Pak. J. Bot., 43(1): 625-633, 2011.

INTEGRATED WEED MANAGEMENT IN WHEAT

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Abstract

The paper summarizes the results of an experiment conducted on wheat at Kohat, Khyber Pakhtunkhwa, Pakistan during winter 2004-05. Randomized complete block design with split-split-plot arrangement was used where wheat line and broadcast sowing were kept in main plots. Seed rates (100 and 150 kg ha^{-1}) were assigned as sub-plots, while four herbicides (Topik, Isoproturon, Puma super and Buctril super) and weed check were assigned to sub-sub-plots. Results revealed that higher biological yield was recorded in line sowing. However, higher wheat seed rate decreased weed biomass and increased biological yield. Herbicides proved to be effective in decreasing weed biomass and enhancing grain yield and its contributing traits. It was suggested that line sowing in combination with higher seeding rate and Buctril super should be used in an integrated weed management fashion. However further studies are required to investigate various ranges of seeding rate and herbicides doses.

Introduction

Wheat is an important cereal crop and is gaining popularity all over the world and especially in Pakistan. Due to increase in population and food prices, higher yield of the wheat can play a vital role in stabilizing the food prices directly or indirectly. Management of many factors can significantly contribute in increasing the grain yield of wheat in Pakistan. Among these factors, weed management is an important factor and can increase the wheat yield by more than one million ton in Pakistan. Weeds are an important obstacle to crop production, particularly in low-input and/or organic systems (Clark *et al*., 1998; Penfold *et al*., 1995; Stonehouse *et al*., 1996). Weeds are notorious yield reducers that are, in many situations, economically more important than insects, fungi or other pest organisms (Savary *et al*., 1997; 2000). Weed management approaches used in Pakistan are mostly dependent largely on herbicide application or manual weeding after critical period of weed competition and thus resources are wasted without any significant yield advantage.

In Pakistan, weed management techniques are mainly applied in irrigated areas while ignored in rainfed areas which ultimately cause yield reduction. As wheat is already in stress conditions in rainfed areas therefore presence of weed further accelerate the moisture loss from the soil. Mahdi *et al*. (1998) reported that soil water is often limited in the top soil layer in rainfed areas and stands of wheat may be established poorly and have low yields while sowing more deeply may enhance establishment due to higher soil water content in the seed zone, leading to better germination and emergence of seedling. Barros *et al*. (2008) reported that the aim of weed management is to keep the weed community at an acceptable level rather than to keep the crop totally free of weeds. Weeds can be suppressed in wheat through variety of techniques as single method of weed control is not sustainable in our country. As crop-weed interference is inevitable therefore a judicious use of herbicides and integration of cultural methods may prove more effective. However due to ignorance and lack of knowledge the farmers blindly apply herbicides without considering its economics, resistance, health and environment. Chemical weed management should not be relied upon as the sole method of protecting crops from weeds in irrigated as well as in rainfed conditions. Herbicides should be used in combination with good preventative, physical and cultural practices.

Method of sowing can greatly influence the weeds growth in wheat. Lodge (2000) reported that mean dry matter yield of perennial grass was higher in row-sown plots than those sown by broadcasting while dry matter yield of perennial grass was lowest at low sowing rate, but not significantly different at medium and high sowing rates. Sowing method suppress the weeds in different ways including canopy architecture, early germination, good stand etc. Under field conditions, crop growth is dependent on the ability of the canopy to intercept incoming radiation, which is function of leaf area index (LAI) and canopy architecture, and convert it into new biomass (Gifford *et al*., 1984).

Under the conditions of irrigation, with an improvement in the irrigation amount, the yield of winter wheat was increased (Quanqi *et al*., 2008. Similarly higher seed rate play a vital role in suppressing weeds but the yield is decreased above optimum seed rate (Khan and Marwat, 2006). Reductions in wheat grain yield of 17–62% have been reported to be dependent on the cultivar's ability to compete with wild oat (*Avena ludoviciana*) (Balyan *et al*., 1991). Dissimilar yield reductions have also been observed in wheat cultivars due to differential response in competitive ability against downy brome (*Bromus tectorum* L.) (Blackshaw, 1994). In higher crop densities, there is potential to suppress weeds because increasing density within rows increases intraspecific competition within the crop population more than it increases competition with the weeds (Weiner *et al*., 2001) while environment can also alter the competitive ability of the weed. According to Marshall & Ohm (1987) and Anderson & Barclay (1991), the optimal plant population changes according to variety and local conditions. Seeding rate and row spacing strongly influence the use of environmental resources as they change the relative importance of intra-plant and inter-plant competition for light, water and nutrients during crop development (Khan *et al.*, 2009; Tompkins *et al*., 1991). Mennan & Zandstra (2005) reported that wheat grain yield increased with seeding rate, either in the presence or in the absence of *Galium aparine* at both locations.

Keeping in view the importance of wheat and weeds associated problems, experiment was conducted to evaluate multi-approached weed suppression in wheat with the objectives to investigate the effects sowing method, seeding rate and herbicides on weeds and grain yield of wheat under irrigated conditions of Kohat, KP, Pakistan.

Materials and Methods

Field trial was conducted at Agricultural Research Station, Kohat, Khyber Pakhtunkhwa, Pakistan during October 2004-05 using wheat variety "Fakhr-i-Sarhad". Experiment was laid out using a Randomized Complete Block Design in a split-split plot arrangement with three replications. The field was ploughed with tractor followed by harrowing to make fine seedbed. Line and broadcast sowing were assigned to main plots while seeding rates (100 and 150 kg ha^{-1}) in sub-plots and four herbicides (Topik, Isoproturon, Puma super and Buctril super) and weedy check to sub-sub-plots. Nitrogen (half dose) and phosphorus (full dose) were applied through broadcast method @100 and

90 kg ha^{-1}, respectively just before sowing; whereas half of the nitrogen was applied during the tillering stage. Urea and single super phosphate were used as the sources of nitrogen and phosphorus, respectively. The size of each subplot was 5 m x 1.8 m consisting of 6 rows (for line sowing), each row 5 m long and 30 cm apart from the adjacent row. All herbicides were applied with the help of knapsack sprayer with nozzle size of 350 µm while volume of water used was @ 300 L ha^{-1} pressurized at 40 psi.

Statistical analysis: Data recorded was subjected to statistical analysis as per design and the means were separated by LSD test (Steel & Torrie, 1980). The means of the data were presented in tabular form while significant interactions were presented in graphical form.

Results and Discussion

Dry weed biomass (Kg ha^{-1}): Statistical analysis of the data indicated that sowing method had non significant effect on dry weed biomass (Table 1). Overall broadcast method of sowing was inefficient to suppress weeds as compared to ling method. This might be due to the fact that in line sowing, seeds were placed in environment that favoured the earlier germination and finally good stand. If soil fertility status is improved and moisture is adequate, the optimum seeding rate of cereal crops increases (Holliday, 1960). Although line sowing is widely used in KPK but many farmers use broadcast method if the sowing is very late. Thus farmers should keep in focus that weeds may get an advantage if crop was broadcasted. Crop-weed competition depends on the available resources, time of germination of the seed planted and weeds present in the soil. Higher seeding rate of wheat suppressed the weeds significantly ($p \leq 0.05$) and thus lower dry biomass was recorded. While in lower seeding rate the dry biomass of weeds was significantly greater (Table 1). Khan & Marwat (2006) reported that higher seeding rate of wheat suppressed the weed in the first year while in the second year, higher seeding rate could not suppress weeds due to change in the climatic conditions. Herbicides proved effective in decreasing weed dry biomass significantly ($p \leq 0.01$). However the efficiency of herbicides was different in controlling weeds and dry biomass. Buctril super was the most promising herbicides as minimum dry weed biomass was observed in Buctril treated plots. This might be due to the fact that broadleaf weeds were dominant in the experimental field. Interaction of sowing method and seeding rate was non-significant (Table 1) while interaction of sowing method and herbicides was significant (Fig. 1). It was observed that line sowing was effective in suppressing weeds in combination with all herbicides. Weed control was constantly greater in line sowing. This might be due to the fact that weeds properly received herbicides in line sowing. Interaction of seeding rate and herbicides showed significant difference in dry weeds biomass (Fig. 2) however, weed control efficiency of Buctril super was greater than the rest of herbicides. Increased weed efficiency in Buctril might be due to the fact that broadleaf weeds were dominant in the experimental plots. The present findings revealed that integrating line sowing with higher seed rate (150 kg ha^{-1}) and herbicides could suppress weeds in the area under study.

Table 1. Effect of sowing method, seed rate and herbicides on dry weed biomass, 1000-grain weight, biological yield and grain yield.

	Weed biomass (kg ha^{-1})	1000-grian Weight (g)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})
	Sowing method (A)			
Line sowing	614.9	42.3	10562.8 A	2124.2
Broadcast method	661.8	40.5	10022.3 B	2082.9
	Seed rate (B)			
100	704.6 A	41.8	10098.5 B	2101.4
150	572.2 B	41.1	10486.6 A	2105.6
	Herbicides (C)			
Topik	321.8 C	41.3 BC	10280 B	1879 D
Isoproturon	147.8 D	42.5 B	10220 B	2294 B
Puma super	422.4 B	40.7 C	10180 B	2107 C
Buctril super	111.5 E	44.7 A	10540 A	2677 A
Weedy check	2189.0 A	38.0 D	10240 B	1561 E
	Interaction			
A x B	NS	*	**	NS
A x C	**	**	**	**
B x C	**	NS	NS	**
A x B x C	**	NS	NS	**

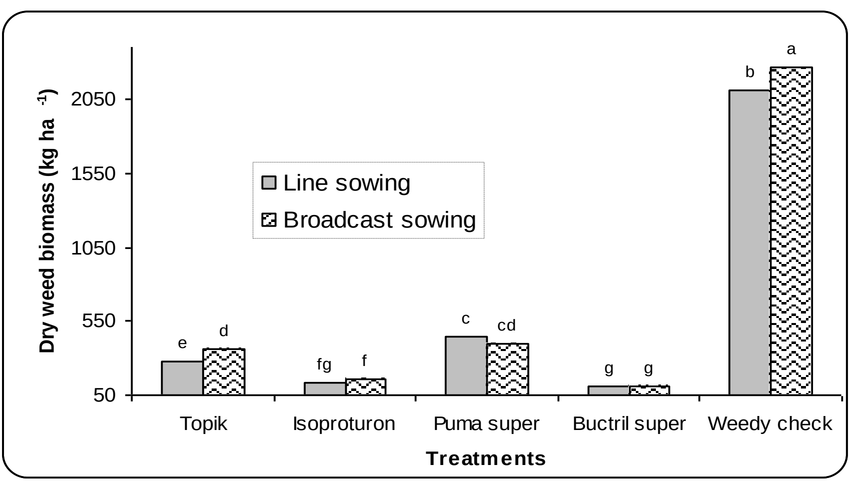

Fig. 1. Interaction of sowing method and herbicides.

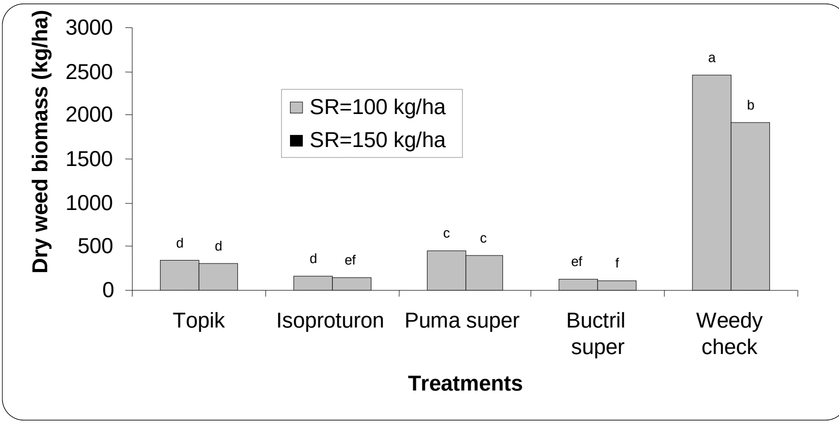

Fig. 2. Interaction of seed rate and herbicides.

1000-grain weight (g): Sowing method or seeding rate of wheat did not affect 1000-grain weight (Table 1). It seems that wheat plants got equal resources in line or broadcast sowing and seeding rate of 100 or 150 kg ha^{-1}. While in general, greater the environmental resources, the higher will be the optimal seeding rate (Holliday, 1960). Crop yield reduction due to *Phalaris minor* competition resulted mainly from reduction in ear number and less from reduction in 1000-grain weight. (Dhima & Eleftherohorinos, 2003). However, it was observed that heavier 1000-grain weight was recorded in line sowing as compared to broadcast sowing. Nearly all parameters were positively affected by line sowing which suggest that line sowing could be proved economical. Seeding rate did not affect the 1000-grain weight. Low seed rates decrease interplant competition especially during vegetative growth, but increase intraplant competition during grain filling because plants tend to produce more spike-bearing tillers (Darwinkel, 1978; Marshall & Ohm, 1987). While Willey & Heath, (1969) claimed that for cereal crops the yield response over a wide range of seeding rates can be depicted by a parabolic type of curve rising quickly to a maximum yield followed by a slow decline at high densities. Although Sobkowicz & Tendziagolska (2005) reported that increased seeding rate of wheat significantly decreased 1000-grain weight but our results did not agree to these findings. Herbicides proved effective in significantly ($p<0.01$) increasing 1000-grain weight (Table 1). Heavier 1000-grain weight (44.7 g) was recorded in Buctril super treated plots while other herbicides although increased 1000-grain weight but were significantly lower than Buctril super. Weedy check lowered the grain weight which indicates the limitation of resources and weeds competition with the crop plants. Although herbicide application is popular and economical in the area studied, but reliance on single herbicide might create resistance in weeds. Thus, herbicides are effective against weeds and ensure heavier 1000-grain weight and finally yield, but the farmers' awareness is necessary to adopt integrated weeds management approach. However availability of resources alters the crop-weed interaction. It has long been known that the optimum seeding rate for cereals is higher in a wet than in a dry environment (Holliday, 1960). While Genotypes within a crop have also been shown to have a significant influence on the yield response curve at different plant densities (Baker, 1977). Interaction of sowing method x seed rate and sowing method x herbicides was also significant (Table 1).

Biological yield (Kg ha^{-1}): Biological yield is the net photosynthetic material and contributes significantly towards economic yield. Statistical analysis of the data presented in Table 1 showed that there was a significant ($p<0.01$) effect of method of sowing on biological yield of wheat. Line sowing gave heavier biological yield as compared to broadcast sowing. In line sowing, seeds are placed at favourable conditions to germination therefore plants establish soon. While in broadcast sowing many seeds could not germinate or establish itself very well. As wheat straw and grain are equally important for the farmers in the area therefore higher biological yield will increase the net return. Therefore line sowing would be proved more effective in increasing the net return. Higher seeding rate produced more biological yield as compared to lower seeding rate. Thus higher seeding rate should be used in conjunction with other methods to suppress weeds and increase biological yield.

However it is suggested that high seed rates were found to increase yield in well watered conditions, whereas the reverse was true with low soil moisture (Wilson & Swanson, 1962; Tompkins *et al*., 1991). While Slafer *et al*. (1994) and Calderini *et al*. (1995) reported that improvement of wheat yield through breeding has been associated with increases in grain number and harvest index but generally not with increased biomass. Means data shown in Table 1 depicted that herbicides application significantly ($p<0.01$) affected biological yield of wheat. It was noted that Buctril super excelled all other treatments in increasing biological yield. The value in Buctril super was significantly higher than the rest while all other treatments produced statistically similar values. Interaction of method of sowing x seed rate and sowing method x herbicides were also significant while all other interaction was statistically non-significant.

Grain yield (Kg ha^{-1}): Statistical analysis of the data revealed that sowing method and seeding rate non-significantly affected the grain yield of wheat (Table 1). It was noted that statistically similar values were recorded in line and broadcast sowing. Dawelbeit & Babiker (1997) claimed that seed drilling as well as ridging after broadcasting resulted in significantly greater wheat grain yields than broadcasting alone. Edwards 1998) reported that the forage crops provided 5.5% more ground coverage with drill seeding than with broadcast seeding. Conversely, Carr *et al*. (2003) and Wood *et al.* (2003) found that grain yield of wheat was higher with 250 than with 450 seeds m^{-2}. This might be due to the fact that lower seeding rate compensated for the yield related traits. In a similar study it was reported that differences in grain yields among the three seeding rates were non-significant (Hemmat & Taki 2001). While Smid & Jenkinson (1979) reported that because of the compensation that occurs between yield components in wheat, high yields may result from relatively wide range of seeding rates. While Tompkins *et al.* (1991) reported that the increase of seed rate from 65 to 400 seeds m^{-2} increased grain yield because the higher number of kernels spike^{-1}, obtained with the lower seed rates, was not able to compensate the low number of spikes per unit land. However it seems that increasing the resources may increase the yield at higher seed rate as high seed rates were found to increase yield in well watered conditions, whereas the reverse was true with low soil moisture (Wilson & Swanson, 1962; Tompkins *et al*. 1991).

Herbicides significantly ($p<0.01$) affected the grain yield of wheat (Table 1). Likewise other parameters, the results of Buctril super were promising. Higher grain yield in Buctril super treated plots and lower grain yield in weedy check. However, the grain yield in all the treatments was statistically different from each other. Interaction of sowing method and herbicides was statistically significant (Fig. 3). Weedy check gave the minimum grain yield while Buctril super give the maximum grain yield. While the rest of the treatments significantly increased the yield as compared to weedy check. Interaction of seed rate and herbicides showed that grain yield was significantly ($p<0.01$) affected (Fig. 4). Overall, broadcast sowing produced higher grain yield as compared to line sowing, while in Buctril super treated plots, reverse was the case.

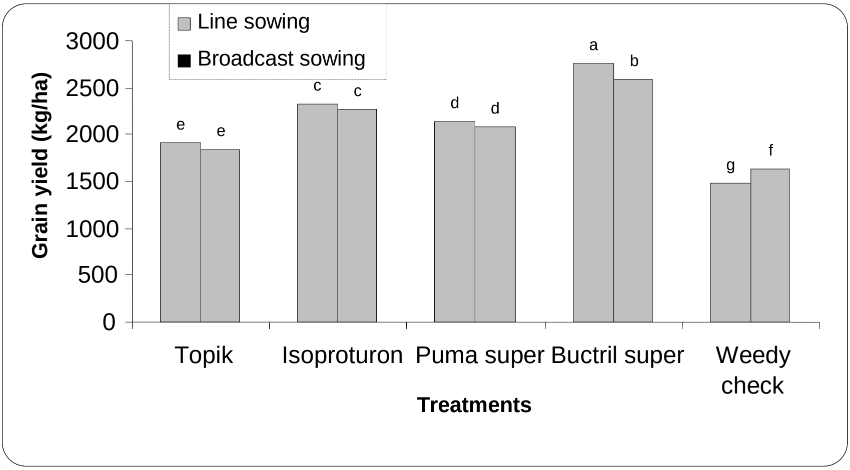

Fig. 3. Interaction of sowing method and herbicides.

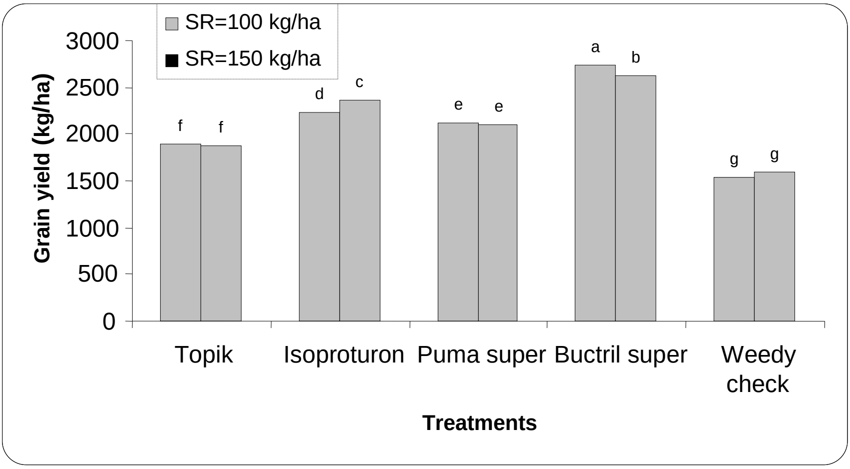

Fig. 4. Interaction of seed rate and herbicides.

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(Received for publication 12 February, 2009)