The efficacy of Spray.Seed® and Axial® herbicides on the narrow-leaved targets annual ryegrass (*Lolium rigidum* Gaudin) and oats (*Avena* spp.) when applied with a range of nozzle types and water volumes

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Summary Results from four field trials indicate that the efficacy of Spray.Seed® (135 g L^{-1} paraquat + 115 g L^{-1} diquat) or Axial® (100 g L^{-1} pinoxaden) herbicides on *Lolium rigidum* Gaudin (annual ryegrass) or *Avena* spp. (cultivated oats) was not compromised when applied with a coarse spray quality from several air induction type nozzles compared with the industry standard, extended range (XR) or drift guard (DG) nozzle generating a fine – medium spray quality.

Efficacy of these two herbicides may be compromised if water volumes are not sufficient and/or if droplet size is increased beyond a very coarse spray quality.

If using air induction nozzles it is important to make sure that line pressure is adequate for the nozzle (especially if using high pressure air induction type nozzles) and the water volume sufficient to compensate for the lower number of droplets produced from these types of nozzles, especially if targeting grasses.

A guide to pressure and water volume by nozzle type is recommended as: for high pressure air induced nozzles, e.g. TeeJet* AI, Hardi INJET, agrotop TurboDrop*, Lechler ID, apply at pressures >4 bar, generally 4–8 bar should be used. For low pressure air induced nozzles, e.g. TeeJet AIXR, Hardi MiniDrift, agrotop AirMix*, Lechler IDK, apply at pressures >2 bar, generally 3–6 bar should be used. A water volume >75 L ha^{-1} is to be used for both high and low pressure air induction nozzles if targeting grass weeds.

Keywords Spray.Seed, Axial, annual ryegrass, oats, efficacy, air induction, nozzle, spray quality, water volume.

INTRODUCTION

Interest in using air induction type nozzles for broadacre spraying has increased dramatically in recent years due to a number of factors. It has been well established that the larger droplet size generated from air induction type nozzles can significantly reduce drift and losses due to evaporation. There is increased pressure from the public and regulators to reduce drift and the use of these types of nozzles will help manage drift issues.

It has also been shown that air induction nozzles can provide good levels of weed control when targeting certain weeds with systemic herbicides. However there has been very little data generated in Australia to show that these nozzles provide adequate efficacy under some of the most challenging scenarios, e.g. when using contact non selective herbicides like Spray.Seed or cereal selective graminicide herbicides like Axial on difficult to target and control weeds like annual ryegrass and oats.

The aim of these trials was to evaluate the efficacy of Spray.Seed and Axial on annual ryegrass and oats when applied with a fine, medium, coarse, very coarse and extremely coarse spray quality from a range of nozzles including air induction type nozzles at up to three water volumes.

MATERIALS AND METHODS

Four replicated field trials were established at Mingenew WA and Roseworthy SA in winter 2006. Two trials were also conducted at Paskeville SA in 2007 to evaluate the efficacy of Spray.Seed and Axial on annual ryegrass and oats. All trials were a RCB design consisting of three replicates each. The rates of Spray.Seed and Axial chosen were targeted to give 80–95% control so that differences between treatments became more evident. In 2006 the treatments in the trials consisted of an untreated control and three nozzle types, representing three spray qualities. 1. TeeJet extended range XR (fine), 2. Turbo TeeJet TT (medium), 3. TeeJet Air Induction AI (coarse). All nozzles were trailed at 50, 75 and 100 L water ha^{-1} respectively. The Hardi INJET 01 nozzle was chosen for the 50 L ha^{-1} rate only, instead of the TeeJet AI 015 as the 01 was more suited to the speed, volume and pressure combination chosen.

In 2007 the treatments in the trials consisted of two untreated controls and eight nozzle types, representing five spray qualities. 1. TeeJet extended range XR (fine), 2. TeeJet drift guard DG (medium), 3. Turbo TeeJet TT (coarse-medium), 4. Turbo Twinjet TTJ, 5. AIXR, 6. Hardi MiniDrift MD all (coarse), 7. TeeJet Air Induction AI (coarse-very coarse), 8. Turbo Teejet Induction TTI (extremely coarse). All nozzles were

trailed at 40 and 80 L water ha^{-1}. In the WA trial in 2006, Spray.Seed was applied at 300 g a.i. ha^{-1} for all treatments to two leaf to early tillering annual ryegrass at 2 pm on 28th July. Weather conditions at spraying were as follows: Temp. 16°C, Delta T 2.5°C, wind calm. Travel speed was kept at 15 km h^{-1}. Assessments were conducted at 10 and 28 days after application.

In the SA trial in 2006, Spray.Seed was applied at 2.30 pm on 31st August at 350 g a.i. ha^{-1} to early tillering annual ryegrass. Weather conditions at spraying were as follows: Temp. 23°C, Delta T 7.0°C, wind calm. Travel speed was kept at 15 km h^{-1}. Assessments were conducted at seven days after application. Unfortunately due to error in the SA trial a Lechler IDK low pressure air induction nozzle was used instead of the Hardi INJET at 50 L water ha^{-1}.

In the SA trials in 2007, Spray.Seed was applied at 300 g a.i. ha^{-1} to four leaf to early tillering annual ryegrass and oats at 11 am on 16th August. Weather conditions at spraying were as follows: Temp. 17°C, Delta T 4.0°C, wind NW 5–10 km h^{-1}. Travel speed was kept at 18 km h^{-1}. Assessments were conducted at 9 and 22 days after application.

In the SA trials in 2007, Axial was applied at 25 g a.i. ha^{-1} 0.5% Adigor® adjuvant to four leaf to early tillering annual ryegrass and oats at 2 pm on 16th August. Weather conditions at spraying were as follows: Temp. 19°C, Delta T 4.5°C, wind NW 5–10 km h^{-1}. Speed of travel was kept constant at 18 km h^{-1}. Assessments were conducted at 9 and 22 days after application.

RESULTS

Figure 1 shows the percent control of annual ryegrass from using Spray.Seed applied via a range of nozzles and water volumes from the field trial in WA in 2006. Statistics were conducted on the results from this trial including ANOVA and factorial analysis, but no significant differences were found between treatments or between factors of spray quality or water volume. However, in this trial there was a trend towards improved control where water rate was increased, e.g. 50 L ha^{-1} (mean 92% control), 75 L ha^{-1} (mean 93% control) and 100 L ha^{-1} (97% control). The efficacy of the air induction nozzle producing a coarse spray quality (93% control) in this trial was equivalent to the TT nozzle producing a medium spray quality (mean 94% control) and the standard XR nozzle producing a fine spray quality (95% control).

Figure 2 shows the % control of annual ryegrass from using Spray.Seed applied via a range of nozzles and water volumes from the field trial in SA in 2006.

Table 1 shows the results of the factorial analysis looking at two factors, spray quality and water volume. In this trial the optimal water rate was found to be

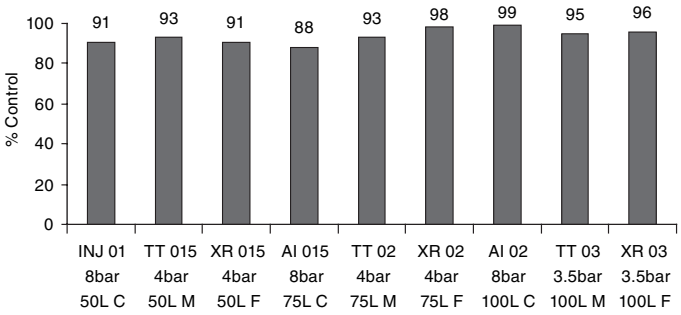

Figure 1. Spray.Seed efficacy on annual ryegrass 28 days after application in WA in 2006. Spray quality: fine (F), medium (M), coarse (C); nozzle types: Hardi INJET (INJ), Turbo TeeJet (TT), TeeJet XR (XR) and TeeJet AI (AI); nozzle sizes: 01, 015, 02, 03 and spray volumes at 50 L ha^{-1} (50L), 75 L ha^{-1} (75L) and 100 L ha^{-1} (100L).

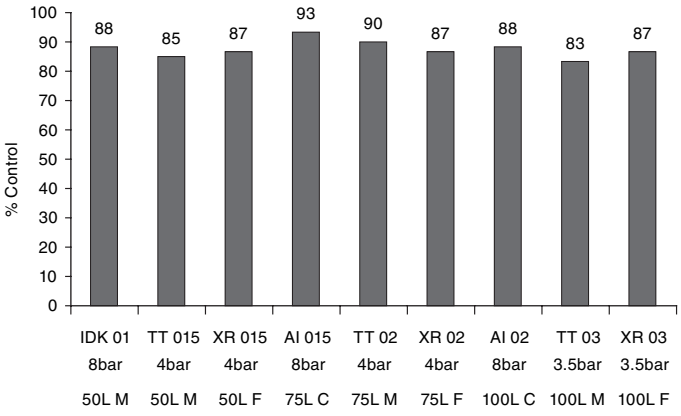

Figure 2. Spray.Seed efficacy on annual ryegrass (7 DAA in SA, 2006). Spray quality: fine (F), medium (M), coarse (C); nozzle types: Hardi INJET (INJ), Turbo TeeJet (TT), TeeJet XR (XR) and TeeJet AI (AI); nozzle sizes: 01, 015, 02 and 03; spray volumes at 50 L ha^{-1} (50L), 75 L ha^{-1} (75L) and 100 L ha^{-1} (100L).

75 L ha^{-1} which was significantly better than either 50 L ha^{-1} or 100 L ha^{-1}. The efficacy of the air induction nozzles producing a coarse spray quality in this trial was significantly better than the standard XR or TT nozzle delivering a fine and medium spray quality respectively.

The results from the Axial trial conducted in SA in 2007 demonstrated 100% control of all oats in all treatments regardless of the water volume or spray quality chosen. There were only minor differences in efficacy when it came to annual ryegrass control. The most notable of these was when an extremely coarse spray quality was used and efficacy was reduced compared to the standard nozzle, 91% control v. standard XR nozzle (97% control). All other spray qualities from fine to very coarse gave equivalent levels of control of annual ryegrass compared with the standard nozzle delivering a fine spray quality.

The results from the Spray.Seed trial in SA in 2007 on annual ryegrass demonstrated a response to water volume. 80 L ha^{-1} gave 85% control of annual ryegrass versus 40 L ha^{-1} which gave 80 % control. In terms of spray quality, fine to very coarse delivered equivalent levels of control to the standard nozzle generating a fine spray quality. The only exception was the nozzle delivering an extremely coarse spray quality, which slightly reduced efficacy (79% control) compared to the standard nozzle (83% control).

Table 1. Factorial analysis for spray quality and water volume.

Level means for factor spray quality	Untrans
Fine treatments	86.67[b]
Medium treatments	86.11[b]
Coarse treatments	90.00[a]
F-test probability	3.20%
LSD (P = 0.05)	3.04
Level means for factor water volume	**Untrans**
50 L treatments	86.67[b]
75 L treatments	90.00[a]
100 L treatments	86.11[b]
F-test probability	0.032
LSD (P = 0.05)	3.04

DISCUSSION

The results from these four trials indicate that Spray.Seed and Axial efficacy in the control of annual ryegrass and oats when applied with a TeeJet AI, TeeJet AIXR, Hardi INJET or Hardi MiniDrift nozzles, producing a coarse spray quality, is equivalent or better than the standard XR or Turbo TeeJet nozzles, producing a fine or medium spray quality. It is important to ensure these nozzles are operated at correct operating pressures and water volumes are increased in order to maintain adequate coverage of the target weeds.

The added benefit of using a coarse spray quality is that herbicide drift can be dramatically reduced which is of major benefit to people and the environment.

Given these trials were designed to represent two of the most challenging situations, there may be scope for air induction type nozzles, producing a coarse spray quality, to be used with many other herbicides on a range of other weeds. More trial work needs to be conducted for Axial and other herbicides to confirm these findings so that product recommendations can be refined and changes to product labels may be made.

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