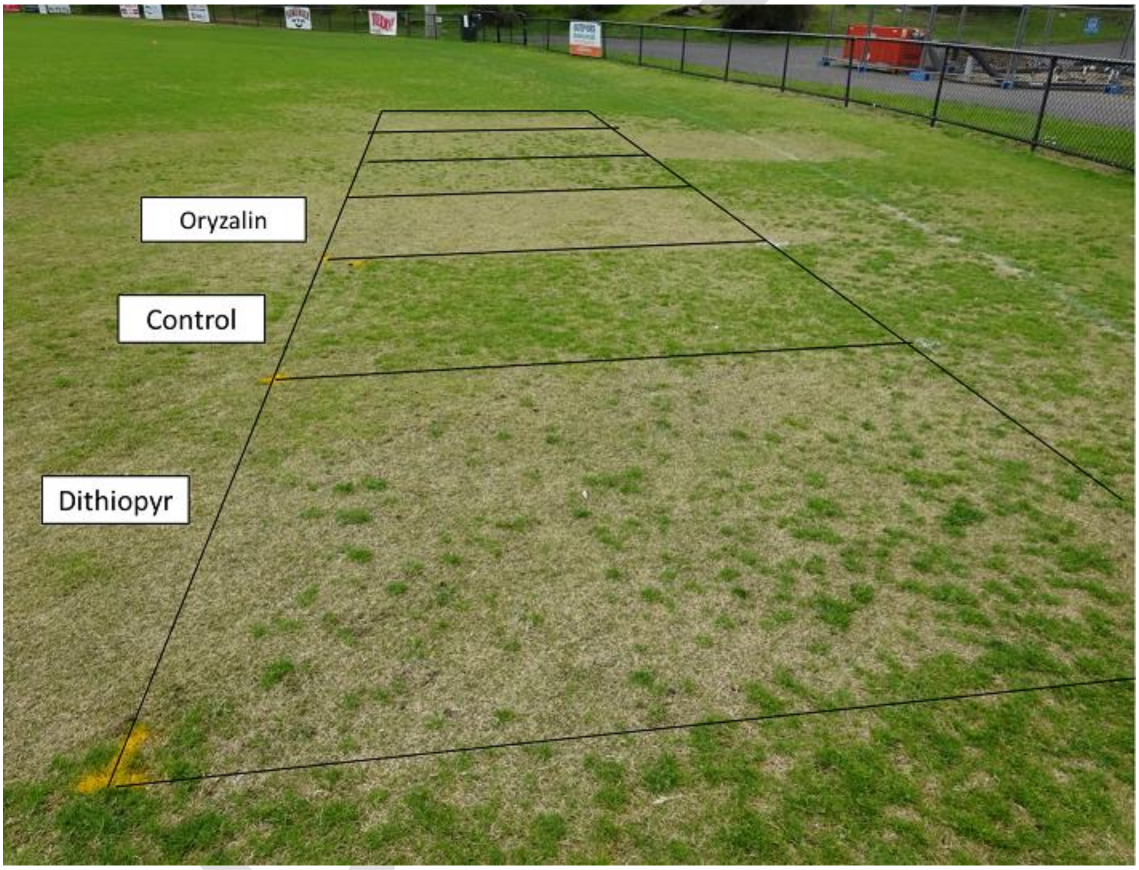
POA ANNUA CONTROL IN WARM-SEASON GRASS SPORTSFIELDS

Final Report May 2016



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1 BACKGROUND

Poa annua is an unsown component of many sportsturf areas in temperate climates. *Poa annua* is the most widespread turfgrass species occurring in intensively cultured turf and it is adapted to a broad array of climatic conditions from the cold Polar Regions to hot deserts. *Poa annua* is one of the five most widely distributed plant species in the world and in Victoria was one of only two turf type grasses found in every horticultural region with the other grass being Couch (*Cynodon* sp.). This ability to adapt to various climates and environmental factors is due to its genetic variability which results in numerous biotypes, even within the one location.

Changing conditions, whether it is the local microclimate, chemical usage or cultural practices will stimulate the development of new biotypes that are better adapted to those conditions. For example, the frequent use of the same herbicide will select out biotypes that are more resistant to that herbicide.

Even though *Poa annua* is such a difficult weed to control it also has a lower tolerance than other turf species to stresses such as heat, drought, high salinity, wear and diseases. Heat and drought stress on *Poa annua* dominated swards will result in die-back and leave dead, bare and unsightly patches. *Poa annua* playing surfaces tend to have poor surface traction because of the shallow and weak root system. Consequently there is greater slippage and more surface damage from divots.

With the predominance of warm-season grasses being used on sportsfields in Victoria, *Poa annua* is the most significant weed species. While it can provide some protection to the Couch and colour over the winter months, if it is allowed to persist it will cause significant thinning of the Couch. This problem is most apparent when the spring and early summer remains cool and wet allowing the *Poa annua* to persist which further inhibits the regeneration of the Couch.

Poa annua is treated by most turf managers as a weed to be eradicated. Most treatment methods give variable results and repeated treatments are necessary to prevent the proportion of *Poa annua* from increasing. The difficulty in achieving control is due to the large seed bank of *Poa annua* and the potential for year round germination and rapid seedling growth. Research undertaken by Neylan (2006) demonstrated that in a sportsfield dominated by *Poa annua* there were 14,000 viable seeds/m^2 and were present to a depth of 5cm (figure 1). In *Poa annua* dominated golf greens these numbers have been reported as high as 200,000 seeds/m^2 (Lush, 1990). This gives *Poa annua* a competitive advantage over other species in mixed swards where the *Poa annua* can colonise bare areas left by mature *Poa annua* plants that have died due to chemical applications or environmental stress. For any *Poa annua* control program to be successful both pre and post emergent control is required.

Herbicide control strategies have generally concentrated on post-emergent control with some limited use of pre-emergent herbicides. Post-emergent control can be very difficult due to the different biotypes of *Poa annua* that occur which have varying susceptibility to the available herbicides.

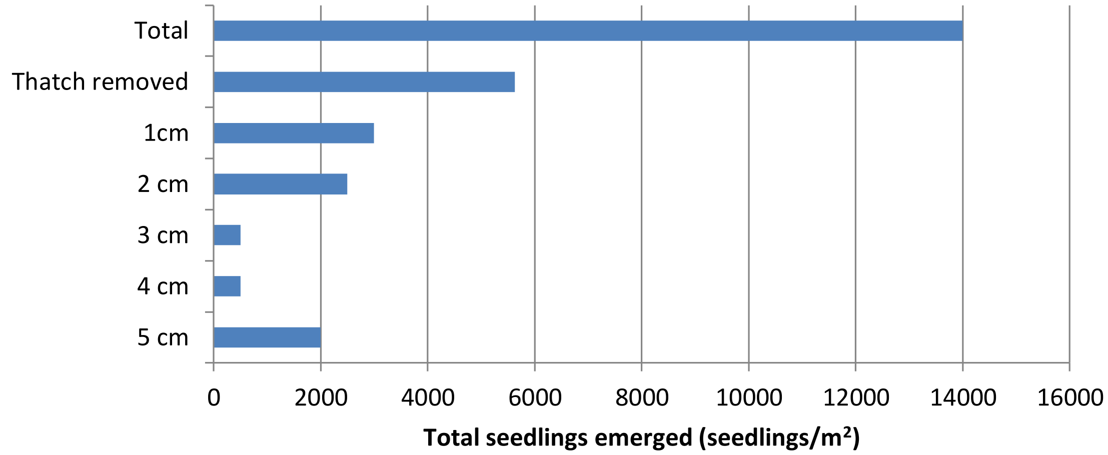
2 THE PROBLEM

Over the past 2 – 3 years it has become apparent that controlling *Poa annua* in Couch and Kikuyu is becoming more difficult and when herbicides are applied the results are more inconsistent. The inconsistent performance of any herbicide can be due to numerous factors including; weed biotype, enhanced biological degradation of the herbicide, application method, weather conditions at the time of application and temperatures post-application. The most concerning problem with *Poa annua* control is the

growing evidence that there is increasing resistance to the available registered herbicides.

Given that most sportsfields only receive 1 - 2 herbicide applications per year for the control of *Poa annua* it is important that the most cost-effective and agronomically advantageous method is employed.

Figure 1: *Poa annua* Seedling Emergence in a Sportsfield Profile



3 PROJECT OBJECTIVE

The objective of this research project was to assess the efficacy of various pre and post emergent herbicides to control *Poa annua* in Couch (*Cynodon* sp.) and Kikuyu (*Pennisetum clandestinum*) sportsfields.

4 TRIAL METHODOLOGY

Trials were undertaken to study the effects of pre and post emergent herbicides on a Couch and a Kikuyu sportsfield. There were 3 replicates for each treatment in a randomised block design with each plot being 6 square metres. The pre-emergent herbicides are detailed in table 1 and the post-emergent herbicides are detailed in table 2.

4.1 Pre-emergent trial

The pre-emergent trial was established on a Couch field (Seaford) and a Kikuyu field (South Frankston). The herbicides were applied on the 27/2/14 and the conditions were calm, warm (24°C) and dry. The soil temperature was 24°C and the plots were irrigated after the herbicides were applied.

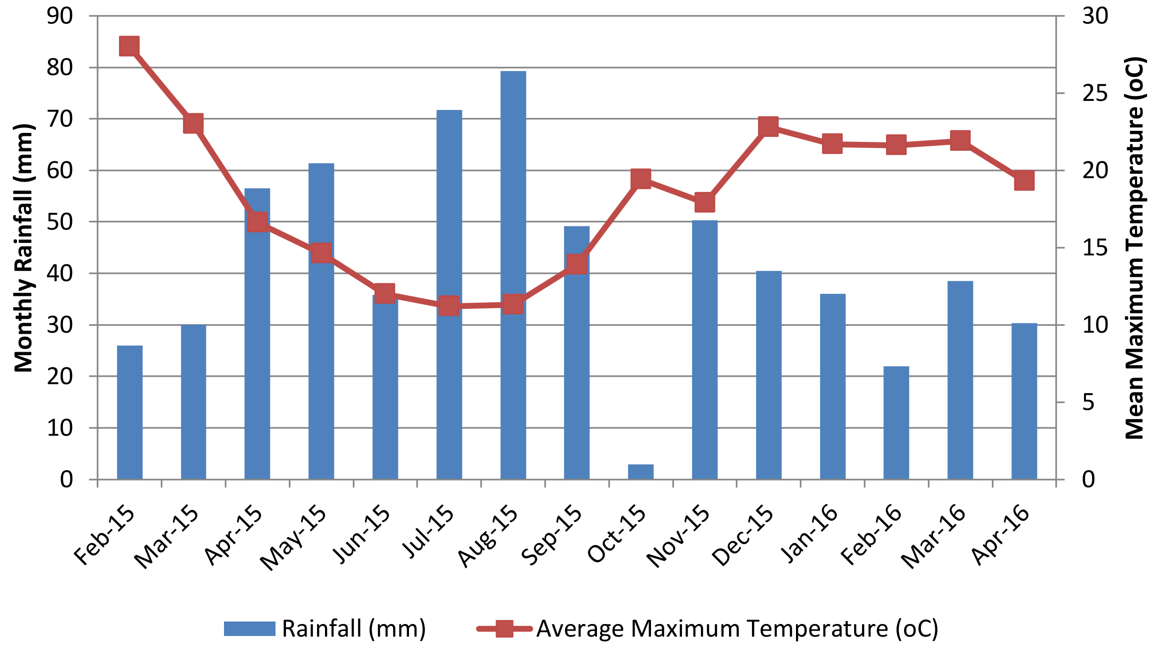
Table 1: Pre-emergent herbicides

TREATMENT	HERBICIDES	PRODUCT	APPLICATION RATE (PRODUCT/Ha)	EXPECTED LIFE (APPROXIMATE)*
T1	Oryzalin	Embargo™	5L/ha	about 100 days
T2	Pendimethalin	Stomp 330™	4.2L/ha	about 70 days
T3	Prodiamine	Barricade™	2L/ha	Up to 150 days***
T4	Oxadiazon	Ronstar Turf and Ornamental Herbicide™	200kg/ha	about 70 days
T5	Dithiopyr	Dimension EW™	3.5L/ha	about 120 days**
T6	Untreated Control	-	-	-

*Information drawn from the label or other company documentation. Always check the label.
**Information drawn from general literature.
***In high infestations the label recommends repeat applications in 3 – 4months.

Following the herbicide applications there was a significant rainfall event on the 1/3/15 (18mm), however, the rainfall totals were below the monthly averages for March, April, May and June (see figure 2). The low rainfall totals resulted in the late germination of *Poa annua* at both sites.

Within one week following the application of the herbicides there was a very slight discolouration of the Kikuyu plots where oxadiazon had been applied. This did not occur on any of the couch plots.



4.2 Post-emergent trial

The post-emergent trial was established on a Couch field (Frankston) with known herbicide resistance. A site was also to be established on a Kikuyu field, however, there were no sites deemed to be suitable and as a result this aspect of the trial was abandoned.

The post-emergent herbicides used are detailed in table 2. The Kerb™ was applied as a subplot treatment across all other treatments. The Kerb™ was applied 7 days prior to the other treatments so that it could be watered according to the label directions.

There were additional single plot treatments established to observe the effects of Glyphosate (a.i. 360g/L) at 0.25L/ha, Tribute™ plus Glyphosate (a.i. 360g/L) at 0.25L/ha and Poacheck at 1.5L/ha plus a sticker (Filmstar™).

The Kerb™ was applied on the 8/10/15 and the remaining treatments applied on the 15/10/15. A second application of treatments 1, 2, 3 and 5 were made on the 11/12/15.

4.3 Assessments

The following assessments were undertaken;

1. ***Poa annua*:** The amount of *Poa annua* was determined with the use of a 1 x 1 metre grid (50mm x 50mm squares) divided into 214 squares. The grid was placed in the centre of each plot and the number of squares containing *Poa annua* plants counted.
2. **% of squares with Couch:** The % of squares with Couch or Kikuyu was determined during the *Poa annua* counts but in particular in the spring/summer transition.
3. **Turf quality:** The treatments were visually assessed for turf quality using a 0 – 5 scale where 0 = very poor and 5 = excellent.
4. **Turf density:** The treatments were visually assessed for turf density using a 0 – 5 scale where 0 = no turf cover and 5 = very dense.

5. **Root depth:** On the pre-emergent trials 100mm diameter core samples were taken to a depth of 200mm and the root depth measured.

Table 2: Post-emergent herbicides

TREATMENT	ACTIVE	PRODUCT	APPLICATION RATE	WATER RATE	IRRIGATION
T1	Foramsulfuron	Tribute™	1.5L/ha	200 - 500L/ha	Irrigation not recommended after application
T2	Trifloxysulfuron sodium	Monument™	225ml/ha + surfactant	400 - 800L/ha	No notes on irrigation - assume same as Tribute
T3	Tribute + Endothal	Tribute™ at label rate + Poacheck™ + Filmstar™	T = 1.5L/ha E = 15mL/100m^2 F = 12mL/100m^2	200 - 500L/ha	No irrigation
T4	Control				
T5	Tribute + Destiny		1.5 L/ha Tribute + 25g/ha Destiny	200 - 500L/ha	No irrigation
T6	Propyzamide	Kerb	1.2L/ha	Sufficient water to get good coverage	Irrigate immediately after application with 12mm (min) of irrigation. After 24 hours apply another 12mm.

*Information drawn from the label or other company documentation. Always check the label.

4.4 *Poa annua* seed bank

The *Poa annua* seed bank is a key to its survival and it was decided to study this particular aspect. At the Seaford and South Frankston pre-emergent trial sites 50mm diameter cores were taken to a depth of 5cm from the oryzalin plots and the untreated control. Four samples were taken from each plot with a total of 24 cores taken.

Each core was separated into the; thatch, 0 – 1cm, 1 – 2cm and 2 – 4cm layers. These segments were broken up and planted into trays and watered regularly.

4.5 *Poa annua* characteristics

The seedlings established in the seed bank study were measured for plant height and tiller number.

5 RESULTS

5.1 Pre-emergent trial

5.1.1 *Poa annua* control

The trial sites were assessed prior to the application of the treatments and there was no *Poa annua* present at either site. The trials were assessed monthly and the results are detailed in tables 3 and 4 and figures 3 and 4.

At the March and April 2015 assessments there was some minor *Poa annua* germination noted in the untreated control plots at the South Frankston site with none at the Seaford site. Detailed assessments were undertaken on five occasions when there was an obvious presence of *Poa annua*.

Seaford (Couch) Site: At the Seaford (Couch) site there was a significant difference between the treatments. At the May 2015 assessment all herbicide treatments had significantly less *Poa annua* than the untreated control. At the June 2015 assessment the oryzalin treatment had significantly less *Poa annua* than all other treatments except for the prodiamine treatment. All of the remaining herbicide treatments had significantly less *Poa annua* than the untreated control.

At the July 2015 assessment the oryzalin and prodiamine treatments had significantly less *Poa annua* than the oxadiazon and the untreated control. At this time the oxadiazon was past its expected longevity and effectiveness. All of the remaining herbicide treatments had significantly less *Poa annua* than the untreated control.

At the August 2015 assessment the oryzalin treatment had significantly less *Poa annua* than all other treatments except for prodiamine. All of the remaining herbicide treatments had significantly less *Poa annua* than the untreated control.

Table 3: Seaford Couch site – Average No. squares where *Poa annua* was present

Treatment	Product	15/4/15* (48 DAT)	15/5/15 (78 DAT)	17/6/15 (111 DAT)	14/7/15 (138 DAT)	13/8/15 (168 DAT)
T1	Oryzalin	0	0^{a}	0^{a}	0^{a}	0^{a}
T2	Pendimethalin	0	20.3^{a}	33.7^{b}	41.7^{ab}	100.0^{b}
T3	Prodiamine	0	0.3^{a}	10.3^{ab}	16.3^{a}	45.7^{ab}
T4	Oxadiazon	0	28.7^{a}	39.0^{b}	100.3^{b}	108.3^{b}
T5	Dithiopyr	0	18.0^{a}	39.0^{b}	67.3^{ab}	104.0^{b}
T6	UTC	0	99.3^{b}	163.0^{c}	194.3^{c}	208.3^{c}
LSD (P<0.05)		**NS**	**36**	**29**	**75**	**90**

Note: Where treatment means have the same letter there is no significant difference.
*On this assessment date there were small *Poa annua* seedlings present but of insufficient size to identify and count.

South Frankston (Kikuyu) Site: At the South Frankston (Kikuyu) site there was a significant difference between the treatments.

In May 2015 there was no significant difference between the treatments and this tends to reflect the variability of the *Poa annua* distribution between the blocks and the difficulty in counting the *Poa annua* amongst the green Kikuyu shoots.

At the June 2015 assessment the oryzalin and prodiamine treatments had significantly less *Poa annua* than the oxadiazon and untreated control. All of the remaining herbicide treatments had significantly less *Poa annua* than the untreated control. At the July 2015 assessment the oryzalin treatment had significantly less *Poa annua* than all other treatments. The prodiamine had significantly less *Poa annua* than the oxadiazon, dithiopyr and untreated control plots.

In August 2015, the oryzalin treatment had significantly less *Poa annua* than all other treatments. The prodiamine treatment had less *Poa annua* than the oxadiazon and the untreated control.

Table 4: South Frankston Kikuyu site - No. squares where *Poa annua* was present

Treatment	Product	15/4/15* (48 DAT)	15/5/15 (78 DAT)	17/6/15 (111 DAT)	14/7/15 (138 DAT)	13/8/15 (168 DAT)
T1	Oryzalin	0	22.0	49.0^{a}	50^{a}	100.0^{a}
T2	Pendimethalin	0	44.7	71.3^{abc}	133^{bc}	185.0^{bcd}
T3	Prodiamine	0	17.0	48.0^{a}	116^{b}	148.3^{bc}
T4	Oxadiazon	0	68.3	117.7^{bc}	164^{c}	187.7^{cd}
T5	Dithiopyr	0	21.0	62.3^{ac}	134^{bc}	179.0^{bcd}
T6	UTC	0	55.0	107.3^{c}	179^{d}	215.0^{d}
LSD (P<0.05)		**NS**	**NS**	**54**	**37**	**37**

Note: Where treatment means have the same letter there is no significant difference.
*On this assessment date there were small *Poa annua* seedlings present but of insufficient size to identify and count.

5.1.2 Turfgrass quality and density

Turfgrass quality and density were assessed on each occasion with no significant differences recorded at either site. Tables 5 and 6 provide an example of the data collected. It was noted that at the South Frankston site that as the soils became wetter there was greater turf deterioration in those plots that had little or no *Poa annua*. This result raises the question as to whether it is appropriate to use pre-emergent herbicides on all sites, particularly those that have poor drainage and high traffic.

In contrast the Seaford site was on a sandy soil type and the surface remained dry throughout the winter months. Consequently the couch cover remained intact throughout.

Table 5: Seaford Couch site – Turfgrass quality and density

	13/8/15		13/10/16		
Product	**Quality***	**Density****	**Quality**	**Density**	**% Couch**
Oryzalin	3.8	3.8	4.4	4.4	100^{a}
Pendimethalin	3.5	3.5	3.9	4.2	51^{bc}
Prodamine	3.8	3.8	4.2	4.3	85^{ab}
Oxadiazon	3.8	3.8	3.8	4.1	52^{bc}
Dithiopyr	3.7	3.7	3.7	4.1	62^{bc}
UTC	3.8	4.0	3.5	4.1	28^{c}
	NS	**NS**	**NS**	**NS**	**37**

*Turfgrass quality (0 = very poor, 5 = excellent)
**Turfgrass density (0 = bare ground, 5 = very high turf density)

Table 6: South Frankston Kikuyu site – Turfgrass quality and density

	14/7/15		13/8/15		13/10/15			7/12/15		
Treatment	*** Quality**	**** Density**	**Quality**	**Density**	**Quality**	**Density**	**% Kikuyu**	**Quality**	**Density**	**% Kikuyu**
Oryzalin	3.3	2.8	1.7	1.7	3.3	3.4	63^{a}	4.1	4.1	81.7
Pendimethalin	3.7	3.5	3.2	3.0	3.5	3.6	37^{bc}	4.0	4.1	70.0
Prodamine	3.8	3.5	2.3	2.2	3.4	3.4	57^{ab}	4.3	4.4	83.3
Oxadiazon	4.0	3.3	3.2	3.0	3.4	3.6	40^{b}	3.7	3.7	70.0
Dithiopyr	3.8	3.3	2.8	2.7	3.3	3.6	53^{ab}	4.2	4.3	81.7
UTC	3.8	3.7	3.3	3.3	3.2	3.7	20^{c}	3.3	3.3	58.3
LSD (P<0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**19**	**NS**	**NS**	**NS**

*Turfgrass quality (0 = very poor, 5 = excellent)
**Turfgrass density (0 = bare ground, 5 = very high turf density)

5.1.3 Turfgrass cover

In the spring/early summer the % Couch and Kikuyu cover was assessed and the results are detailed in tables 5 and 6. The results at both sites indicate that there are advantages in achieving a quicker recovery of the desired species if they are kept free of *Poa annua*.

At the Seaford site during the October 2015 assessment, the oryzalin treatment had a significantly greater couch cover than all other treatments except for the prodiamine treatment. At the Seaford site it was not possible to get any meaningful data on the 7/12/15 because the field had been scarified.

The Frankston South site was wet and shaded and there was substantial damage to the turf where there was no *Poa annua* present. Consequently the % Kikuyu is quite low though recovery was very strong. At the October 2015 assessment the oryzalin had a significantly greater kikuyu cover than all other treatments except for prodiamine and dithopyr. By the December 2015 assessment there was no significant difference between the treatments.

5.1.4 Root depth

In the spring of 2015 core samples were taken from each plot and the depth of the main root mass was measured. The data is detailed in table 7. The results show that there was no significant difference between the treatments when compared against the untreated control.

Table 7: Depth of main root mass at the pre-emergent sites

		Root depth (cm) 8/9/15	
Treatment	**Product**	**Couch - Seaford**	**Kikuyu – South Frankston**
T1	Oryzalin	17.0	11.0
T2	Pendimethalin	19.0	11.3
T3	Prodamine	19.7	10.3
T4	Oxadiazon	20.0	10.8
T5	Dithiopyr	19.3	12.7
T6	UTC	18.7	11.7
LSD (P<0.05)		**NS**	**NS**

5.1.5 *Poa annua* characteristics

A total of 17 *Poa annua* plants from each trial site were taken from the seed bank trial and the plant height and tiller number determined (table 8). There is a significant difference between the characteristics of the Poa annua plants between the two sites. At the South Frankston site the *Poa annua* plants were significantly taller and had fewer tillers compared to the plants from the Seaford site. The plants at the Seaford site were shorter and more compact with a greater number of tillers.

Table 8: Average plant height and tiller number for *Poa annua* plants

SITE	**Plant height (cm)**	**Tiller No.**
South Frankston	19.7	1.2
Seaford	8.8	3.2
t-test (P<0.05)	**SIG**	**SIG**

5.2 Post-emergent trial

A pre-treatment count was undertaken and at 5 weeks after treatment. The % change was calculated and reported in table 9.

Table 9: % Reduction in *Poa annua*

Treatment	**% Reduction in *Poa annua* 23/11/2015**	**% Reduction in *Poa annua* 21/12/2015**
Tribute	70[a]	-19.7*
Monument	54[a]	-117.5
Tribute + Endothal	76[a]	-42.2
UTC	57[a]	-65.7
Tribute + Destiny	88[b]	33.5
Kerb	76[a]	NT
LSD (P<0.05)	**22**	**NS**

*Note: a negative number means there was an increase in *Poa annua* numbers

The data has been analysed using several methods. The only significant result has been the Tribute™ + Destiny™ that had significantly less *Poa annua* than the untreated control at the 23/11/15 assessment. There was no significant interaction with the use of the Kerb™.

The single plot treatments did not yield any outstanding results with the endothal showing some promise. The endothal effects the *Poa annua* in the first day or so after application, however, the *Poa annua* at this site tended to recover relatively quickly.

On all plots there was still a reasonable *Poa annua* population and some regeneration of the herbicide affected *Poa annua* and therefore a second application was made with the exception of the Kerb™. The results detailed in table 9 demonstrate that for most treatments and the untreated control there was an increase in the number of *Poa annua* plants. There was a large variation in the *Poa annua* population between individual plots and consequently there was no significant difference between treatments. The trend in the data indicates that the Tribute™ + Destiny™ was potentially the most effective treatment.

5.3 Seed bank

The seedlings were identified and counted at 2 and 4 weeks after seeding. The data for 4 weeks after seeding is detailed in table 10 and figures 3 and 4.

At both sites the results indicate that there is a substantial seed bank with most of the seeds in the thatch layer. The seed numbers at the South Frankston site are significantly greater in the thatch layer. In comparison, at the Seaford site there was no significant difference between the thatch layer, the 0 – 1cm layer and the 1 – 2cm layer. While there are variations between the sites these results demonstrate the ongoing regenerative potential of *Poa annua* and clearly not all seeds germinate in the same time period. This long term seed reserve needs to be understood if a suitable management program is to be implemented.

The results from the Seaford site demonstrated a significantly higher seed reserve in the untreated control compared to the pre-emergent treatment. The difference between the pre-emergent plots and the untreated control indicates that over time the use of pre-emergent herbicides could be expected to reduce the seed bank.

Table 10: Seedling numbers/m^2

Depth	**South Frankston**	**Seaford**
Thatch	8755[a]	6055[a]
0 - 1cm	949[b]	2785[ab]
1 - 2cm	527[b]	1624[ab]
2 - 4cm	443[b]	549[bc]
LSD (P<0.05)	**3038**	**5316**
Pre - emergent v Control		
Pre - emergent	2316	1646
Control	3038	3797
LSD (P<0.05)	**NS**	**SIG**
Interaction	**NS**	**NS**

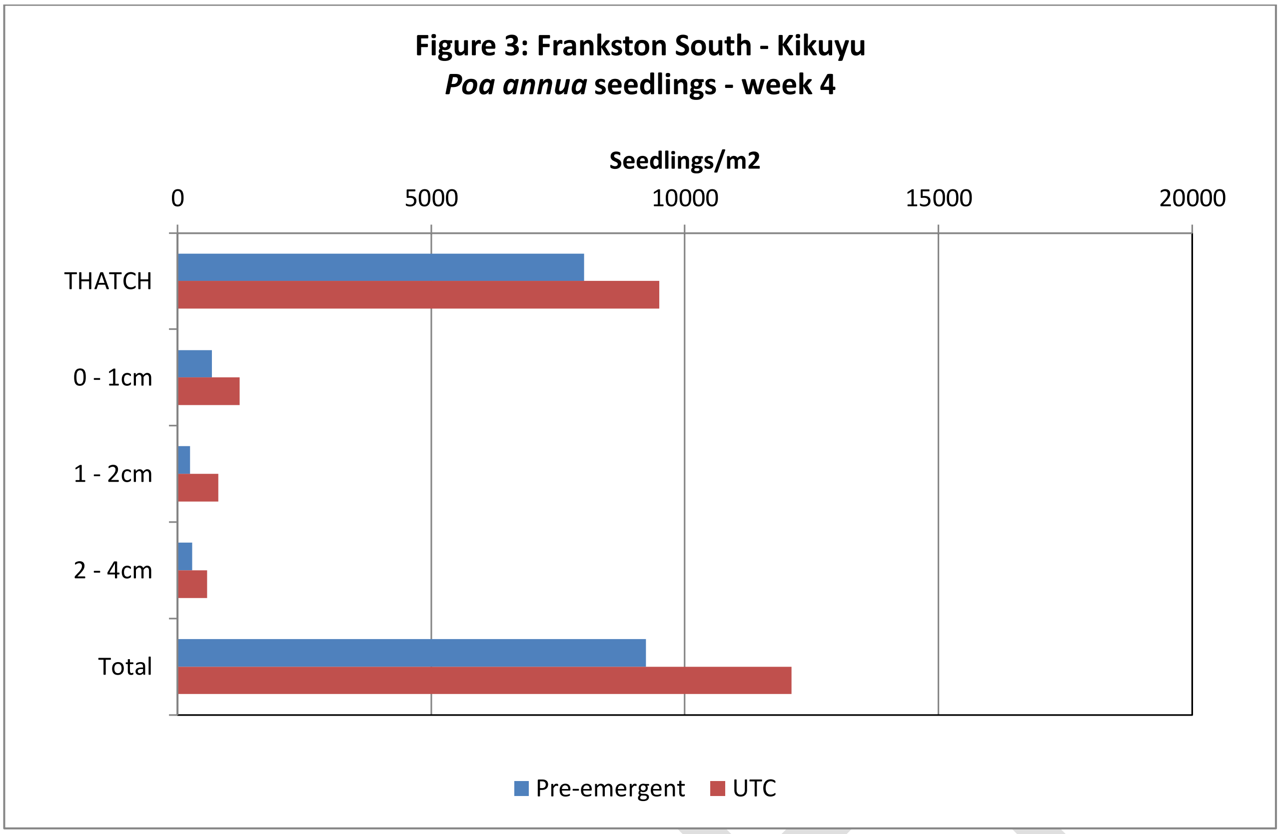


Figure 3: Frankston South - Kikuyu
Poa annua seedlings - week 4
Seedlings/m2
0
5000
10000
15000
20000
THATCH
0 - 1cm
1 - 2cm
2 - 4cm
Total
Pre-emergent
UTC

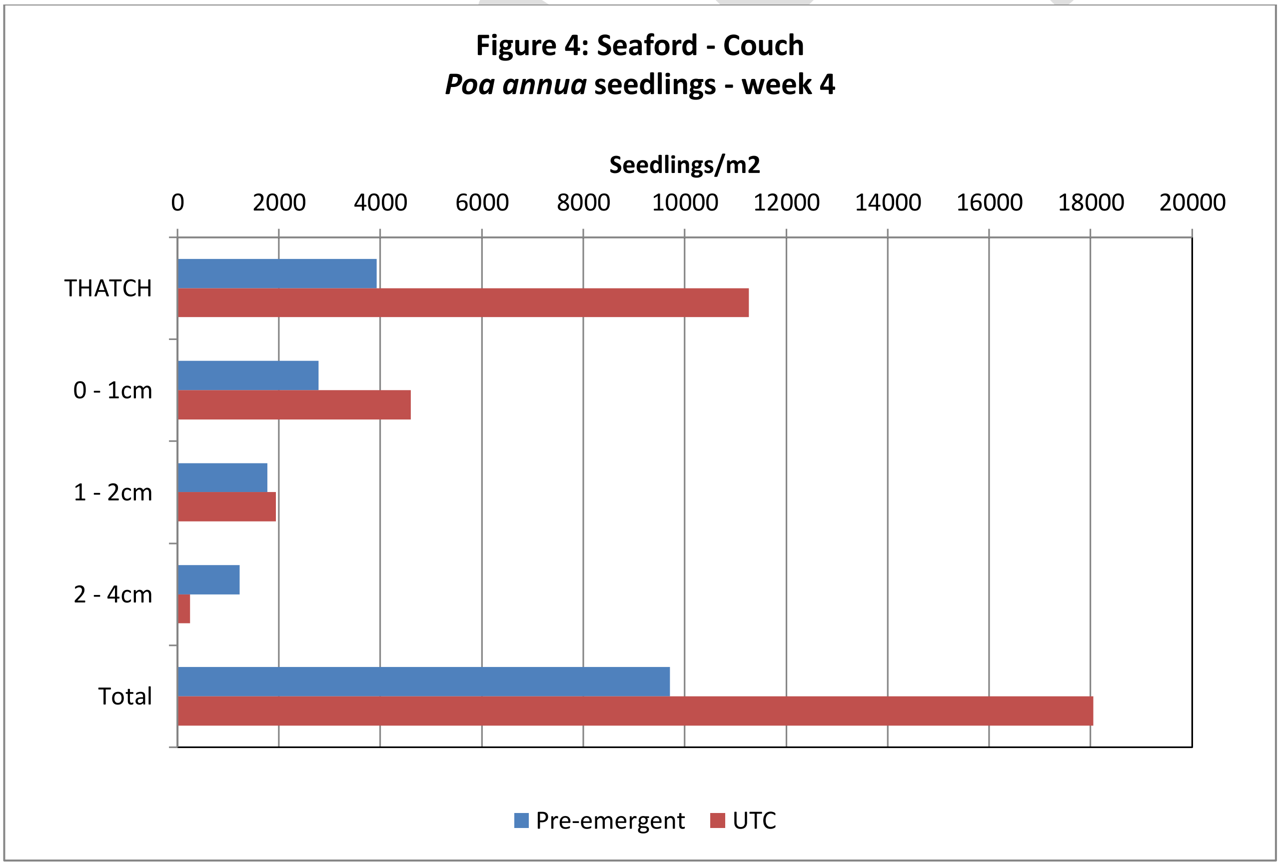


Figure 4: Seaford - Couch
Poa annua seedlings - week 4
Seedlings/m2
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
THATCH
0 - 1cm
1 - 2cm
2 - 4cm
Total
Pre-emergent
UTC

Figure 3: Typical *Poa annua* germination from profile cores.

6 CONCLUSIONS

6.1 *Poa annua* control

6.1.1 Pre-emergent trial

The results of the pre-emergent trials indicate the following;

- All the pre-emergent herbicides are effective in controlling or minimising the germination of *Poa annua*.
- The site conditions can have a significant effect on the efficacy of the herbicide treatments. High soil moisture content in particular appears to reduce the efficacy of the herbicides.
- Timing of applications in relation to the peak germination of *Poa annua* is critical for effective control.
- During this trial the prolonged dry conditions meant that the peak *Poa annua* germination period was late into the period after the herbicides were applied and some were close to the end of their effectiveness (e.g. oxadiazon) before there was significant germination.
- Repeat applications for some pre-emergent herbicides are required.
- The results should be viewed in terms of their expected activity and at 168 days after application all of the herbicides would be expected to be beyond their normal period of effectiveness.
- Monitoring conditions is critical in understanding how to get the best out of the pre-emergent herbicide program.
- At the Seaford site where the conditions are drier, the pre-emergent treatments appear to have been more effective.
- The South Frankston site is relatively wet compared to the Seaford site and the conditions are more conducive to a higher population of *Poa annua*. It is also postulated that the high soil/thatch moisture content had reduced the efficacy of the herbicides.

6.1.2 Post-emergent trial

The results of the post-emergent trial indicate that at this particular trial location there was minimal success with the herbicides trialled and indicates that the *Poa annua* population has a proportion of herbicide resistant individuals. The tank mix of Tribute™ + Destiny™ was the most successful of the herbicides used.

6.2 Turfgrass quality and density

There has been some significant difference in the turfgrass quality and density in relation to the application of pre-emergent herbicides. However, at the South Frankston site there was an obvious deterioration in the plots where there was little or no *Poa annua* when compared to the untreated control. These observations would indicate that on poorly drained and wet soils that there is a case to be made to let the *Poa annua* develop over winter to provide some surface protection and then remove it in the spring/summer.

6.3 Seedbank

The *Poa annua* seedbank is large and provides long term regenerative potential for this invasive weed species. The data collected indicates that over a prolonged period that the *Poa annua* population could be reduced through a targeted pre and post emergent herbicide program

7 REFERENCES

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8 ACKNOWLEDGEMENTS

Many thanks to the Sports Turf Association, Victoria for its financial support and to Garry Woolard - Coordinator Parkland Services and Gavin Bock - Team Leader Active Reserves from Frankston City Council for making the trial sites available to us.

9 PHOTOGRAPHS

Figure 1: South Frankston (Kikuyu) site

Figure 2: Seaford (Couch) site

Figure 3: Edge of trial area – note *Poa annua* lhs (untreated)

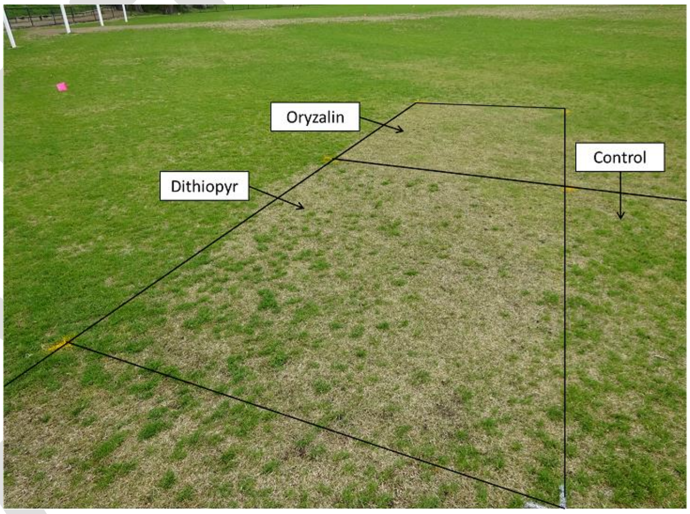

Figure 4: Pre-emergent herbicide effects (note minimal *Poa annua*)

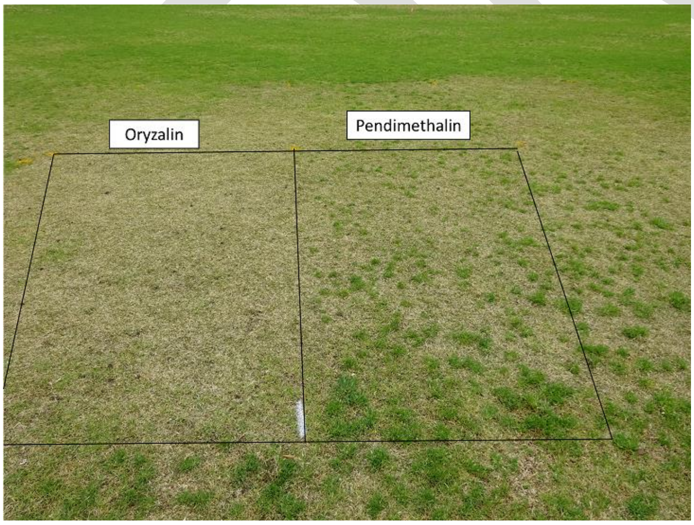

Figure 5: Pre-emergent herbicide effects (minimal *Poa annua*)

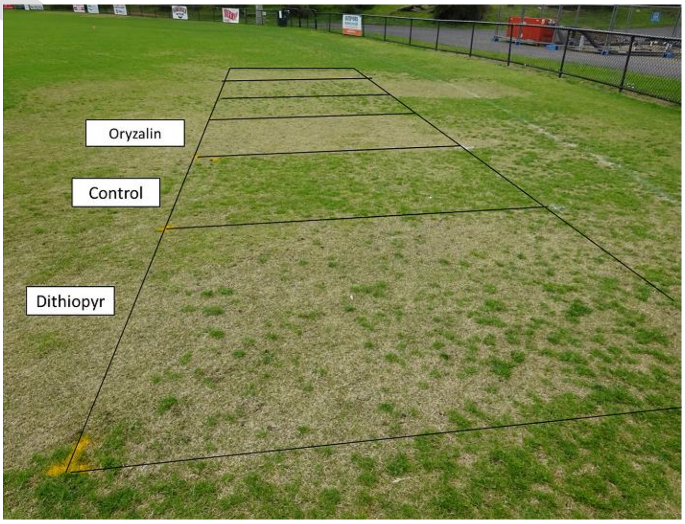

Figure 6: Pre-emergent herbicide effects (minimal *Poa annua*)

Figures 7 and 8: Good *Poa annua* control and low turf density due to wear

Figure 9: Post-emergent herbicide trial set up – note presence of *Poa annua*

Figures 10 and 11: *Poa annua* population on oval at time of post-emergent herbicide trial set up

Figure 12: Effect of Tribute + Destiny

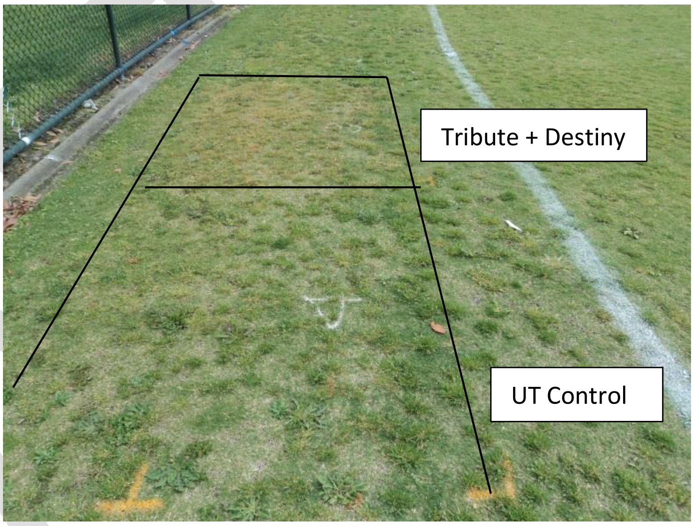

Figure 13: Effect of Tribute + Destiny next to UTC

Figure 14: Effect of Tribute + Destiny – some surviving *P. annua*

Figure 15: Variable effect of herbicide on oval

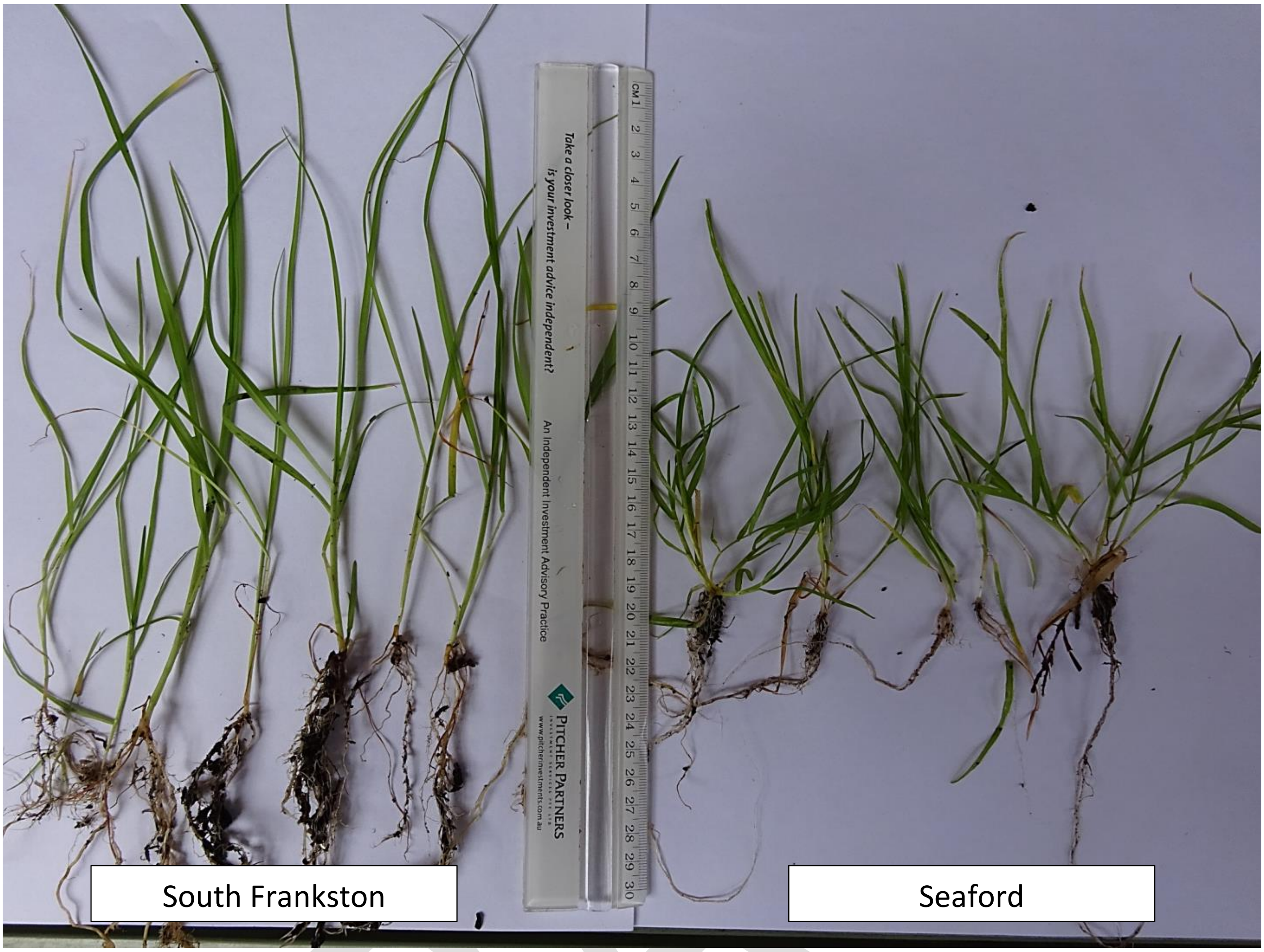

Figure 16: Height of *Poa annua* plants