the impact of water temperature, fertiliser, Primo Max®, Pennmag® and humic acid applications on the condition of four turf cultivars that were submerged for up to 21 days. Funding for this project was provided by the NSW Government Sector Recovery and Resilience Grant. The study which was performed by Steve Garland and Dr Mick Battam (Certified Professional Soil Scientist).

## Background

In the past two years there have been 4 major flooding events in the Hawkesbury, with these resulting in the turf on these farms being submerged for 3 to 14 days, in some cases by more than 8 m of water. Investigations following the March 2022 floods found the thickness of the silt layer deposited on turf in the Freemans Reach area was often thinner in areas where the turf was shorter and/or there was less turf cover (Battam, 2023). These observations align with other studies, with the drag friction model in Kouwen (1989) suggesting the silt deposition layer thickness could be reduced by about 9 mm by reducing the mowing height from 25 mm to 15 mm.

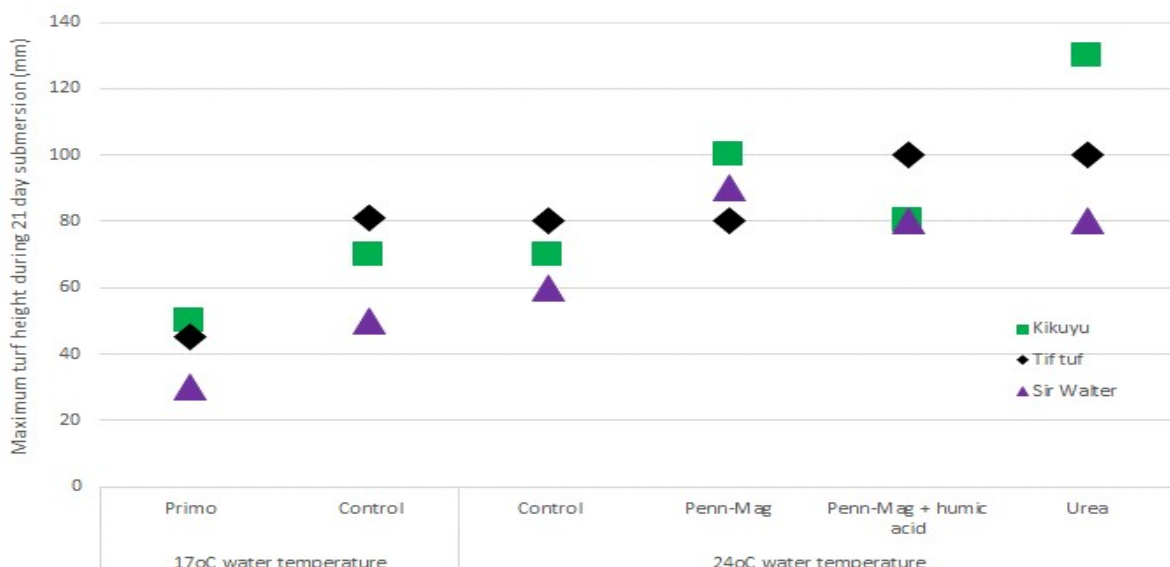
## Study findings

This study found the height of kikuyu and TifTuf continued to increase for about 11 days after flooding, with Sir Walter still growing after 21 days submerged. The study found the application of Primo Max® reduced the submerged maximum height of:

- Kikuyu from 70 mm (control) to 55 mm (Primo Max®)
- TifTuf from 80 mm (control) to 45 mm (Primo Max®)
- Sir Walter from 48 to 60 mm (control) to 30 mm (Primo Max®), but the application of Primo Max® had also significantly reduced the quality of the Sir Walter
- Sir Grange from 45 m (control) to 30 mm (Primo Max®) but had reduced turf quality.

In contrast, the addition of urea, Pennmag® and humic acid increased the maximum height of all grasses. Whilst the addition of Pennmag® slowed the rate of loss in turf quality during submersion, this was possibly at the expense of root growth (Peter McMaugh, pers. comm.).

Using a lower mowing height and/or Primo Max® applications could be used by turf farmers during periods of elevated flood risk. Whilst maintaining a lower grass height can be effective in reducing silt deposition from sheet flow by flood waters, it will have limited impact on mass sediment deposition as was observed along Cornwallis Lane during the 2022 floods.



**Figure E.1:** Impact of treatments on maximum turf height during 21 days submersion.

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## 1 Background

Many of the turf farms that service the Sydney Basin are located on the Hawkesbury River floodplain near Richmond and Windsor NSW (Figure 1.1). In the past two years there have been 4 major flooding events, with these resulting in the turf on these farms being submerged for 3 to 14 days, in some cases by more than 8 m of water.

Investigations following the March 2022 floods found the thickness of the silt layer deposited on the surface in the Freemans Reach area was generally thinner in areas where the turf was shorter and/or there was less turf cover (Battam, 2023). These observations align with studies on the impact of vegetation cover and grass height on either manning coefficients or sediment capture (Gavric *et. al*, 2019; Hewlett *et. al.*, 1987, Hou *et. al*, 2019 & Lee *et.al*, 2020).

Whilst similar observations were made on turf farms in nearby areas such as Richmond lowlands, the amount of silt deposited was also dependent on the site location relative to plough paddocks or eroded riverbank areas (e.g. missing section of road in Cornwallis Lane).

Turf NSW engaged Agenviro Solutions to undertake this study which examines the impact of water temperature, fertiliser, Primo Max®, Pennmag® and humic acid additions on the condition of four turf cultivars that were submerged for about 21 days:

- TifTuf couch
- Sir Walter buffalo
- Male sterile kikuyu
- Sir Grange

Funding for this project was provided by the NSW Government Sector Recovery and Resilience Grant. The study which was performed by Steve Garland and Dr Mick Battam (Certified Professional Soil Scientist and Certified Irrigation Agronomist).



**Figure 1.1:** Hawkesbury River 1 in 100 year floodplain near Richmond, with shading showing the location of turf farms (green), sporting fields (yellow) and higher ground (white).

## 2 Trial 1: 17°C water temperature

A trial was conducted to measure the impact of light and Primo Max® addition on the condition of four turf species submerged for 21 days. The trial was conducted in a submersion tank that fluctuating in temperature from 15.5 to 17.9°C, with the water in the tank pumped in a loop to simulate the aeration levels that would occur if flood waters were flowing over a field.

### 2.1 Trial description

The trial involved 66 turf plugs, each being 200 mm tall and having 100 mm diameter. The plugs were harvested from the Greener Lawns turf farms at Freemans Reach and included:

- TiffTuf couch (18 plugs or 3 replicates per treatment)
- Sir Walter buffalo (18 plugs or 3 replicates per treatment)
- Male sterile kikuyu (18 plugs or 3 replicates per treatment)
- Sir Grange zoysia (12 plugs or 2 replicates per treatment)

Turf samples were cut to a height of 30mm prior to trial commencement and submersion.

### 2.2 Treatments

One third of each turf species were randomly assigned to the following treatments:

- stored in the dark (but not submerged)
- in the light and submerged
- stored in the dark and submerged

Primo Max® (20 ml per 100m<sup>2</sup>) was applied to half of the turf plugs in each treatment two weeks prior to the trial commencement. The trial was conducted in a tank that resulted in the submerged treatment being covered by about 100 mm of water (Figure 2).



**Figure 2.1:** Layout of the turf submersion trial.

## 2.3 Results

The trial found turf continues to grow in the dark and when submerged. Those samples in the dark (but not submerged) were typically 20 to 35 mm taller than those that were submerged and in the dark, with interim heights observed on samples that were submerged and in the light.

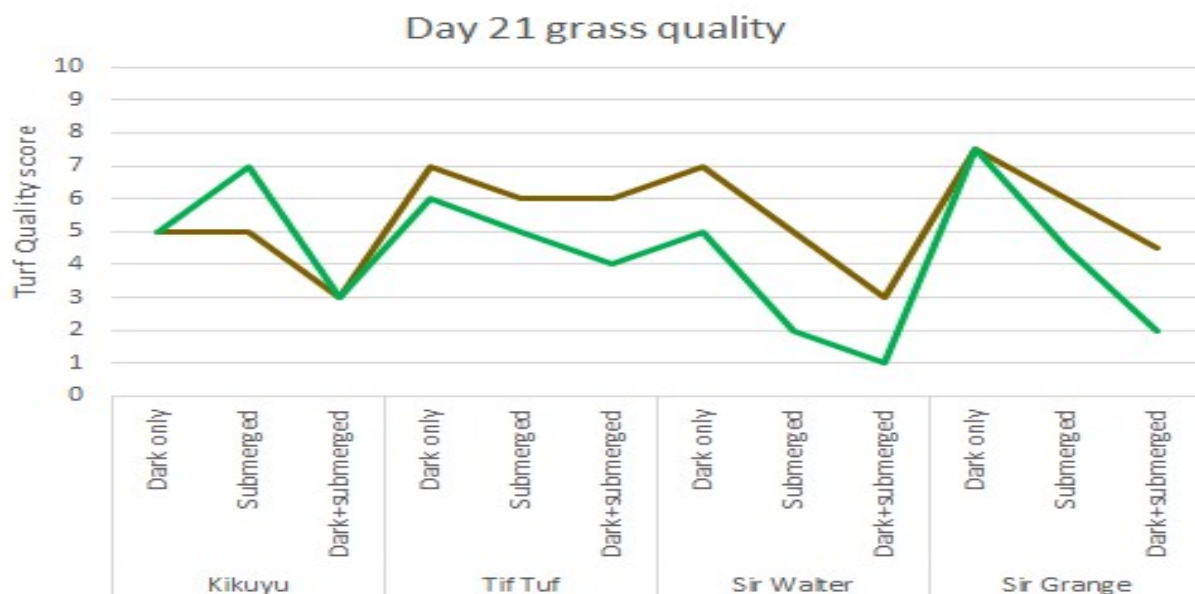
The maximum turf height observed during the trial was typically reduced by about 20 mm by the application of Primo Max® (Figure 2.2). For the samples that were:

- In the dark only: Sir Grange had the best turf quality
- Submerged only: all the species had a similar turf quality (if not treated with Primo Max®)
- Submerged and in the dark: Tif Tuf and Sir Grange (no Primo Max®) had the best quality.

The Primo Max® application rates applied to Sir Walter and Sir Grange resulted in reductions in turf quality for these species (Figure 2.3).



**Figure 2.2:** Impact of the 17°C water submersion trial on maximum turf height achieved and turf quality after 21 days.



## 3 Trial 2: 24°C water temperature

A second trial was conducted to measure the impact of light and Primo Max® addition on the condition of four turf species submerged for 21 days. This time the water in the submersion tank was maintained at an average temperature of 24°C, with the water reticulated in the tank to simulate the aeration levels that would occur if flood waters were slowly flowing over a field. Dissolved oxygen levels in the water fluctuated from 7.2 to 9.4 mg/L.

### 3.1 Trial description

The trial involved 66 turf plugs, each being 100 mm tall and having 100 mm diameter. The plugs were harvested from the Greener Lawns turf farm and included:

- TifTuf couch (18 plugs or 3 replicates per treatment)
- Sir Walter buffalo DNA certified (12 plugs or 2 replicates per treatment)
- Male sterile kikuyu (12 plugs or 2 replicates per treatment)
- Sir Grange (12 plugs or 2 replicates for one treatment and 1 replicate for Primo Max®)

All samples were cut to a uniform height of 30mm just prior to the commencement of the trial.

### 3.2 Treatments

One third of each turf species were randomly assigned to the following treatments:

- in the light and submerged
- stored in the dark (but not submerged)
- stored in the dark and submerged

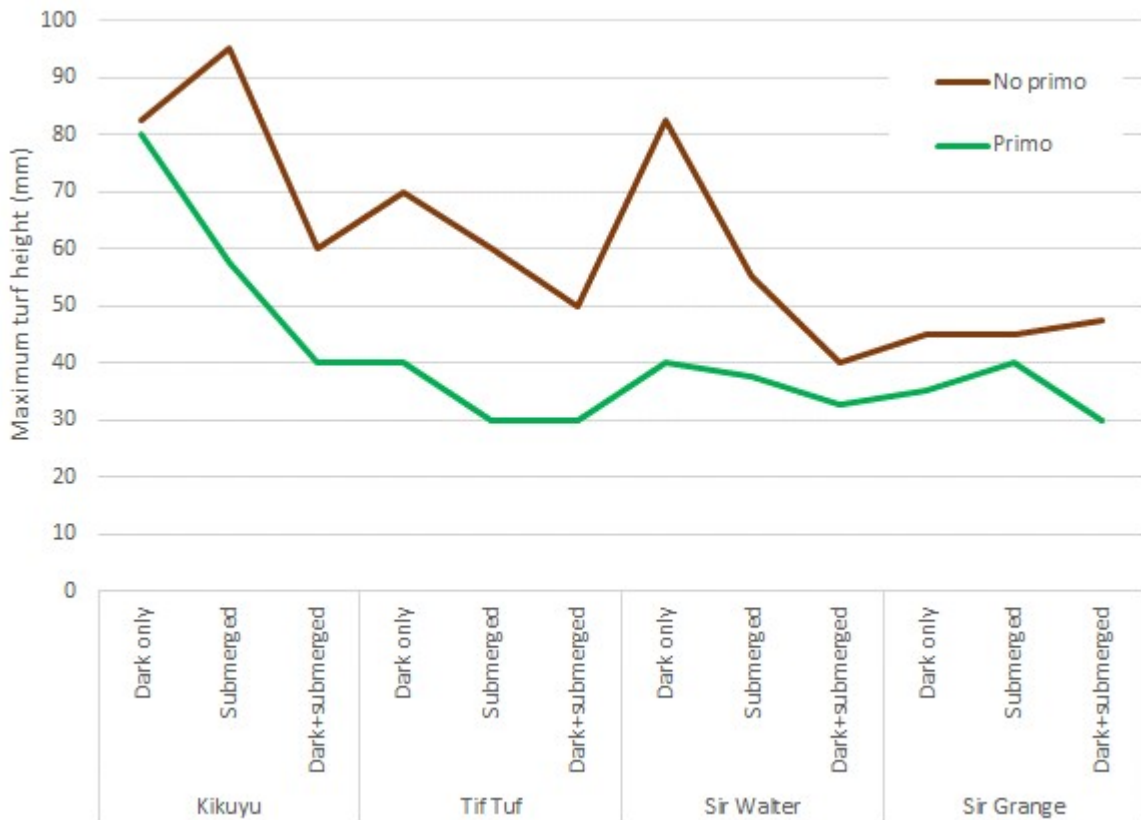
Primo Max® (20 ml per 100m<sup>2</sup>) was applied to half of the turf plugs in each treatment two weeks prior to the trial commencement. The trial was conducted in a tank that resulted in the submersed treatment being covered by about 100 mm of water (Figure 2.1).

### 3.3 Results

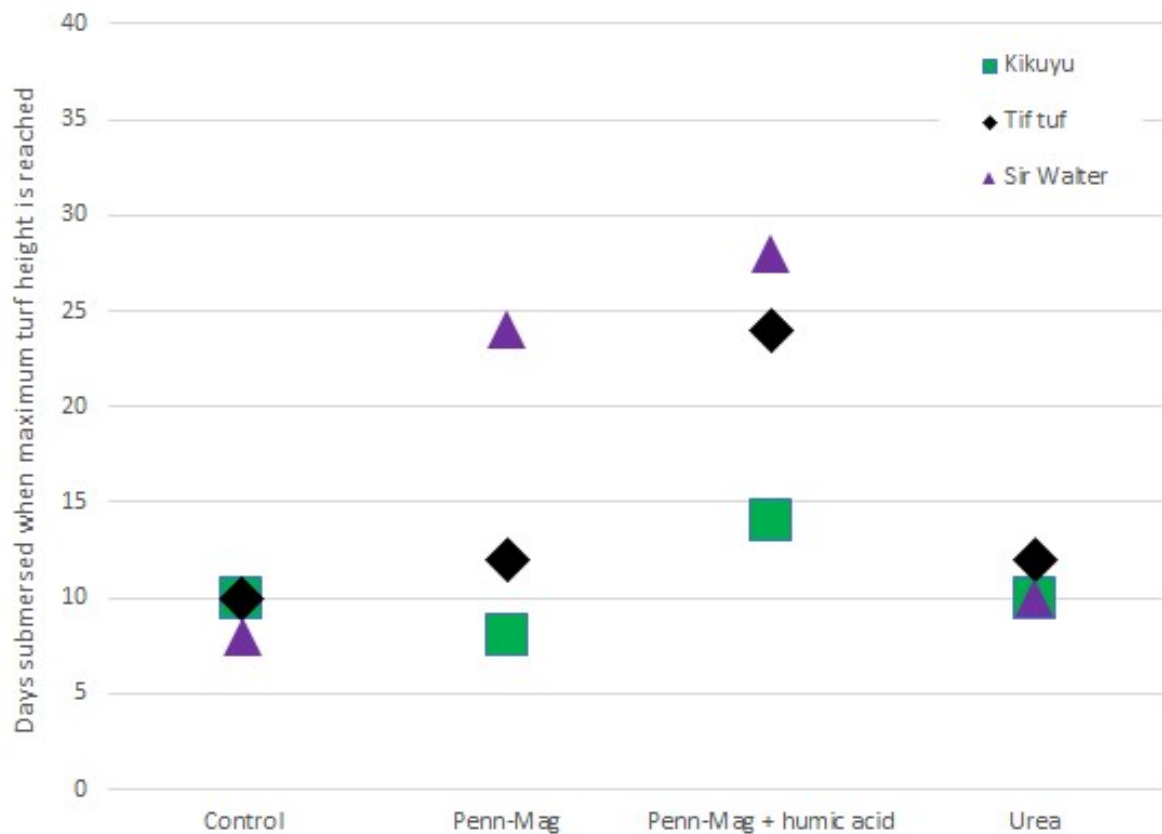
The trial found that turf continues to grow when submerged, but that the amount of growth can be reduced by 15 to 25 mm through the addition of Primo Max® (Figure 3.1). The trial also found the lowest grass heights for each turf species were generally observed for samples that were both submerged and in the dark (Figure 3.1). For samples that were:

- In the dark only: Sir Grange had the best turf quality
- Submerged only: all the species had a similar turf quality (if not treated with Primo Max®)
- Submerged and in the dark: Tif Tuf and Sir Grange (no Primo Max®) had the best quality.

For the submerged samples that were in the dark (as would occur under deep floodwaters), the maximum grass heights were achieved after 7 to 10 days (control) and 10 to 14 days (Primo Max®) for most grasses. However, the Sir Grange treated with Primo Max® did not increase in height at any stage (Figure 3.3).



**Figure 3.2:** Impact of the 24°C water temperatures on maximum turf height achieved during 21 days submersion.



**Figure 3.3:** The day at which maximum turf height was achieved during 21 days submersion, with 24°C water temperatures.

## 4 Trial 3: Urea, humic acid & Pennmag® additions

A third trial was conducted to measure the impact of Pennmag®, Humic acid and urea on the condition of three turf species submerged for 24 days. The trial was conducted in submersion tank that fluctuating in temperature from 23.8 to 25.0°C, with the water in the tank pumped in a loop to simulate the aeration levels that would occur if flood waters were slowly flowing over a field. Dissolved oxygen levels in the water fluctuated from 6.5 to 8.7 mg/L.

### 4.1 Trial description

The trial involved 36 turf plugs, each being 150 mm tall and having 100 mm diameter. The plugs were harvested from the Greener Lawns turf farm and included:

- TifTuf couch (12 plugs or 3 replicates per treatment)
- Sir Walter buffalo DNA certified (12 plugs or 3 replicates per treatment)
- Male sterile kikuyu (12 plugs or 3 replicates per treatment)

### 4.2 Treatments

Three turf plugs from each of the turf species were submitted to the following treatments which were applied 2 weeks prior to submersion:

- 20 g/m<sup>2</sup> of urea
- 20 ml/100m<sup>2</sup> Pennmag®
- 40ml/100m<sup>2</sup> of Blackjak® (Humic/fulvic acid) plus 20 ml/100m<sup>2</sup> Pennmag®

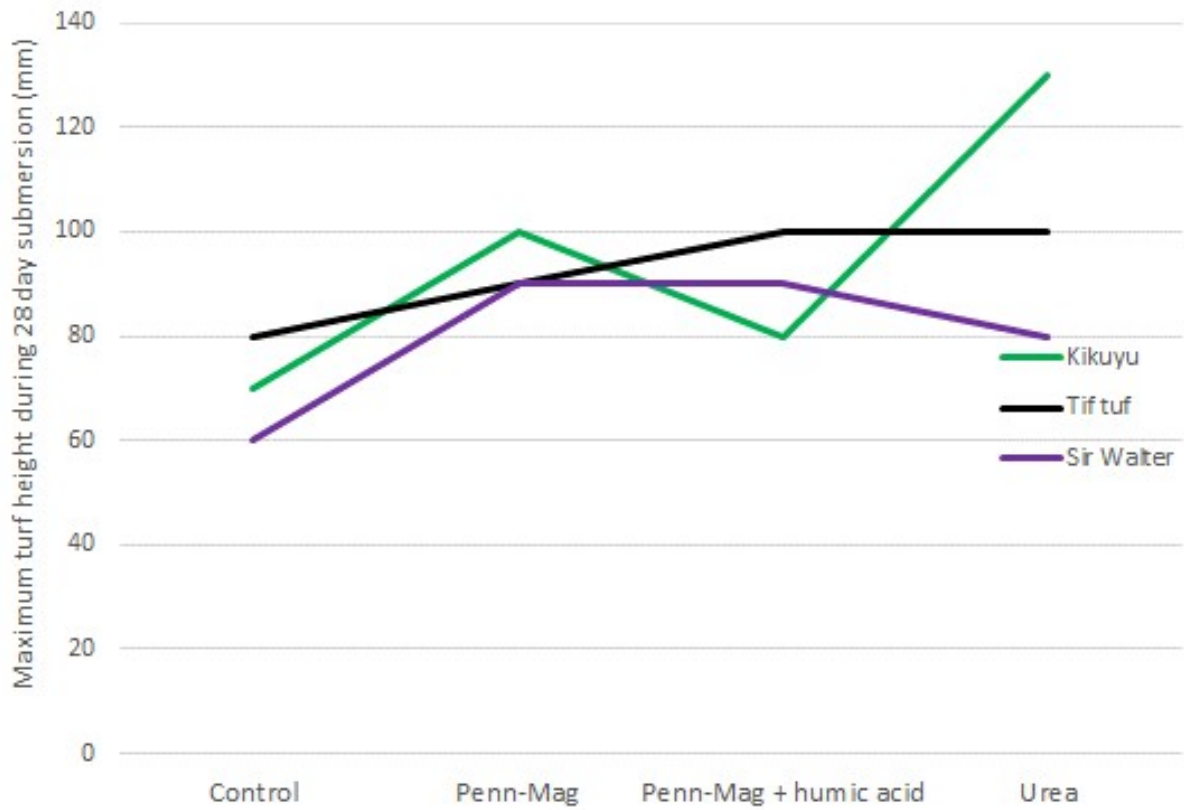
The trial was conducted in a tank that resulted in the submersed treatment being covered by a minimum of 80 mm of water (Figure 4.1).

### 4.3 Results

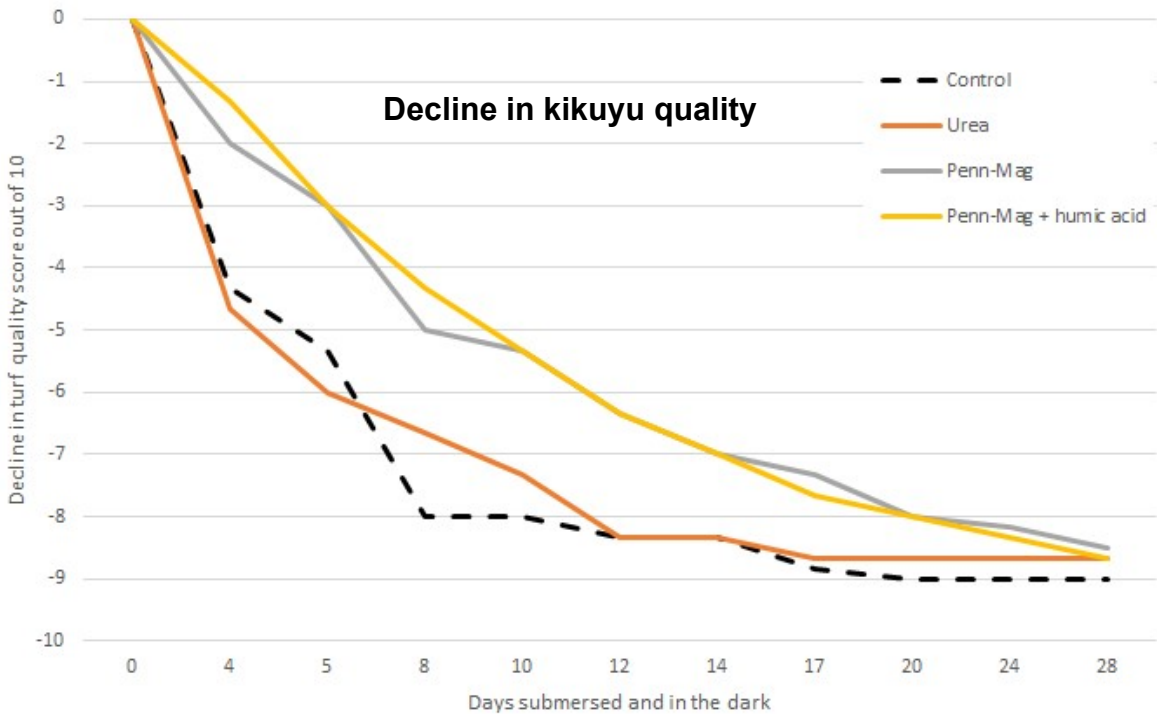
The trial found the addition of (Figures 4.1 to 4.4):

- Pennmag® treatments: turf was 10 to 30 mm taller, with a slower decline in turf quality relative to the control
- Pennmag® plus humic acid treatment: turf was 10 to 30 mm taller than the control and showed a slower decline in turf quality kikuyu and sir Walter (minimal impact on TifTuf)
- Urea increased turf height by 20 mm (TifTuf and Sir Walter) to 60 mm (kikuyu), with a faster decline in turf quality for TifTuf (minimal impact on kikuyu and Sir Walter quality).

The increased growth and slower decline in turf quality for the Pennmag® treatments was possibly at the expense of root growth (Peter McMaugh, pers. comm.). For the control treatments, turf quality declined most rapidly during the first 8 days of submersion. During these first 8 days, turf quality declined fastest for kikuyu and slowest for Sir Walter.



**Figure 4.1:** Impact of the 24°C water temperatures on maximum turf height achieved during 21 days submersion.



**Figure 4.2:** Impact on the rate of decline in turf quality (water temperature 24°C).

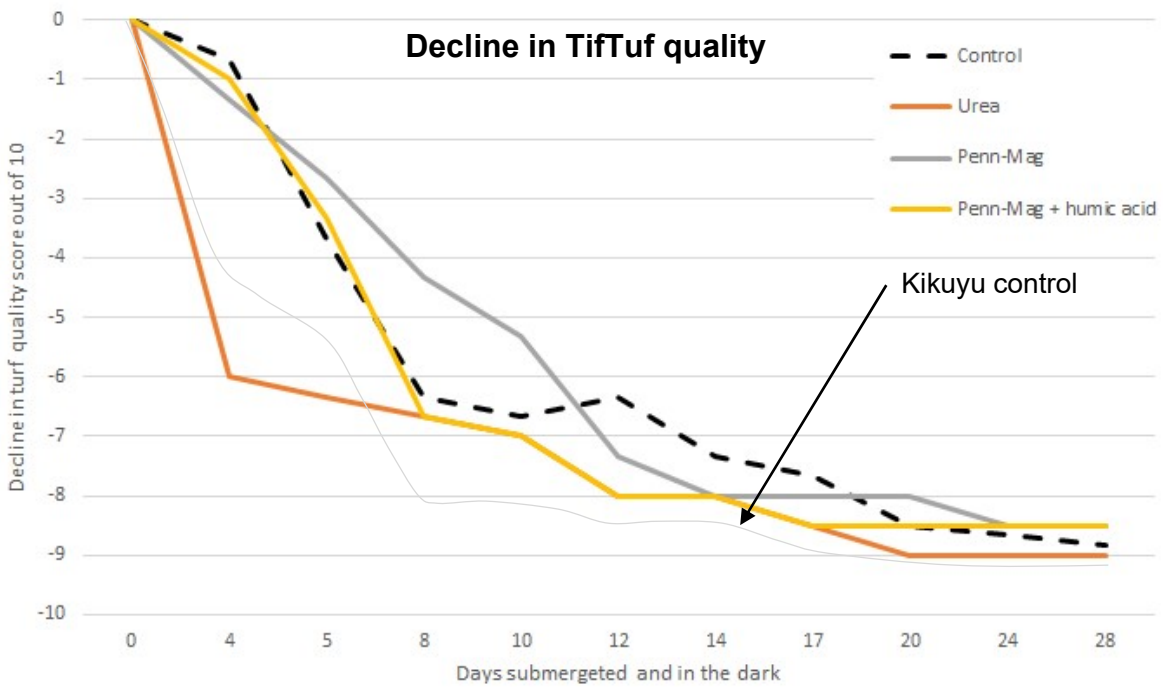


Figure 4.3: Impact on the rate of decline in turf quality (water temperature 24°C).

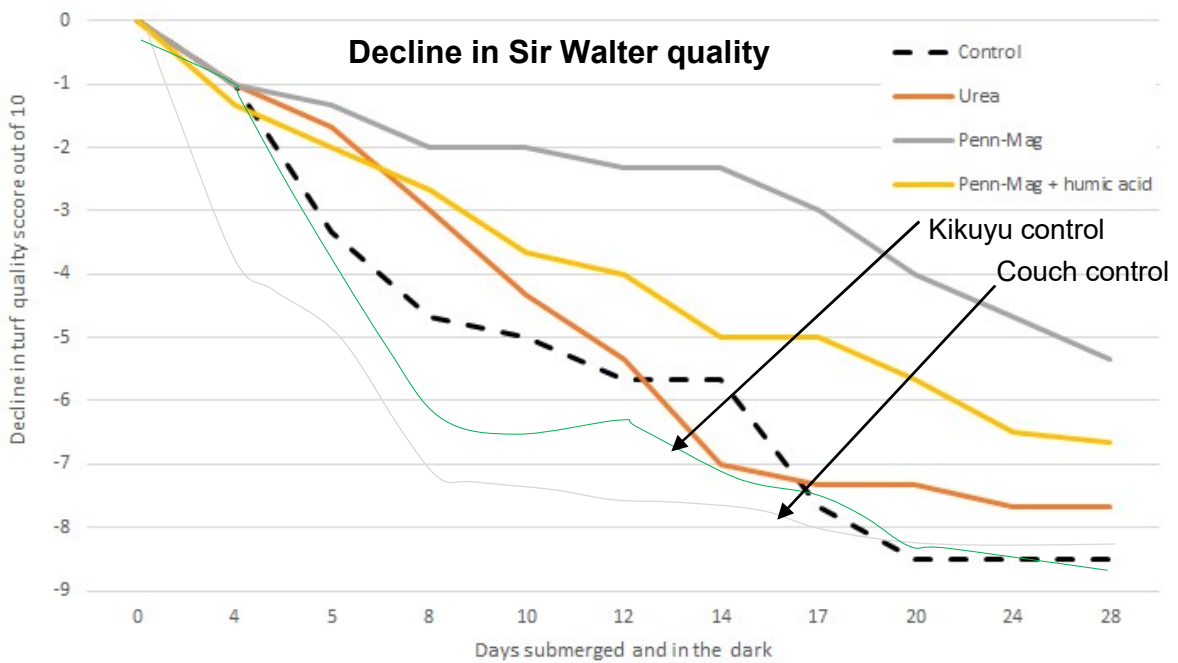


Figure 4.4: Impact on the rate of decline in turf quality (water temperature 24°C).

## 5 Discussion

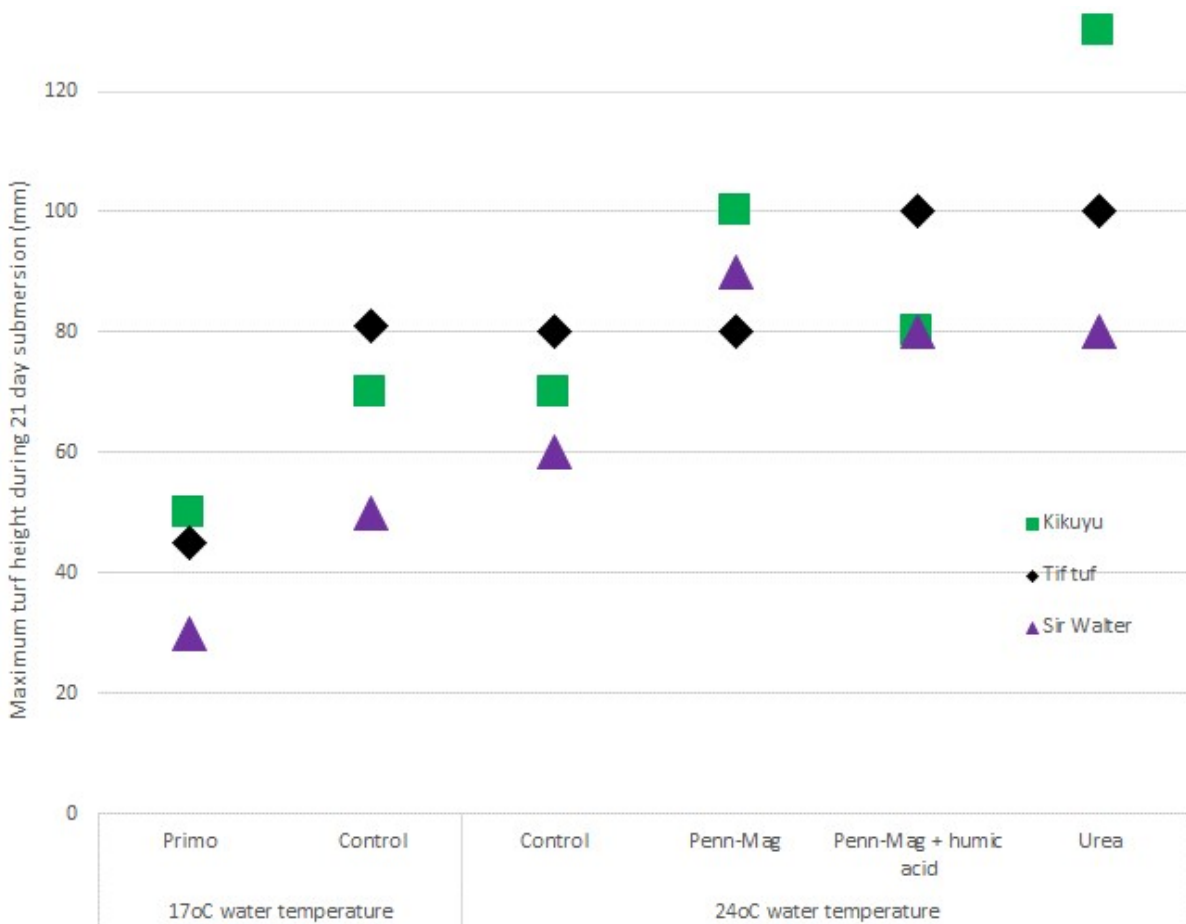
The results from the three trials found turf continues to grow when submerged. For the samples that were both submerged and in the dark (as would occur under deep floodwaters), the turf height increased from 30 mm to a maximum height of about (Figure 5.1):

- Primo Max®: 45 mm (TifTuf) to 55 mm (kikuyu), with nil growth in Sir Walter
- Control: 48 to 60 mm (Sir Walter), 70 mm (kikuyu) and 80 mm (TifTuf)
- Pennmag® (with/without humic acid): about 85 mm (Sir Walter), 90 mm (kikuyu & TifTuf)
- Urea: 80 mm (Sir Walter), 100 mm (TifTuf) and 130 mm (kikuyu)

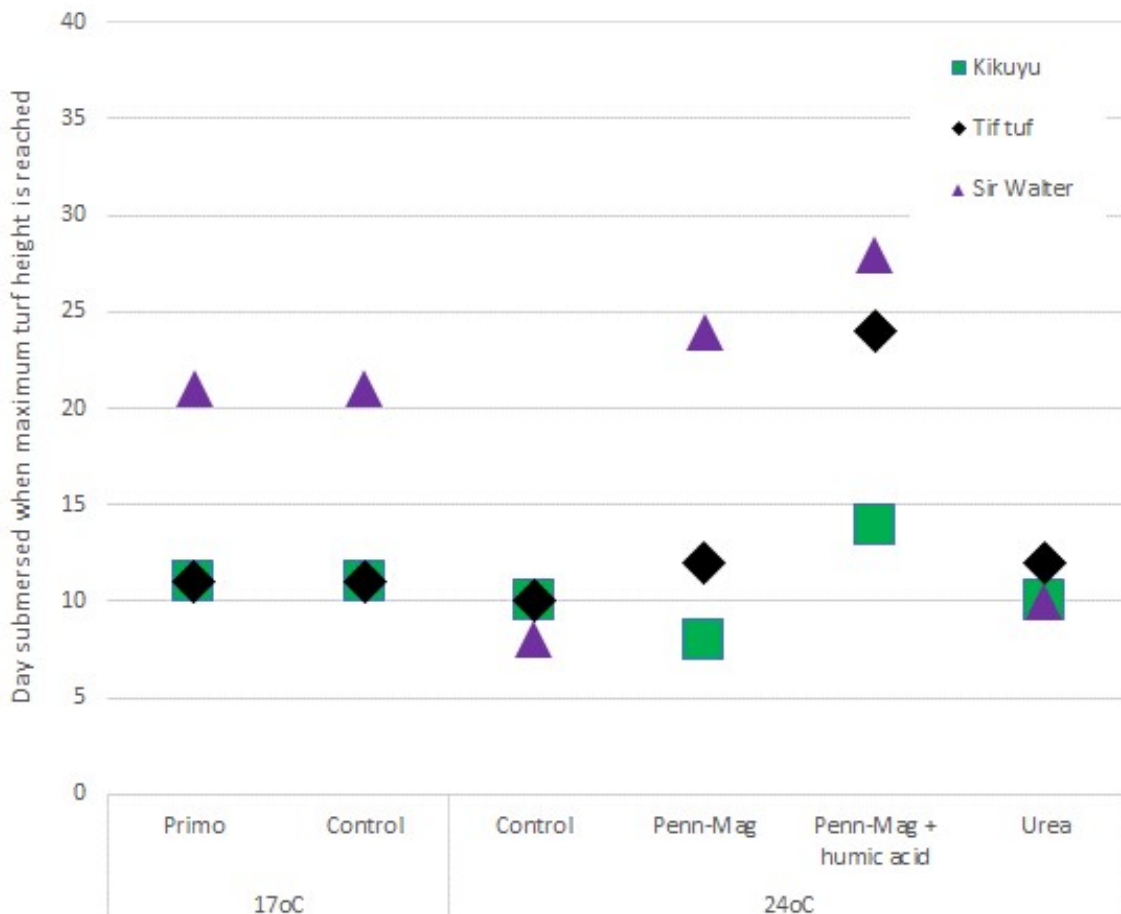
Regardless of the water temperature, for the control treatments the maximum turf height typically occurred by day 10 to 12 for kikuyu and TifTuf. However, Sir Walter reached its maximum height faster when the water temperature was warmer (Figure 5.2).

The application of Primo Max® and urea had minimal impact on the day to reach maximum turf height (Figure 5.2). However, the application of Pennmag® enabled Sir Walter to grow for longer and achieve a higher turf height, with a similar effect on kikuyu and TifTuf only observed when the Pennmag® was applied with humic acid.

Turf quality generally declined mostly rapidly during the first 8 days of submersion, declining fastest for kikuyu and slowest for Sir Walter (Figures 4.2 to 4.4).



**Figure 5.1:** Impact of water temperatures and various treatments on the maximum turf height achieved during submersion.



**Figure 5.2:** The day at which maximum turf height was achieved during submersion.

## 6 Conclusions

Investigations after the March 2022 floods found the thickness of the silt layer deposited on the surface in the Freemans Reach area was generally thinner in areas where the turf was shorter and/or had less turf cover (Battam, 2023). These observations align with other studies (Gavric *et. al*, 2019; Hewlett *et. al.*, 1987, Hou *et. al*, 2019 & Lee *et.al*, 2020), with the drag friction model described in Kouwen (1989) suggesting the silt deposition layer thickness could be reduced by about 9 mm by reducing the mowing height from 25 mm to 15 mm.

This study found kikuyu and TifTuf continued to grow upright for about 11 days after flooding, with Sir Walter still growing after 21 days submerged. The study found that the application of Primo Max® reduced the submerged maximum height of:

- Kikuyu from 70 mm (control) to 55 mm (Primo Max®)
- TifTuf from 80 mm (control) to 45 mm (Primo Max®)
- Sir Walter from 48 to 60 mm (control) to 30 mm (Primo Max®) but the application of Primo Max® significantly reduced the quality of the Sir Walter and Sir Grange

In contrast, the addition of urea, Pennmag® and humic acid increased the maximum height of all grasses. Whilst the addition of Pennmag® slowed the rate of loss in turf quality during submersion, this was possibly at the expense of root growth (Peter McMaugh, pers. comm.).

Using a lower mowing height and/or Primo Max® applications could be used by turf farmers during periods of elevated flood risk. Whilst maintaining a lower grass height can be effective in reducing silt deposition from sheet flow by flood waters, it will have limited impact on mass sediment deposition as was observed along Cornwallis Lane during the 2022 floods.

## 7 References

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