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INFLUENCE OF VARIETIES, ROW SPACINGS AND WEED MANAGEMENT ON DIFFERENT TRAITS OF WHEAT

Muhammad Iqbal Marwat[1], Haji Khalil Ahmad[2], Khan Bahadar Marwat[3] and Gul Hassan[3]

ABSTRACT

An experiment was conducted at Agricultural Research Farm, Faculty of Agriculture Gomal University D.I.Khan, NWFP, Pakistan, for two consecutive seasons 1998-1999 and 1999-2000 to study the effect of varieties (Bakhtawar 92, Ghaznavi-98, and Inqilab-91) assigned to main plots, herbicides [broad-spectrum (2,4-D + Isoproturon) broad leaf (2,4-D), grass killer (Isoproturon), and a weedy check plots kept in subplots, and row spacings (18, 25 and 32 cm) allocated to sub-sub plots. The experiment was laid out in a split-split plot design replicated three times. Broad-spectrum herbicide significantly reduced grasses and broad-leaved weeds by 90 and 80% over the weedy check, respectively. Variety Inqilab-91 significantly reduced te density of grasses and broad-leaved weeds because Inqilab-91 is a taller variety as compared to Bakhtawar-92 or Ghaznavi-98. Grasses and broad leaved weeds density m^{-2} was significantly lower in 18 cm row spacing as compared to 25 and 32 cm row spacing. Dry weed biomass g m^{-2} was reduced with treatment of broad-spectrum herbicide over weedy check treatments. Among varieties minimum dry weed biomass (48.56 g m^{-2}) was recoded in variety Inqilab-91 followed by Bakhtawar-92 (51.84 g m^{-2}) and Ghaznavi-98 (53.03 g m^{-2}), while minimum biomass was recorded in 18 cm (46.20 g m^{-2}) row spacing. Relative growth rate (g m^{-2} day^{-1}) was significantly more in variety Inqilab-91 up to 4th cutting (which is fast growing and tall variety), but later on maximum RGR was recorded in Bakhtawar-92 having more tillers m^{-2}. In herbicides, highest dry matter accumulation was recorded in broad-spectrum herbicide treated plots. The relative growth rate was more in 18 cm row spacing, followed by 25 and 32 cm, respectively. Broad spectrum herbicide significantly affected grain yield to an extent of 20% more yield over weedy check plots. Grain yield in variety Bakhtawar-92 was more 6 and 7% than Ghaznavi-98 and Inqilab-91, respectively. The grain yield in 18 cm row space was more by 5% and by 11% over 25 cm and 32 cm row spacing, respectively. The interaction of broad-spectrum herbicide with variety Bakhtawar-92 and with 18 cm row spacing was significant, while the interaction of variety Bakhtawar-92 with 18 cm row spacing was also significant, thus it can be concluded that 18 cm row spacing integrated with broad-spectrum herbicide would minimize weeds density and maximize wheat production

Key words: Varieties, row spacing, herbicides, weed density/biomass, yield, RGR

[1] Institute of Development Studies, NWFP Agricultural University, Peshawar, Pakistan
[2] Faculty of Agriculture, Gomal University, D.I.Khan, Pakistan.
[3] Weed Science Department, NWFP Agricultural University, Peshawar, Pakistan
E-mail: kbmarwat@yahoo.com

INTRODUCTION

Wheat (*Triticum aestivum* L.) yield in Pakistan is lower as compared to other advanced wheat growing nations of the world. To increase production ha^{-1}, cultural management plays a significant role. Among which weed control, planting and quality seed can improve yield by about 50 - 70 percent (Burns, 1944). Proper row spacing is one of the most important factors affecting the growth specially the weeds growth in the early stages of the crop development. Narrow row spacing may be one of the possible ways of suppressing weeds as the soil surface is quickly covered and consequently leaving a meager chance for weed growth. Narrow row spacing also has the higher leaf photosynthesis and suppresses weeds growth compared with wider row spacing (Dwyer et al., 1991). It helps in maximizing light interception, penetration and distribution in crop canopy. Weeds are the most serious pests reducing the growth and yield of wheat in addition to several other factors. Control of weeds is a basic requirement and major component of management in most crop production systems (Young et al., 1994; Norris, 1982; Triplett, 1976). Malik *et al.* (1993) and Jarwar *et al.* (1999) observed that chemical weed control method was more effective when integrated with cultural methods of weed control. An investigation shows that 9 to 17 weeds $feet^{-2}$ decreased wheat yield by 10% (Chatta, 1973). Studies of Appleby et al., 1976, Froud (1997), Malik and Hassan, (2002) and Hassan (2002) and Hashim et al. (2002) exhibit that wheat varieties had a differential suppressive effect on weeds depending on their height and growth habit. The percent reduction tended to be lower in tall than dwarf wheat cultivars. Later studies (Hashim and Radosevich, 1991) also quantified a proportionate decline in wheat yield with increasing Italian ryegrass densities. Carlson (1989) and Khan and Thill (1992) quantified the consequent decline in wheat grain yield as the *Avena fatua* density increased in the plots.

MATERIALS AND METHODS

An experiment was carried out at Gomal University, D.I.Khan (Pakistan), during 1998-1999 and 1999-2000 to study the effect of varieties, row spacing and herbicides on different traits of wheat. The design of the experiment was split-split plot in randomized complete block with three replications. The treatments were: three wheat varieties (Bakhtawar-92, Ghaznavi-98, Inqilab-91), four herbicides - Broad-spectrum herbicide (2,4-D Butyl Ester: 72% EC + Isoproturon 75% WP), Broad leaf herbicide (2.4-D Butyl Ester: 72% EC), Grassy herbicide (isoproturon 75% WP), and control (weedy check), and three row spacings 18, 25 and 32 cm. Wheat varieties were allotted to main plots, herbicides to sub-plots and row spacings were kept in sub-sub-plots. Data for various traits were collected using the following procedure: Weed density for grasses and broad leaved was determined 60 days after herbicides spray. A quadrate 33 cm x 33 cm was placed randomly in three places in each sub sub-plot and weeds were counted and then the means were converted to m^{-2} basis. For dry weed biomass, the above weeds were harvested at above ground level at the time of wheat earing from an area of a quadrate 33 cm x 33 cm from each sub sub-plot, bagged each separately and were oven dried at 60 °C for 72 hours. The dried weeds were weighed with an electronic balance and thereafter its dry matter yield was computed on m^{-2} basis. Wheat dry matter accumulation was determined at fifteen days interval. An area of 30 cm of the central two rows was harvested from each treatment, sun dried for two days and then placed in an oven at 60 °C (for 72 hours) till it dried to a constant weight and thereafter its dry matter yield was calculated $g\ m^{-2}\ day^{-1}$. Grain yield was recorded on a per plot basis and then converted into $t\ ha^{-1}$.

The data were statistically analyzed using ANOVA procedure. For the analysis of data years and locations were also included as variables Analysis of variance and mean separation tests were applied according to the method described by Gomez and Gomez, (1984) using the MSTAT-C software package.

RESULTS AND DISCUSSION

Grasses density (m^{-2})

The effect of varieties, herbicides, row spacing, interaction of varieties x herbicides, herbicide x row spacing and variety x row spacing on grasses weeds density were significant. The lowest grasses weeds were recorded in variety Inqilab-91 (16.72 m^{-2}), broad-spectrum herbicide (6.53 m^{-2}), 18 cm row spacing (15.95 m^{-2}). and interaction of variety Inqilab-91 x broad spectrum herbicide (6.27 m^{-2}), broad spectrum herbicide x 18 cm row spacing (5.69 m^{-2}) and variety Inqilab-91 x 18 cm row spacing treatments (Tables 1-3). Variety Inqilab-91 is the tallest and thus having larger canopy as compared to other two varieties (Bakhtawar-92 and Ghaznavi-98), it might have suppressed weeds germination and establishment by better shading. The broad-spectrum herbicide best controlled grasses weeds. The above findings are in agreement with the work of Boparai et al., (1991), Panwar et al., (1995), Prasad and Singh, (1995), Brar et al., (1997), Sodhi and Dhaliwal, (1998) and Kotru et al., (1999). who found that greater height and broad spectrum herbicide (Isoproturon + 2,4-D) controlled weeds population more effectively as compared to grasses weeds killer used alone. The second best interaction having minimum grasses weeds (8.32 m^{-2}) was Inqilab-91 treated with grasses weeds herbicide. These findings were also in agreement with Sharma et al., (1991), Roperia et al., (1991), Thakur and Singh (1991), Brar et al., (1997), and Sodhi and Dhaliwal (1998), who reported that greater height of wheat variety and application of Isoproturon controlled grasses weeds density in wheat crop.

The lowest grasses weeds found in 18 cm row spacing might be due to more competition of wheat crop for development resources. While comparing the interaction of herbicides with row spacing and row spacing with variety, the least grasses weeds density found in broad-spectrum herbicide x 18 cm row space interaction and 18 cm row spacing x variety Inqilab-91; as availability of lesser space for weeds development and use of broad-spectrum (2,4-D + Isoproturon) herbicide and taller variety effectively controlled weeds. These findings were in analogy with the work of Appleby et al. (1976) Bhagawati et al., (1989), Sharma et al., (1989), Rath et al., (1990), Boparai et al., (1991). Panwar et al., (1995), Prasad & Singh, (1995), Sharma et al., (1996), Sarir (1998), Jena and Behera (1998), Sodhi and Dhaliwal, (1998) and Kotru et al., (1999), who verified that with the closer row spacing (15 cm), the weeds growth rate was lower, while light interception, crop growth rate and grain yield were higher than with the distant row spacing (20 cm), greater height of wheat variety and with use of Isoproturon + 2,4-D better weed control was accomplished

Table 1. Effect of varieties, herbicides, and varieties x herbicides interaction on grasses weeds density m^{-2} during 98-99 and 99-2000.

Varieties	Herbicide				Varieties Mean
	Broad Spectrum	Broad Leaf	Grasses	Control	
Bakhtawar-92	6.71 d	32.03 b	7.82 d	40.93 a	21 67 a
Ghaznavi-98	6.62 d	23 93 c	7.04 d	31.19 b	17.20 c
Inqilab-91	6.27 d	23 38 c	6 52 d	30.40 b	16.72 b
Herbicide Mean	6.53 c	24 45 b	7.23 c	34 17 a	

$LSD_{0.01}$ for variety = 1 79
$LSD_{0.01}$ for herbicide = 1.11
$LSD_{0.01}$ for variety x herbicide = 1 92

Table 2. Effect of row spacing & herbicides x row spacing on grasses density m^{-2} during 98-99 and 99-2000.

Row Spacing (cm)	Herbicide				Row Spacing Mean
	Broad Spectrum	Broad Leaf	Grasses	Control	
Row space-18	5.69 g	22.87 e	6.27 fg	28.96 cd	15.95 c
Row space-25	6.45 fg	27.27 d	7.23 fg	35 73 b	19 17 b
Row space-32	7.45 fg	29.21 c	8 17 f	37 83 a	20 67 a

$LSD_{0.01}$ for row spacing = 0.96
$LSD_{0.01}$ for herbicide x row spacing = 1.92

Table 3. Effect of herbicide x row spacing on grasses density m^{-2} during 98-99 & 99-2000.

Row Spacing (cm)	Herbicide		
	Bakhtawar-92	Ghaznavi-98	Inqilab-91
Row space-18	20.18 b	14.11 e	13.56 e
Row space-25	21.93 a	18.03 cd	19.45 bc
Row space-32	13.56 e	17.56 d	19.03 b d

$LSD_{0.05}$ for herbicide x row spacing = 1.66

Broadleaf weeds density (m^{-2})

The effect of varieties, herbicides, row spacing and interaction of varieties x herbicides on broad-leaved weeds density were significant. Table 4 and 5 revealed that minimum number of broad leaved weeds were recorded in variety Inqilab-91 (103.43 m^{-2}), broad-spectrum herbicide (38.26 m^{-2}), 18 cm row spacing (100.36 m^{-2}) and interaction of variety Inqilab-91 x broad spectrum herbicide (38.06 m^{-2}). Variety Inqilab-91 is the tallest and thus having larger canopy as compared to other two varieties (Bakhtawar 92 and Ghaznavi-98), it might have suppressed weeds germination and establishment by better shading. The broad-spectrum herbicide best controlled broad leaved weeds. The lowest broad leaved weeds found in 18 cm row spacing might be due to more competition of wheat crop for development resources. The above findings were in agreement with work of Prasad and Singh, (1995), Brar et al., (1997), Sodhi and Dhaliwal, (1998). Kotru et al., (1999), and Hashim et al. (2002) who found that greater height, broad spectrum herbicide (Isoproturon + 2,4-D) controlled weeds population more effectively as compared to broad leaved weeds herbicide used alone and in closer row spacing the weeds growth rate was lower, while light interception, crop growth rate and grain yield were higher than with the distant row spacing (20 cm)

Table 4. Effect of varieties, herbicides and varieties x herbicides on broad leaved weeds density m^{-2} during 1998-99 and 1999-2000.

Variety	Herbicide				Variety Mean
	Broad Spectrum	Broad Leaf	Grasses	Control	
Bakhtawar-92	38.17 d	40.56 d	159.61 b	187.94 a	106.57ab
Ghaznavi-98	38.56 d	43.28 d	165.61 b	190.33 a	109.44 a
Inqilab-91	38.06 d	40.72 d	150.17 c	184.78 a	103.43 b
Herbicide Mean	38.26 c	41.52 c	158.46 b	187.69 a	

$LSD_{0.05}$ for varieties = 4.75

$LSD_{0.05}$ for herbicide = 3.93

$LSD_{0.05}$ for variety x herbicide = 6.81

Table 5. Effect of row spacing on broad leaved weeds density m^{-2} during 1998-99 and 1999-2000 at D.I. Khan.

Row spacing (cm)	Row spacing Mean
Row space-18	100.36 c
Row space-25	106.83 b
Row space-32	112.25 a

$LSD_{0.05}$ for row spacing = 0.96

Dry weed biomass (g m^{-2})

Varieties, herbicides and row spacing significantly affected the dry weed biomass, while interactions were non significant. Table 6 shows that the lowest dry weed biomass (48.56 g m^{-2}) was recorded in variety Inqilab-91, followed by var. Bakhtawar-92 (51.84 g m^{-2}) and Ghaznavi-98 (53.03 g m^{-2}). Among herbicides, minimum dry weed biomass (41.46 g m^{-2}) was recorded in broad spectrum herbicide treated plots, followed by broad leaved (46.43 g m^{-2}), grasses (54.44 g m^{-2}) and weedy check (62.25 g m^{-2}) treatments (Table 6). Row space measuring 18 cm had minimum dry weed biomass (46.20 g m^{-2}) followed by 25 and 32 cm (Table 6). Minimum dry weed biomass in variety Inqilab-91 was due to its height which shaded weeds and slowed down their development. These findings are in analogy with the work of Appleby et al. (1976), Sodhi and Dhaliwal, (1998), Froud (1997), Hashim et al., (2002), and Malik and Hassan et al. (2002) also observed a differential suppression of weeds in different wheat cultivars based on height and growth habit. Among herbicides, minimum dry weed biomass recorded in broad-spectrum herbicide treated plots was due to effective control of weeds population. These findings were in agreement with Patel & Upadhyay (1990), Prasad & Singh (1995), Rajender et al., (1996), and Azad et al., (1997), who reported that combination of 2,4-D + Isoproturon herbicide reduced dry weed biomass. The minimum dry weed biomass found in 18 cm row spacing might be due to less space available for development of weeds as compared to wider row spacings. These results were in agreement with the work of Patel & Upadhyay (1990), Angiras and Sharma (1996), Jena & Behera (1998), and Sarir (1998), who reported that dry weed biomass increases with the increase in row spacing

Table 6. Effect of herbicides, varieties and row spacing on dry weed biomass (g m^{-2}) during 98-99 and 99-2000.

Herbicide		Variety		Row spacing (cm)	
Name	Mean	Name	Mean	Name	Mean
Broad Spectrum	41.46 d	Bakhtawar-92	51.84 a	Row space-18	46.20 c
Broad Leaf	46.43 c	Ghaznavi-98	53.03 a	Row space-25	51.08 b
Grasses	54.44 b	Inqilab-91	48.56 b	Row space-32	56.15 a
Control	62.25 a				

$LSD_{0.05}$ for herbicide = 1.29
$LSD_{0.05}$ for variety = 1.64
$LSD_{0.05}$ for row spacing = 1.12

Relative growth rate (RGR)

Variety Inqilab-91 leaded in dry matter accumulation up to 4th cutting, followed by Bakhtawar-92 and Ghaznavi-98. While after 4th cutting maximum dry matter accumulation was recorded in variety Bakhtawar-92 (Table 7). The broad-spectrum herbicide treated plots accumulated maximum dry matter, followed by broad leaved, grasses weeds herbicides treated plots and a weedy check (Table 8). Among row spacing, the highest dry matter accumulation was recorded in 18 cm row spacing, followed by 25 and 32 cm row spacing (Table 9). Among all cuttings and in all factors, maximum dry matter accumulation was found in 5th cutting and then declined in 6th cutting. Maximum dry matter accumulation in variety Inqilab-91 in the earlier cuttings correlates with less dry weed biomass recorded in the same variety. Evidently Inqilab-91 captured the space earlier; hence it was more competitive with the weeds and affected their growth adversely. These findings were in agreement with Sodhi and Dhaliwal, (1998), who reported that taller variety had more dry matter accumulation as compared to dwarfer variety. From 5th cutting onward maximum accumulation of dry matter was found in Bakhtawar-92, followed by Ghaznavi-98, which might be due to more number of tillers m^{-2} in Bakhtawar-92 and Ghaznavi-98 as compared to Inqilab-91. The maximum dry matter accumulation found in broad-spectrum herbicide treatments was due to lesser number of weeds present in the concerned plots, as weeds were controlled by use of broad spectrum herbicide, and it ultimately increased tillers m^{-2} in broad spectrum herbicide treated plots, followed by broad leaf, grasses herbicide and weedy check, which ultimately increased dry matter accumulation in wheat. The maximum dry matter accumulation in 18 cm row space might be due to fact that in the same row space, maximum number of tillers m^{-2} were observed, which probably gave maximum dry matter accumulation in 18 cm row space. These findings were in agreement with Ercoli and Masoni (1995), who reported that above ground biomass progressively decreased with increasing row spacing.

Table 7. Effect of varieties on dry matter accumulation (g m^{-2}. day^{-1}) of wheat crop during 1998-99 and 1999-2000.

No of Cutting	Date of Cutting (15 days interval)	Variety		
		Bakhtawar-92	Ghaznavi-98	Inqilab-91
1st	28-12-11/1	0.87	0.77	0.95
2nd	12/1-26/1	2.29	2.26	2.66
3rd	27/1-10/2	5.30	5.15	6.18
4th	11/2-25/2	14.08	12.79	17.48
5th	26/2-12/3	34.40	32.59	30.90
6th	13/3-27/3	32.04	29.95	27.69

Table 8. Effect of herbicides on dry matter accumulation (g m^{-2}. day^{-1}) of wheat crop during 1998-99 and 1999-2000.

No of Cutting	Date of Cutting (15 days interval)	Herbicide			
		Broad spectrum	Broad Leaf	Grassy Leaf	Control
1st	28-12-11/1	0.89	0.88	0.86	0.87
2nd	12/1-26/1	2.43	2.42	2.36	2.35
3rd	27/1-10/2	5.86	5.70	5.56	5.43
4th	11/2-25/2	16.10	15.07	14.25	13.83
5th	26/2-12/3	33.71	32.76	32.34	29.98
6th	13/3-27/3	30.04	28.73	27.83	25.62

Table 9. Effect of Row spacing on dry matter accumulation (g. m^{-2}. day^{-1}) of wheat crop during 1998-99 and 1999-2000 at D.I. Khan.

No of Cutting	Date of Cutting (15 days interval)	Row space		
		18 cm	25 cm	32 cm
1st	28/12-11/1	1.03	0.85	0.84
2nd	12/1-26/1	2.69	2.39	2.30
3rd	27/1-10/2	7.82	5.35	4.07
4th	11/2-25/2	20.32	13.31	10.28
5th	26/2-12/3	34.05	29.48	23.30
6th	13/3-27/3	29.47	25.98	18.98

Grain yield (t ha^{-1})

The effect of varieties, herbicides, row spacing and interaction of varieties with row spacing was significant. Tables 10 & 11 shows that maximum grain yield was recorded in the variety Bakhtawar-92 (4.67 t ha^{-1}), broad-spectrum herbicide (4.81 t ha^{-1}) treated plots, and 18 cm row spacing (4.72 t ha^{-1}). In the interaction of varieties with row spacing higher grain yield was recorded in variety Bakhtawar-92 x 18 cm row spacing (4.93 t ha^{-1}) while lowest yield was observed in variety Inqilab-91 with 32 cm row spacing (4.21 t ha^{-1}). The maximum grain yield in variety Bakhtawar-92 was due to higher number of productive tillers m^{-2} as compared to other two varieties (Ghaznavi-98 and Inqilab-91). Appleby et al. (1976), Froud (1997), Hashim et al. (2002), and Malik and Hassan et al. (2002) also harvested variable yield in wheat varieties due to the differential suppression of weeds. Maximum grain yield in broad-spectrum herbicide treated plots might be that it controlled both types of weeds in the treatments and out yielded rest of the herbicides. These results were in agreement with the findings of Boparai et al., (1991), Panwar et al., (1995), Prasad & Singh (1995), Azad et al., (1997), and Kotru et al. (1999), who reported that post-emergence application of 2,4-D + Isoproturon was found to be the best treatment combination in reducing dry matter of weeds and producing the greatest straw and grain yields (5.93 and 3.96 t ha^{-1}, respectively, compared to 2.74 and 1.66 t ha^{-1} in the un weeded control). Maximum grain yield observed in 18 cm row spacing and interaction of variety Bakhtawar-92 with 18 cm row spacing was due to the fact that the productive tillers were more in variety Bakhtawar-92 and 18 cm row spacing as compared to other two varieties and row spacings. These results were in agreement with the work of Rath et al. (1990)

Marko (1994), Behera, (1995), Ercoli and Masoni (1995), Malik et al.. (1996) and Kotru et al., (1999) who found that grain yield was highest with the treatment of broad spectrum herbicide and narrow row spacing and decreased at weedy check and wider row spacing.

Table 10. Effect of varieties, row spacing and varieties x row spacing on grain yield (t ha^{-1}) during 1998-99 and 1999-2000.

Row spacing (cm)	Variety			Row spacing Mean
	Bakhtawar-92	Ghaznavi-98	Inqilab-91	
Row space-18	4.93 a	4.70 b	4.36 de	4.72 a
Row space-25	4.71 b	4.34 de	4.17f	4.48 b
Row space-32	4.52 c	4.39 cd	4.21 ef	4.25 c
Varieties Mean	4.67 a	4.41 b	4.37 b	

$LSD_{0.01}$ for row spacing = 0.09
$LSD_{0.01}$ for variety x row spacing = 0.15

Table 11. Effect of varieties on grain yield (t ha^{-1}) during 1998-99 and 1999-2000.

Herbicides	Herbicides Mean
Broad spectrum	4.81 a
Broad Leaved	4.68 b
Grasses	4.43 c
Control	4.01 d

$LSD_{0.01}$ for herbicide = 0.10

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