Applications of pre-emergent pyroxasulfone, flufenacet and their mixtures with triallate for the control of Bromus diandrus (ripgut brome) in no-till wheat (Triticum aestivum) crops of southern Australia

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ABSTRACT

Four field experiments were conducted over a three-year period in Victoria and South Australia to investigate the effectiveness of pre-emergence (PRE) applications of pyroxasulfone, flufenacet and their mixtures with triallate for the control of Bromus diandrus in spring wheat. Herbicide mixtures of pyroxasulfone plus triallate and flufenacet plus triallate applied PRE to wheat provided consistently high levels of B. diandrus control (>85%). In contrast, applications of pyroxasulfone and flufenacet alone along with trifluralin plus metribuzin (a common farmer practice in southern Australia) provided more variable control of B. diandrus (33–90%). Pyroxasulfone plus triallate treatments had a much lower (<47 panicles m⁻²) panicle density of B. diandrus than trifluralin plus metribuzin (42–318 panicles m⁻²) and the non-treated control (118–655 panicles m⁻²). PRE herbicides which were safe to spring wheat and provided the greatest level of control of B. diandrus resulted in significantly (P < 0.05) higher grain yields at Culgoa (120%) and Gama (13%) than non-treated wheat (720 and 1740 kg ha⁻¹). Although flufenacet was effective against B. diandrus, crop phytotoxicity at the higher dose (900 g ai ha⁻¹) reduced spring wheat grain yield. Based on these results, PRE pyroxasulfone plus triallate could play an important role in the management of B. diandrus in spring wheat. However, high cost of these herbicides (AUS$35–$70 ha⁻¹) may limit their adoption in low rainfall and low yielding wheat environments in southern Australia where B. diandrus is most prevalent.

1. Introduction

Bromus diandrus Roth (ripgut brome) is an annual grass weed of Mediterranean origin that has been naturalised across the cropping zone of southern Australia (Gill and Carstairs, 1988; Kon and Blacklow, 1988). This weed is common on lighter textured soils and appears to be well adapted to shorter-growing seasons and lower rainfall regions of southern Australia (Kon and Blacklow, 1988). Similar to Bromus rigidus Roth (rigid brome), B. diandrus has proliferated due to the unavailability of effective herbicides for its control in cereals and with the introduction of conservation tillage in southern Australia (Kon and Blacklow, 1988). This highly competitive and well adapted weed species competes strongly for nutrients and water with crops and can reduce wheat yields by as much as 50% (Gill et al., 1987). Furthermore, seeds of B. diandrus can contaminate harvested grain and often cause injury to grazing livestock in pastures (Kon and Blacklow, 1995).

Previous research showed that the seedling emergence pattern of B. diandrus had changed over time, possibly because of selection for longer seed dormancy in populations present in fields used for crop production (Kleemann and Gill, 2013). It has been suggested that selection for longer seed dormancy in B. diandrus could enable such populations to avoid pre-planting weed control methods. As a consequence of selection for increased dormancy and delayed emergence in B. diandrus, post-emergent herbicides tend to be more effective and are the preferred method of control by growers (Kleemann and Gill, 2009). ALS-inhibiting herbicides (acetolactate synthase), sulfonylurea, sulfonamide and imidazolinone, can be used post-emergence to control B. diandrus in wheat. In the legume and canola phases of crop rotations, selective control of B. diandrus is achieved by the use of grass selective ACCase- (acytetyl CoA carboxylase) inhibiting herbicides. However, heavy reliance on post-emergent ALS- and ACCase-inhibiting herbicides has resulted in evolution of herbicide resistant B. diandrus populations...
and a pH (water) of 6.5 would provide effective control of B. diandrus populations resistant to ALS and ACCase herbicides.

Pyroxasulfone (Sakura®, Bayer CropScience Australia) is a new pre-emergent herbicide that inhibits very long chain fatty acid synthesis (Tanetani et al., 2009), which was recently released in Australia to control several weed species in wheat (Walsh et al., 2011; Boutsalis et al., 2014a). The introduction of pyroxasulfone into the Australian market was largely driven by the need for an effective alternative to ACCase- and ALS-inhibiting herbicides to which Lolium rigidum (annual ryegrass) had evolved widespread resistance. Extended soil activity of pyroxasulfone as compared to the current grower practice of trifluralin plus metribuzin may provide greater control of B. diandrus.

Flufenacet, an ox酰acetamide herbicide has been shown to control many grass and broadleaf weed species (Hopkins et al., 1998) by inhibiting very long chain fatty acid biosynthesis in plants (Senseman, 2007). Primary uptake of the herbicide occurs via both the roots and emerging shoots of treated plants (Grichar et al., 2003) and flufenacet can be applied pre- or early post-emergence. In North America, flufenacet is pre-packaged in mixture with metribuzin and is registered for the control of broadleaf and grass weed species in corn, soybean and winter wheat. Studies from southeastern United States (Koepeke-Hill et al., 2011) showed that pre- or post-emergence flufenacet plus metribuzin was effective against Lolium multiflorum (Italian ryegrass). In these studies winter wheat injury was apparent but varied with application rate, cultivar, and year of application. It is possible that flufenacet and its mixtures with other residual herbicides could provide effective control of B. diandrus without any injury to spring wheat. However, at present there are no reports of the efficacy of pyroxasulfone and flufenacet for the pre-emergent control of B. diandrus in spring wheat in southern Australia.

The objective of this research was to compare the effectiveness of pyroxasulfone and flufenacet used alone or in mixtures with triallate to standard grower practice of trifluralin and metribuzin for the pre-emergence control of B. diandrus in spring wheat.

2. Materials and methods

Four field experiments were conducted over a three-year period in Victoria at Pira (2012), Culgoa (2013), and Gama (2014), and in South Australia at Balaklava (2014). The soil at the sites was sandy loam (10–20% clay content) with organic matter content of 1–1.5% and a pH (water) of 6.5–7.5. Rainfall characteristics and long-term patterns for each site are presented in Table 1. Herbicides used in the trials were: trifluralin (Trifluran®) + metribuzin (Lexone®) applied at 1200 g ai ha⁻¹; 112.5 g ai ha⁻¹, which is considered the standard grower practice, pyroxasulfone (Sakura®) applied at 100 g ai ha⁻¹, pyroxasulfone + triallate (Avadex Xtra®) applied at 100 g ai ha⁻¹ + 1600 g ai ha⁻¹, flufenacet applied at 450, 600 and 900 g ai ha⁻¹, flufenacet + triallate applied at 450 and 600 g ai ha⁻¹ + 1600 g ai ha⁻¹, and flufenacet + pyroxasulfone applied at 450 and 600 g ai ha⁻¹ + 100 g ai ha⁻¹. A non-treated control was included at each location. Herbicides were applied pre-emergence (PRE) and incorporated by sowing within 24 h with knife-point and press-wheel seeding equipment. Plot sizes were 2.5 by 10 m at Pira, Culgoa and Gama, and 2 by 6 m at Balaklava; plots were planted in rows at 0.27 and 0.30 m apart. Wheat cultivar, planting date and seeding rate are presented in Table 2. Fertiliser rate was consistent with the standard grower practice of 50–60 kg ha⁻¹ of urea blend 27:12:0 (N:P:K) drilled at sowing. Pre-plant weed control included applications of glyphosate at 900 g ai ha⁻¹ + oxyfluorfen at 22 g ai ha⁻¹. Post-emergence bromoxynil at 105 g ai ha⁻¹ + pyrasulfotole at 18.7 g ai ha⁻¹ (Velocity®) were applied with 0.5% spray oil (Up-take®) to provide broadleaf weed control.

Experiments were established in a randomised complete block design with three replicates. All herbicide treatments were applied using a pressurised handheld spray boom fitted with medium droplet size flat-fan nozzles (TTO1 and LD110-015) delivering 64–100 L ha⁻¹ at a pressure of 200 kPa. Dates of herbicide application are shown in Table 2. B. diandrus plant and panicle densities were assessed by using a 0.25 m² quadrat placed at three random locations in each plot. Assessments of plant density were taken 5–6 wsks after planting (WAP) and panicle density 14–17 WAP when all panicles had emerged. Wheat injury was visually rated at 5 WAP on a scale of 0 to 100 where 0 represented no injury and 100 represented plant death. Wheat yield was determined with a small plot harvester when the grain had reached a moisture content of <12%. Harvest dates are shown in Table 2. Wheat yield was not determined at Pira in 2012 because of logistical issues or at Balaklava in 2014 due to severe frost damage to the crop.

Weed control (plant and panicle density) and wheat injury and grain yield data were analysed with ANOVA (GenStat Version 15.3, VSN International, 2011). As residuals of weed density, panicle density and wheat grain yield showed normal distribution, ANOVA was performed on non-transformed data. Non-transformed treatment means were separated using LSD at $P = 0.05$.

3. Results and discussion

3.1. Weed control

Herbicide treatments applied at the experimental sites in Victoria (Pira, Culgoa and Gama) and South Australia (Balaklava) provided significant ($P < 0.05$) but variable B. diandrus control (8–95%) in spring wheat (Tables 3 and 4; Fig. 1a). Trifluralin plus metribuzin, a commonly applied treatment by growers, provided adequate control (69–89%) at 3 of the 4 sites. The exception was at Pira in 2012 where trifluralin plus metribuzin provided only 33 and 51%