An integrated approach to managing Noogoora burr in maize crops

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Summary This paper summarises the integrated approach taken to control Noogoora burr in a large maize crop. The ecology of both the weed and the crop were studied in detail to determine which changes to the cropping regime could be made to reduce the number of Noogoora burr plants, with the long term goal of eradication.

Keywords Herbicide trial, ecology, life cycle.

INTRODUCTION

Noogoora burr (*Xanthium strumarium* L.) is a pest plant of relatively limited distribution in New Zealand, but is a significant pest in Australia where it has impacts on cropping and wool production areas (Government of South Australia n.d.). It is classified as an eradication pest in the Bay of Plenty Region of New Zealand, where the goal is immediate control leading to eradication (Bay of Plenty Regional Council 2011).

The largest Noogoora burr site in the Bay of Plenty Region an area of arable land approximately 100 hectares used for maize cropping. In the 2012–2013 growing season, 33,450 Noogoora burr plants were found and hand-pulled by manual surveillance teams surveying the whole site, row by row. This was both a time-consuming and expensive exercise, and has not halted the spread of this pest plant. A change of approach was required if the number of Noogoora burr plants at this site were to be reduced and achieve the stated goal of eradication.

This paper outlines the integrated approach taken to better manage Noogoora burr at this site, and summarises unpublished research trials completed by AgResearch for the Bay of Plenty Regional Council. To support the efficacy of the new maize crop regime at this site, additional data was collected and analysed by the Bay of Plenty Regional Council.

The ecology and lifecycle of both Noogoora burr and the maize regime at this site were studied to determine whether changes could be made to aid the control of this pest plant. The aim was to achieve better pest management by concentrating on the system as a whole, rather than the pest plant in isolation. To do this, knowledge gaps would have to be filled with a mix of observational and empirical research.

It was observed that the long-rotation maize-for-grain regime at this site allowed two generations of Noogoora burr to grow and set seed each year. In addition, it was also noted that the greatest number of Noogoora burr plants were emerging in the small furrow caused by the side cutting of urea fertiliser into the soil (possibly due to breaking the residual pre-emergence herbicide layer in the soil). A pre- and post-emergence spray regime was in use at this site but it was not effectively controlling Noogoora burr.

Deep cultivation can be an effective mechanical method of weed control for many species (Pennsylvania State University 2004) and could possibly be utilised at this site. However the maximum depth of Noogoora burr emergence was not known.

To aid control of Noogoora burr at this site, the maize regime was switched from a long-rotation maize-for-grain regime to a short-rotation maize-for-silage regime. This had the benefit of harvesting before the second generation of Noogoora burr could germinate, and allowed for the sowing of a ryegrass or a summer oats crop for the remainder of the growing season. Any Noogoora burr that germinated in this second crop could then be effectively controlled by the application of a broadleaf-specific herbicide. In addition, the fertiliser application method was changed from side cutting to surface broadcasting, to prevent the cutting of furrows that appeared to be aiding Noogoora burr germination. Rigorous machinery hygiene practices were adopted, to prevent movement of seed from the site via contaminated soil. These practices included keeping the seed planting machine on site longer to allow full cleaning, and harvesting the maize with a site-based tractor and trailer, followed by a transfer of maize to trucks in a designated load-out area adjacent to the maize crop.

MATERIALS AND METHODS

Herbicide trial A field trial was conducted to evaluate several post-emergence herbicide options (Tables 1 and 2) for their efficacy on Noogoora burr. Plot sizes were 3 m wide by 12 m long, containing four rows of maize, set up in a randomised block design with four replicates. The treatments included an untreated

experimental control, current selected post-emergence herbicides, as well as a new herbicide from BASF and an experimental product from Bayer. Two post-emergence treatments of herbicide were applied to the plots at week two and week five, respectively. Counts of Noogoora burr plants in each plot were conducted pre-treatment, and three times post-treatment. Visual assessments of overall weed control were also undertaken twice.

Depth of emergence trial The aim of this trial was to determine whether burying Noogoora burr seeds to a depth where they could not germinate would be a viable mechanical control method at this site. Fresh Noogoora burr seeds (burrs) were collected from this site, and scarified to aid germination. Ten scarified burrs were placed in columns at various depths between 0–100 mm to evaluate depth of emergence. Each depth was replicated four times. The columns were regularly checked for Noogoora burr emergence, and once recorded the germinated plants were cut off 10 mm above ground so that further emergence was not inhibited.

Noogoora burr density pre- and post-regime-change Point data was collected for two growing seasons pre regime-change for the locations of all Noogoora burr plants found and removed from the site using handheld Global Positioning System (GPS) units.

To monitor the efficacy of the new regime at this site, eight transects were set up in January 2015, through field areas where the highest density of Noogoora burr was found in previous years. Noogoora burr plants were counted several times during the growing season between 2015 and 2016 in one row either side of each transect. As the length of each transect was dictated by paddock size, transects varied in length from 200–276 m. In order to standardise the data from each transect, the number of plants per 100 m was calculated.

Table 2. Herbicide products/active ingredients used (see Table 1).

Product	Active ingredient	Source
Adengo™	isoxaflutole/ thiencarbazone-methyl/ cyprosulfamide (experimental product)	Bayer
Arietta™	topramezone	BASF
Astound Ultra™	nicosulfuron	Orion
Banvel™	dicamba	Orion
Callisto™	mesotrione	Orion
Gesaprim™	atrazine	Orion
Roustabout™	acetochlor	Nufarm

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Table 1. Post-emergence treatments for a herbicide trial to control Noogoora burr.

Tr. #	Post-Em 1	Rate (mL ha^{-1})	Post-Em 2	Rate (mL ha^{-1})
1	Control	–	Control	–
2	Banvel™	1500	–	–
3	Astound Ultra™	1500	Astound Ultra™	1500
4	Astound Ultra™ + Banvel™	1500 + 1500	–	–
5	Callisto™ + Gesaprim™	200 + 1000	Callisto™ + Gesaprim™	200 + 1000
6	Callisto™ + Gesaprim™ + Banvel™	200 + 1000 + 1500	–	–
7	Arietta™ + Gesaprim™ + Hasten™	200 + 1000 + 0.5%	Arietta™ + Gesaprim™ + Hasten™	200 + 1000 + 0.5%
8	Arietta™ + Gesaprim™ + Hasten™ + Banvel™	200 + 1000 + 0.5% + 1500	–	–
9	Adengo™	440	Adengo™	440
10	Adengo™ + Banvel™	440 + 1500	–	–
11	Gesaprim™	3000	Gesaprim™ + Synoil™	3000 + 1%
12	Gesaprim™ + Banvel™	3000 + 1500	–	–
13	Atsound Ultra™ + Callisto™	1500 + 200	Atsound Ultra™ + Callisto™	1500 + 200
14	Atsound Ultra™ + Callisto™ + Banvel™	1500 + 200 + 1500	–	–

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To compare the pre and post regime-change data, a geographical information system analysis (using ArcGIS™) of the point data was collected in the two growing seasons pre regime-change period. The transect lines were overlaid on this point data and a buffer of 2 m was applied to simulate the area searched during the transect surveys, post-regime-change. All points that fell within the 2 m buffer of each transect were counted, then the data was standardised to plants per 100 m. (Note that due to the eradication status of Noogoora burr at this site, an untreated area could not be left to use as an experimental control to compare the new management regime with the old regime).

RESULTS AND DISCUSSION

Herbicide trial Eight of the treatments controlled >80% of Noogoora burr plants after the first post-emergence treatment. Treatment 3 (Astound Ultra™) was the least effective. Banvel™ was also added to each product, as well as the product being used without, as it was expected to be especially effective on Noogoora burr, however control only improved with its addition to Astound™ (Table 3).

The second herbicide treatment was applied to the treatments that did not receive Banvel™ in the first application. Contrary to the results observed with the first application, the second application of Astound alone (Treatment 3), or in combination with Callisto (Treatment 13), was quite effective. Noogoora burr was also effectively controlled by the second application of the other treatments (5, 7, 9 and 11).

The other main weeds present at this site were assessed 10 days and 34 days after the second herbicide application (Table 4). Five of the treatments provided

Table 4. Weed Control scores (0 = no control; 100 = complete control) for weeds other than Noogoora burr 10 and 34 days after the second application: Post-Em 2 (Scores are the average of 4 replicates).

Treatment	16/12/2013	09/01/2014
1	0	0
2	71	50
3	90	96
4	83	75
5	99	99
6	93	86
7	100	99
8	91	85
9	87	93
10	88	87
11	71	48
12	72	64
13	98	99
14	87	86
LSD (P<0.05)	6.6	10.1

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Table 3. The number (sum of 4 replicates) of Noogoora burr plants per plot after treatments with various herbicides (Table 1).

Treatment	14/11/2013	04/12/2013	% reduction	16/12/2013	09/01/2014	% reduction[1]
1	93	101	–	109	120	–
2	9	1	89	1	0	100
3	40	37	9	27	3	92
4	6	1	83	6	4	33
5	13	2	85	0	0	100
6	17	1	94	8	1	94
7	8	0	100	0	0	100
8	7	4	43	2	5	29
9	27	4	85	0	0	100
10	236	25[2]	89	36	12	95
11	119	8[2]	93	3	0	100
12	4	2	50	0	1	75
13	26	9	65	3	1	96
14	1	3	0	0	0	100

[1] % reduction from the original population after Post-Em 2 application.
[2] Mostly seedlings appearing in the urea furrow.
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excellent efficacy (scores of 93–99), while five provided medium efficacy (scores of 75–87); and three provided low/poor efficacy.

Based on these results, both Banvel™ and Gesaprim™ provided excellent control of Noogoora burr alone and in combination with other products. Callisto™ (with Gesaprim™) and Adengo™ provided good control of Noogoora burr alone as well as in combination with Banvel™. These treatments also provided excellent control of all other weeds.

Depth of emergence trial Seedlings emerged from all depths except for 100 mm deep (Figure 1). More, rapid seedling emergence occurred from shallower depths. At depths of 30 mm or less, Noogoora burr plants started emerging after 8 days, and after 14 days from 90 mm depth.

Approximately half of the seedlings emerged in the first three weeks of this study. Emergence did however continue, for a further 90 days duration the study (Figure 2).

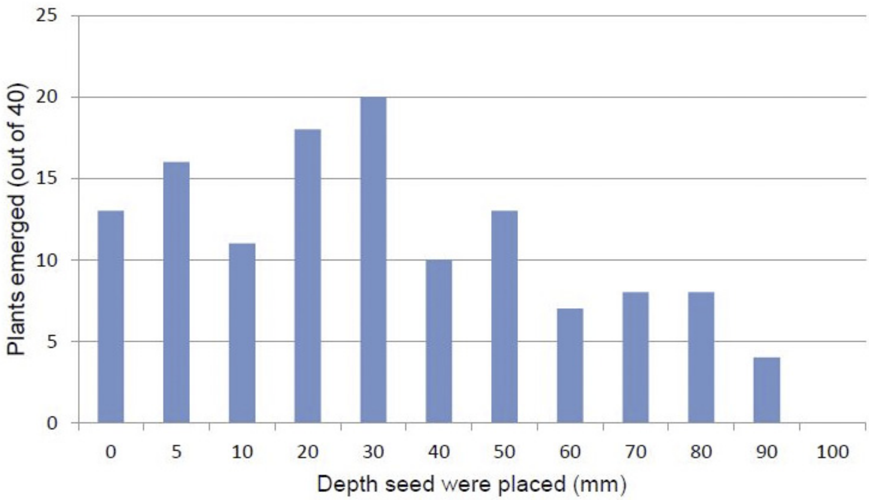

Figure 1. Total emergence of Noogoora burr plants (out of 40 burrs), buried at various depths, after 3 months. From James and Dowsett (2015) and reprinted with permission.

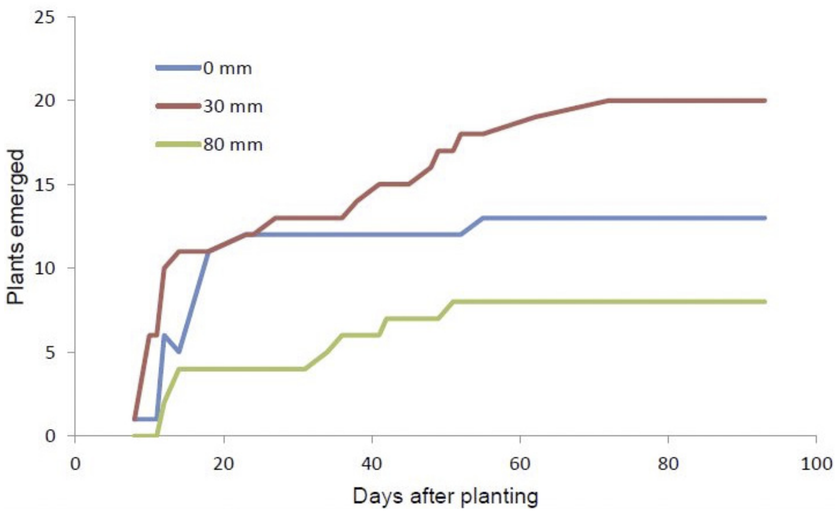

Figure 2. Sequential emergence of Noogoora burr for three selected depths (0, 30 and 80 mm) from a total of 40 burrs. From James and Dowsett (2015) and reprinted with permission.

Cultivation would probably not be an effective control method for Noogoora burr, as seedlings readily emerged from a depth of up to 90 mm.

Noogoora burr density pre- and post- regime-change There was a marked decrease in Noogoora burr plants found in the transects post regime-change when compared with the pre-regime-change data (Table 5). As well as the average decrease across all transects, Noogoora burr plants were only ever found in one or two of the eight transects after the move to the new regime compared to the pre regime-change, where Noogoora burr plants were found in 15 of the 16 transects. This data suggests that the new maize-for-silage regime is helping reduce Noogoora burr numbers at the site.

Table 5. Noogoora burr plants found 100 m^{-1}.

Transect #	2012–2013	2013–2014	16/01/2015	17/04/2015	20/01/2016	04/04/2016	20/04/2016
1	12.1	22.2	0	0	6.1	10.1	3.3
2	0	1.0	0	0.5	0	0	0
3	11.0	6.0	0	0	0	0	0
4	0	0.8	4.3	0	0	0	0
5	12.8	6.8	0	0	0	0	0
6	4.4	5.1	0	0	0	0	0
7	2.8	5.9	0	0	0	0	0
8	1.1	8.3	0	0	0	0.4	0
Average of all transects	5.4	7.1	0.6	0.1	0.8	1.3	0.4

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