

EFFECT OF HERBICIDES AND ROW SPACING ON DIFFERENT TRAITS OF WHEAT (*Triticum aestivum* L.)

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ABSTRACT

An experiment was laid out to study the effect of different weed management practices and row spacings on the yield and yield components of wheat variety Daman - 98 during 2000 - 2001 at Agricultural Research Farm, Faculty of Agriculture, Gomal University, Dera Ismail Khan. Wheat was sown at row spacing of 20, 30 and 40 cm, while herbicides applied were broad spectrum 2,4-D butyl Ester: 72 EC + Isoproturon 75 WP @ 865 ml and 865 g ha⁻¹ respectively, broad leaf Buctril M 40 EC @ 1.25 liter ha⁻¹ and a weedy check (no herbicide). Row spacing significantly affected all parameters. Minimum weeds density m⁻² and maximum spikelets spike⁻¹, grain yield, harvest index and net income were found in 20 cm row spacing. While number of grains spike⁻¹ were highest in 30 cm row spacing. Among herbicides, minimum weeds density m⁻² and maximum spikelets spike⁻¹, grains spike⁻¹, grain yield, harvest index and net income were found in plots treated with broad-spectrum herbicide followed by Buctril-M 40 and the weedy check, respectively. It is concluded that maximum grain yield and net income can be obtained using broad spectrum (grasses + broad leaved) herbicides and narrow row spacing.

Key words: Herbicides, row spacing, wheat, *Triticum aestivum*, yield, income.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is globally important cereal crop with respect to area and production. In Pakistan, it ranks first among the cereal crops and occupies about 66% of the annual food crop area (Anonymous, 1996). The area in Pakistan under wheat cultivation in 1999-2000 was 8.14 million hectares, producing 18.54 million tons with an average yield of 2.28 t ha⁻¹ (Anonymous, 2001). The wheat yield in Pakistan is lower as compared to other advanced countries of the world. Cultural management plays significant role in increasing production ha⁻¹. Among which weed control, row spacing and quality seed can improve yield by about 50 - 70 percent (Burns, 1944). Adapting the above-mentioned technology in the country we will be able to export more wheat to other countries or to allocate some area of wheat to the production of other exportable agricultural commodities.

Weeds are one of the major constraints in crop production. They compete with crop plants for light, moisture, nutrients and space. Weeds also increase harvesting costs, require costly cleaning of seeds, clog water ways, and increase fire hazards (Arnon, 1972). Young *et al.*, (1994) reported that weeds reduced the wheat yield from 9.50 to 16.03% depending on the intensity of weeds. It is therefore, essential to control weeds in order to obtain maximum yield of wheat having good quality grains. Management of weeds has been practiced from time immemorial by manual labor or animal drawn implements. These methods, besides being laborious and tiresome are expensive due to the increase in labor, animal and implements cost (Iqbal, 1994) and as such have stimulated interest in the use of chemical weeds control. But, the exclusive reliance on herbicides has resulted in pollution of the environment and inter- and intra-specific shifts (Integrating the chemical with cultural is an excellent option for the weed control (Hassan and Marwat, 2001). Proper row spacing is another most important management factor affecting the agronomic characteristics of wheat and weed infestation (Marwat *et al.*, 2002). Narrow row spacing produces high leaf area index, which

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results in more interception of photo-synthetically active radiation and dry matter accumulation (Tollenaar and Aguilera, 1992 and Dwyer et al., 1991).

A limited research has been carried out in Pakistan on the integrated efforts of wheat production. In order to ascertain the integrated use of crop management practices, the present study was conducted in irrigated plains of Dera Ismail Khan with the objectives to evaluate the impact of integrated weed management viz. chemical and cultural on the agronomic parameters and economics of wheat production.

MATERIALS AND METHODS

A study was undertaken on wheat variety Daman-98 at the Research Farm, Faculty of Agriculture, Gomal University, Dera Ismail Khan during the winter season 2000 – 2001. The experiment was laid out in factorial arrangement in randomized complete block design (RCBD) with three replications. The factors included in the experiment were: row spacing (20,30, 40 cm) and herbicides including broad-spectrum (2,4-D Butyl Ester 72 EC + Isoproturon 75 WP @ 865 ml ha⁻¹ and 865 g ha⁻¹, respectively), broad leaf herbicide (Buctril M 40 EC @ 1.25 l ha⁻¹) and a weedy check. The standard seed rate of 120 kg ha⁻¹ was used. A standard dose of 120:70 N:P kg ha⁻¹ was used in the form of urea and di-ammonium phosphate. Half the nitrogen and full dose of phosphorus was applied at the time of seedbed preparation, while remaining half of the nitrogen was applied at first and second irrigation. The herbicides were sprayed 40 days after sowing to control all germinated weeds. Data on individual observations were recorded using the following procedure: weed density for grasses and broad leaf weeds was determined 15 days after herbicides application. A quadrate of one m² made of iron wire was placed randomly in three places in each sub-plot and weeds were counted and then mean was calculated m⁻². Fertile spikelets spike⁻¹ were counted at the time of harvest from ten randomly selected spikes from each treatment and the mean spikelets spike⁻¹ were calculated. The grains spike⁻¹ were counted by threshing the above spikes, counting the grains and subsequently computing the mean grains spike⁻¹. The grain yield (t ha⁻¹) was recorded by obtaining per plot yield in kg and subsequently converting the data into t ha⁻¹. The data on harvest Index (H.I) were obtained by using the following formula

$$H.I. = \frac{(\text{Economic yield (t ha}^{-1}\text{)}) \times 100}{(\text{Biological yield (t ha}^{-1}\text{)})}$$

Economics of crop production: Cost of all operations/inputs included in the production of wheat crop was calculated ha⁻¹ (i.e. manual labour, machine labour, animal labour, land rent, seed, fertilizers, herbicides, water rates etc.). Gross income for main product (grain) and by product (straw) was calculated. The net income (Profit ha⁻¹) was calculated by subtracting production cost from the gross income.

Analysis of variance and mean separation tests were applied according to the method described by Gomez and Gomez (1984) using the MSTAT-C computer software package.

RESULTS AND DISCUSSION

Grasses weeds density (m⁻²)

The effect of herbicides, row spacing and interaction of herbicide with row spacing on grasses weeds density m⁻² was highly significant. The lowest grasses weeds (22 m⁻²) were recorded in row spacing 20 cm, followed by 30 cm (29 m⁻²) and 40 cm row spacing (34 m⁻²) (Table 1). Among herbicides minimum number of grasses weeds m⁻² were recorded in treatments treated with broad-spectrum herbicide (12 m⁻²) followed by broad leaved (35 m⁻²) and weedy check (38 m⁻²) [Table 1]. In the interaction of row spacing with herbicides, minimum grasses weeds (8 m⁻²) were recorded in row spacing 20 cm with broad spectrum herbicide treated plots, while maximum (43 m⁻²) were found in row spacing 40 cm with control treatment (Table 1). The lowest density m⁻² of grasses weeds recorded in 20 cm row spacing might be due to more competition of wheat crop for development resources as compared to wider row spacing. These results were in agreement with

Table 2. Effect of row spacing, herbicides and their interaction on broad leaved weeds density m^{-2} in wheat.

Herbicides	Row spacing (cm)			Herbicide means
	20	30	40	
Broad Spectrum	10 a	12 a	14 ab	12 a
Broad Leaf	18 bc	20 c	20 c	19.33 b
Weedy check	50 d	62 e	72 f	61.33 c
Row spacing mean	26 a	31.33 b	35.33 b	

LSD value for row spaces, herbicide and row space x herbicide = 4.26

Means not sharing a common letter in the respective category differ significantly at 1 % level of probability.

Spikelets $spike^{-1}$

The effect of herbicides on spikelets $spike^{-1}$ was significant, while that of row spacing and interaction of herbicides with row spacing was non-significant. The maximum spikelets $spike^{-1}$ were observed in broad spectrum herbicide (2,4-D+ isoproturon) treated plots followed by broad leaved herbicide and weedy check (Table 3). The highest spikelets $spike^{-1}$ in broad spectrum herbicide treated plots might be due to control of both grasses and broad leaved weeds density and consequently wheat crop solely used plant nutrients and other resources, which might have increased spikelets $spike^{-1}$. These findings are in agreement with the work of Marwat (2002) and Khan et al. (2001), who reported that maximum spikelets $spike^{-1}$ were the result of application of broad spectrum herbicide (2,4-D+ isoproturon) and (Puma + Logran).

Table 3. Effect of row spacing, herbicides and their interaction on spikelets $spike^{-1}$ in wheat.

Herbicides	Row space (cm)			Herbicide means
	20	30	40	
Broad Spectrum	19.60	19.20	19.40	19.40 a
Broad Leaf	18.60	18.70	18.50	18.60 b
Weedy check	18.20	18.10	17.90	18.07 b
Row spacing mean	18.80 NS	18.66	18.60	

LSD value for row spaces, herbicides and row space x herbicide = 0.59

* NS : Non-significant.

* Means not sharing a common letter in the respective category differ significantly at 1 % level of probability.

Grains $spike^{-1}$

The effect of herbicides, row spacing and interaction of row spacing with herbicides were highly significant. The maximum grains $spike^{-1}$ (55.07) were recorded in broad spectrum followed by broad leaved (53.50) herbicide, while minimum grains $spike^{-1}$ (52.07) were recorded in the weedy check (Table 4). Among row spacings, the highest grains $spike^{-1}$ were found in 30 cm (54.73), followed by 20 cm (54.06), while minimum was recorded in 40 cm (51.83) row spacing. In row spacing x herbicides interaction, the highest grains $spike^{-1}$ were recorded in 30 cm row space treated with broad-spectrum herbicide (56.70), while minimum grains were counted in 40 cm row spacing with weedy check plots (51.20) (Table 4). Maximum grains $spike^{-1}$ in broad-spectrum herbicide treated plots might be due to the control of both grasses and broad leaved weeds and thus wheat crop might have used nutrients sufficiently, which could have ultimately increased number of grains $spike^{-1}$. These findings are in agreement with the work of Marwat (2002), who found that maximum grains $spike^{-1}$ were recorded in plots treated with broad spectrum herbicide. Maximum grains $spike^{-1}$ recorded in 30 cm row spacing might be due to suitable row space for higher grains $spike^{-1}$. These findings are in accordance with the work of Marwat (2002), who reported that maximum grains $spike^{-1}$ were found in row spacing 25 cm at Peshawar and row spacing 30 cm at Dera Ismail Khan.

the work of Marwat (2002a), Marwat *et al.*, (2002a), and Sarir (1998), who reported that minimum grasses weeds m^{-2} were recorded in narrow row spacing. While minimum number of grasses weeds in broad-spectrum herbicide treated plots were due to the presence of isoproturon in broad-spectrum herbicide, which controlled grasses weeds. Minimum grassy weeds m^{-2} in the interaction of broad spectrum herbicide and 20 cm row spacing might be due to its best combination as less space was available for grassy weeds development and application of broad spectrum herbicide controlled grasses weeds. These findings are in agreement with Marwat *et al.*, (2002) and Marwat *et al.*, (2002a), who reported that interaction of broad spectrum herbicide and narrow row spacing suppressed weeds population more effectively.

Table 1. Effect of row spacing, herbicides and their interaction on grasses weeds density m^{-2} in wheat.

Herbicides	Row spacing (cm)			Herbicide means
	20	30	40	
Broad Spectrum	8 a	12 b	16 c	12 a
Broad Leaf	27 d	35 f	43 g	35 b
Weedy check	31 c	40 g	43 g	38 b
Row spacing mean	22 a	29 b	34 c	

LSD value for row spaces, herbicide and row space x herbicide = 3.57

* Means not sharing a common letter in the respective category differ significantly at 1 % level of probability.

Broad leaved weed density (m^{-2})

The effect of row spacing, herbicides and interaction of row spacing and herbicides on broad leaf weeds density m^{-2} were highly significant. Among row spacings, 20 cm row spacing had minimum broad leaf weeds ($26 m^{-2}$) followed by 30 cm ($31.33 m^{-2}$) and 40 cm ($35.33 m^{-2}$). While minimum broad leaf weeds ($12 m^{-2}$) were recorded in broad-spectrum herbicide treated plots followed by broad leaf herbicide ($19.33 m^{-2}$) and weedy check ($61.33 m^{-2}$), where no herbicide was used (Table 2). For row spacing x herbicides interaction, minimum ($10 m^{-2}$) and maximum ($72 m^{-2}$) broad leaf weeds m^{-2} were observed in row spacing 20 cm with broad-spectrum herbicide and row spacing 40 cm with control treatment, respectively (Table 2). Maximum number of broad-leaved weeds in treatments of wider row spacing might be due to more space available for weeds development, while narrow row spacing suppressed weeds growth. These results are in agreement with the work of Marwat *et al.* (2002), Marwat *et al.*, (2002a) and Khan *et al.* (2002), who concluded that with the closer row spacing (18 and 15 cm), the weed growth rate was lower, and light interception, crop growth rate and grain yield were higher than with the wider row spacing. Among herbicides, minimum broad leaf weeds were recorded in broad-spectrum herbicide treated plots, which might be due to efficient control of broad leaf weeds. These findings were in agreement with the results of Marwat (2002a) and Marwat *et al.*, (2002a) who found that broad spectrum herbicide (Isoproturon + 2,4-D) controlled weeds population more effectively as compared to grasses weeds killer or broad leaf herbicide used alone. Minimum broad leaf weeds recorded in the interaction of 20 cm row spacing and broad-spectrum herbicides might also be due to less space available for weeds growth in narrow row spacing, and also application of broad-spectrum herbicide controlled broad leaf weeds. These results were also in agreement with the work of Marwat (2002a) and Marwat *et al.*, (2002a) who enunciated that with the closer row spacing (15 and 20 cm), the weed growth rate was slower, and light interception, crop growth rate and grain yield were higher. The broad-spectrum herbicide (Isoproturon + 2,4-D) controlled weeds population more effectively as compared to grasses weeds killer or broad leaf herbicide used alone.

Table 4. Effect of row spacing, herbicides and their interaction on number of grains spike⁻¹ in wheat.

Herbicides	Row spacing (cm)			Herbicide means
	20	30	40	
Broad Spectrum	56.10 a	56.70 a	52.40 d	55.07 a
Broad Leaf	54.10 bc	54.50 b	51.90 de	53.50 bc
Weedy check	52.00 d	53.00 cd	51.20 e	52.07 c
Row spacing mean	54.06 b	54.73 a	51.83 c	

LSD value for row spaces, herbicide and row space x herbicide = 1.47

* Means not sharing a common letter in the respective category differ significantly at 1% level of probability.

Grain yield (t ha⁻¹)

The effect of row spacing, herbicides and row spacing x herbicide on grain yield (t ha⁻¹) was highly significant. The highest grain yield was observed in 20 cm (4.80 t ha⁻¹) row spacing, followed by 30 cm (4.43 t ha⁻¹) and 40 cm (4.23 t ha⁻¹) respectively (Table 5). Among herbicide treatments, maximum grain yield (4.83 t ha⁻¹) was recorded in broad-spectrum herbicide, which was significantly different from broad leaf (4.45 t ha⁻¹) and control treatment plots (Table 5). The effect of row spacing x herbicides interaction on grain yield was also significant. The highest grain yield (5.35 t ha⁻¹) was recorded in 20 cm row spacing treated with broad spectrum herbicide, while minimum grain yield (4.00 t ha⁻¹) was recorded in 40 cm row spacing with control treatment (Table 5). The maximum grain yield observed in 20 cm row spacing, broad spectrum herbicide and interaction of 20 cm row spacing x broad spectrum herbicides was due to the fact that productive tillers m⁻² were more in row spacing 20 cm and broad spectrum herbicide as compared to other two row spacing (30 cm and 40 cm) and broad leaved and weedy check treatments. These results are in agreement with the work of Marwat (2002a), Marwat *et al* (2002) and Malik *et al* (1996) who reported that grain yield and straw yield were highest at 18 and 15 cm row spacing and decreased at wider row spacing. In case of broad spectrum herbicide, both narrow and broad leaf weeds were controlled by application of narrow + broad leaf herbicides and ultimately increased grain yield. These findings are in agreement with the work of Marwat (2002a), Marwat *et al* (2002) and Azad *et al* (1997) who reported that post-emergence application of isoproturon + 2,4-D was found to be the best treatment combination in reducing dry matter of weeds and producing the greatest straw and grain yield compared to control treatment.

Table 5. Effect of row spacing, herbicides and their interaction on grain yield (t ha⁻¹) in wheat

Herbicides	Row space (cm)			Herbicide means
	20	30	40	
Broad Spectrum	5.35 a	4.70 b	4.45 c	4.83 a
Broad Leaf	4.70 b	4.40 c	4.25 cd	4.45 b
Weedy check	4.35 c	4.20 de	4.00 e	4.18 c
Row spacing mean	4.80 a	4.43 bc	4.23 c	

LSD value for row spaces, herbicide and herbicide x row space = 0.209

* Means not sharing a common letter in the respective category differ significantly at 1% level of probability.

Harvest Index (%)

The effect of row spacing, herbicides and row spacing x herbicides interaction on harvest index was significant. Among row spacing the highest harvest index (32.66) was recorded in 20 cm row spacing, followed by 30cm row spacing (31.09) and lowest harvest index was observed in row spacing 40 cm (Table 6). Maximum harvest index was found in broad spectrum (33.49), followed by broad leaf (31.29), while minimum was recorded in control treatment (Table 6). From the interaction of row spacing x herbicides, the highest harvest index was observed in row space 20 cm x broad spectrum herbicide (35.91), followed by row spacing 30 cm x broad spectrum

herbicide (32.78), while lowest harvest index (29.10) was computed for row spacing 40 cm with control (Table 6). The highest harvest index recorded in row spacing 20 cm, herbicide broad spectrum and interaction of row spacing 20 cm x broad spectrum herbicide might be due to maximum productive tillers m^{-2} found in row spacing 20 cm and broad spectrum herbicide, which controlled both narrow and broad leaf weeds and the up take of maximum soil nutrients by wheat crop increased grain yield and thus harvest index was increased. These findings are in agreement with the work of Marwat (2002), who found that the higher harvest index was recorded in narrow row spacing and application of broad-spectrum herbicide.

Table 6. Effect of row spacing, herbicides and their interaction on harvest index (%) in wheat.

Herbicides	Row space (cm)			Herbicide means
	20	30	40	
Broad Spectrum	35.91 a	32.78 b	31.79 bc	33.49 a
Broad Leaf	31.97 b	31.10 c	30.80 cd	31.29 bc
Weedy check	30.10 d	29.41 de	29.10 e	29.83 c
Row spacing mean	32.66 a	31.09 ab	30.56 b	

LSD value for row spaces, herbicide and row space x herbicide = 1.66

* Means not sharing a common letter in the respective category differ significantly at 1% level of probability.

Net income (Rs. ha^{-1})

The effect of herbicides, row spacing and herbicides x row spacing was significant. Table 7 revealed that maximum net income (Rs.29748 ha^{-1}) was found in broad-spectrum herbicide, followed by broad leaf (Rs. 26450 ha^{-1}), while minimum was in control treatment (Rs.24828 ha^{-1}). Among row spacing, maximum net income (Rs.29655 ha^{-1}) was recorded in 20 cm row spacing, followed by 30 cm (Rs.26538 ha^{-1}) and 40 cm (Rs. 24838.33 ha^{-1}), respectively (Table 7). Comparing the interaction, highest net income (Rs. 34140 ha^{-1}) was found in row spacing 20 cm treated with broad spectrum herbicide, followed by 30 cm row spacing (Rs. 28615 ha^{-1}) plots sprayed with broad spectrum herbicide, while minimum net income was found in 40 cm row spacing and with weedy check treatment (Table 7). The maximum net income recorded in broad spectrum herbicide might be due to the fact that broad spectrum herbicide containing both narrow and broad leaved herbicides, controlled both kinds of weeds effectively and grain and straw yield of wheat was increased which ultimately increased the net income. These findings are in agreement with the work of Marwat et al (2002a) and Kotru et al., (1999) who reported that post-emergence application of isoproturon + 2,4-D gave the highest benefit cost ratio of 2.57 and 1.38 and net profit of Rs.35350 and Rs.712.5 ha^{-1} , respectively. The highest net income recorded in row spacing 20 cm was due to maximum productive tillers m^{-2} , which increased both grain and straw yield of wheat and effectively increased net income. These findings are in agreement with the work of Marwat et al (2002a) and Pattanaik et al., (1996) who reported that closer unidirectional sowing + integrated weed management resulted in the highest net returns (Rs. 35433 and Rs. 5753 ha^{-1} , respectively) and the highest net return for each Rupee invested (Rs. 2.57 and 1.72, respectively). The narrow rowed sowing was superior in field and more economical.

Table7. Effect of row spacing, herbicides and their interaction on net income (Rs. ha^{-1}) in wheat.

Herbicides	Row space (cm)			Herbicide means
	20	30	40	
Broad Spectrum	34140	28615	26490	29748
Broad Leaf	28580	26030	24755	26450
Weedy check	26245	24970	23270	24828
Row spacing mean	29655	26538	24838	

* Means not sharing a common letter in the respective category differ significantly at 1 % level of probability.

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