



Valuation of Weed Control Methods by using Inter Row Rotary Weeder in Sugarcane Crop

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ABSTRACT

Background: Weeds are one of major threats to crop yield and quality. Weeds compete with cane crop and reduce the yield significantly in a very short period. Planned use of all available farm resources leads to integrated control strategy. The current study aimed to study the use of inter row rotary weeder for integrated weeds management to control population dynamics of weeds in sugarcane crop. The objective of experiment is to find out economical, feasible and easy to use approach to minimize the weed density below the threshold level in sugarcane crop and to minimize the use of chemicals for weeds control to promote organic farming.

Methods: In this research experiment, at Sugarcane Research Institute, Faisalabad during 2017 and 2018, the treatment includes viz. Application of Click (atrazine and acetochlor) @ 3.75 Liter per hectare as Pre-emergence, Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare as post-emergence, Mechanical Inter-culture with Rotary weeder and cultivator plough and earthing up. These treatments in different combinations were compared with control.

Result: The application of Pre-emergence weedicide Click (atrazine and acetochlor) @ 3.75 Liter per hectare + Inter culture with Rotary weeder 50 days after planting (DAP) + Inter culture with cultivator plough before earthing up (100 DAP) produced significantly higher cane yield of 105 t. ha⁻¹ and highest net benefits per hectare of Rs. 156250/-. The lowest cane yield of 70 t. ha⁻¹ was noted from the experimental units with Weedy check / control. If farmers use this approach, the use of post emergence weedicides will be minimized and will encourage organic farming with safe and healthy environment.

Key words: Atrazine, Click, Inter-culture, Rotary weeder, Sunstar.

INTRODUCTION

Despite the presence of modern weed management practices from last few decades, weeds are still the threat to crop yield and quality. Weeds compete with cane crop for light, nutrients, moisture and reduce the yield significantly in a very short period of time. Therefore, it is vital to maximize the yield by implementing a cost effective and timely weeds management strategy. Integrated weed management (IWM) includes planned use of all available resources at farm and integration of best tools to make cropping systems critical for weeds and curtails the effects of weeds population dynamics on crop yield (Srivastava *et al.*, 2012). These methods should be environmentally beneficial and economically viable to cope in the current and future challenges of weed management in agro-ecosystems (Wilson *et al.*, 2017). In IWM, farmers should identify weed species, weed densities, product, equipment available, weather conditions, soil type, critical period of crop weed competition, competition of weeds, effect of weed on crop growth and product efficacy for successful and economical weeds management (Suganthi *et al.*, 2019). The knowledge of these factors are keys for successful weed control and enable the farmer to make timely decisions. The main objectives behind IWM tools is to lessen the potential of weeds to set and thus minimize weed seed bank in all crop phases.

Inter row cultivation suppress the growth of weeds and improves the aeration for better cane growth. Normally in

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Pakistan, Cultivation is practiced by the use of cultivator between the rows of 4 feet apart plantation of sugarcane. Sugarcane research institute (SRI), Faisalabad made Rotary weeder by adopting some modification in rotavator. The rotary weeder worked in 2 feet bed of 4 feet apart cane plantation. It cuts all weeds and mix them in soil without damaging the sugarcane plants.

Herbicide can be valuable, economical, and easiest tool to boost sugarcane production. However, inappropriate herbicide application by seeing the neighbor farmer may have adverse impacts on soil, water and environment. To minimize these adverse effects, choosing the right strategy including timing of application, proper calibration of spray machine, use of proper nozzles, use of recommended rates and band spraying are important in effective weed control.

In the modern world, weeds control biologically by using plant pathogens has gained popularity and are on upswing (Shirsagar, 2008). The health of agro-ecosystems is of main concern for future generation including soil quality, water quality and crop productivity (Srivastava *et al.*, 2012). The basic principal of IWM is that management decision may time and site specific and to reflect the causes of weeds problem (Tahir and Ismail, 2016).

Sugarcane crop faces yield losses from 12-72% due to weeds competition (Khan *et al.*, 2015). Sugarcane has prolonged growing period. First 90-120 days are very important for cane crop and it should be free from weeds to curtail the yield and quality losses (Wilson *et al.*, 2017). In early days after planting, the growth is very slow but the growth of weeds is fast. In weed flora, grasses, sedges and broad leaf weeds offer great competition with cane crop. Weed flora exhaust more than two times the quantity of Nitrogen, Phosphorus and Potash taken by sugarcane crop in early fifty days. In ratoon crop very slight preparatory tillage is done by farmers and weeds that have already established in the plant crop tend to flourish well (Singh and Tomar, 2015).

In a field experiment different herbicides and cultural practices of weed management in sugarcane were studied and it was found that spray of metribuzine @1 kg /ha at 45 days after ratoon initiation recorded minor number of weeds and weed dry weight with 80.38 weed control efficiency and higher cane yield (Begum and Boardoloi, 2016).

In an experiment it was found that use of ametryn + atrazine @ 3.75 kg ha⁻¹ with inter row cultivation was more effective and economical than hand hoeing and inter row cultivation with tractor (Cheema *et al.*, 2010). In Integrated weeds management, it is possible to minimize weeds density below threshold level by reducing the quantity of chemicals (Khan *et al.*, 2017).

In the study in hand, the use of inter row rotary weeder was introduced and evaluated appropriate way of integrated weeds management to control population dynamics of weeds in sugarcane crop.

MATERIALS AND METHODS

The field experiment was conducted during the two year 2017 and 2018 at farm area of Sugarcane Research Institute, Faisalabad. The experiment was laid out in randomized block design (RCBD). Each treatment was replicated thrice. The plot size was 8 x 8.4 m. The treatments are as following:

- T₁: Click (atrazine and acetochlor) @ 3.75 Liter per hectare as Pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP (Days after planting).
 T₂: Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare as post-emergence + one mechanical weeding 60 DAP + earthing up 100 DAP.
 T₃: Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare + Sunstar (Ethoxysulfuron) @ 50 g per hectare as post-

emergence + one mechanical weeding 60 DAP + earthing up 90-100 DAP.

T₄: Falisto gold (Ametryn + Atrazine) @ 2.5 liter per hectare post-emergence 30 DAP, 60 DAP and 90 DAP.

T₅: Manual weeding 30 DAP + one mechanical weeding 60 DAP + earthing up 100 DAP.

T₆: Control / Weedy Check (no application of weedicides and inter-culture).

Crop husbandry

Trenches were made at 120 cm apart with sugarcane ridger designed by the SRI, Faisalabad. All experimental units were received recommended agronomic practices uniformly. The complete dose of phosphorus and potash fertilizers was applied manually in trenches at the time of planting in the form of di-ammonium Phosphate and Sulphate of Potash. Nitrogen was applied in the form of Urea in three equal splits viz. 45, 75 and 120 days after planting. All other agronomic of practices were followed by recommended package.

Statistical analysis

The data collected were subjected to statistical analysis (Freed, 1990), employing Statistix 8.1 and least significant difference test (LSD) was used to compare all sugarcane genotypes for their biometric performance (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Weed density and biomass

The data (Table 1) showed significant differences among different treatments for weeds density and weeds biomass. The control / weedy check showed the largest weed density. Click (atrazine and acetochlor) @ 3.75 Liter per hectare as Pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP. presented an effective control of weeds. The data also showed that the *Cyperus rotundus* was not completely controlled by Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare + Sunstar @ 50 g per hectare as post-emergence + one mechanical weeding 60 DAP + earthing up 90-100 DAP. Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare + Sunstar @ 50 g per hectare as post-emergence + one mechanical weeding 60 DAP + earthing up 90-100 DAP. Weeds other than *Cyperus Rotundus* were eradicated to variable extent. It was however, observed that weed density of *Cyperus Rotundus* not completely checked but its growth was condensed. Plants turned pale and weak and did not compete with the growth of cane plants. Hand weeding and herbicide alone could not control weeds effectively. Hand hoeing / weeding also could not check the growth of new weeds after irrigation. Pre-emergence application of Acetochlor + atrazine along with inter-culture with rotary weeder and cultivator plough suppressed the growth of weeds till complete crop canopy cover was achieved. These findings are in a great analogy with the work of Wilson *et al.* (2017), who reported an effective control of weeds with application of herbicide and inter-culture.

Table 1: Effect of different integrated weed management practices on the weed density and biomass in sugarcane crop.

Treatments	Convolvulus arvensis	Euphorbia helioscopia	Cyperus rotundus	Weed Biomass 75 DAS (g m ⁻²)
T ₁ : Click (atrazine and acetachlor) @ 3.75 Liter per hectare as Pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP.	9 D	5 D	35 F	205 D
T ₂ : Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare as post-emergence + one mechanical weeding 60 DAP + earthing up 100 DAP	14 B	7 C	75 D	246 C
T ₃ : Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare + Sunstar @ 50 g as post-emergence + one mechanical weeding per hectare 60 DAP + earthing up 90-100 DAP.	12 BC	8 C	60 E	235 C
T ₄ : Falisto gold @ 2.5 liter per hectare post-emergence 30 DAP, 60 DAP and 90 DAP.	17 B	11 B	90 C	265 C
T ₅ : Manual weeding 30 DAP + one mechanical weeding 60 DAP + earthing up 100 DAP.	15 B	14 B	104 B	310 B
T ₆ : Control (no application of weedicides and inter-culture).	26 A	18 A	115 A	415 A
LSD (P ≤ 0.05)	3.65	3.45	4.63	45

Table 2: Yield and yield contributing factors in relation to integrated weeds management in sugarcane.

Treatment	Tiller/ Plant	No. of canes (000 ha ⁻¹)	Cane height (m)	Cane yield (t ha ⁻¹)
T ₁ : Click (atrazine and acetachlor) @ 3.75 Liter per hectare as Pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP.	2.9 a	105 e	2.9 a	105 a
T ₂ : Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare as post-emergence + one mechanical weeding 60 DAP + earthing up 100 DAP	2.7 b	90 b	2.6 b	91 c
T ₃ : Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare + Sunstar @ 50 g per hectare as post-emergence + one mechanical weeding 60 DAP + earthing up 90-100 DAP.	2.6 c	100 ab	2.8 ab	102 b
T ₄ : Falisto gold @ 2.5 liter per hectare post-emergence 30 DAP, 60 DAP and 90 DAP.	2.4 d	85 d	2.5 b	86 d
T ₅ : Manual weeding 30 DAP + one mechanical weeding 60 DAP + 100 DAP.	2.7 b	86 c	2.5 b	86 e
T ₆ : Control (no application of weedicides and inter-culture).	2.0 e	75 e	2.0 c	70 f
LSD (P ≤ 0.05)	0.16	3.20	0.15	2.20

It was evident from the data in the Table 2 showed that maximum tillers per plant was found in T1 (Click @ 3.75 Liter per hectare pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP) having 2.9 tillers per plant followed by T3 (Ametryn + Atrazine 80 W.P) @ 2.50 kg per hectare pre-emergence + Sunstar @ 50 g ha⁻¹ post-emergence + one mechanical weeding 60 DAP + earthing up 90-100 DAP) with 2.7 tillers per plant. The treatment which yields lowest number of tillers per plant is T6 (Control i.e no application of weedicides and inter-culture) in which nothing was applied i.e. control. Similar results were reported by Wilson *et al.*, (2017).

Maximum canes per ha was found in T1 (Click @ 3.75 Liter per hectare pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP) having 105 thousand canes per ha followed by T3 (Ametryn + Atrazine 80 W.P) @ 2.50 kg per hectare + Sunstar @ 50 g / ha post-

emergence + one mechanical weeding 60 DAP + earthing up 90-100 DAP) with 102 thousand canes per ha. The treatment which yields lowest number of 75 thousand canes per ha is T6 (Control i.e no application of weedicides and inter-culture) in which nothing was applied i.e. control. Similar results were reported by Khan *et al.*, 2015.

Maximum height per plant was found in T1 (Click @ 3.75 Liter per hectare pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP) having 2.9 m per plant followed by T3 (Ametryn + Atrazine 80 W.P) @ 2.50 kg per hectare + Sunstar @ 50 g per hectare post-emergence + one mechanical weeding 60 DAP + earthing up 90-100 DAP) with 2.8 m per plant. The treatment which yields lowest (2 m) height per plant is T6 (Control i.e no application of weedicides and inter-culture) in which nothing was applied i.e. control. Similar results were presented by Wilson *et al.*, (2017).

The highest cane yield was found in T1 (Click @ 3.75

Liter per hectare pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP) having 105 t ha⁻¹ cane yield followed by T3 (Ametryn + Atrazine 80 W.P) @ 2.50 kg per hectare + Sunstar @ 50 g per hectare post-emergence + one mechanical weeding 60 DAP + earthing up 90-100 DAP) with 102 t ha⁻¹ cane yield per ha. The treatment which yields lowest 70 t ha⁻¹ cane yield is T6 (Control *i.e.* no application of weedicides and inter-culture) in which nothing was applied *i.e.* control. Sugarcane is the most important sugar crop in Pakistan occupying an area 1217 thousand hectares with an average productivity 65.5 million tons (GOP, 2017). This low yield is mainly due to heavy weed infestation in early growth stage and poor weed management practices (Suwanarak, 2012). Initial slow growth and wider row spacing provide ample opportunity for weeds to occupy the vacant spaces between rows and offer serious crop-weed competition (Khan *et al.*, 2015) Reported yield loss to an extent of 28-38% in ratoon crop due to weeds and the much critical period for competition of weed among 30 to 60 days after the ratooning. The treatment T1 is applied between this periods resulted in higher tillers, number of canes, cane height and finally cane yield. *Cyperus rotundas* is a serious weed in plant and ratoon crop of sugarcane. Farmers normally used labour to control manually. Timely availability of rural labor is a problem and labor-intensive weeding is laborious and costly in cultural weed control. With the use of Pre-emergence application of weedicides along with inter-culture by rotary and cultivator plough, weeds controlled easily and effectively. In this way, only one weedicide is used. Mainly mechanical methods were used. It reduces input of harmful chemicals to soil and environment. Similar results were reported by Suwanarak , (2012).

Economics of weeds control methods

In Table 3, economics of weeds control methods was calculated and found that lowest cost per ha on T4 (Falisto gold @ 2.5 liter per hectare post-emergence 30 DAP, 60 DAP and 90 DAP) is Rs. 9500/- while T5 (Manual weeding 30 DAP + one mechanical weeding 60 DAP + earthing up 100 DAP) treatment bears highest cost of Rs. 15000/-. As regarding with yield difference maximum yield increase of 35 t ha⁻¹ was seen in T1 (Click (atrazine and acetachlor) @ 3.75 Liter per hectare as pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP) having Rs. 166250/- additional benefits over T6 (control). Similarly, highest net benefits per ha of Rs. 156250/- was found in T1 Click (atrazine and Acetochlor) @ 3.75 Liter per hectare as pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP) followed by T3 (Ametryn + Atrazine 80 W.P) @ 2.50 kg per hectare + Sun-star @ 50 g per hectare post-emergence + one mechanical weeding 60 DAP + earthing up 90-100 DAP) with net benefits of Rs. 140000/-.

Table 3: Economical analysis in relation to integrated weeds management in sugarcane.

Treatment	Cost of weeds control /ha (Rs)	Yield MT/ha	Yield difference /ha over control per MT (Rs)	Additional Benefit over control @4750/- Rs.	Net benefits/ha	Numbering with more benefits
T ₁ : Click (atrazine and acetachlor) @ 3.75 Liter per hectare as Pre-emergence + Inter-culture with Rotary weeder 50 DAP (Days after planting) + Inter-culture with cultivator plough before earthing up 100 DAP.	10000	105	35	166250	156250	1
T ₂ : Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare as post-emergence + one mechanical weeding 60DAP + earthing up 100 DAP	11000	91	21	99750	88750	3
T ₃ : Ametryn + Atrazine 80 W.P @ 2.50 kg per hectare + Sunstar @ 50 g per hectare as post-emergence +one mechanical weeding 60 DAP + earthing up 90-100 DAP.	12000	102	32	152000	140000	2
T ₄ : Falisto gold @ 2.5 liter per hectare post-emergence 30 DAP, 60 DAP and 90 DAP.	9500	86	16	76000	66500	4
T ₅ : Manual weeding 30 DAP + one mechanical weeding 60 DAP + earthing up 100 DAP.	15000	86	16	76000	61000	5
T ₆ : Control (no application of weedicides and inter-culture).	00	70	0	0	0	6

In view of aforementioned discussion, the T1 treatment stands on top having number (01) with less cost, more net benefits than all other methods. This strongly favors because this treatment has more tillers per plant, cane count and cane yield. In this treatment, only one weedicide as pre-emergence was used. The pre-emergence weedicide Click with composition acetachlor and atrazine @ 3.75 Liter per hectare controlled all types of weeds before emergence. This control was continued till 50 days. After 50 DAP, weeds like itsit, dheela, lay etc starts to germinate and it was mechanically controlled with Inter-culture by Rotary weeder. Rotary weeder rotavated all weeds effectively and mixed in soil. It increased the organic matter and fertility in soil. In sugarcane crop planted in dual row four feet apart, earthing is done after 100 DAP to support the plants and prevents the crop from lodging. Before earthing up, one inter-culture with cultivator plough is done to remove weeds and increase the aeration in crop roots and encourage more tillering in cane crop. Similar results were presented by Wilson *et al.* (2017).

CONCLUSION

It is concluded that use of Pre-emergence weedicide *i.e.* Click (Atrazine + Acetochlor) @ 3.75 Liter per hectare + Inter-culture with Rotary Weeder at 50 days after planting + Inter-culture with cultivator plough before earthing up at 100 days after planting resulted higher cane yield with more net benefits and less weeds density and weeds biomass. Farmers are recommended to use the Rotary Weeder for Inter-culture in sugarcane to control weeds and increase organic matter of soil.

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