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AGRO ECONOMIC EVALUATION OF VARIOUS WEEDING TECHNIQUES IN WHEAT UNDER RAINFED CONDITIONS

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ABSTRACT

Significant effects of row spacing and weeding techniques in different combinations on wheat cultivar "GA-2002" were obtained in a field trial conducted at Experimental Farms of University of Arid Agriculture Rawalpindi during Rabi 2004-05, laid out in a randomized complete block design with two factors under split plot arrangement having three replications. The row spacings were comprised of 15 cm, 22.5 cm and 30 cm apart and there were six weeding techniques viz. weedy check, hand weeding, chemical control, bar harrow 2–way, hoe and bar harrow 1-way. Hand weeding and chemical control with different spacing combinations showed significant effects on weed density, weed mortality percentage, plant height, tillersm^{-2}, spike length, 1000 grain weight, biological and grain yield of wheat. The 15 cm spacing arrangement significantly enhanced grain yield. The interaction of weeding techniques and row spacing was significant for grain yield. The highest wheat crop yields of 5448 and 5970 kg ha^{-1} were achieved by using hand weeding and chemical weed control along with 15 cm row spacing that caused significant increase over weedy check with 30 cm spacing by 133.93% and 113.47%, respectively. The highest net benefit was attained in chemical application to control weeds which was 25,605 PKR and the same highest was observed in chemical control in benefit cost ratio analysis which was 1.79.

Key words: Benefit cost ratio, grain yield, weeding techniques, wheat.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is a staple food in Pakistan and plays a vital role in its economy. It was grown on area of 8.693 million hectares with a total production of 24.2 million tons in Pakistan with an average yield of 2787 kg ha^{-1}. It contributed10.1 percent to the value added in agriculture and 2.2 percent to GDP in Pakistan (GOP, 2012-13). The average yield of wheat of different wheat growing countries is higher as compared to Pakistan. Among the several other factors responsible for low yield in Pakistan; weed competition and improper row spacing are important and research on these limiting factors will certainly lead to high crop yields.

Annual losses to wheat crop due to weed infestation are reported to be in billions, these enormous losses warrant an efficient control of weeds for lucrative economic returns (Khan *et al.*, 2012). Weeds compete with wheat crop for nutrition, water, sunlight and other elements and weaken the main crop, which ultimately lead to low crop yield. The introduction of high yielding short stature wheat varieties having high fertilizer requirements has resulted in tremendous increase in weed flora in wheat. Weeds consume at least as much NPK fertilizer as crop plants. In row crops, much of the cost of intertillage, seedbed preparation and seed cleaning operations is due to weed infestation. It is estimated that in wheat, yield losses range from 20 to 40% due to weeds. The critical weed competition period in wheat is 30 to 60 days after sowing of crop and after 60 days of sowing there is no economic benefit to eradicate weeds from wheat crop (Ahmad and Shaikh, 2003). Control of weeds is, therefore, essential for obtaining higher yields, better quality of produce and higher net monetary returns. There is a negative linear relationship between above-ground weed biomass and crop yield at harvest, so weed suppression is translated directly into yield (Weiner *et al.*, 2001).

Row spacing is an important management factor affecting the agronomic characteristics of wheat. Narrow row spacing leads to higher leaf photosynthesis and suppresses weed growth as compared with the wider spacing (Dwyer *et al.,* 1991). Row spacing arrangement affects the crop density. The biomass of the target weed and target weed plus naturally-occurring weeds decreases with the increasing crop density (Olsen *et al.*, 2002).

Wheat grown on large areas needs harrowing operation to control weeds, which is an economical mechanical practice by the use of bar harrows. Bar harrowing is one of the important practices. It opens root zone of wheat field during early crop growth stages, resulting in better root establishment. By this means, wheat crop may be kept clean from annual weeds such as lamb's quarter, white sweet clover, nettle leaf weed, wild onion, shepherds clock, vetch weed etc.

Control of weeds by chemical or cultural practices is essential to avoid losses caused by weed (Anjum *et al*., 2007). The chemical weed control is one of the improved methods to control weeds for having more crop yields (Malik *et al*., 2001). In wheat crop, the most easy and economical method is the use of weedicides, which takes less time and is an effective measure to control weeds on a large scale.

Several weeding techniques i.e. mechanical, cultural, biological, chemical or ecological are commonly used to control the weeds in wheat crop as control of weeds by a single method usually does not give good results and is also not socio-economically acceptable. An integrated weed control practice involves specific control measures to be directed not only against one weed species, but also for all the species affecting one crop in a particular area. But in order to control weeds effectively for achieving higher yields and returns, control of weeds must be critically monitored at desired recommended crop sensitive stages because many farmers put complaints that in spite of spraying very costly herbicides, yet they cannot get higher crop yields. So it is very important that they must be guided about the proper weed control methods.

The present study was designed to evaluate the effects of integrated weed control techniques and their net benefit cost ratios in controlling the weed and as well wheat crop yield under rain fed condition.

MATERIALS AND METHODS

The study was conducted to evaluate the effects of different weeding techniques and row spacing on weed control and wheat crop productivity during the year 2004-05. For this purpose wheat variety"GA-2002" was planted at the Experimental Farm Area of University of Arid Agriculture, Rawalpindi. The experiment was laid out in randomized complete block design (RCBD) with two factors under split plot arrangement. The plot size was 3x4 $m^2$with three replications. The treatments regarding row spacingincluded15 cm, 22.5 cm and 30 cm apart, whereas weeding techniques which were kept in sub plots included weedy check, hand weeding , chemical control , Bar harrow 2 –way, hoe and Bar harrow 1-way. Wheat crop was planted by keeping the seed rate of 125 $kgha^{-1}$. Different fertilizers i.e. Nitrogen, phosphorus and potassium were applied at the time of sowing @ 110, 85, and 60 kg ha^{-1}, respectively. All the other agronomic practices were kept same during the whole crop growing season.

The following data were recorded regarding weeds and as well as for wheat crop. Weed density was recorded by using a quadrate of $1m^2$. For this purpose two samples were recorded from each plot and then, the average was computed.The surviving weeds were counted by using the quadrate of 1m^2. Two samples at random were recorded from each plot15 days after the treatment applications. The average was taken out and then the mortality percentage was calculated species wise for each treatment. Height of the main tillers was measured in centimeters from the ground level to the tip of spike excluding awns for 10 randomly selected plants from each plot and the average was worked out. Numbers of tillers m^{-2}were recorded by taking samples at random from each plots and the average was worked out. At maturity the spike length was measured for ten randomly selected spikes and the average was computed for further analysis. At random, three samples for 1000 grain weight were collected from the produce of each plot. The samples were then averaged. At maturity each plot was manually harvested and biological yield was recorded and converted in to biological yield ha^{-1}.After threshing, grain yield was recorded and converted to ha^{-1}. Finally Benefit Cost Ratio (BCR) was calculated for the different weeding techniques being used for wheat production under rainfed condition.

Statistical analysis was done by using the method as described by Steel and Torrie (1984).

RESULTS AND DISCUSSION

Weed Density

(a) Weed Density before the application of treatments

Varying row spacings affected weed population. The highest weed density (24.167) was recorded in 30 cm row spacing followed by (21.17) in case of 22.5 cm row spacing (Table-1). In wider row spacing i.e. 30 cm, maximum weeds were recorded. It was mainly because due to wider row spacing weeds were not effectively suppressed by crop plants and got chance to grow freely; whereas, the lowest (i.e. 18) weed density was recorded in case of 15 cm row spacing (18). This shows that narrow spacing suppressed the weeds germination. These findings are in line with the findings of Dwyer *et al.* (1991), who also reported that narrow spacing suppressed weed density and growth.

(b) Weed density after the application of treatments

The lowest number of weed were recorded in case of hand weeding (Table-1), which was followed by chemical control with15 cm row spacing having (03).These findings are similar to the findings of Pandey and Singh(1994),who concluded that hand weeding was better than herbicide treatment for weed control. Whereas the highest weed density (38) was recorded in case of weedy plots (control) with row spacings of 30 cm and 22.5 cm respectively followed by 36 weeds/ in case of15 cm row spacing (Fig.1). In controltreatment,as no weed control measure was applied, so weeds had the maximum opportunity to thrive in the highest number because of the absence of any of the competing agents and factors and hence, weeds utilized all the resources up to the optimum level. It is evident from the data that complete hand weeding combined with row spacing significantly reduced weed density. These findings are inline to the findings of Deshmukh and Atale (1995). They reported that hand weeding was efficient in controlling weeds when it was compared with weedy check. Similarly, narrow row spacing arrangement significantly reduced weed number by suppressing weed population. There was a linear relationship between spatial arrangement and weed density (Fig. 2). Narrow spacing resulted in less weed density, whereas, wider row spacing caused higher weed density. The results of study are in line with those of Marwat (2002.) who reported less weed number in narrow spaced rows. These conclusions are also in conformity to the outcome of Jabbar *et al*. (1999) who examined the significant decrease in weed population and weed biomass with herbicide application.

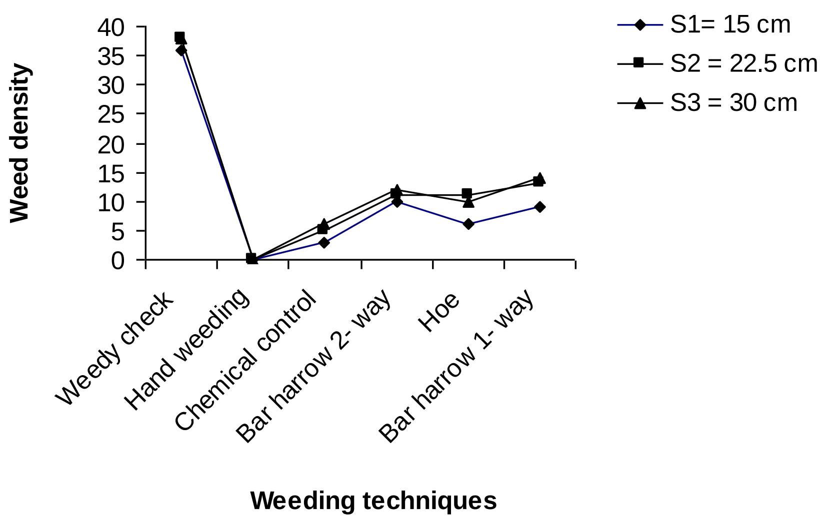

Figure 1. Weed density as affected by planting spacing and weeding techniques

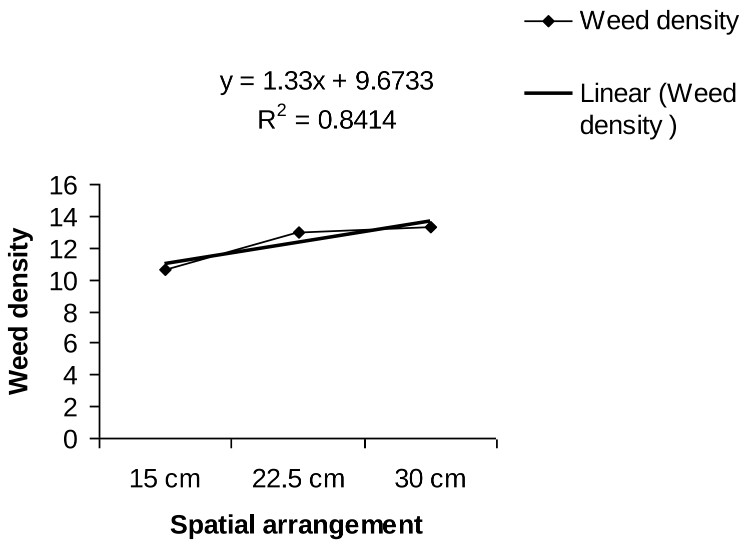

Figure 2. Relationship between Row spacing and Weed density

Table-1. Weed Density (m^{-2}) in wheat before and after the application of Treatments

	Weed density in wheat before and after the application of treatments			Weed density in wheat after the application of treatments		
Treatments	S_1	S_2	S_3	S_1	S_2	S_3
Weedy check	12	23	18	36	38	38
Hand weeding	24	30	32	00	00	00
Chemical control	13	12	17	03	05	06
Bar harrow2-way	25	22	31	10	11	12
Hoe	14	21	24	06	11	10
Bar harrow1-way	20	19	23	09	13	14

RS_1=15 cm, RS_2=22.5 cm and RS_3=30 cm

Weed Mortality (%)

Examination of data (Table-2) revealed that the effects of different weeding techniques and row spacing arrangements on weed mortality percentage were significant. In case of *Convolvulus arvensis*, the maximum mortality percentage (100%) was recorded in case of hand weeding in combination with all row spacings followed by bar harrow 2-way with 15 cm row spacing (80.55%).Maximum mortality percentage of *Medicago polymorpha* (100%) was recorded in case of hand weeding in combination with all spatial arrangements, followed by chemical control with 15 cm spacing (71.66%), whereas minimum mortality was found in weedy check with all spatial arrangements. Maximum mortality percentage of *Fumaria indica* was recorded in case of hand weeding with all spacings (100%), followed by chemical control with 15 cm row spacing (100%). Minimum mortality percentage was recorded in (control plots with all kinds of spacings. In case of *Chenopodium album*, hand weeding resulted in maximum mortality percentage with 22.5 and 30 cmspacings (100%), followed by chemical control having 30 cm row spacing (50%).Maximum mortality percentage of *Euphorbia helioscopia* was attained with bar harrow 2- way along with 15 cm row spacing (50%), followed by bar harrow 1-way with the spacing of 22.5 cm (16.66%); while minimum mortality percentage was recorded in check (control) with22.5 and 30 cm rowspacings (0%). Hence, it may be concluded that hand weeding with all row spacings significantly reduced weed population which was followed by chemical control in combination with different spacings.

Number of tillers m^{-2}

Data presented in Table-3 revealed that different weed control techniques differed significantly for number of tillers m^{-2}.The highest number of tillers m^{-2}were recorded in case of chemical control, followed by barhar row 2-way. The lowest number of tillers m^{-2}wasrecorded in control plots. These findings are in line with the result of Akhtar *et al.* (1999). They reported that chemical control produced relatively more fertile tillers. Similarly, the effect of row spacing was also significant on number of tillers m^{-2}. The highest number of tillers m^{-2}wasrecorded in case of 15 cm, followed by row spacing of (22.5 cm). While the lowest number of tillers m^{-2}wasrecorded in 30 (cm) row spacing. In weed control treatments chemical control produced relatively higher number of tillers m^{-2} as compared to weedy check and this effect was significant, whereas narrow row spacing of 15 cm produced higher number of tillers m^{-2}. However when weed control treatments and row spacings were combined together, there was no significant effect on number of tillers m^{-2}.

Plant height (cm)

Data pertaining to plant height is presented in Table-4, which indicates that different weed control methods differed significantly for plant height. Maximum plant height was recorded for chemical application, followed by bar harrow 1-way. Chemical control was better in this case when compared to check. These findings are in line with the results of study conducted by Malik *et al.* (2001), who reported that plots treated with chemical and manual practices produced relatively tall plants. As far as row spacing was concerned the highest plant height was recorded in 30 cm row spacing, followed by 22.5 cm row spacing. The lowest value for plant height was recorded in 15 cm row spacing. All row spacings did not differ significantly among themselves for the plant height. Similarly interaction between different weed control methods and row spacing showed a non significant effect on plant height.

Table-3. Number of tillers m^{-2} as influenced by weed control treatments and row spacings.

Treatments	(15 cm)	(22.5 cm)	(30 cm)	Means
Weedy check	329.667 NS	328NS	321NS	326.4c*
Hand weeding	350.667	347	340	345.9b
Chemical control	373.333	363.333	359.667	365.4a
Bar harrow 2- way	364.333	361.667	355.000	360.3a
How/Kasola	363	360	351.667	358.2a
Bar harrow 1- way	359.333	359	352.667	357a
Means	356.7a*	353.2ab	346.8b	

*Any two means not sharing same letter are significantly different from one another at 5% level of probability, NS= Non significant

Table-4. Plant height (cm) as influenced by weed control treatments and row spacings

Treatments	15 cm	22.5 cm	30 cm	Means
Weedy check	77 NS	75.56 NS	80.16 NS	77.58d
Hand weeding	86.93	91.13	90.03	89.37c
Chemical control	101.46	100.50	100.46	100.8a
Barharrow2-way	90.43	90.30	90.36	90.37c
Kasola	91.13	93.26	93.66	92.69bc
Barharrow 1-way	95.56	96.83	95.80	96.07ab
Means	90.42NS	91.26NS	91.75 NS	

Any two means not sharing same letter are significantly different from each other at 5 % probability level

Spike length (cm)

Data presented in Table-5 revealed that different weed control treatments differed significantly for spike length. Maximum spike length was recorded in case of chemical control, followed by bar harrow 1-way,while minimum spike length was recorded in case of control treatments. The chemical control was significantly different from control plots. These findings match with the results of Malik *et al.* (2001). They reported that chemical control and manually weeded plots produced longer spikes as compared to control plots. No significant differences were recorded among different row spacings for spike lengths. The interactions between weed control treatments and various row spacings was also non-significant.

Table-5. Spike length (cm) as influenced by weed control treatments and row spacings

Treatments	15 cm	22.5 cm	30 cm	Means
Weedy check	8.357 NS	8.737 NS	9.403 NS	8.832d
Hand weeding	10.833	10.913	11.570	11.11c
Chemical control	14.033	12.390	13.293	13.24a
Bar harrow 2-way	11.933	11.153	11.613	11.57bc
Kasola	11.060	11.833	12	11.63bc
Bar harrow 1-way	12.100	11.973	12.453	12.18b
Means	11.386 NS	11.167 NS	11.722 NS	

Any two means not sharing same letter are significantly different from each other at 5 % probability level

1000-Grain weight (g)

Data of 1000-grain weight presented in Table-6shows that different weed control treatments differed significantly for 1000-grain weight. Among different weed control treatments the highest 1000-grain weight was recorded in chemical control followed by kasola i.e. mechanical control; while the lowest 1000-grain weight was recorded in case of control treatments. It is evident from data that there was significant effect of chemical control treatment on 1000-grain weight as compared to weedy check. These findings are in line with the work of Malik *et al.* (2001). Theyreported that plots treated with chemical and as well as manually weeded plots produced relatively more 1000-grain weights as compared to the other treatments. For row spacing, there was no significant effect ofrow spacings on 1000-grain weights. The interaction between treatments and row spacings was found nonsignificant.

Table-6.1000 grain weight (g) as influenced by weed control treatments and row spacings

Treatments	15 cm	22.5 cm	30 cm	Means
Weedy check	32.66 NS	32.66 NS	30.333NS	31.89c
Hand weeding	45	47	51.33	47.78b
Chemical control	55	55	54	54.67a
Bar harrow2-way	47	50	46.33	47.78b
Kasola	50	48.33	48.33	48.89b
Bar harrow1- way	46.33	50.33	49.33	48.67b
Means	46 NS	47.22 NS	46.61NS	

Any two means not sharing same letter are significantly different from each other at 5 % probability level

Biological yield (kg ha^{-1})

Data presented in Table-7 revealed that different weed control treatments differed significantly for biological yield. The highest biological yield was recorded in case of chemical control followed by barharrow 2-way,while the lowest biological yield was recorded in case of control plots. These findings are in line with the work of Khan *et al.* (2012) who reported that hand weeding and chemical control significantly increased biological yield. Similarly, different row spacings also produced significant effects on biological yield. Statistically,15 cm row spacing had the highest biological yield, whereas the lowest value was recorded in 30 cm row spacing. These findings are in line with the work of Marwat *et al.* (2002), who reported that narrow row spacing had the highest biological yield. It has been also reported that narrow row spacing has higher leaf photosynthesis as compared with the wider row spacing (Dwyer *et al*., 1991). The interactions between weed control treatments with row spacings were found non-significant.

Table-7. Biological yield (kg ha^{-1}) as influenced by weed control treatments and row spacings

Treatments	15 cm	22.5 cm	30 cm	Means
Weedy check	9386.66NS	9394.33 NS	8816.33 NS	9199.11d
Hand weeding	14994.33	11899	11495	12796.11bc
Chemical control	15214.33	13867.66	13549	14210.33a
Bar harrow2-way	14007.66	13137.66	12073	13072.77b
Kasola	13130.33	12216.66	11084	12143.66c
Bar harrow 1-way	13412.66	12211.66	12107.66	12577.33bc
Means	13357.66a*	12121.16b	11520.83c	

Any two means not sharing same letter are significantly different from each other at 5 % probability level

Grain yield (kg ha^{-1}):

Weeding techniques differed significantly regarding grain yield (Table-8). Among various treatments, chemical control produced the highest grain yield, (5630 kg ha^{-1}) followed by bar harrow 2- way (4654 kg ha^{-1}) (Fig. 4), while the lowest grain yield (2665 kg ha^{-1}) was recorded in case of control plots . These findings are similar to the findings of Akhtar *et al.* (1999) and Malik *et al.* (2001) who reported that chemical control of weeds resulted in more grain yields. These results are also in agreement with those of Chilot *et al.* (1993) who reported that the application of herbicide gave a yield advantage of 27% in wheat. Saeed *et al*. (1984) resolved that grain yield decreased significantly when the weeds competed with crop for full season.

Similarly, row spacings also had significant effects on grain yield. The highest grain yield (4657kg ha^{-1}) was recorded in 15 cm row spacing, while the lowest (4072 kg ha^{-1}) was recorded in 30 cm spacing. These findings are in line to the results of Marwat *et al.* (2002), who reported that narrow row spacing arrangement produced the highest grain yield. However, these results are in contradiction to the findings of Champion *et al.*(1999) who determined that spacing did not influence weed suppression and grain yield was reduced in 15 cm rows.

The effect of interaction between weeding techniques and row spacings was found significant. The highest grain yield (5970 kg ha^{-1}) was recorded for chemical control with 15 cm spacing. After chemical control, hand weeding technique along with 15 cm spatial arrangement produced higher grain yield of 5448 kg ha^{-1} as compared to all the other treatment combinations, while the lowest grain yield (2552kg ha^{-1}) was recorded in weedy plots with 30 cm spacing. These conclusions are in consistency with the work of Marwat *et al.* (2002), who reported that the interaction of herbicides with row spacing was significant for grain yield. A negative linear relationship was found between weed density and grain yield (Fig. 5). Decrease in weed density by using suitable weeding technique and adopting appropriate row spacing arrangement, resulted in higher grain yields. This finding is in agreement with the conclusion of Weiner *et al.* (2001) who also determined a negative linear relationship between above-ground weed biomass and crop yield at harvest, so weed suppression translated directly into yield.

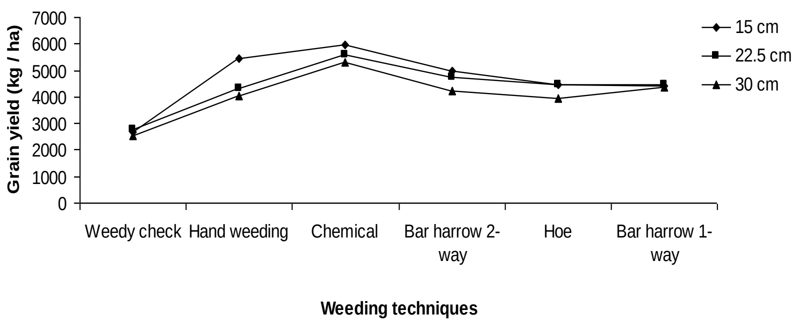

Figure 4. Grain yield as affected by row spacing and weeding techniques

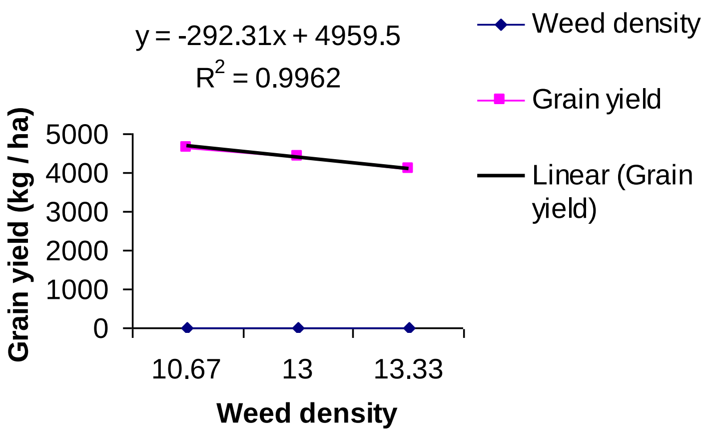

Figure 5. Relationship between weed density & Grain yield

Table-8. Grain yield (kg ha^{-1}) as influenced by weeding techniques and row spacing arrangement

Treatments	S_1	S_2	S_3	Means
Weedy check	2694.66g	2749.33g	2551.66g	2665.22D*
Hand weeding	5448bc	4329.66ef	4034.66f	4604.11B
Chemical control	5970.33a	5613ab	5308Bc	5630.44A
Bar harrow2-way	4974.66cd	4765.0de	4224ef	4654.55B
Hoe	4441def	4470.33def	3932.66f	4281.33C
Bar harrow 1-way	4412ef	4446.66def	4382.0ef	4413.55BC
Means	4656.77A*	4395.66B	4072.16C	

Any two means not sharing same letter are significantly different from each other at 5 % probability level

Benefit Cost Ratio

Economic analysis of various weeding techniques for wheat, calculated on the basis of average grain yield, revealed that herbicide gave considerably higher grain yield kg ha^{-1} than other weeding control techniques (Table-9). There was 111.25% increase in grain yield from chemical control followed by 74.63% in bar harrow 2-way.The highest economic value of grain yield was also observed in herbicide control which was Rs.29650 followed by hand weeding technique which was Rs. 19390.

Benefit cost analysis is performed by calculating benefit cost ratio for the various weeding techniques in wheat production under rain fed conditions. The highest gross income, net benefits and benefit cost ratio (%) recorded in chemical application were Rs. 39880, Rs.

25605 and 1.79 respectively. These findings are in line with the results of Marwat *et al*. (2002) who reported that there was highest net income, net benefits and benefit cost ratio by the application of herbicide. Comparative analysis revealed the most economical weeding technique is chemical weeding technique with highest BCR value of 1.79 while barharrow 2-way is the second best option with BCR value of 1.35. Results also suggest that farmers will get less benefit/gain by adopting the kasola as weed control technique. So farmers can achieve more economic benefits by adopting the chemical weeding control technique for higher grain yield kg/ha of wheat (Table-10).

Table-9. Economic analysis of various weeding techniques in wheat

Particulars	Weedy	Hand weeding	Chemical	Bar harrow 2-way	Kasola	Bar harrow 1-way	Remarks
Grain yield (kg ha^{-1})	2665	4604	5630	4654	4281	4413	
Increase over control (kg ha^{-1})		1939	2965	1989	1616	1748	
%age of Increase		72.75	111.25	74.63	60.63	65.59	
Grain yield value (Rs.)		19390	29650	19890	16160	17480	Rs.400 / 40kg
Straw yield (kg ha^{-1})	6534	8192	8580	8418	7862	8164	
Increase over control (kg ha^{-1})		1658	2046	1884	1328	1630	
%age of Increase		25.37	31.31	28.83	20.32	24.96	
Straw yield value (Rs.)		8290	10230	9420	6640	8150	Rs.200 / 40kg

Table-10. Benefit Cost Ratio analysis of various weeding techniques in wheat

Particulars	Hand weeding	Chemical	Barharrow 2-way	kasola	Barharrow 1-way
Cost (Rs.)	11925*	11925*	11925*	11925*	11925*
Charges for application (Rs.)	1125	2350	500	500	500
Total cost (Rs.)	13050	14275	12425	12425	12425
Gross income (Rs.)	27680	39880	29310	22800	25630
Net benefit (Rs.)	14630	25605	16885	10375	13215
B.C.R	1.12	1.79	1.35	0.84	1.06

Operational cost: Rs. 11925ha^{-1}

Table-2. Weed mortality (%) as influenced by weeding techniques and row spacing arrangements
CL = *Convolvulus arvensis,* M = *Medicago polymorpha*, F = *Fumaria indica,* CH = *Chenopodium album*, E = *Euphorbia helioscopia*

Treatments	S_1					S_2					S_3				
	CL	M	F	CH	E	CL	M	F	CH	E	CL	M	F	CH	E
Weedy check	00	00	00	--	--	0	00	00	--	00	00	00	00	--	00
Hand weeding	100	100	100	--	--	100	100	100	100	--	100	100	100	100	--
Chemical control	100	71.66	100	--	33.33	66.66	44.43	66.66	33.33	--	58.33	68.25	47.61	50	16.66
Barharrow2-way	80.55	45.09	28.88	00	50	58.33	38.64	52.38	--	--	50	55.71	43.33	50	16.66
Hoe	63.33	52.38	49.99	--	33.33	72.22	44.13	30	33.33	00	50	58.33	49.99	33.33	33.33
Barharrow 1-way	27.77	43.49	25.39	--	16.66	50	34.73	52.22	--	50	55.55	46.66	62.62	33.33	16.66

RS_1=15 cm, RS_2=22.5 cm and RS_3=30 cm

CONCLUSION

Varying weeding techniques significantly affected grain yield since weed suppression translated directly into higher crop yield. Hand weeding and chemical control combinations with all spatial arrangements produced significant effects on weed density, weed mortality percentage and weed biomass. Different row spacings also had significant effects on grain yields. 15 cm planting spacings decreased weed density. The interaction between weeding techniques with row spacings was found significant only for grain yield. The highest net benefit was attained in chemical control which was Rs. 25605 and the same highest was recorded in chemical control in benefit cost ratio analysis which was 1.79. It can be concluded that higher wheat crop yields and higher net benefit returns can be achieved by using chemical control weeding techniques along with 15 cm row spacings under rain fed condition.

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