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EFFICACY OF HERBICIDES ON CONTROLING *CONYZA STRICTA* IN SUGARCANE PLANTED IN DIFFERENT GEOMETRIES

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ABSTRACT

Different herbicides were evaluated for the control of Conyza stricta in sugarcane planted at different planting geometries under agro-ecological conditions of D. I. Khan, Pakistan during 2000-2001 and 2001-2002. The experiments were conducted in randomized complete block design with split plot arrangement with each treatment replicated thrice. Main plots comprised of planting geometries whereas the sub plots comprised of herbicides. Data were recorded on weed population, weed dry weight, sugarcane stalks/stool, stem girth, cane yield in tons per hectare and Benefit cost ratio (BCR). Planting geometries significantly differed for weed and sugarcane parameters. The highest decrease in the weed population and dry matter was accounted in the planting geometries of triple rows at 120 cm. It significantly increased sugarcane parameters and produced the highest yield of 58.2 t ha^{-1} when averaged across herbicides and year. All the herbicides significantly decreased weed population and dry weight and increased sugarcane stalks per meter and yield. The herbicide 2,4-D alone procured the maximum yield of 48.22 t ha^{-1} when averaged across geometries. The control gave significantly lowest yield of 33.38 t ha^{-1}. The herbicide 2,4-D registered the highest benefit cost ratio (BCR) of 2.19 and the highest gross income of Rs. 51913 at planting geometry of triple row at 120 cm. The lowest BCR ration of 1.72 with the lowest gross income of Rs. 36164 was depicted in the control. It is suggested that for obtaining economic yield from sugarcane at D. I. Khan, it may be planted in triple rows 120 cm apart with application of 2,4-D for control of Conyza stricta.

Key words: Herbicide, *Conyza stricta, Saccharum officinarum*, planting geometry, benefit cost ratio

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is one of the leading cash crops of Pakistan. It provides major raw material input for the domestic sugar industry. It provides income to the grower and employment for numerous farm and industrial workers throughout the year. In 2000-2001 sugarcane was planted in Pakistan on an area of 9608 thousand hectares with production of 43606 thousand tons. Pakistan ranks fifth in the world on the basis of land planted to sugarcane. But, the average yield of sugarcane is about 45.4 t ha^{-1} (Anonymous, 2001) which is very low as compared to other sugarcane growing countries around the world such as Burma, Malaysia, Morocco, Cuba, USA and India.

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In NWFP, farmers plant sugarcane on vast acreage due to developed sugar industry and lucrative income generated by gur making. In D. I. Khan sugarcane is planted on a vast acreage. Under the Chashma Right Bank Canal in D. I. Khan, there is scope for both vertical and horizontal increase in the production of sugarcane. In 2000-01, an area of 106 thousand hectares was under sugarcane in D. I. Khan that produced a total cane yield of 4784 thousand tons. There are several reasons for low cane yield and low sucrose recovery from the sugarcane in Pakistan, but weed infestation is the major constraint for low yield in Pakistan. Gravity due to weeds becomes even more serious when this crop has to stay in the field for 10-12 months and ratooning further complicates the weed problem. Weeds not only reduce yield of sugarcane but also increase the cost of production. Holm (1971) claimed that more labor was used for the weeding of agricultural crops worldwide than any other human activity. This probably remains true for many sugarcane growers in D. I. Khan.

There is no simple method to control weeds of all forms. Different kinds of social, economical and environmental factors influence the choice of control method to be used. The old practices are being revised and integrated with the chemicals herbicides, biological agents and planting patterns. Millholon (1984) and Singh and Singh (1988) observed that heavy infestation of weeds in sugarcane fields reduced cane yields by more than 50%. Makhdoom (1987) reported that 15-30% reduction in yield of sugarcane due to weeds in Pakistan is very common. The introduction of new highly effective herbicides has revolutionized the weed control in sugarcane field Zainullah et al. (1990). Researchers have discovered that herbicides applied alone are comparatively less effective than applied as mixture. The enhanced activity has been attributed to the synergistic effect of the herbicides in mixture. There are also reports that some herbicides are more effective than the others in controlling weeds in sugarcane. Padilla et al. (1986) reported that diuron applied as pre-emergence was more effective than Gezaprim in controlling weeds in sugarcane. Kanwar et al. (1992) found atrazine and 2,4-D controlling wide spectrum of weeds in sugarcane. They also observed that atrazine and 2,4-D when applied in combination produced effective control of *Cyperus rotundus* and gave the maximum yield of 59.7 t ha^{-1}. A new weed *Conyza stricta* (vern. Daryai booti) has been observed very common recently infesting sugarcane fields and inflicting enormous growth and yield losses to sugarcane in D. I. Khan.

Weeds are easily and effectively controlled culturally by adjusting the planting geometry. Conventional methods of planting sugarcane in single 60 cm a part rows, is not convenient for weed control. To find out an effective and economical combination of planting geometry and herbicide (s), for weed control in sugarcane, experiments were conducted during the years 2000-01 and 2001-02.

MATERIALS AND METHODS

The efficacy of different herbicides alone and in different combinations was evaluated for the control of weeds especially the newly introduced weed *Conyza stricta* in sugarcane planted at different geometrical patterns. Sugarcane variety Co-1148 was planted in randomized Complete Block Design with split plot arrangements with three replications at the Department of Agronomy, Faculty of Agriculture, Gomal University, D. I. Khan during 2000-01 and repeated during 2001-02 to confirm the reliability of the results. The geometrical patterns were kept as main plots where as the herbicides treatments were allotted to the sub-plots with net sub-plot size of 5 x 3.6 m^2 in the successive year of studies. Both geometrical pattern and herbicides treatments were assigned at random to the experimental units at procedure laid down in Steel and Torrie (1980). Fertilizer was applied @ 170-110-110 kg NPK ha^{-1}. The P and K along with one third N were applied at sowing, while the remaining N was top dressed in two equal splits with each at the completion of germination and tillering. Nitrogen, phosphorus and potash were applied in the form of urea, diammonium phosphate and sulphate of potash, respectively. Irrigations were applied when needed. The herbicides were applied 30 days after sowing. The main plots and sub plots were as under.

Main plots

1. Single rows 60 cm apart
2. Double rows 90 cm apart
3. Triple rows 120 cm apart

Sub Plots: Herbicides

T1- Control	No herbicide
T2-.Ancom 80 WP alone	2 kg ha^{-1}
T3- Gizapex alone	1.7 kg ha^{-1}
T4- 2,4-D alone	
T5 Ancom+Gizapex	
T6- Ancom + 2,4-D	
T7- Gizapex + 2,4-D	
T8- Ancom + Gizapex + 2,4-D	

Data on weed density, weed dry weight, sugarcane stalk per stool, stem girth, yield in tons per hectare and benefit cost ratio, were recorded according to the standard procedures.

RESULTS AND DISCUSSIONS

Different herbicides alone and in combination were evaluated for the control of weed (*Conyza stricta*) in sugarcane planted at different planting geometries during the year 2000-2001 and 2001-2002. The results are as under.

Weed density (m^{-2})

A perusal of weed population means in (Table-1) depicted that planting geometry significantly ($P \leq 0.05$) differed in reducing the weeds population. The weed population (4.16 weed m^{-2}) in the triple row strips at 120cm was significantly less than the weed population in the other geometry used in this study. The planting geometry of single rows 60 cm apart induced the least reduction in the weed population and produced the highest number of 6.58 weed m^{-2}. The reduction in weed population was to the reduced competition from weeds for nutrients, space and light resulting in accelerated growth of the sugarcane plants at early growth stage. The highest reduction in weed population per unit area was obtained in the herbicide mixture of Ancom+Gizapex+2,4-D, followed by Gizapex+2,4-D and 2,4-D alone with weed population of 2.33 and 2.83 m^{-2}, respectively. The highest weed population was found in the control. The highest efficiency in weed control by the mixture of Ancom+Gizapex+2,4-D may be the synergistic effect of the three in mixture. Our results corroborate the results Afzal et al (1995) and Afghan (1996) who reported higher weed control efficiency with blended application of herbicides.

Weed plant dry weight $plant^{-1}$ (g)

A study of weeds dry weight means (Table 1) showed that sugarcane-planting geometry significantly ($P \leq 0.05$) differed in affecting the weeds dry weight when averaged across herbicidal control treatments and years. The lowest single weed dry weight of 2.10 g $plant^{-1}$ was obtained at the planting geometry of triple rows at 120 cm. It the planting geometry of single rows at 60cm gave the highest weed dry weight of 2.54 g. Due to more space between strips at planting geometry of triple rows, competition between sugarcane plants and weeds for space, nutrients and light was less compared to the other geometries. The reduced competition resulted into good growth of sugarcane plants at early growth stage reducing weed growth by shading it.

All the herbicides treatments significantly ($P=0.05$) reduced the weed dry weight as compared to the weed dry weight in the weedy check (Table 1). The lowest weed dry weight was depicted in the treatment where Ancom+Gizapex+2,4-D was applied as a blended mixture. It was significantly different from all the herbicides treatments used in this study followed by Gizapex+2,4-D treatment that produced weed dry weight of 1.94 g $plant^{-1}$. The other herbicide treatments were statistically at par with each other. The highest weed dry weight per plant of 3.44 g was obtained in the weedy check. Our results validate the reports forwarded by Chauhan and Singh (1993), Mehra et al (1995) who reported that all the herbicide treatments reduced weeds dry weight as compared to the weedy check.

Number of sugarcane stalks stool^{-1}

The means of stalk stool^{-1} in Table1 depicted that the planting geometry significantly (P≤0.05) differed in affecting the number of stalks per stool. The highest (11.93) stalks per stool were harvested in the planting geometry of triple rows 120cm apart. This geometry produced significantly higher number of stalks stool^{-1} as compared to the stalk stool^{-1} produced in the other geometry used in this study. The planting geometry of single rows 60cm apart gave the lowest (8.7) number of stalks per stool. The herbicides significantly (P=0.05) differed in increasing the number of stalks stool^{-1} as compared to the weedy check (Table 1). The highest (12.11) number of stalks per stool was obtained where Ancom+Gizapex+2,4-D was used as a blend. This treatment gave significantly more stalks per stool than all the herbicides used in the study. Herbicide treatment Gizapex+2,4-D and Acom+2,4-D gave 10.88 and 11.11 stalks per stool respectively and were statistically at par between them but significantly different from the Ancom+Gizapex, and 2,4-D alone which produced 10.00 and 10.22 stalks per stool and were statistically at par between them. The treatment 2,4-D alone was the only herbicide of the three used as alone that significantly increased the number of stalks per stool compared to the weedy check. The treatments Ancom alone and Gizapex alone failed to increase the number of stalks per stool as compared to the weedy check. The higher number of stalks in the treatment Ancom+Gizapex+2,4-D might be the synergistic effect of the herbicide in combination. The highest efficiency of this treatment at planting of triple rows 120 cm apart may be the result of reduced competition, because 120 cm between triple row strips provided enough space and nutrients for sugarcane plants at early growth stage with reduced competition from the weeds. These results confirm those of Shafi et al (1994) and Afzal et al (1995). However, results, contradicting our findings were reported by Singh and Singh (1988), and Agrawal (1995). The adverse effect reports may be the result of incorrect spraying technique or mixing of incompatible herbicides or use of overdose and the wrong time of spraying.

Sugarcane stem girth (cm)

The stem thickness means (Table1) displayed significant difference (P≤0.05) for the stem thickens among planting geometry evaluated in this study. The highest stem thickness of 4.02 cm was obtained in the planting geometry of triple rows 120 cm apart. The stems in this geometry were significantly thicker than the stems produced in the other planting geometry. The smallest stem thickness of 3.01 cm was harvested in the planting geometry of single rows at 60cm spacing. The herbicidal means averaged across planting geometry and years failed to significantly (P=0.05) increase the stem thickness. However, the largest stem thickness of 3.65 cm was registered in the herbicide mixture of Ancom+Gizapex followed by Ancom+2,4-D, Gizapex+2,4-D and Ancom+Gizapex+2,4-D mixtures with stem thickness of 3.61, 3.61 and 3.60 respectively (Table 1). The weedy check produced the lowest stem thickness of 2.37 cm throughout the study. These findings approve the results of Tejada and Saravia (1984) and Shafi et al. (1994)

Yield (t ha^{-1})

The yield means (Table1) revealed that planting geometry significantly (P≤0.05) differed in affecting the sugarcane yield in ton ha^{-1} when averaged across planting geometry and years. The highest yield of 52.28 tons ha^{-1} was obtained in the planting geometry of Triple rows 120 cm apart, which was significantly higher than the yield recorded in the other planting geometry used in this study. The lowest yield of 33.08 tons ha^{-1} was recorded in the planting geometry of single rows 60cm apart. The highest yield at planting geometry of triple rows 120 cm apart may be the result of reduced competition for nutrients, moisture and space from the weed population on account of wider space available. Another reason for high yield may be reduced root interference of the weed roots with sugarcane plants because of enough space for the two at early growth stage as compared to the space in the narrow spacing. The herbicide treatments significantly (P=0.05) differed in affecting the sugarcane yield as compared to the yield recorded in the weedy check (Table 1). The highest yield of 48.22 tons ha^{-1} was harvested in the treatment where 2,4-D was used as alone followed by Gizapex alone and Ancom alone with 46.72 and 43.61 tons ha^{-1} yield. The 2,4-D used alone was statistically at par with Gizapex alone and Ancom alone in affecting the yield in t ha^{-1}, but was significantly (P=0.05) different from the herbicide treatments used as mixture in this study. The lowest yield of 33.78 t ha^{-1} was obtained from the weedy check. The more effectiveness of 2,4-D alone indicates the preponderance of broad leaves that were successfully controlled by 2,4-D alone. The less effective of the 2-4-D in the mixture may be the result of lower dose of 2,4-D in the mixture. The lowest yield in the weedy check revealed the enhanced competition for space and nutrients between weeds and sugarcane plants resulting in lower yield of sugarcane per unit area as compared to the plots where weeds were controlled with herbicides spraying. These results were analogous to those of Makhdoom (1987), Singh and Singh (1988), Das and Borthakur (1991), Patil et al (1991), Agrawal et al (1995) and Afghan (1996). Contradictory to these results findings were reported by Singh and Singh (1988), and Agrawal et al. (1995). The adverse effect reports may be the result of incompatible mixture of herbicides or the resistance in the weeds to the continuous use of one type of herbicides.

Table 1. Effect of herbicides on weed and sugarcane parameters in sugarcane.

Herbicides	Weed density (m^2)	Weed biomass (g)	Sugarcane stalks(stool)	Stalk Girth (cm)	Yield t ha^{-1}
Control	20.55a	3.44a	8.94d	2.87NS	33.38d
Ancom	6.55b	2.44b	9.06d	3.30	43.61abc
Gizapex	3.05cd	2.22bc	9.33d	3.57	46.72ab
2.4-D	2.03cd	2.33bc	10.22c	3.59	48.22a
Ancom+Gizapex	4.00c	2.17bc	10.00c	3.65	42.72bc
Ancom+2,4-D	3.05cd	2.33bc	11.11b	3.61	42.22bc
Gizapex+2,4-D	2.33d	1.14c	10.87b	3.61	40.16c
Ancom+Gizpex+2,4-D	1.00e	1.33d	12.11a	33.60	41.50c
LSD (0.05)	1.09	0.40	0.52	NS	4.82
CV%	30.42	27.06	7.79	4.64	17.21
Planting geometries					
Single rows at 60cm	6.58a	2.54a	8.78c	3.06c	33.80c
Double rows at 90cm	5.52b	2.19b	9.92b	3.40b	41.00b
Tripple rows at 120cm	4.61c	2.10b	11.94a	4.02a	52.80a
LSD0.05	0.83	0.27	1.93	NS	3.51
CV%	30.42	27.06	7.79	4.64	17.21

Values sharing a common letter are not significantly different at 0.05 % probability.

NS = Non significant at 0.05 % probability

Benefit cost ratio

The benefit cost ratio (BCR) for different herbicides in controlling weeds in sugarcane and increasing cane yield (Table 2) revealed that 2,4-D gave the highest gross income of Rs 51913/- and the highest BCR of 2.19 at the planting geometry of triple rows at 120 cm. The herbicide 2,4-D also gave the highest gross income of Rs 40101/- and the highest BCR in the planting geometry of double rows at 90 cm compared to other herbicides in this geometry. The planting geometry of single rows at 60 cm gave the lowest gross income and BCR compared to the other planting geomtries used in this study. Comparing controls among the planting geometries, the highest gross income and BCR was procured in the control at planting geometry of tripe rows at 120 cm. It is evident that wide spaces between strips reduced competition of weeds with sugarcane plants and hence higher cane yields were obtained. The herbicides were more effective in controlling weeds at wide spaces between sugarcane strips. The combined effect of wide spaces and herbicides produced highest BCR at planting geometry of triple rows by all the herbicides. The herbicide 2,4-D was found as the best for obtaining maximum net benefits.

Table 2. Effects of herbicides on benefit cost ratio in sugarcane.

Herbicides	Single rows at 60 cm			Double Rows at 90 cm			Triple rows at 120 cm		
	Gross income	Cost of product	BCR	Gorss income	Cost of product	BCR	Gross income	Cost of product	BCR
Control	21577	19000	1.14	29890	20250	1.48	36164	21000	1.72
Ancome	29890	21000	1.42	37625	22400	1.68	46952	23700	1.98
Gizapex	36164	22175	1.63	37327	22500	1.67	49140	24200	2.03
2,4-D	34562	21200	1.63	40101	22300	1.80	51913	23600	2.19
Ancom+Gizapex	27851	21000	1.32	37038	22400	1.65	47250	23850	1.98
Ancom+2,4-D	28140	20950	1.34	35437	21900	1.62	47250	23650	1.99
Gizapex+2,4-D	25812	20600	1.25	34413	22000	1.56	45202	23500	1.92
Ancome+Gizpex +2,4-D	27562	20900	1.32	35140	22350	1.57	46226	24100	1.92

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