

INTEGRATED WEED MANAGEMENT IN UPLAND COTTON

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ABSTRACT

Comparative efficacy of different pre-emergence herbicides Stomp 330 E (pendimethalin), Stomp 455 CS (pendimethalin), Top 33 EC (pendimethalin), Ronstar 25 EC (Oxadiazon), Treflan 5 EC (trifluralin), Acetor 50 EC (acetochlor) and Dualgold 960 EC (S-metolachlor) was evaluated along with hand weeding and weedy check. The herbicides studied for weed control and their effect on seed cotton yield and its components during 1999, 2000 and 2001. The recommended production technology except herbicidal treatments was adopted for all the experiments. Most dominant weeds were *Echinochloa colonum*, *Cyperus rotundus*, *Covolvulus arvensis*, *Digitaria sanguinalis* and *Cynodon dactylon*. The data were recorded on phytotoxicity of herbicides on the crop, weed mortality and weed density, bolls per plant, boll weight and seed cotton yield. Non of the herbicidal treatments showed phytotoxicity on the crop except Dualgold 960 EC which adversely affected the crop germination and plant population when it was incorporated in soil. Results further revealed that in all the treatments, hand weeding and chemical weed control treatments were at par in reducing the weed infestation and increasing the seed cotton yield.

Key Words: Cotton, Herbicides, Weed Flora and Weed Control.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is mainly concentrated to southern area of NWFP like D.I.Khan. The yield ha⁻¹ of cotton in Pakistan particularly in Dera Ismail Khan is very low. Thus there is tremendous scope of expansion of cotton cultivation around the command area of Chashma Right Bank Canal (CRBC) and also to check the water table which is continuously rising up due to high delta crops like rice and sugarcane. Therefore, along with vertical improvement, there is a great scope of the horizontal improvement by increasing the crop area. There are certain problems / constraints for getting maximum yield in cotton. Weed infestation and its management is one of the major causes of low yield. Dominant weeds in cotton are *Echinochloa colonum* (jungle rice), *E. crus-galli* (barnyard grass), *Cyperus rotundus* (purple nutsedge), *Covolvulus arvensis* (field bindweed), *Digitaria sanguinalis* (large crabgrass) and *Cynodon dactylon* (bermuda grass). According to an assessment, grasses cause 15 to 40% and broad leaf weeds 15 to 30% yield losses in cotton crop. The cotton yield could be increased if we made the effective weed management either manually or through chemicals and overcome the weed problem along with other constraints. However, in case of crop cultivation on large scale with a very high density of weeds and their germination over a prolonged period of time, the manual weeding is impracticable. Thus, for better economic returns screening of friendly herbicides is important.

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Chemical weed control decreased the weed infestation and gave highest seed cotton yield and net return ha^{-1} (Patel *et al.* 1985). Balyan *et al.* (1983) and Singh *et al.* (1987) and Khan *et al.* (1994) obtained highest seed cotton yield with application of pendimethalin and found also at par with hand weeding. Halimie *et al.* (1994) and Shafi *et al.* (1996) reported that Agil 100 EC and pendimethalin gave better weed control and increased seed cotton yield than Trifluralin. Hassan *et al.* (1996) noted that pendimethalin and trifluralin significantly decreased the weed infestation and increased seed cotton yield. Gill *et al.* (1996a) reported that pendimethalin gave best weed control and seed cotton yield when applied on well prepared land during pre-planting irrigation (rouni). Gill *et al.* (1996b) noted that when pendimethalin applied on dry land and irrigated immediately, exhibited 81% weed control and increased seed cotton yield as compared to delayed irrigation. Cheema *et al.* (1996) reported in his studies that an increase of 54% in seed was recorded by manual inter-culturing coupled with earthing up and was followed by combination of pendimethalin with mechanical weed control with an increase of 52%. The use of Pendimethalin only increased the seed cotton yield upto 32%. Khan *et al.* (2001) observed significant decrease in weed population through pendimethalin and oxadiazon and showed significant increase in bolls per plant and seed cotton yield. Memon *et al.* (2001) reported that the lowest weed flora was recorded in S-metolachlor (Dualgold 960 EC) which was at par with hand weeded plots and in case of seed cotton yield Dualgold 960 EC was statistically at par with Stomp 330 E.

The present studies were carried out during crop seasons 1999 to 2001 to study the efficacy of different pre- and post-em cotton crop herbicides against weed flora and their effect on seed cotton yield also to observe their phytotoxicity on the crop under the prevailing agro-ecological conditions of Dera IsmailKhan, NWFP, Pakistan.

MATERIALS AND METHODS

Herbicidal efficacy was tested through different pre- and post-em herbicides (Table 1) in comparison with hand weeding and weedy check in cotton during the crop seasons 1999, 2000 and 2001 at Agricultural Research Institute D.I.Khan. The soil was silty clay with pH of 8.4 and organic matter was 7.5%. During each crop season Cultivar CIM-446 was sown by dibbling during mid of May on well prepared seedbed using RCB design with four replications. Plot size was kept at $7.60 \times 3 \text{ m}^2$. Rows and plants spacing were kept 75 and 30 cm, respectively. NP fertilizers were applied @ $100:60 \text{ kg ha}^{-1}$. Pre-em herbicides (pendimethalin, oxadiazon, trifluralin, acetochlor and S-metolachlor were incorporated and applied at sowing time before the germination of the weeds and crop in a proper moisture condition of the soil. In pendimethalin, the herbicides Stomp 330 E and Stomp 455 CS were used as full dose (F.D) and low dose (L.D). The post-em herbicides (glyphosate and paraquat) were applied with shielded spray at 3-5-leaf stage of the weeds. Weed density and the data on different weed species were recorded in one m^2 after 35 and 20 days after the pre- and post-em herbicide application, respectively.

The data were recorded on four parameters viz; weeds density, bolls per plant, boll weight and seed cotton yield. The data were subjected to ANOVA and $\text{LSD}_{0.05}$ to determine the level of significance among the treatment means by using the MSTATC computer programme (Bricker, 1991).

Table-1. Pre- and post-em herbicides applied in cotton

S.No.	Common Name	Trade Name	Time of Application	Dose L.ha ⁻¹
1.	Pendimethalin	stomp 330 E	Pre-em	4.00
2.	Pendimethalin	Top 33 EC	Pre-em	3.00
3.	pendimethalin	Stomp 455 CS	Pre-em	1.88
4.	Oxadiazon	Ronstar 25 EC	Pre-em	3.00
5.	trifluralin	Treflan 5 EC	Pre-em	2.50
6.	acetochlor	Acetor 50 EC	Pre-em	1.25
7.	S-metolachlor	Dualgold 960 EC	Pre-em	2.50
8.	glyphosate	Roundup	Post-em	3.75
9.	paraquat	Gramaxone	Post-em	1.88

RESULTS AND DISCUSSION

The null hypothesis for equality of all the treatment means through ANOVA, proved false at $P < 0.01$ by having highly significant differences among the means for weed density, bolls per plant, boll weight and seed cotton yield.

Weed Density (m⁻²)

During 1999 hand weeding and all the herbicidal treatments decreased the weed infestation significantly (Table 2). The lowest weed infestation was recorded in hand weeding, which was statistically at par with Stomp 330 E (full dose) and Gramoxone. These were followed by Ronstar 25 EC and Treflan 5 EC. Maximum weed density (48 m²) was recorded in weedy check. During 2000 hand weeding and all the herbicidal treatments also decreased the weed infestation significantly (Table 4). The lowest weed infestation was recorded in hand weeded plots followed by Stomp 330 E, Top 33 EC, Stomp 455 CS (with full dose), Acetor 50 EC and Dualgold. Maximum weed density (62 m²) was recorded in weedy check. In 2001, the results revealed that the lowest weed infestation was recorded in hand weeded plots and was statistically at par with Stomp 330 E (Table 6) followed by Top 33 EC, Stomp 455 CS (with full dose). Maximum weed density (67 m²) was recorded in weedy check.

Summarizing the results in all the experiments, weedy check has shown maximum number of weeds m⁻² ranging from 48 to 67 m² due to no weed management. From the data, it is also revealed that the *Cyperus rotundus* has shown low mortality rate which was followed by *Echinochloa colonum* and *Cynodon dactylon*. The weeds like *Covolvulus arvensis* and *Digitaria sanguinalis* were controlled in relatively better way. These results are in concurrence with the findings of Khan et al. (1994), Gill et al. (1996a), Gill et al. (1996b), Hassan et al. (1996) and Khan et al. (2001) who reported that pendimethalin has shown excellent efficacy on weed control as compared to the other cotton herbicides. Where as Memon et al. (2001) reported that S-metolachlor was found best in weed control.

Bolls Plant⁻¹

In case of bolls per plant during 1999, hand weeding gave maximum bolls per plant followed by Stomp 330 E with full dose and Ronstar 25 EC (Table 3). The latter was at par with Treflan 5 EC. In case of bolls per plant during 2000, hand weeding gave maximum bolls per plant followed by Stomp 330 E, Dualgold 960 EC and Top 33 EC (Table 5). These herbicides were also followed by plots treated with Stomp 455 CS (both high & low doses) and Acetor 50 EC. In 2001, the maximum bolls per plant were recorded in hand weeding and was comparable with chemical treatments viz. Stomp 330 E, Top 33 EC and Stomp 455 CS (full dose) ranging from 16.00 to 16.77 (Table 7). It was followed by Stomp 455 CS (low dose), Acetor 50 EC and Dualgold 960 EC.

In all the experiments, weedy check has shown the lowest number of bolls per plant due to maximum weed infestation. These results are in corroboration with the results reported by Halimie *et al.* (1994), Gill *et al.* (1996 a & b), Cheema *et al.* (1996) and Shafi *et al.* (1996), who reported that the plots treated with Stomp 330 E (pendimethalin) shown maximum bolls per plant due to best weed control. Hassan *et al.* (1996), Khan *et al.* (2001) and Memon *et al.* (2001) also found trifluralin, oxadiazon and S-metolachlor, respectively more effective like Pendimethalin in obtaining maximum bolls per plant.

Boll Weight (g)

In 1999, the maximum boll weight was recorded in hand weeding followed by all the herbicides viz; Stomp 330 E (with full and low doses), Treflan 5 EC, Ronstar 25 EC and Gramoxone (Table 3). During 2000, the maximum boll weight was recorded in hand weeding followed by chemical treatments like Stomp 330 E, Dualgold 960 EC, Stomp 455 CS (with full dose), Top 33 EC (Table 5). During 2001, the maximum boll weight ranging from 2.48 to 2.50 g was recorded in hand weeded plots and Stomp 330 E (Table 7). The rest of five herbicides followed it.

In all the experiments during 1999-2001, the lowest boll weight was recorded in weedy check by having weak plants suppressed by high weed infestation. These results are in line with the findings of Halimie *et al.* (1994), Gill *et al.* (1996a), Hassan *et al.* (1996), Khan *et al.* (1994) and Khan *et al.* (2001).

Seed Cotton Yield (kg ha⁻¹)

During 1999, the highest seed cotton yield was recorded in hand weeding which was statistically at par with Stomp 330 E with full dose, Ronstar 25 EC and Treflan 5 EC (Table 3). These were followed by Stomp 330 E with low dose and Gramoxone. During 2000, the highest seed cotton yield was recorded in hand weeding. It was followed by the chemical treatments viz; Stomp 330 E, Stomp 455 CS, Dualgold 960 EC, Acetor 50 EC and Top 33 EC (Table 5). During 2001, the results revealed that the highest seed cotton yield was recorded in hand weeded plots and were statistically comparable with the plots treated with Stomp 330 E, Top 33 EC and Stomp 455 CCS with full dosage (Table 7). It was followed by Stomp 455 CCS with low dosage, Acetor 50 EC and Dualgold 960 EC.

In all the three experiments during 1999-2001, the lowest seed cotton yield was obtained in weedy check due to highest weed infestation. The highest yield in hand weeded plot, which may be due to least weed density while the weeds are not controlled completely in the herbicidal treatments. Secondly in hand weeding soil is tilled, which helps in better crop growth. These results are in conformity with the results reported by Khan *et al.* (1994), Gill *et al.* (1996a), Gill *et al.* (1996b), Hassan *et al.* (1996), Cheema *et al.* (1996), Shafi *et al.*

(1996) and Khan *et al.* (2001) who reported that the plots treated with Stomp 330 E (pendimethalin) has shown maximum seed cotton yield. Hassan *et al.* (1996), Shafi *et al.* (1996), Khan *et al.* (2001) and Memon *et al.* (2001) also found trifluralin, Agil 100 EC, oxadiazon and S-metolachlor, respectively more effective in controlling weeds and increasing seed cotton yield.

It is concluded from the above three years findings, that the pre-emergence herbicide 'Stomp 330 E' has shown best performance in controlling weeds in cotton with no phytotoxicity on the crop and found helpful in enhancing the seed cotton yield.

Table-2. Effect of weed control treatments on weed density, percent weed decrease and the different weed species during 1999

Treatments	Weed Density (No/m ²)	% Weed decrease over W.C	Different Weed Species				
			<i>Echinochloa colonum</i>	<i>Cyperus rotundus</i>	<i>Covolvulus arvensis</i>	<i>Digitaria sanguinalis</i>	<i>Cynodon dactylon</i>
Stomp 330 E (F.D)	5 cd	89.58	1	2	0	1	1
Stomp 330 E (L.D)	15 b	68.75	3	6	1	2	3
Treflan 5 EC	9 c	81.25	2	3	1	1	2
Ronstar 25 EC	7 c	85.42	1	2	1	1	2
Gramoxone	3 d	93.75	0	2	0	0	1
Hand Weeding	2 d	95.83	0	2	0	0	0
Weedy Check	48 a	-	15	10	5	8	10

F.D = Full Dose L.D = Low Dose

Means not sharing a letter in common differ significantly at $\alpha=0.05$.

Table-3. Effect of weed control treatments on weed density, bolls/plant, boll weight and seed cotton yield during 1999

Treatments	Weed Density (No/m ²)	Bolls per Plant	Boll weight (g)	Seed Cotton Yield (kg ha ⁻¹)
Stomp 330 E (F.D)	5 cd	21.00 bc	2.50 b	1880 ab
Stomp 330 E (L.D)	15 b	17.00 d	2.49 b	1581 b
Treflan 5 EC	9 c	19.33 cd	2.47 b	1719 ab
Ronstar 25 EC	7 c	20.67 bc	2.48 b	1838 ab
Gramoxone	3 d	16.50 d	2.46 b	1513 bc
Hand Weeding	2 d	25.00 a	2.55 a	2168 a
Weedy Check	48 a	9.50 e	2.30 c	1013 c

F.D = Full Dose L.D = Low Dose

Means not sharing a letter in common differ significantly at $\alpha=0.05$.

Table-4. Effect of weed control treatments on weed density, percent weed decrease and the different weed species during 2000

Treatments	Weed Density (No/m ²)	% Weed decrease over W.C	Different Weed Species				
			<i>Echinochloa colonum</i>	<i>Cyperus rotundus</i>	<i>Covolvulus arvensis</i>	<i>Digitaria sanguinalis</i>	<i>Cynodon dactylon</i>
Stomp 455 CS (L.D)	6 b	90.32	1	3	0	0	2
Stomp 455 CS (F.D)	4 bcd	93.55	1	2	0	0	1
Stomp 330 E	3 cd	95.16	0	2	0	0	1
Top 33 EC	4 bcd	93.55	0	3	0	1	0
Acetor 50 EC	4 bcd	93.55	1	2	0	0	1
Dualgold 960 EC	5 bc	91.94	1	2	0	1	1
Roundup	3 cd	95.16	0	2	0	0	1
Hand Weeding	1 d	98.39	0	1	0	0	0
Weedy check	62 a	-	16	13	11	10	12

F.D = Full Dose L.D = Low Dose

Means not sharing a letter in common differ significantly at $\alpha=0.05$.**Table-5. Effect of weed control treatments on weed density, bolls/plant, boll weight and seed cotton yield during 2000**

Treatments	Weed Density (No/m ²)	Bolls per Plant	Boll weight (g)	Seed Cotton Yield (kg ha ⁻¹)
Stomp 455 CS (L.D)	6 b	18.00 d	2.38 c	1710 c
Stomp 455 CS (F.D)	4 bcd	19.00 d	2.44 bc	1873 b
Stomp 330 E	3 cd	21.00 b	2.50 b	1890 b
Top 33 EC	4 bcd	19.33 cd	2.42 bc	1843 b
Acetor 50 EC	4 bcd	19.00 d	2.40 c	1847 b
Dualgold 960 EC	5 bc	20.67 bc	2.46 bc	1850 b
Roundup	3 cd	15.67 d	2.45 bc	1653 c
Hand Weeding	1 d	24.00 a	2.60 a	2063 a
Weedy Check	62 a	8.00 e	2.20 d	1077 d

F.D = Full Dose L.D = Low Dose

Means not sharing a letter in common differ significantly at $\alpha=0.05$.

Table-6. Effect of weed control treatments on weed density, percent weed decrease and the different weed species during 2001

Treatments	Weed Density (No/m ²)	% Weed decrease over W.C	Different Weed Species				
			<i>Echinochloa colonum</i>	<i>Cyperus rotundus</i>	<i>Covolvulus arvensis</i>	<i>Digitaria sanguinalis</i>	<i>Cynodon dactylon</i>
Stomp 455 CS (L.D)	12 b	82.09	2	4	1	2	3
Stomp 455 CS (F.D)	9 bc	86.57	2	2	1	2	2
Stomp 330 E	5 cd	92.54	1	2	0	1	1
Top 33 EC	8 bc	88.06	1	3	1	1	2
Acetor 50 EC	13 b	80.60	3	4	1	2	3
Dualgold 960 EC	12 b	82.09	2	3	2	2	3
Roundup	4 cd	94.03	0	2	0	0	2
Hand Weeding	1 d	98.51	0	1	0	0	0
Weedy Check	67 a	-	18	13	12	10	14

F.D = Full Dose L.D = Low Dose

Means not sharing a letter in common differ significantly at $\alpha=0.05$.**Table-7. Effect of weed control treatments on weed density, bolls/plant, boll weight and seed cotton yield during 2001**

Treatments	Weed Density (No/m ²)	Bolls per Plant	Boll weight (g)	Seed Cotton Yield (kg ha ⁻¹)
Stomp 455 CS (L.D)	12 b	14.67 ab	2.48 a	1339 ab
Stomp 455 CS (F.D)	9 bc	16.00 a	2.35 b	1466 a
Stomp 330 E	5 cd	17.00 a	2.40 b	1545 a
Top 33 EC	8 bc	16.33 a	2.34 b	1499 a
Acetor 50 EC	13 b	13.00 b	2.33 b	1295 b
Dualgold 960 EC	12 b	13.33 b	2.40 b	1239 b
Roundup	4 cd	13.67 d	2.39 b	1350 ab
Hand Weeding	1 d	16.67 a	2.50 a	1600 a
Weedy Check	67 a	9.00 c	2.15 c	840 c

F.D = Full Dose L.D = Low Dose

Means not sharing a letter in common differ significantly at $\alpha=0.05$.

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