Efficacy of candidate herbicides for post-emergence weed control in kenaf (*Hibiscus cannabinus* L.)

Abstract

Post emergence application of herbicides reduced weed growth, enhanced kenaf agronomic traits and fibre yield. A study was conducted to determine the efficacy of some herbicide formulations for post emergence weed control in kenaf at Ibadan (0.7.38N; 003.84E- Derived savanna agro-ecology) station of the Institute of Agricultural Research and Training (IAR&T), Obafemi Awolowo University, Ibadan in 2016 and 2017 rainy seasons. Herbicides applied were Quazilofop-P-ethyl (100, 150, 200ml/ha), Oxyfluorfen (0.96, 1.20 and 1.44 kg ai/ha) and Fluazifop-p-butyl 150, 225 and 300g ai/ha) at three rates each, while weed-free and weedy were the control treatments. Herbicides improved kenaf agronomic traits (plant height, stem-butt girth and number of leaves/plant), reduced weed flora composition and weed weight relative to weed infested kenaf plants in weedy control. Oxyfluorfen (0.96, 1.20 and 1.44 kg ai/ha); fluazilof-p-butyl (225 and 300g ai/ha); Quazilofop-P-ethyl (100 and 200ml/ha) reduced weed dry weight by 60-70%. Kenaf plant sown into weed-free plot and Fluazilofop-p-butyl (150, 225 and 300g ai/ha) treated plots had comparable maximum Gross fibre yield/ha. Weed-free had the highest weed control efficiency (WCE %). This was followed by Oxyfluorfen (1.20 and 1.44 kg ai/ha) and Fluazilofop-p-butyl (300 g ai/ha) with an acceptable WCE of ≥ 80%. Quazilofop-p-ethyl rates had WCE 50 – 65%. These should be increased for higher efficacy (WCE ≥80%). Kenaf gross fibre yield was reduced by 65%, due to weed infestation and superior weed dry weight in the weedy control plot. Notwithstanding, the benefit-cost ratio and environmental impact assessment of the study must be carried out for economically viable kenaf production and environmental friendliness.

***Keywords**: kenaf, herbicides, post-emergence, weed control efficiency, weed dry weight*

Introduction

Kenaf is a commodity crop that can produce numerous money spinning value added products. Kenaf stalks as provender contain 12% crude protein (1) and serve as bedding for livestock. Kenaf seed is an excellent source of edible oil (2). Kenaf is used for making premium paper, particleboard and bio-composites for building, automobile dashboards and bumpers, carpet padding, substitutes for fiberglass, produce and shopping bags, non-woven fashion bags, ropes and thread.

The negative impacts of weeds on kenaf production reduced its potentials (3). However, weed control remain an uphill task for kenaf farmers, especially the resource-poor ones. Delayed weeding and weedy kenaf fields may significantly reduce both fibre and seed yield by about 50 - 80% (4; 5) and net return (NR) reduced by 86% (3).

Herbicides are effective and more economical for weed control than manual weed control in cropping system (6; 7). Oxyfluofen, Quazilofop-p-ethyl and Fluazilofop-p-butyl have been identified as effective herbicides with broad spectrum of activities for weed control in cotton, vegetable, soybean and fruit crops (8; 9). The use of these herbicides for post-emergence weed control will enhance season-long weed suppression, eliminate the drudgery and high cost of manual weeding; increase land cultivated to kenaf and improves farmers' livelihood.

Methodology

A study was conducted to determine the efficacy of some herbicide formulations for post emergence weed control in kenaf at Ibadan (0.7.38N; 003.84E) station of the Institute of Agricultural Research and Training (IAR&T), Obafemi Awolowo University, Ibadan (Derived savanna agro-ecology) in 2016 and 2017 rainy seasons. Weed spectrum of the land was identified with the hand book of West African weeds (10) before land preparation and the predominant weeds were noted. The experimental plot has been under continuous cultivation of annual crops for 10 years. The land was ploughed and later harrowed before planting. Ifeken DI 400, an elite kenaf variety released by the IAR&T was sown using a plant spacing of 50 x 10 cm. Quazilofop-P-ethyl [($C_{19}H_{17}ClN_2O_4$) (100, 150, 200ml/ha)], Oxyfluorfen 240g/L [($C_{15}H_{11}CIF_3NO_4$) (0.96, 1.20 and 1.44 kg ai/ha)] and Fluazifop-p-butyl (2-(4{[5-(trifluoromethyl)pyridin-2-yl]oxy) propanoate - $C_{19}H_{20}F_3NO_4$) 150g/L (150, 225 and 300g ai/ha) were applied at specified rates at 6 WAS directed to the weeds, while weed-free and weedy were the control treatments. The experiment was arranged in randomized complete block design (RCBD) with three replicates.

Data collection

Data were collected on kenaf agronomic traits and weed growth. Herbicide phyto-toxicity at 3 DAT and 21 DAT was visually rated using a scale of 1 minimum to 10 maximum. Kenaf plant height was measured at 4, 6, 8, 10 WAS and maturity. Kenaf stem butt diameter was measured at 10 WAS using the Vanier's caliper. Kenaf bast fibre and core yield were measured after retting and drying. Weed dry weight at harvest was measured with sensitive weighing scale, relative yield loss and weed control efficiency were determined. The data were analyzed and means separated with Duncan's Multiple Range Test (DMRT) at $P \leq 0.05$.

Effects of herbicides on kenaf agronomic traits

Plots treated with herbicides and the control plots had varied agronomic traits measured (Table 1). Plot treated with Fluazilofop-p-butyl 225g ai/ha had the highest plant height, number of leaves (similar to Quazilofop-p-ethyl 100ml/ha, Quazilofop-P-ethyl 150ml/ha, Quazilofop-P-ethyl 200ml/ha, weed-free and Oxyfluorfen 4L/ha) and stem butt diameter across the treatments applied. These were comparable with other treatments except weedy check plot that had the lowest plant height and butt diameter at 10 WAP. The similarity in plant height and stem-butt diameter across treated plots and weed-free control might have been influenced by the application of weed control methods, that minimized weed interference in the treated plots and enhanced superior agronomic traits measured. Superior agronomic traits in crop plant influence crop yield and suppress weeds in a crop-weed interaction through canopy coverage and light intercept from taller crop plant (8; 11). Leafy kenaf plants might have enhanced canopy formation and suppression of weeds after herbicides application. However, weed interaction with kenaf in weedy plots consequently reduced kenaf plant growth due to critical weed interference. This confirmed the previous reports that weedy kenaf plot reduced agronomic traits and caused yield penalties in both fibre and seed production (3, 4, 5).

Table 1: Effects of herbicides on kenaf agronomic traits at 10 WAS

Herbicides	Plant height (cm)	Stem-butt girth (cm)	Number of leaves
Quazilofop-P-ethyl 100ml/ha	180.53^{ab}	1.79^{ab}	69.40^{ab}
Oxyfluorfen 1.20 kg ai/ha	181.00^{ab}	1.53^{ab}	52.20^{b}
Quazilofop-P-ethyl 150ml/ha	181.93^{ab}	1.71^{ab}	69.40^{ab}
Weed-free	200.30^{ab}	1.76^{ab}	74.40^{ab}
Quazilofop-P-ethyl 200ml/ha	210.40^{ab}	1.73^{ab}	77.10^{ab}
Fluazifop-p-butyl 225g ai/ha	226.10^{a}	1.93^{a}	92.07^{a}
Oxyfluorfen 0.96 kg ai/ha	222.93^{a}	1.64^{ab}	71.10^{ab}
Weedy control	130.53^{c}	1.29^{b}	50.10^{b}
Fluazifop-p-butyl 300g ai/ha	217.20^{ab}	1.92^{a}	73.20^{ab}
Oxyfluorfen 1.44 kg ai/ha	226.00^{a}	1.88^{ab}	90.00^{a}

Legend: values with the same alphabet are not significantly different at $p \leq 0.05$

Effects of herbicides on weed growth

Significant reduction in weed growth of about 60 -70% was measured in plots treated with Oxyfluorfen 0.96 kg ai/ha, 1.20kg ai/ha, and 1.44 kg ai/ha; fluazilof-p-butyl 225g ai/ha and 300g ai/ha and Quazilofop-P-ethyl-ethyl (100 and 200ml/ha) (Figure 1). This showed the efficacy of herbicides applied relative to weed dry matter accumulation in weedy check plots. Invariably, this consequently influenced the superior kenaf growth in the aforementioned treated plots. This is line with the previous study (6) that herbicides are effective for weed suppression. This was in line with the efficacy of pre-emergence herbicide + hoe weeding earlier reported earlier (3). The drudgery of hoe-weeding and associated cost may be replaced by the evaluated herbicides with some economic benefits where cost of labour is prohibitive and large scale kenaf production is of essence.

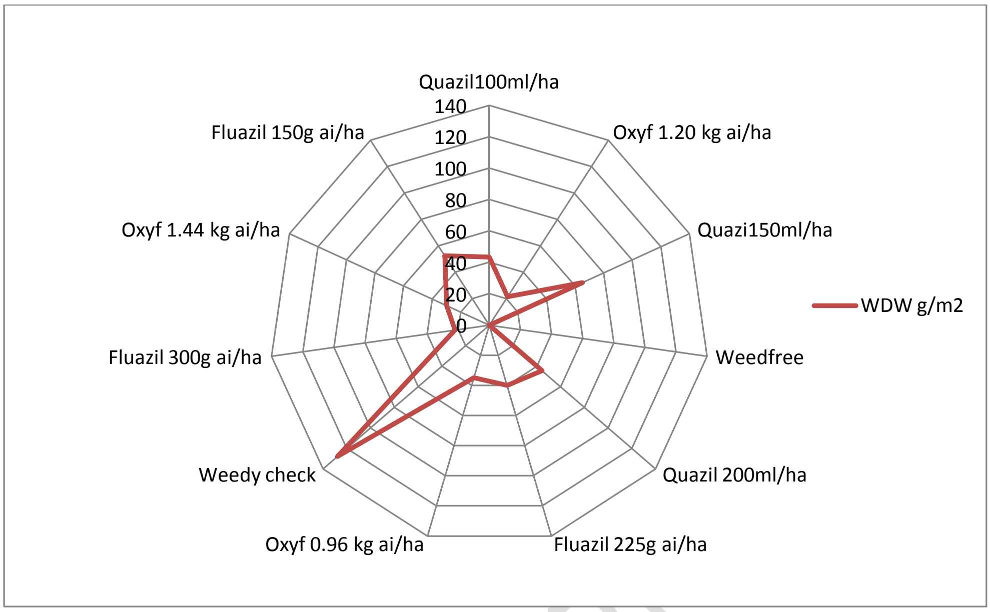

Figure 1: Effects of herbicides on weed growth at kenaf fibre harvest

Gross fibre yield as influenced by herbicide application

Kenaf plant sown into weed-free plot and plot treated with Fluazilofop-p-butyl (150, 225 and 300g ai/ha) had comparable maximum gross fibre yield/ha (bast and core fibre yield) (Figure. 2). This is due to reduced weed infestation evident in herbicide treated plots and weed-free plots. In previous studies when kenaf plots were kept weed-free or weeds controlled, kenaf yield components were enhanced tremendously (5). It was earlier reported thet crop performance was higher in herbicide treated plots due to their efficiency (6). Conversely, weed infestation in weedy check plot reduced kenaf gross fibre yield by about 65% in this study. This is due to the acute weed interference and high weed growth measured in weedy check. The cumulative effect of the prolonged weed interaction with kenaf plants negatively impacted on agronomic traits and yield. This corroborates previous studies that weeds reduced kenaf components yield by 50 – 80% (4, 5, 12).

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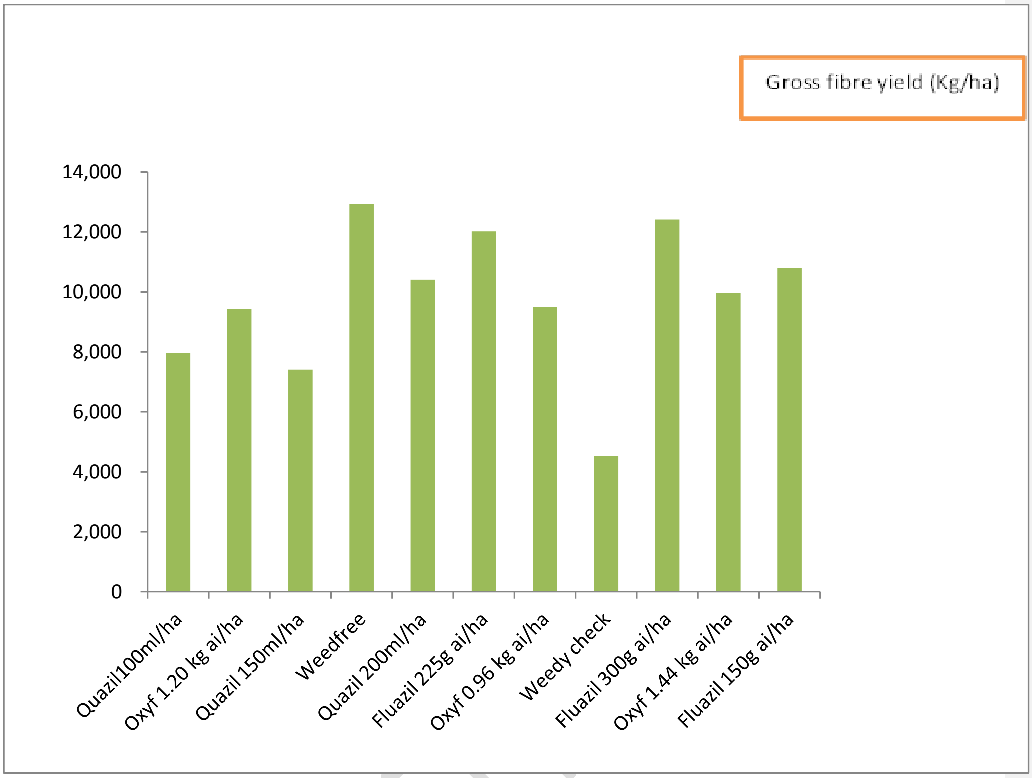

Figure 2: Effects of herbicides on kenaf gross fibre yield

Herbicide weed control efficiency

Weed control efficiency (WCE %) was significantly influenced by herbicide application (Figure 3). Weed-free had the highest weed control efficiency relative to weedy check. Oxyfluorfen (1.20 and 1.44 kg ai/ha), and Fluazilofop-p-butyl (300 g ai/ha) had high weed control efficiency of ≥ 80%. This confirmed the efficacy of oxyfluofen as earlier reported as an effective herbicide for the control of both broad leaf and grass weeds in in vegetables (8). This was also confirmed by Eko and Fadhilah (2017), that Oxyfluofen reduced weed dry weight by 92.36% in broccoli (*Brassica oleracea* L.) and had similar WCE% with weed-free plot. The differences in WCE% of other herbicides might be due to variations in the quantity applied, degradation of formulation and their spectrum of activities in the agro-ecology. Notwithstanding, the study showed that herbicides reduced weed dry weight in kenaf plots by 70% compared with weedy check plots.

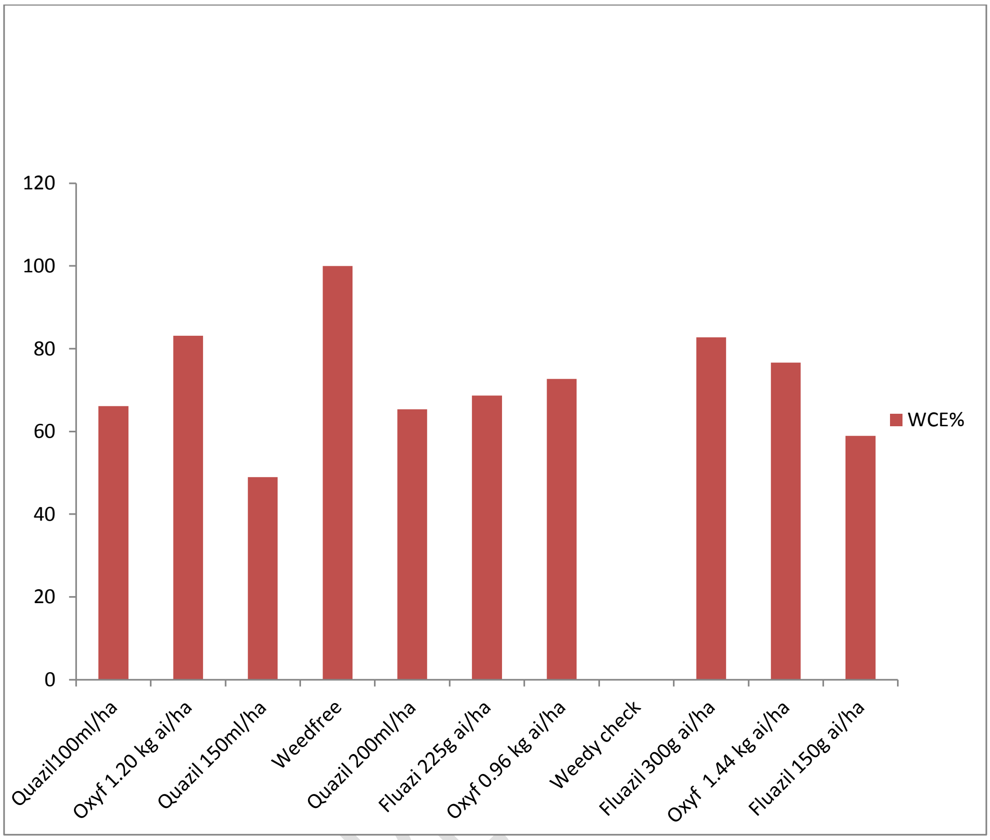

Figure 3: Weed control efficiency of herbicides

Relative yield loss in kenaf

Weedy check plot had the highest relative yield loss (RYL %) in kenaf gross fibre yield (Figure 4). This is due to the higher weed growth and superior weed interference. This is line with study that established an inverse relationship between weed growth and kenaf performance (12). In another study, negative impact of prolonged weed incursion in kenaf field reduced economic return by about 86% (3). This established the inverse relationship between weed growth and economic return on kenaf investment.

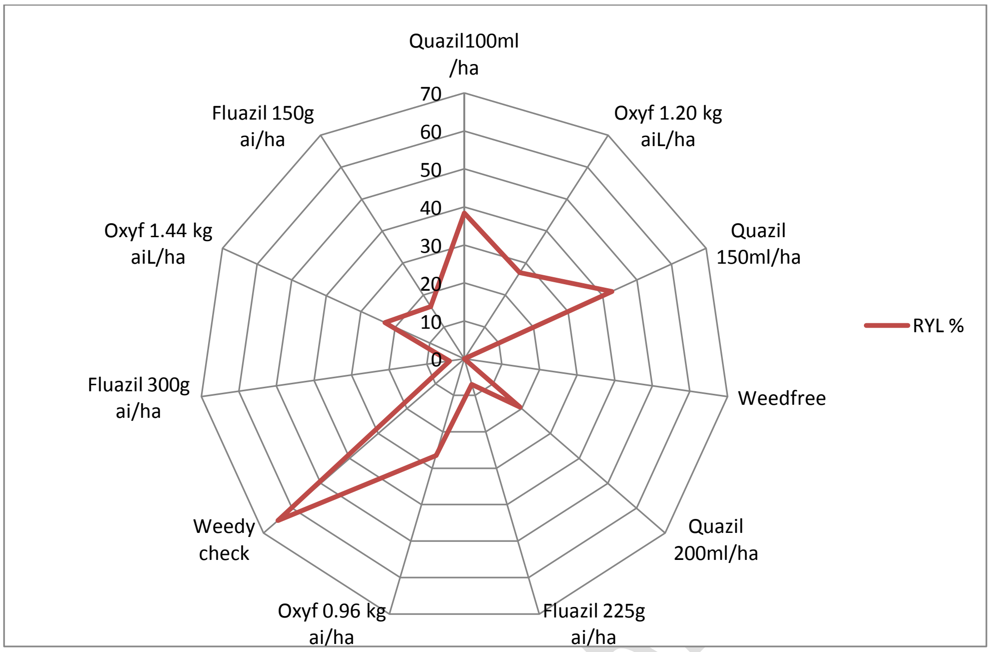

Figure 4: Effects of herbicides on kenaf relative yield loss

Conclusion

Kenaf growth and fibre yield are limited by weed infestation. Herbicides have been identified for effective pre-emergence weed control in kenaf. However, post-emergence weed management in kenaf is challenge when farmers rely on manual hoe especially where labour is scarce. Kenaf gross fibre yield was reduced by 65%, due to weed infestation and superior weed dry weight in the weedy control plot. The use of herbicides for post emergence weed control is germane for season-long weed control, timeliness of weed management and large scale production of kenaf fibre and seeds. Oxyfluofen 240g/L (1.20 and 1.44 kg ai/ha) and Fluazilofop-p-butyl at 300g ai/ha were found to be effective for broadleaf and grass weeds with considerable WCE % (≥80%). %. Quazilofop-p-ethyl rates had lowest WCE 50 – 65%. These may call for application of higher rate to increase WCE %. Notwithstanding, the benefit-cost ratio and environmental impact assessment of the study must be carried out for economic kenaf production and environmental friendliness.

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