Impact of fallow management regimes on nutgrass (*Cyperus rotundus* L.) tubers in irrigable broadacre crops in central Queensland

Vikki Osten[1], Megan McCosker[1], Anne Sullivan[1] and Jim Barnes[2]
[1] QDPI, LMB 6, Emerald, Queensland 4720, Australia
[2] QDPI, PO Box 23, Kingaroy, Queensland 4610, Australia

Summary The effect of sequential applications of various herbicides applied during a long fallow period on nutgrass tubers has been recorded and compared with untreated unweeded controls as well as cultivated controls. Over 32 months, tuber mortality ranged between 15 and 95% for the different treatments. Brief implications to cropping systems management are drawn.

Keywords Nutgrass, tubers, mortality, fallow, herbicides.

INTRODUCTION

Over 50 years of world wide research has been devoted to finding management solutions to *Cyperus rotundus*. Very few solutions apply to all situations where nutgrass is a problem so management often needs to be site specific and on-going. Integrated weed management offers the best hope.

In central Queensland research and development work is currently in progress to develop best management practices for nutgrass in both irrigated and dryland broadacre cropping systems using IWM principles. Fallow and crop rotation trials are being undertaken, however this paper is only reporting on the fallow studies at one irrigable site. An understanding of nutgrass dynamics during the fallow has provided valuable information for incorporation into the crop rotation studies.

MATERIALS AND METHODS

A long term fallow trial at Biloela has been in progress since 1998. Sequential applications of the individual herbicides glyphosate (1350 g ha^{-1}), imazapic (96 g ha^{-1}), imazethapyr (96 g ha^{-1}), and halosulfuron (98 g ha^{-1}) have been compared with a cultivated treatment and a weedy control. All sequential applications (five for each herbicide except glyphosate having six) were made within the first 11 months. The cultivated treatment has received 10 disturbances in that same period. At 22 months, the entire trial area was cultivated and then split in half with each half then receiving either an application of imazapic (96 g ha^{-1}) or glyphosate (1350 g ha^{-1}) at 24 months. Shoot numbers and tuber mortality have been measured periodically since initial treatment applications for a period up to 32 months. Only the impact on tubers is being reported here.

The six original treatments were replicated four times. The splitting of the trial after two years maintained the plot integrity but halved the number of replicates. Tuber counts taken at 8 and 20 months are presented as the mean from four replicates while those taken at 32 months are the mean of two replicates. Tubers were collected from a single 0.0375 m^3 quadrat (0.15 m deep × 0.5 m × 0.5 m surface area) $plot^{-1}$. Each sample was divided into dead and live tubers and counts were recorded. Count data are included rather than the changes in numbers over time. For the purposes of this paper and to keep data simple, no statistics have been applied.

RESULTS AND DISCUSSION

Tables 1 and 2 provide a summary of total number of tubers collected at three sampling periods for each treatment, as well as the number deemed to be

Table 1. Tuber numbers for the first two samplings.

Treatment	8 months		20 months	
	Total	Dead	Total	Dead
weedy control	740	30	3735	224
cultivated	586	228	641	301
glyphosate	747	217	126	481
imazapic	612	214	604	199
imazethapyr	947	142	3993	319
halosulfuron	413	116	416	183

Table 2. Tuber numbers at 32 months, and after the trial was split for either overall application of imazapic or glyphosate.

Treatment	Post-imazapic		Post-glyphosate	
	Total	Dead	Total	Dead
weedy control	1666	1156	1480	632
cultivated	856	496	338	246
glyphosate	936	752	326	310
imazapic	774	682	56	32
imazethapyr	1142	826	862	388
halosulfuron	106	500	158	100

dead at each time. The number of live tubers can be calculated by subtracting the number of dead tubers from the respective 'total' figures provided. Data have been extrapolated to number m^{-2} surface area × 0.15 m soil depth.

After 8 months tuber mortality ranged from 15% (imazethapyr) to 39% (cultivated control), with less than 4% natural mortality in the weedy control. Glyphosate provided 37% tuber mortality and was the most effective of the herbicides over the short term. By 20 months the total number of tubers had dramatically increased in the weedy control and in the imazethapyr treatment. Total tuber number increased in the glyphosate treatment, while the remaining herbicide treatments remained static. However, at 20 months tuber mortality ranged from 8% (imazethapyr) to 46% (cultivated control), with 6% natural mortality occurring in the weedy control. Little extra impact was recorded for the glyphosate (now 38%) and the imazapic (shift from 29 to 33%) treatments. Halosulfuron (44% tuber mortality) was the most effective herbicide over the medium term.

Effectively the weedy controls became either glyphosate or imazapic treatments after the trial was split for the 'overall' applications at 24 months. For these same treatments (ex-weedy controls), impacts on tuber mortality were greatest from imazapic (69%) compared to glyphosate (43%). This trend was not evident across the entire treatment range. Imazapic had greater impact on tubers mortality in the treatments which originally received imazapic (88% compared to 57% from glyphosate) and imazethapyr (72% compared to 45% from glyphosate). On the otherhand, glyphosate had greater impact on the cultivated control (73% compared to 58% from imazapic), glyphosate (95% compared to 80% from imazapic) and halosulfuron (63% compared to 47% from imazapic) treatments.

Another interesting aspect of the data is the very low total number of tubers recorded in the treatment originally treated with imazapic and followed with the glyphosate (total 56 tubers per sample). This could be a sampling anomaly, or it could be attributed to a massive disintegration of tubers caused by the cultivation at 22 months in combination with the residual effects of the imazapic followed by the more immediate effects of the glyphosate. This particular aspect needs to be examined more closely and therefore validated before sound conclusions can be drawn.

Irrespective of whether glyphosate or imazapic were applied in particular, the overall tuber mortality across all treatments had increased compared to the previous sampling dates. The lowest recorded mortality after 32 months was 43% and the highest was 95%.

Overall, sequential applications of glyphosate followed by a single cultivation and then retreatment again with glyphosate produced the greatest impact on tubers (95% mortality) over the 32 months. This scenario is also the cheapest and likely to be the most cost-effective since the other herbicides are relatively expensive and are impractical for sequential applications. The other advantage of glyphosate is its non-residual character, so repeated use can still maintain cropping flexibility (crop choice and crop timing). Repeated use though is a concern for development of herbicide resistance, not necessarily in nutgrass but in the annual weeds which make up the flora for the situations. Another consideration is the unlikelihood of irrigable broad acre cropping land being fallowed for long periods of time (>6 months) unless the nutgrass populations are very high and cropping becomes muted. Where fallows are quite short (<3 months) and nutgrass populations are moderately high, sequential applications of glyphosate should still be considered in order to produce weed free conditions at planting. Competitive crops should be chosen, preferably with in-crop herbicide options that target nutgrass.

It is unlikely that nutgrass will be eradicated in irrigable broad acre situations but it can be managed by constant attention and action during the fallow and following with competitive crops. More work is needed to clarify the impacts of using imazapic as part of an integrated management approach.

ACKNOWLEDGMENTS

This study was funded by the Grains Research and Development Corporation. The authors thank the farm staff of the Biloela Research Station for assistance with the sampling activities.