Pak. J. Agri. Sei., Vol. 39(4), 2002

EFFECTIVENESS OF DIFFERENT WEED CONTROL METHODS IN CANOLA *(Brassica napus* L.)

Z.A. Cheema, Abdul Khaliq and Asghar Ali
Dept. of Agronomy, University of Agriculture, Faisalabad 38040

A field experiment was conducted to evaluate the performance of different weed control methods in canola at Agronomic Research Area, University of Agriculture, Faisalabad. The weed control methods evaluated were manual (two hand weedings at 20 & 40 DAS) chemical (S. metolachlor @ 1 and 1.4 kg a.i. ha" at sowing), allelopathic (sorgaab concentrated @ 12 L ha" two and three foliar sprays at 20, 40 and 20, 40 & 60 DAS). Sorgaab @ 12 L ha" was combined with S. metolachlor @ 500 and 700 g a.i. ha" and sprayed either at sowing or 15 DAS and weedy check was maintained for comparison. The experiment was laid out in randomized complete block design (RCBD) with four replications in 5m x 2.1 m plots. Results showed that two hand weedings gave maximum reduction (67 & 77%) in total weed density, dry weight and highest canola yield (942 kg ha") but was uneconomical due to hi~her cost. Combinations of concentrated sorgaab @ 12 L ha" with half dose of S. metolachlor @ 700 g a.i. ha- sprayed at sowing or at 15 DAS was quite effective in reducing weed density and dry weight (45 to 55%), improving canola yield (32%) and appeared economical due to relatively higher net benefits and marginal rate of return. Sorgaab alone (three sprays) and S. metolachlor alone @ 1 kg a.i. ha" was neither effective nor economical. However sorgaab (two sprays) and S. metolachlor @ 1.4 kg a.i. ha" were economical treatments.

Key Words: Sorgaab, S. *metolaehlor,* canola, weed control, economic analysis

INTRODUCTION

Canola was introduced in Pakistan in 1995 to replace traditional oil seed crops like rape and mustards because of its low erucic acid contents. In Pakistan's agro-ecological conditions, the agronomic requirements of canola as water, fertilizer, seed, sowing time etc. have been investigated, but no research about weed control in canola has been conducted. Uncontrolled weeds in canola and other rapeseeds may cause significant yield reductions (23%). The weeds in rapeseed and mustards are generally controlled manually using hand hoes or chemically with weedicides. Hand weeding is labour intensive, while few herbicides are available for brassica species and their unwise usage may cause crop injuries, moreover herbicidal use might disturb ecological balance and create environmental issues as ground water pollution and soil microbial activities.

Allelopathic materials are environment friendly and relatively cheaper. However the extent of weed control with allelopathic products such as sorgaab may be relatively less than herbicides or hand weedings. A recent study revealed that one to three foliar sorgaab sprays inhibited weed dry weight in raya by 47-75% (Bhatti *et al. 2000).*

Possibilities of reducing herbicidal dose in combination with allelopathic materials are being investigated in different crops as wheat, maize and cotton. It has been reported that concentrated sorgaab @ 10 or 12 L ha" with one third or half dose of herbicide have given weed control equivalent to the recommended full dose of herbicides (Cheema *et al.* 2002 a & b). A study was conducted to compare the efficacy of different weed control techniques and to explore the feasibility of reducing herbicides dose in combination with sorgaab (sorghum water extract) for weed control in canola.

MATERIALS AND METHODS

A field study to investigate the performance of different weed control methods in canola cv. Hiola-401 was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad. The experiment was laid out according to randomized complete block design (RCBD) with four replications in 5m x 2.1 m plots. The experimental treatments comprised of control (weedy check), S. metolachlor @ 1 kg a.i. ha" and 1.4 kg a.i. ha" at pre-emergence, concentrated sorgaab @ 12 L ha" combined with S. metolachlor @ 700 g a.i. ha^{-1} at pre-emergence and 15 days after sowing (DAS), concentrated sorgaab @ 12 L ha" combined with S. metolachlor @ 500 g a.i. ha^{-1} (pre-emergence and 15 DAS). Two and three foliar sprays of concentrated sorgaab @ 12 L ha" 20+ 40 DAS and 20 + 40 + 60 DAS respectively and two hand weedings at 20 + 40 DAS. Canola was sown on October 13, 2000 in a well prepared seed bed in 30 cm apart rows with the help of single row hand drill, using a seed rate 5 kg ha^{-1}. A basal fertilizer dose of 90 kg N and 60 kg P_2O_5 ha" in the form of urea and diammonium phosphate respectively was used. Half of the nitrogen and whole of phosphorus was applied at sowing by side dressing. The remaining half of the nitrogen was applied at first irrigation. All other agronomic practices were kept normal and uniform for all the treatments. The herbicide and sorgaab were sprayed with knapsack hand sprayer fitted with flat fan nozzle using 375 liters of water. Weed density was recorded at 70 DAS from randomly selected quadrates of 0.5J<. 0.5 m. The weed

dry weight was recorded after drying the samples in an oven at 70°C for 48 hours. The crop was harvested when 90% pods were mature. Parameters as plant height, number of branches per plant, number of pods per plant and 1000-grain weight were recorded using standard procedures. The straw and grain yield were determined by threshing and calculated to kg per hectare. Data collected were analyzed statistically using Fisher's analysis of variance techniques and LSD test was applied at 5% probability level to compare the treatment means (Steel and Torrie, 1984). Economic and marginal analyses were carried following the procedures devised by Byerlee (1988).

RESULTS AND DISCUSSION

Weed species recorded at the experimental site were purple nutsedge, lambsquarters and horse purslane. Purple nutsedge density was relatively more than others.

metolachlor @ 700 g a.i. ha^{-1} applied at pre-emergence or 15 DAS decreased total weed density by 49% and 50% and was followed by three sorgaab foliar sprays with 36% decrease. Maximum suppression (77%) of total dry weight was observed in case of two hand weedings and was followed by concentrated sorgaab @ 12 L ha^{-1} combined with S. metolachlor @ 700 g a.L ha^{-1} (pre-emergence or 15 DAS) which suppressed weed dry weight by 55%. S. metolachlor @ 1.4 kg ha^{-1} at pre-emergence reduced total weed dry weight by 44%. Three foliar sprays of sorgaab at 20, 40 and 60 DAS reduced total dry weight of weeds by 29% over control.. The reduction in weed density and dry weight with concentrated sorgaab @ 12 L ha^{-1} in combination with half dose of S. metolachlor (700 g a.i. ha") one spray either at pre-emergence or early post emergence at 15 DAS appeared good treatments in suppressing the weeds and supported the hypothesis of reducing herbicide dose in combination with allelopathic products as sorgaab.

Table 1. Effect of weed control practices on weed dynamics per 0.25 m^2

Treatments	Density (70 DAS)	Dry weight (g)
Control (Weedy check)	11.13a[1]	9.17 a
S. metolachlor (Dual Gold 960 EC) 1 kg a.i. ha^{-1} pre-em*.	7.61 d (32)[2]	7.17 e (22)
S. metolachlor (Dual Gold 960 EC) @ 1,4 kg a.i ha" pre-em.	4.63 f (58)	5.13 g (44)
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 500 g a.i ha^{-1} pre-em.	7.64 d (30)	7.28 d (21)
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 700 g a.i. ha^{-1} pre-em.	5.54 e (50)	4.14 h (55)
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 500 g a.i. ha-[1]15 DAS	9.60 b (14)	8.14 c (11)
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 700 g a.i. ha-[1]15 DAS	5.62 e (49)	4.091 (55)
Concentrated sorgaab @ 12 L ha^{-1} two sprays 20+40 DAS	9.82 b (12)	8.64 b (6)
Concentrated sorgaab @ 12 L ha" three sprays 20+40+60 DAS	8.19 c (26)	6.52 f (29)
Hand weedings two (20+40) DAS	3.72 g (67)	2.10 j (77)
LS α *0.05*	4.58	4.58

[1] Figures not sharing a letter differ significantly at 5% probability level, [2] Figures given in parenthesis show percent decrease over control, *pre-emergence

Total weed population was significantly decreased by all the treatments (Table 1). The maximum suppression (67%) was observed in two hand weedings at 20 + 40 DAS. It was followed by S. metolachlor @ 1.4 kg a.i. ha^{-1} pre-emergence which decreased weed population by 58%. Application of concentrated sorgaab @ 12 L ha^{-1} with half dose of S.

The highest canola grain yield was obtained with the application of two hand weedings at 20 + 40 DAS which gave 40% increase over control and was followed by S. metolachlor @ 1,4 kg a.i. ha^{-1} pre-emergence with 36% increase while treatment combination Le. concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor @ 700 g a.i ha" per-emergence at 15

Table 2. Effect of weed control practices on canola yield and its components.

Treatments	Plant population	No. of branches per plant	Plant height at maturity	No. of seeds per pod	No. of pods per plant	1000-grain weight (g)	Grain yield (kg ha^{-1})
Control (Weedy check)	22.50 N.S	17.75e'	136.25 d	18.25 f	489^{NS}	3.13 9	673 e
S. metolachlor (Dual Gold 960 EC) 1 kg a.i. ha^{-1} pre-em *	22.50	19.75de	15250 bc	20.50 def	601	4.06 c	862 c (28)2
S. metolachlor (Dual Gold 960 EC) @ 1.4 kg a.i. ha^{-1} pre-em	22.50	23.50 b	153.50 bc	25.25 b	625	4.23b	916 ab (36)
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 500 9 a.i. ha^{-1} pre-em	22.62	19.50 de	155.00 b	20.25 ef	591	3.64 f	808 d (20)
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 700 9 a.i. ha^{-1} pre-em.	22.62	20.75 cd	176.25 a	22.25 cde	620	3.81 d	889 bc (32)
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 500 9 a.i, ha^{-1} 15 DAS	22.62	19.00 de	151.25 bc	21.50 cde	601	3.66 f	781 d (16)
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 700 9 a.i. ha^{-1} 15 DAS	22.50	22.00 bc	178.75 a	23.25 bc	617	3.82 d	889 be (32)
Concentrated sorgaab @ 12 L ha^{-1} two sprays 20+40 DAS	22.50	19.00 de	141.25cd	18.50 f	591	3.72 e	703 e (4)
Concentrated sorgaab @ 12 L ha^{-1} three sprays 20+40+60 DAS	22.37	20.25 cd	162.50 b	23.00 bcd	601	3.79 d	808 d (20)
Hand weedings two (20+40) DAS	22.62	27.50 a	184.25 a	29.75 a	685	4.35 e	942 a (40)
LS a 0.05	-	2.14	0.16	2.59	-	4.58	0.31

, Figures not sharing a letter differ significantly at 5% probability level, 2 Figures given in parenthesis show percent decrease/increase over control, NS Non-significant 'pre-emergence

Table 3. Economic analysis

	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	Remarks
Total yield (kg ha^{-1})	673	862	916	808	889	781	889	703	808	942	kg ha^{-1}
10% less	67.3	86.2	91.6	80.8	88.9	78.1	88.9	70.3	80.8	94.2	kg ha^{-1}
Adjusted value	605.7	775.8	824.4	727.2	800.1	702.9	800.1	632.7	727.2	849.8	kg ha^{-1}
Gross income	12871	16486	17518	15453	17002	14937	17002	13445	15453	18014	@ Rs. 2125 per 100 kg
Cost of hand weedings	-	-	-	-	-	-	-	-	-	1600	10 man day^{-1} ha^{-1} @ Rs. 80 man^{-1}
Cost of herbicides	-	469	656	235	328	235	328	-	-	-	S. metolachlor Rs. 469 kg^{-1} a.i,
Cost of sorgaab	-	-	-	50	50	50	50	100	150	-	Rs. 40/40 kg sorghum + sorgaab preparation
Spray application	-	80	80	80	80	80	80	160	240	-	@ Rs. 80 man^{-1} 1 man day^{-1} ha^{-1}
Sprayer rent	-	50	50	50	50	50	50	100	150	-	Rs. 50 spray^{-1}
Cost that vary	-	599	786	415	508	415	508	360	540	1600	Rupees
Net benefits	12871	15887	16732	15038	16494	14522	16494	13085	14913	16414	Rupees ha^{-1}

T_1 Control (Weedy check), T_2 S. metolachlor (Dual Gold 960 EC 960 EC) 1 kg a.i. ha^{-1} pre-emergence, T_3 S. metolachlor (Dual Gold 960 EC) @ 1.4 kg a.i. ha^{-1} pre-emergence, T_4 Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 500 9 a.i. ha^{-1} pre-emergence, T_5 Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 700 9 a.i, ha^{-1} pre-emergence, T_6 Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 500 9 a.i. ha^{-1} 15 DAS, T_7 Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 700 9 a.i. ha^{-1} 15 DAS, T_8 Concentrated sorgaab @ 12 L ha^{-1} three sprays 20+40+60 DAS and T_{10} Hand weedings two (20+40) DAS.

Table 4. Marginal and dominance analyses

Treatments	Cost that vary (Rs. ha^{-1})	Net benefit (Rs. ha^{-1})	MRR %
Control (Weedy check)	0	12871	0
Concentrated sorgaab @ 12 L ha^{-1} two sprays 20+40 DAS	360	13085	59.45
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 500 9 a.i. ha^{-1} pre-em.	415	15038	3550.91
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 500 9 a.i. ha^{-1} 15 OAS	415	14522	D
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 700 9 a.i, ha^{-1} pre-em.	508	16494	1556.59
Concentrated sorgaab @ 12 L ha^{-1} + S. metolachlor (Dual Gold 960 EC) @ 700 9 a.i. ha^{-1} 15 DAS	508	16494	
Concentrated sorgaab @ 12 L ha^{-1} three sprays 20+40+60 DAS	540	14913	D
S. metolachlor (Dual Gold 960 EC) 1 kg a.i ha^{-1} pre-em.	599	15887	D
S. metolachlor (Dual Gold 960 EC) @ 1,4 kg a.i. ha^{-1} pre-em.	786	16732	85.61
Hand weedings two (20+40) DAS	1600	16414	D

MRR= Change in net benefits/ Change in cost that vary x 100, D = Dominated*pre-emergence

DAS increased grain yield by 32% over control (Table 2). Three foliar sprays of concentrated sorgaab @ 12 L ha^{-1} at 20, 40 & 60 DAS increased canola yield by 20%. Canola plant population at harvest was almost same in all the treatments revealing that none of the treatments had phytotoxic effect on canola germination and growth. The increase in canola yield was initially due to weed control which lead to more branching, greater pods per plant, higher seeds per plant and heavier grains (Table 2). Similar results were reported by Ilyas (1990) who stated that weed control resulted in the improvement of yield and related properties.

Economic analysis (Table 3) revealed that S. metolachlor (Dualgold 960 EC) @ 1,4 kg a.i. pre-emergence gave maximum net benefits of Rs. 16732 ha^{-1} and was followed by combination of sorgaab @ 12 L ha^{-1} with S. metolachlor @ 700 9 a.i. ha^{-1} sprayed as pre-emergence or at 15 DAS after sowing with net benefits of Rs. 16494 ha^{-1}. While marginal and dominance analysis (Table 4) showed that treatment combination of concentrated sorgaab @ 12 L ha^{-1} with S. Metolachlor @ 500 9 a.i. ha^{-1} gave highest marginal rate of return (MRR) Le. 3550.91 % and was followed by sorgaab 12 L ha- + S. metolachlor @ 700 9 a.i. ha^{-1} at pre-emergence or 15 DAS with 1556.59% MRR. Treatments as two foliar sprays of sorgaab at 20 + 40 DAS and S. Metolachlor @ 1,4 kg a.i. ha^{-1} pre-emergence were also economical due to 59.45 and 85.61% MRR, respectively. While other treatments as two hand weedings at 20 + 40 DAS, three sorgaab sprays at 20, 40 and 60 DAS. S. metolachlor @ 1 kg a.i. ha^{-1} pre-emergence were dominated due to higher costs that vary and hence appeared uneconomical. On the basis of findings of this study it is suggested that concentrated sorgaab @ 12 L ha^{-1} could be used in combination with half dose of S. metolachlor @ 700 9 a.i. ha^{-1} pre-emergence or early post-emergence Le. 15 DAS for weed control in canola.

REFERENCES

Anonymous. 1999-2000. Economic Survey. Govt. Pak. Finance Div. Econ. Advisors Wing, Islamabad.

Bhatti, M.Q.L., IA Cheema and T. Mahmood. 2000. Efficacy of Sorgaab as natural weed inhibitor in Raya. Pak. J. Bio. ScL 3(7): 1128-1130.

Byerlee, D. 1988. From Agronomic Data to Farmers Recommendation-an economic training Manual. CIMMYT, Mexico, D.F. pp. 3133.

Cheema, IA, M.S. Farid, and A. Khaliq. 2002a. Efficiency of concentrated sorgaab in combination with low rates of Atrazine for weed control in maize. Accepted for publication in *JAPS.*

Cheema, IA, A. Khaliq and M. Tariq. 2002 b. Evaluation of concentrated Sorgaab alone and in combination with reduce rates of three pre-emergence herbicides for weed control in cotton *(Gossypium hirsutum* L.). Int. J. Agric. Biol. 4(4): 549-552.

Ilyas, M. 1990. Response of toria *(Brassica compestris* L.) and weeds to various weed control practices. M.Sc. Thesis, Univ. of Agric., Faisalabad.

Steel, R.GD. and J.H. Torrie. 1980. Principles and Procedures of Statistics. 2nd edition, Mc.Graw Hill Book Co., New York, USA.