Increasing array of herbicides for post-emergence weed control and seed yield in maize (*Zea mays* Linn).

Abstract *Study was conducted at the Institute of Agricultural research and Training (IAR&T) Ilora (Derived savanna agro-ecology) substation in the rainy seasons of 2014 and 2015, to appraise herbicides for post-emergence weed control and increase array of herbicides for weed control in maize. Weed samples were taken from a three-year fallow field before land preparation. Herbicides under evaluation were assigned to 3 x 3 plots at different rates. These were arranged in randomized complete block design (RCBD) with three replicates. The results showed that initial weed flora richness were 22% and 78% grass and broad-leaved weeds respectively. These were found in five (5) plant families. All the weeds sampled were annuals. Narrow annual weed spectrum, described continuous cropping activities in the location. Herbicides improved plant height by 36 to 50% compared to weed infested maize plants. Though phyto-toxicity was evident at three and twenty-one days after treatment (DAT), ranging from* $^{1}/_{10}$ *to* $^{3.79}/_{10}$ *and* $^{2}/_{5}$ *and* $^{3.67}/_{10}$ *correspondingly when visually rated (0 – 10 scale). Notwithstanding, herbicides gave impressive weed control rate (WCR) at 21 DAT (*$^{6.7}/_{10}$ *-* $^{8.7}/_{10}$*), with evidence of superior weed control efficiency (WCE >80%) at harvest across herbicide treated plots relative to weedy control plots. 2,4-D DMA (0.86 kg ai/ha), Fluroxypyr methyl (0.40 ai kg/ha), 2,4-D + Dicamba (0.68 + 0.24 kg ai/ha) and 2,4-D DMA (2.58 kg ai/ha) had <30% relative yield loss (RYL%) with comparable seed yield compared to the highest recorded in weed-free plot (13.29 t/ha). Plant height at 8 WAS (weeks after sowing) had significant inverse relationship with weediness at 5 WAS and weed dry weight at harvest (- 0.62) . Consequently, early weed control is essential for maize performance. On the other hand, plant height enhanced weed control efficiency at harvest (0.62) . Tall plants have tendency to reduce relative yield loss (RYL %) as they were inversely related 1 (- 0.42). Comparable WCE% (83 -99%) in herbicide treated plots reduced weed growth by about 88%. Hence, lower rate of herbicides with <30% phyto-toxicity level should be considered to increase array of herbicides for post-emergence weed control, sustainable maize production and environmental friendliness.*

Keywords: weed, post-emergence, maize seed yield, weed control efficiency, relative yield loss

Introduction

Weed incursion in cropping activities remains a challenge. Weed infestation is of supreme importance, among various factors responsible for maize low yield per hectare. This calls for immediate intervention especially where manual labour is scarce and untimely, herbicides have been reported to come handy in large scale crop production. In maize cropping especially, weed infestation results in 66 - 80%, a significant yield reduction in poorly managed field (Chikoye *et al.*, 2004; Amosun *et al.*, 2015; Aluko, 2019; Amosun *et al.*, 2021). In such a situation, herbicides offer the most effective and economical method of weed control and increase crop yield (Noor *et al*. 2011). Pre and post emergence herbicides reduced the weed population, weed biomass and increased various yield components and grain yield (Noor *et al*. 2011). Herbicide application increased the grain yield of maize crop by decreasing the density, growth and dry weight of weeds (Khan and Haq, 2004). According to Chikoye *et al*. (2004) and Ishrat *et al*. (2012), herbicides are very effective for weed control in maize with good benefit cost ratio. This was further confirm by Aluko (2019) that weed weight in maize plots was reduced by about 80% with pre-emergence herbicide treatments. Studies also showed that weed control practices in maize resulted in 77 - 97% increase in grain yield over weed infested maize field (Khan *et al*., 1998; Aluko, 2019). Meanwhile, post emergence weed infestation in crop fields are more challenging and expensive. The efficiency of manual weeding is reduced during rainy season and farmhands are not easy to come by (Oreck and Dehne, 2004; Oerke, 2005). Crops plant may suffer the penalty of delay weeding ultimately at harvest if timely control method(s) are not adopted. The control of weeds using herbicides will cut production costs, time and control the weeds.

Atrazine, nicosulfuron and 2-4 D are popular post-emergence herbicides used in maize production among others in Nigeria with remarkable weed suppression. However, high cost of effective herbicides resulted in adulteration, poor weed control, loss of capital and little or no profit due to reduced grain yield. Evaluating more herbicide formulations is essential to increase the array of herbicides for season-long post-emergence weed suppression, cost effectiveness and economic maize production. Thus, the study evaluated herbicides for season-long post-emergence weed control for improved maize seed yield.

Materials and methods

The experiment was conducted at the research farm of the Institute of Agricultural Research and training (IAR&T) Ilora (07.81N; 003.82E) substation in 2014 and 2015 rainy seasons. Weed flora composition of the ecology was taken using quadrat randomly placed on the site before ploughing. The weeds were identified and classified. The soil was ploughed and harrowed before planting. The trial was planted in 3 x 3 m plot size, with a plant spacing of 75 × 50cm. The treatments were randomly assigned to different plots and arranged in Randomized complete block Design (RCBD) with three replicates. Maize variety (SUWAM-1-SR) obtained from IAR&T was sown and thinned to 2 plants/stand. Fertilizer (N:P:K 20:10:10) was applied at 5WAS, at the rate of 200kg/ha. Herbicides evaluated for post-emergence weed control in maize were obtained from Rainbow Agro chemicals Nigeria. These were applied at 4 weeks after sowing (4WAS) by varying the concentrations of recommended rates by the company. 2, 4-dichlorophenoxyl acetic acid (2, 4-D) was used as reference herbicide with weed-free and weedy control plots. Cultural practices were conducted as at when due. Data were collected on agronomic traits, herbicide phytotoxicity, weed growth, weed control rate (WCR) at 21 DAT, weed dry weight, weed control efficiency (WCE %) at harvest and relative yield loss % (RYL %). These were statistically analyzed using analysis of variance (ANOVA) and means were separated with Duncan's Multiple Range Test (DMRT) at $p \leq 0.05$. Correlation analysis was also done. Tables below showed the results from the study carried out. Weed control efficiency and relative yield loss were calculated using these equations

$WCE\% = \{(W_{wy} – W_t)/W_{wy}\} \times 100$
Where W_{wy} is the weed weight in weedy plot and W_t is the weed in treated plot.

$RYL =\{(Y_{ht} –Y_t) /Y_{ht}\} \times 100$
Where RYL is the relative yield loss, Y_{ht} is the highest yield, Y_t is the yield from treatment

List and rates of herbicides applied

T1	2,4-D DMA 0.86 kg ai/ha
T2	Triclopyr 1.80 kg ai/ha
T3	2,4-D+Dicamba (0.53 + 0.18) kg ai/ha
T4	Weed-free
T5	2,4-D+Dicamba (0.86 + 0.30) kg ai/ha
T6	Triclopyr 1.20 kg ai/ha
T7	Triclopyr 1.50 kg ai/kg
T8	Fluroxypyr.methyl 0.40 kg ai/ha
T9	2,4-D DMA 1.72 kg ai/ha
T10	2,4-D + Dicamba (0.69 + 0.24) kg ai/ha
T11	Fluroxypyr-methyl 0.60 kg ai/ha
T12	Fluroxypyr.methyl 0.50 kg ai/ha
T13	2,4-D DMA 2.58 kg ai/ha
T14	2, 4-D (Ref)
T15	Weedy control

Results

Table 1 shows the weed flora composition before land preparation. The results showed that initial weed flora richness were 22% and 78% grass and broad-leaved weeds respectively. These were found in five plant families. All the weeds sampled were annuals.

Table 2 shows the variation in weed incursion after treatment. Eleven (11) weed types from six plant families were recorded in all the plots. These were mostly annuals weeds. Weed morphology showed that 19% sedge, 41.50% broadleaf weed and grass weeds 41.50%. Across the treatment applied, *Tryclopyr* 1.20 kg ai/ha and weed-free control had three (3) weed species (27%), while weedy control plots had ten (10) weed species representing 91% of total weed recorded in the study. *Hachelochloa granularis* was found in all the treated plots at differing density as minor or major weed. This was follow by the presence of *Cyperus rotundus* in all the plots except plot treated with 2, 4-D.

Tallest plants were recorded in plots treated with *Fluroxypyr-methyl* (0.40 ai kg/ha) (Table 3). This was similar to other treated plots except those treated with 2, 4-D+Dicamba (0.53 + 0.18), Weed-free and Weedy control with the shortest plants (Table 3). Plant phytotoxicity at 3 DAT was highest in plots treated with 2, 4-D DMA (2.58 kg ai/ha). The lowest phytotoxicity was recorded in 2, 4-D+Dicamba [(0.53 + 0.18) ai kg/ha] treated plots. At 21 DAT, 2, 4-D DMA (2.58 kg ai/ha) and *Triclopyr* (1.80 kg ai/ha) retained the highest toxicity level. Varying weed control rate (WCR) were recorded visually at 21 DAT, weed-free plot had the least weed incursion with the highest WCR $^{9.33}/_{10}$. This was comparable with WCR in most treated plots except *Triclopyr* (1.80 kg ai/ha), *Triclopyr* (1.50 kg ai/ha), *Fluroxypyr-methyl* (0.50 kg ai/ha) and Weedy control with the least WCR ($^{1.33}/_{10}$).

In Table 4, maximum seed yield was recorded in weed-free plot. This was comparable to seed yield in 2, 4-D DMA (0.86), *Triclopyr* (1.80 kg ai/ha), *Triclopyr* (1.20 kg ai/ha), *Fluroxypyr-methyl* (0.40 kg ai/ha), 2, 4-D DMA (1.72 kg ai/ha), 2, 4-D + *Dicamba* [(0.69 + 0.24) kg ai/ha] and 2, 4-D DMA (2.58 kg ai/ha). However, weedy control plots had the minimum seed yield (3.92 t/ha). This was about 30% of the maximum crop yield in weed-free. This lowest seed yield was similar to crop seed yield in *Fluroxypyr-methyl* (0.60 kg ai/ha) and 2, 4-D (Ref). Hence, most evaluated herbicides had higher seed yield than weedy control plot and the reference herbicide.

Seed yield per treatment is inversely proportional to relative yield loss. This varied significantly as recorded in Table 4. Weedy control plot had the highest relative yield loss (72.48%), similar to *Fluroxypyr-methyl* (0.60 kg ai/ha) and 2,4-D (Ref). 2,4-D DMA (0.86 ai kg/ha), Weed-free control, *Fluroxypyr-methyl* (0.40 kg ai/ha), 2, 4-D + *Dicamba* [(0.69 + 0.24) kg ai/ha] and 2,4-D DMA (2.58 kg ai/ha) had RYL < 30%. Weed-free plots had the highest weed control efficiency. This was not different significantly from the weed control efficiency recorded in other plots except weedy control plots that had the least weed control efficiency. Evidently, all herbicide rates had ≥80 % weed control efficiency (Table 4).

Correlation between agronomic parameters and weed growth showed different relationships. Plant height at 8 WAP had significant inverse relationship with weed dry weight at harvest (-0.62) at $p \leq 0.01$. Meanwhile, plant height enhanced weed control efficiency at harvest (0.62) at $p \leq 0.001$. Tall plants have a tendency to reduce relative yield loss (RYL %) as it was negatively correlated at $p \leq 0.01$ (- 0.42). Early weed infestation (weediness-WDN) at 3 DAT critically impacted on plant height (- 0.45) at $p \leq 0.01$. This had similar relationship with weed control rate (WCR) at 21 DAT (- 0.72, $p \leq 0.001$), grain yield (- 0.44, $p \leq 0.01$), and weed control efficiency (WCE %) at harvest (- 0.76, $p \leq 0.001$). Meanwhile, weed control rate (21 DAT) and weed control efficiency had strong positive correlation at $p \leq 0.001$ (0.94). However, grain yield was inversely correlated with weed dry weight at harvest (- 0.50) at $p \leq 0.001$.

Discussion

Weed flora richness depicts the status of weed seed bank and dominance species in the study site. Scanty weed flora families on the experimental site might be influenced by continuous cropping system. The location has been under cultivation for more than five decades. Meanwhile, Derived savanna agro-ecology is noted for more grass weed flora composition covering larger geographical range than broad-leaved annuals. However, 22% grass and 78%

annual broadleaf weeds evidently showed a shift in weed flora composition due to previous cultural practices especially weed control methods adopted.

Herbicide treatments reduced weed flora composition in all the treated plots compared to weedy control plot. Meanwhile, most weed species identified in treated plots were minor weeds with scanty stands. This showed a marked reduction in weed flora richness (27 – 72 %) after herbicide application, while weedy control plot had about 91% weed richness compared to the overall weed flora composition. Evidently, herbicides suppressed weeds significantly. This is similar to the previous studies authenticating herbicide efficacy for weed control in maize (Chikoye *et al.*, 2004; Ishrat *et al.*, 2012; Amosun *et al.*, 2015; Aluko, 2019). Though, emergence of *Cyperus rotundus* in all herbicide plots except 2, 4-D treated plots showed the efficacy of the herbicide on *Cyperus rotundus*. This in line with the previous study conducted by Ishrat *et al.* (2012) that *Cyperus rotundus* was the most tolerant to all herbicides evaluated in maize with arrays pre and post emergence of hebicides. The presence of *Hachelochloa granularis* in all plots at varying density suggested its low susceptibility to herbicides rates.

Plant height was negatively impacted by weed incursion in weedy plots at 8 WAP. This evidently showed in about 50% reduction in height in weedy plots relative to other treated plots and weed –free plots. This showed the suppressive effect of herbicides on weeds. This further reaffirmed the previous study that herbicides enhanced plant growth and overall crop performance (Chikoye *et al.*, 2004, Aluko, 2019; Amosun *et al.*, 2021). Though, herbicides have varying phytotoxicity level on crop plant. Notwithstanding, herbicidal efficacy may be sacrificed by high phyto-toxicity (≥ 30%). Acceptable plant injury level should give room for crop plant recovery with economic crop yield and prolonged weed suppression. Critical phytotoxicity (≥ 30%) may slow down plant growth and reduce crop performance. Though, herbicide rates showed mild phyto-toxicity level (≤ 30%) which was not critical between 3 and 21DAT in 2, 4-D DMA 2.58 kg ai/ha at 3 DAT and 30% in *Triclopyr* rates, 2, 4-D + *Dicamba* (0.86 + 0.30) kg ai/ha, *Fluroxypyr-methyl* 0.40 kg ai/ha, *Fluroxypyr-methyl* 0.50 kg ai/ha, 2, 4-D DMA 1.72 kg ai/ha and 2, 4-D DMA 2.58 kg ai/ha with rapid recovery and considerable weed control rate (WCR $^{6.67}/_{10}$ – $^{9.33}/_{10}$) in all the treated plots except weedy control plots which was way off ($^{1.33}/_{10}$) from other treated plots at 21 DAT. This was distinctly due to weed interference.

In Table 4, maximum seed yield was recorded in weed-free plot. This was comparable to seed yield in 2, 4-D DMA (0.86), *Triclopyr* (1.80 kg ai/ha), *Triclopyr* (1.20 kg ai/ha), *Fluroxypyr-methyl* (0.40 kg ai/ha), 2, 4-D DMA (1.72 kg ai/ha), 2, 4-D + Dicamba (0.69 + 0.24) kg ai/ha and 2, 4-D DMA (2.58 kg ai/ha). This evidently showed minimal weed interference, hence superior seed yield was recorded in weed free plot. This can be linked to similar relative yield loss and weed dry weight in plots treated with herbicides at harvest. This is in resonance with previous studies that herbicide reduced weed growth and improved grain yield (Chikoye *et al.*, 2004; Ishrat *et al.*, 2012; Aluko, 2019). On the other hand, weed incursion in field crops especially maize, accounted for significant reduction in plant growth and grain yield (Arben *et al.* 2012). This is might be responsible low grain yield in maize sown to weedy control plot and other herbicide treatments with comparable weed growth at harvest. However, degradation of herbicide might have reduced the efficacy of 2, 4-D and *Fluroxypyr-methyl* (0.60 kg ai/ha) with comparable relative yield loss. Weed competition in weedy plot reduced seed yield by 70% relative to maximum seed yield obtained from seed yield in weed-free.

High weed control efficiency ($> 80\%$) recorded in study in all the treated plots showed significant weed suppression compared with weedy control plot. Though, weed-free control plots had the highest weed control efficiency, this was not quite different from herbicide treated. Evidently, all herbicide rates had more than 80 % weed control efficiency, showed the level of weed suppression of herbicides and acceptable efficacy levels.

Crop agronomic parameters and weed growth showed different relationships during the study. Plant height at 8 WAP had significant inverse relationship with weed dry weight at harvest (-0.62) at $p \leq 0.01$. Hence, cultivation of fast growing tall crop varieties will minimize weed competition through light interception and reduce resultant yield penalty. In the same vein, positive relationship between plant height and weed control efficiency at harvest (0.62 at $p \leq 0.001$), further expressed plant height as suitable trait for weed suppression. This had positive effect on the relative yield loss (RYL %) as it was inversely related to plant height at 8 WAS (-0.42, $p \leq 0.01$). However, weediness at 3 DAT critically impacted on plant height at 8WAP (-0.45) at $p \leq 0.01$. Hence, weed control intervention should be anticipated early to prevent lingering effect of weed incursion in form of plant growth retardation and reduced grain yield (-0.44, $p \leq 0.01$) as recorded in weedy control plots.

Early weediness in crop plant or delayed weed control might reduce weed control efficiency (WCE %) of weed management option. This was evident in the negative relationship with weed control efficiency at harvest (- 0.76, $p \leq 0.001$). Consequently, crop yield will be reduced from early and prolonged weed interaction. Consequently, grain yield had inverse relationship with weed dry weight at harvest (- 0.50) at $p \leq 0.001$ in the study. On the other hand, weed control rate (21 DAT) and weed control efficiency had strong positive correlation at $p \leq 0.001$ (0.94) and grain yield. Hence, herbicide weed control efficiency will improve overall crop performance as weed competition is minimized through prompt weed control. This is line with previous studies where weed control efficiency of herbicides and other weed control practices in increasing maize grain yield (Shinde *et al*., 2001; Khan *et al*., 2002; Chikoye *et al*., 2004; Khan and Haq 2004; Aluko, 2019).

Conclusion

Herbicides reduced weed growth remarkably with more than 83% weed control efficiency. It is worthy of note that early weed control (3 WAS) is imperative to minimize weed competition with crop plant and enhance plant growth which is a significant trait for weed suppression. Delayed or weedy maize plot may reduce seed yield by about 70%. Herbicides application for post-emergence weed control in maize reduced weed growth and improved grain yield.

Table 1: Weed flora composition of experimental sites before land preparation

Family	Weed spp	Morphology	Life cycle
Poaceae	*Panicum maximum*	G	A
“	*Hackelochloa granularis*	G	A
Lamiaceae	*Hyptis suaveolens*	B	A

Asteraceae	*Tridax procumbens*	B	A
“	*Aspillia africana*	B	A
“	*Agerantum conyzoides*	B	A
“	*Tithonia diversifolia*	B	A
Rubiaceae	*Mitracarpus villosus*	B	A
Leguminosae-Papilinoideae	*Desmodium scorpiurus*	B	A

Legend: A- annual, G- grass, B- broadleaf

Table 2: Weed Flora composition and prevalence 5 weeks after post emergence herbicide treatments in maize

Family	Weed Spp	Morph.	Life cycle	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15
Cyperaceae	*Cyperus rotundus*	S	A/P	a	b	b	a	b	a	a	a	a	a	b	a	-	b	a
“	*Mariscus alternifolius*	S	A/P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	b
Rubiaceae	*Mitracarpus villosus*	B		b	a	b	b	b	b	b	b	a	b	-	-	-	-	b
Asteraceae	*Tridax procumbens*	B	A		b	-	-	-	-	-	b	b	b	-	-	-	b	b
“	*Tithonia diversifolia*	B	A	-	b	-	b	b	-	-	-	b	b	-	b	-	-	b
Leguminosae-Papilinoideae	*Desmodium scorpiurus*	B	A	-	-	-	-	-	-	-	-	b	b	-	b	b	-	b
Lamiaceae	*Hyptis suaveolens*	B	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	b
Poaceae	*Panicum maximum*	G	A	-	-	-	-	-	b	-	b	-	b	b	-	-	-	
“	*Cynodon dactylon*	G	A	-	b	-	-	-	b	b	b	b	b	-	b	a	-	b
“	*Digitaria horizontalis*	G	A	-	-	b	-	-	-	b	-	-	-	-	-	p	-	b
“	*Hachelochloa granularis*	G	A	a	b	a	a	a	a	a	a	a	a	a	a	a	b	a
“	*Brachiaria deflexa*	G	A	-	-	b	-	-	-	b	b	b	-	b	-	b	-	-

Legend: a – Major weed , b – Minor weed, B- broadleaf, G- grass, Sp- Spiderwort, S – Sedge, P- Perennial, A – Annual, A/P – annual/perennial. T1-Triclopyr 2L, T2- Triclopyr 3L, T3- Triclopyr 2.5L, T4- 2,4D DMA 2L, T5- Fluroxypyr-methyl 2.5L, T6- 2, 4-D+Diamba 2L, T7 - 2, 4-D DMA 3L, T8- Fluroxypyr-methyl 2L, T9- 2, 4-D DMA 1L, T 10- 24D + Dicamba 2.5L, T 11- 2, 4-D + Dicamba 1.5L, T12 – Fluroxypyr-methyl 3L and T13 - 2, 4-D (Reference), T14 – weed-free, T15 –weedy control

Table 3: Herbicide effects on plant growth, phytotoxicity and weed control rate.

Treatment	Plant height 8WAP (cm)	Phytotoxicity 3DAT Score (1-10)	Phytotoxicity 21DAT Score (1-10)	Weed control rating 21DAT (1-10)
2,4-D DMA (0.86)	165.53ab	1.33bcd	2.00ab	8.00abc
Triclopyr (1.80)	156.83ab	2.00abcd	3.67a	6.67c
2,4-D+Dicamba (0.53 + 0.18)	147.77b	1.00cd	2.00ab	8.00abc
Weed-free	135.77b	0.00d	0.00b	9.33a
2,4-D+Dicamba (0.86 + 0.30)	169.83a	2.33abc	3.00a	8.00acb
Triclopyr (1.20)	163.07ab	3.33ab	3.33a	8.33abc
Triclopyr (1.50)	168.29a	2.33abc	3.33a	7.00bc
Fluroxypyr.methyl (0.40)	173.97a	2.00abcd	3.00a	7.67abc
2,4-D DMA 1.72	146.97b	1.67abcd	3.00a	8.33abc
2,4-D + Dicamba (0.69 + 0.24)	156.30ab	1.67abcd	2.67ab	8.33abc
Fluroxypyr-methyl (0.60)	164.40ab	2.00abcd	2.67ab	8.67ab
Fluroxypyr.methyl (0.50)	154.53ab	1.67abcd	3.33a	7.33bc
2,4-D DMA (2.58)	168.17ab	3.79a	3.67a	7.67abc

2, 4-D (Ref)	166.20ab	2.00abcd	0.00b	8.00abc
Weedy control	87.42c	0.00d	0.00b	1.33d

Table 4: Effects of herbicides on seed yield, relative yield loss, weed growth and herbicide efficiency

Herbicide (ai kg/ha)	Seed yield (t/ha)	Relative yield loss (%)	Weed dry weight (g/m^2)	Weed control efficiency %
2,4-D DMA (0.86)	10.75abc	25.33bcd	33.94bc	92.55ab
Triclopyr (1.80)	9.54abc	33.72bcd	75.84b	83.35b
2,4-D+Dicamba (0.53 + 0.18)	8.80bc	38.90bc	41.47bc	90.90ab
Weed-free control	13.29a	0.00e	2.30c	99.50a
2,4-D+Dicamba (0.86 + 0.30)	8.55bc	42.00bc	42.54bc	90.66ab
Triclopyr (1.20)	9.77abc	32.12bcd	29.09bc	93.61ab
Triclopyr (1.50)	8.00bc	44.46bc	69.32bc	84.78b
Fluroxypyr.methyl (0.40)	10.52abc	26.93bcd	49.59bc	89.11ab
2,4-D DMA 1.72	9.74abc	32.36bcd	29.38bc	93.55ab
2,4-D + Dicamba (0.69 + 0.24)	10.31abc	28.41bcd	33.63bc	92.62ab
Fluroxypyr-methyl (0.60)	6.75cd	53.10b	34.24bc	92.48ab
Fluroxypyr.methyl (0.50)	8.97bc	37.67bc	52.39bc	88.50ab
2,4-D DMA (2.58)	11.05ab	23.23cd	47.07bc	89.67ab
2, 4-D (Ref)	6.84cd	52.48bc	37.08bc	91.86ab
Weedy control	3.92d	72.48a	455.54a	0.00c

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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