Larvicide testing for blackfly control

11/04/2020

Testing the blackfly organophosphate larvicide Abate® for viability in the Orange River Blackfly Control Programme

Industry Sector: Cattle And Small Stock

Research Focus Area: Animal Health And Welfare

Research Institute: University Of KwaZulu-Natal

Researcher: Dr Nicholas Rivers-Moore PhD

Research Team:

Title	Initials	Surname	Highest Qualification
Dr	Helen	Dallas	PhD
Dr	Robert	Palmer	PhD
Mr	Shahin	Naidoo	BSc (Hons)
Ms	Esther	Ndou	BSc (Hons)

Year Of Completion : 2017

Aims Of The Project

- To confirm non-resistance to Abate in the Orange River pest blackfly populations;
- To investigate the potential for re-activation of Abate as an alternative larvicide to Vectobac for control under high-flow conditions.

Executive Summary

Downstream flow alteration resulting from river impoundment or inter-basin transfer schemes, while improving water supply assurance levels, has been shown to have negative ecological consequences, including outbreaks in pest blackfly. Outbreaks along the middle and lower Orange River have the potential to cause losses to livestock production estimated at US$13.3 million per annum (Rivers-Moore et al. 2014). This figure is a conservative estimate as it excludes losses in the tourism and irrigated agricultural sectors through lost revenue and labour days. Economic losses occur approximately 1200 km along the middle and lower reaches of the Orange River (Palmer 1997). This is the river segment downstream of Van Der Kloof Dam, the major impoundment regulating flows in the Orange River. The major pest species is *Simulium chutteri*, with more than 250 breeding sites (riffles) identified along the

affected river sections, however *S. damnosum*, *S. nigritarse* and *S. adersi* are also of concern (de Moor 1994, and citing others).

The Orange River Blackfly Control Programme, established in the early 1990s, was originally based on alternating use of two larvicides, viz. a bacterial larvicide (Vectobac®) and an organophosphate (Abate®; active ingredient is Temephos). This programme extends over some 850 km of the middle and lower Orange River, where 148 rapids have been identified as optimal breeding habitat for pest blackfly species (Palmer et al. 2007). The success of the control programme depends largely on correct timing of larvicide applications. It is based on monitoring using a ten-point scoring system for larval and pupal densities developed by Palmer (1994), which is scientifically robust and user-friendly. Larval density data are scored by the Department of Agriculture, Forestry and Fisheries (DAFF; Upington and De Aar regional offices) on a two-weekly basis, using the 10 point scale developed by Palmer (1994), reflecting seasonal changes of larval densities of the main blackfly pest complex comprising *Simulium chutteri* and *S. damnosum*. The blackfly control programme along the middle and lower Orange River is based on aerial applications of larvicides to control the pest species *Simulium chutteri*. Larvicides are generally applied three times in autumn and six times in spring (Palmer and Palmer 1995). The two larvicides registered for blackfly control in South Africa are Vectobac® (produced from the naturally occurring bacteria *Bacillus thuringiensis* var. *israelensis* (*Bti*), and Abate® (organophosphate temephos) (Palmer and Palmer 1995). However, wide scale application of the Abate larvicide, and blackfly larvae's continuous exposure to it, has resulted in resistance being developed (Palmer and Palmer 1995).

Both larvicide options had advantages and drawbacks to their use. In the case of Vectobac, the likelihood of pest blackfly developing resistance was low, but the higher viscosity and lower concentration of this larvicide in solution came with drawbacks including the need for more helicopter doses and clogging of nozzles. While Abate does not result in these application drawbacks due to its more concentrated, lower viscosity formulation, its over-use was cautioned against because of the higher likelihood of resistance developing in *Simulium chutteri.*

By 2005, due to overuse of Abate, larvicidal resis been confirmed (Palmer et al. 2007), and a study completed in 2007 was unable to recommend any viable alternatives. With ten years after the last use of Abate in the Orange River, it was hypothesized that larval resistance had diminished to the point where Abate could be used again. During this period, where blackfly take 12-24 days to complete a life cycle, there is likely to have been at least 120-240 generations. The purpose of this study was to establish whether blackfly larval resistance to Abate has subsided, thereby re-establishing a second larvicidal alternative for blackfly control on the Orange River.

Results

In the Great Fish River trials, larvae were a mixture of Simulium damnosum and S. chutteri in approximately a 3:1 ratio, while the reverse applied to pupae, and pupae dominated. Stock populations of blackfly larvae for the larvicide trials were low, with median values on the reeds sampled being 6.5 ± 1.4. Turbidity was relatively high, and flow rates were very low. Water was slightly alkaline, but with very high conductivity. In the Orange River, larvae were dominated by S. chutteri, with S. damnosum present, while pupal cases were almost exclusively S. damnosum with few S. chutteri present. Stock populations of blackfly larvae for the larvicide trials were higher than in the Great Fish River, with median values on the reeds sampled being 4.0 ± 1.4. Turbidity was relatively low, with prolific algal growth on rocks. Flow rates in the main river channel were normal; water was slightly alkaline, with conductivity comparable between river channel and irrigation canal.

Two concentrations of Abate were used: 0.3 mg.l-1 0.5 mg.l-1. Gutter trials of the efficacy of Abate on blackfly in the Great Fish River confirmed viability of the product, with mortalities of 95 and 97% respectively. Trials on Orange River populations showed similar trends at the same concentrations of larvicide. In all instances, declines in density classes were statistically significant ($p < 0.05$). In contrast, the class changes in the controls were not statistically significant ($p < 0.05$).

Conclusion

A downward change in density classes of blackfly larvae is expected to occur in both the control and trial gutter channels, due to a degree of downstream drift, where some larvae are dislodged and wash out of the gutters. Despite this, there was a clear differentiation between changes in density scores between control sample populations and samples exposed to larvicide. Not only was the viability of the Abate stocks confirmed after prolonged storage, but mortalities on the Orange River were significantly marked to indicate that larval resistance has subsided for concentrations of 0.3-0.5 $mg.l^{-1}$. In the project proposal, the original intention was to conduct larvicide trials on blackfly mortalities at a range of concentrations (0,

0.5, 1.0, 5.0 and 20.0 mg.l^{-1}). This range of concentrations was designed to range from the dosage concentration recommended by the manufacturers of Abate (0.10 ppm = 0.1 mg.l^{-1} or 30l per 100m^3 where flows can be accurately determined), to higher concentrations to enable confirmation of larvicidal viability. In this study, undertaking this full spectrum of trials was not possible due to the limited numbers of blackfly larvae available. Additionally, it was demonstrated that Abate was effective at concentrations of 0.3-0.5 mg.l^{-1}, which is within the magnitude of range recommended by the manufactures of Abate.

After a dormancy period of 10-15 years, blackfly larval resistance in the Orange River appears to no longer be a constraint in the use of Abate for blackfly control in the Orange River.

Objective Statement

- **Aim 1** (confirm non-resistance to Abate in the Orange River pest blackfly populations) has been successfully achieved.
- **Aim 2** (investigate the potential for re-activation of Abate as an alternative larvicide to Vectobac for control under high-flow conditions) will be an ongoing process. The Upington DAFF staff assisted with field trials. Further discussion will be required with DAFF (Upington and head office).

POPULAR ARTICLE

New Hope For Reintroduction Of Second Larvicide To Control Muggies On The Orange River

Dr. Nick Rivers-Moore.

Red Meat Research and Development SA funded a recently completed study that tested a second larvicide for controlling pest blackfly on the middle and lower Orange River. Mnr. Hoffie Joubert from KLK was also instrumental in assisting with project supplies. While the larvicide is not new, it became ineffective in the mid-2000s for controlling pest blackfly here, because of a build-up of resistance to the product in the local blackfly population. This means that only one larvicide, a bacterial larvicide called Vectobac, has been available for controlling blackfly for the past 10-15 years. The Orange River Blackfly Control Programme, established in the early 1990s, was originally based on alternating use of two larvicides – a bacterial larvicide (Vectobac®) and an organophosphate (Abate®). Both options had advantages and drawbacks to their use. In the case of Vectobac, the likelihood of pest blackfly developing resistance was low, but the higher viscosity and lower concentration of this larvicide in solution came with drawbacks including the need for more helicopter doses, clogging of applicator nozzles. While Abate does not result in these application drawbacks due to its more concentrated, lower viscosity formulation, its over-use was cautioned against because of the higher likelihood of resistance developing in *Simulium chutteri.*

By 2005, due to overuse of Abate, larvicidal resistance had been confirmed, and a study completed in 2007 was unable to recommend any viable alternatives. With more than ten years after the last use of Abate in the Orange River, it was hypothesized that larval resistance had diminished to the point where Abate could be used again. During this period, where blackfly take 12-24 days to complete a life cycle, there is likely to have been a few hundred generations, with resistance being bred out.

Dr Nick Rivers-Moore, an aquatic ecologist with fifteen years of research expertise on blackfly ecology, recently re-tested the efficacy of the larvicide Abate on pest blackfly. This was first tested for product viability at a site about half an hour's drive from Grahamstown on Great Fish River. Here, the same species of blackfly which cause the outbreak problems on the Orange River have not been exposed to Abate. Next, the gutter trials were repeated on the Orange River near Upington in the Northern Cape. In all trials, larval mortalities were significant after application of the larvicide. Dr Rivers-Moore said that "after a dormancy period of 10-15 years, blackfly larval resistance in the Orange River appears to no longer be a constraint in the use of Abate for blackfly control in the Orange River." These results were met with enthusiasm by the Blackfly Control Programme officers in the Upington DAFF office. However, he says that "it is recommended that upscaling of these results is considered prior to re-introduction of Abate as a second larvicide for controlling pest blackfly on the Orange River."

Please contact the Primary Researcher if you need a copy of the comprehensive report of this project –

Nicholas Rivers-Moore on blackfly1@vodamailcom

Animal Health and Welfare, Cattle and Small Stock

2020, Animal Health & Welfare, Online, Paper, RiversMoore, UZ

TrichLabCheck – A voluntary trichomonosis inter laboratory comparison project

Detection of Mycobacterium spp. in slaughter cattle at Gauteng abattoirs

DEADLINES for RESEARCHERS 2021

Proposals for 2021: TBC
Progress reports: 28 Jan 21
Final reports: 29 Jan 21 Final includes comprehensive report and popular article

COMMITEE MEETINGS for 2021

RMRDSA CSS Planning - TBC
Project Committee - TBC
Pork Planning - TBC

Calendar

< Apr 2021 >

Sun	Mon	Tue	Wed	Tur	Fri	Sat
				1	2	3
4	5	6	7	8	9	10

11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

PORK Priority Areas

Cattle & Small Stock Programmes

1 Sustainable natural resource utilisation

2 Improvement of Livestock production and forage

3 Management of agricultural risk to create a resilient Red Meat sector

4 Sustainable health and welfare for the Red Meat sector

5 Enhancement of production and processing of Animal Products

6 Consumer and market development of the Red Meat sector

7 Commercialisation of the emerging sector