WALIA journal 31(S3): 158-162, 2015
Available online at www.Waliaj.com
ISSN 1026-3861

Effect of seed rate and post emergence herbicide application on weed infestation and subsequent crop performance of wheat (Triticum aestivum L.)

Meysam Babaei, Saeed Saeedipour *

Department of Agronomy, College of Agriculture, Shoushtar Branch, Islamic Azad University, Shoushtar, Iran

Abstract: Crop-weed competition has a profound effect on wheat grain yield. We evaluated the effects of both the seed rate and weeding regime on the weed infestation and crop performance of wheat. Two factors *via* seed rate (180, 200and 220 kg ha^{-1}) and weeding regimes [no weeding, sulfosulfuron (Apyrous) and sulfosulfuron plus metsulfuron-methyl (Total)] were included in the experiment. The experiment was implemented in a randomized complete block design accommodating with a factorial arrangement and four replicates. Mean data from the experiment showed that weed density and weed dry weight were significantly affected by seed rate; these two variables decreased with the increase in the seed rate ($p < 0.01$).The seed rate significantly influenced different variables that included; spike m^{-2}, grain spike^{-1}, 1000 grain weight, grain yield, biological yield and harvest index. Increased seeding rate was able to increased grain yield and number spike m^{-2}. However, 1000-grain weight decreased with increasing seeding rate. Compared with the weedy check, application of herbicides reduced weed biomass and increased wheat biological and grain yield. The sulfosulfuron treatment resulted in better yield performance compared to other weeding treatments. Overall, the interaction effect of seed rate and weeding regime was significant in respect to grain yield. So, a seed rate of 200 kg ha^{-1}, coupled with sulfosulfuron herbicide treatment, illustrated the best grain yield. Therefore, crop competition accompanied by sulfosulfuron herbicide can be explored as an effective weed management strategy and achieving optimal yield.

Key words: *Crop-weed competition; Grain yield; Seed rate; Wheat*

1. Introduction

Weed infestation is a major concern for crop production; this is particularly the case where modern agricultural practices such as mechanical weeding and the application of herbicides are limited. At present, the aim of weed management is to keep the weed population at an acceptable level rather than to keep the crop totally free of weeds. Among the weed control methods, the chemical control is the easiest one of the recent origins, and the most successful alternative method. Chemical weed control enables farmers to obtain higher yields per unit area with an overall lower production cost. The chemical method of weed control can provide us abrupt and promising results. Herbicides are a quick tool to control dense weed populations. Knowledge about effects of different factors affecting herbicide efficiency, e.g., weed species present, growth stage, competitiveness of the crop, variety, weather conditions and stress from pest or disease damage (Bruce *et al.,* 1996; Xie et al., 1997; Skuterud et al., 1998; Tottman et al., 1998; Medd et al., 2001), increases the accuracy and reliability of using an herbicide. However, a lower dose of herbicide may kill most of the target weeds under favorable conditions. Under less favorable conditions, a higher dose will be required, and under unfavorable conditions even the highest doses of herbicide may still give unsatisfactory results (Medd et al., 2001). Moreover, modern weed science also emphasizes following an ecological approach based on keeping weed populations below threshold levels rather than eradicating them (Barroso et al., 2009). Cultural practices are often effective for enhancing weed competition in crops (Khaliq et al., 2012). Overall, mechanical weed control is expensive in developing countries due to prohibitive initial investment costs and chemical methods often leads to environmental pollution (Omezzine et al., 2011); in addition, many weed species have developed resistance against herbicide. Thus, alternative weed control could be an important way to increase wheat yield by reducing the initial cost of investment and maintaining environmental integrity. Weed species generally have better nutrition efficiency and typically dominates and weakens crop plants, which negatively affects plant morphology and eventually crop yield. Crop density significantly influences the incidence of weeds due to their competition for resources. Several studies have shown higher suppression of weeds by increased crop densities (Carlson and Hill, 1985; Roberts et al., 2001; Scurson and Satorre, 2005; Lemerle et al., 2004; Olsen et al., 2012; Stougaard and Xue, 2004). Lemerle et al. (2004) suggested that increasing crop density reduced the negative impact of rigid ryegrass (Lolium rigidum) on wheat. Olsen et al. (2012)

* Corresponding Author.

indicate that increased crop density in cereals can play an important role in increasing the crop competitive advantage over weeds. Kristensen *et al*. (2008) indicate that increased crop density was negative effects on weed biomass and positive effects on crop biomass and yield. High crop densities can reduce weed biomass and seed yield and yield loss of wheat (Triticum aestivum.) (Cudney et al., 1989). The aim of the present work is to study the seeding density and efficacy of different most effective and economical herbicides to control grass and broad-leaved weeds in wheat under direct drilling, while maintaining acceptable weed population levels and consequently crop yields.

2. Materials and methods

Field experiments were conducted at the Shoushtar Branch, Islamic Azad University, Iran (32^0 3´ N, 48^0 50´ E). during winters of 2012-2013 to evaluate the weed suppressive activity sulfosulfuron and sulfosulfuron plus metsulfuron-methyl at 30 and 45 g a.i, ha^{-1} respectively, applied and wheat density at 180, 200 and 220 kg ha^{-1}. Experiments were laid out in a randomized complete block design (RCBD) with a factorial arrangement and four replicates. The net plot size was 6 m × 2. m. The soil was a clay loam texture, pH of 7.4 and 0.6 % organic matter content. The 30-yr average annual rainfall is 321.4 mm, average annual air temperature is minimum and maximum 9.5 °C and 46.3 °C, respectively. Wheat cv. Chamran was planted in the first fortnight of November. Seedbed preparation consisted of moldboard plowing, disking and leveling. A basal fertilizer dose of 125 kg N, 75 kg P_2O_5, and 60 kg K_2O ha^{-1} was applied in the form of urea (46% N), diammonium phosphate (18% N; 46% P_2O_5) and sulfate of potash (50% K_2O). The whole P and K and half of N were applied at sowing. The remaining half of N was top dressed with the second irrigation at the booting stage. Besides soaking irrigation, four irrigations were applied to produce the wheat crop.

2.1. Statistical Analyses

All data were subjected to analysis of variance using SAS statistical software (SAS, Institute, 2000), and means were separated using protected LSD at P=0.05.

3. Results and discussion

3.1. Effect of seed rate and weeding regime on the density and biomass accumulation of weed

As the crop population brings competition for limited resources with the weeds, we tested different seeding rates to increase crop plant density as a measure to control weeds. The weed population was significantly affected by seed rate ($p < 0.01$; Table1). The highest weed density (m^{-2}) was observed in the area with the lowest seed rate (i.e. 180 kg ha^{-1}). The lowest weed density was recorded in the area with the seed rate of 220 kg ha^{-1} (Table2). In general, there was an inverse relationship between a decreasing weed density ($p < 0.01$) and an increasing seed rate. The increased seed rate resulted in a higher crop plant population providing less space for weeds to grow and offering much higher competition for light, nutrient and other growth factors. These factors collectively resulted in lower weed density. Increasing seed rate of wheat significantly decreased ($p < 0.01$) weed dry weight. The seeding rate also has a profound effect on the weed dry weight in wheat. The highest weed dry weight was recorded in the seed rate of 180 kg ha^{-1} and the lowest was found in 220 kg ha^{-1}. There are several reasons why there was a lower density of weed infestation in areas that had a higher seed rate. At relatively low crop densities, crop cover early in growing season is low, leaving a larger amount of resources available for the weeds, thus enabling them to establish and grow quickly (Kristensen et al., 2008). Olsen et al. (2012) showed increased crop density resulted in reduced weed biomass and increased crop biomass. Guillermo et al. (2009) showed that areas with higher plant densities might have a competitive advantage over weeds due to fast canopy development. A higher seeding rate may keep the weed flora under check through a smothering effect (Mahajan et al., 2010). Mohler (1996) revealed that a higher seeding rate may provide a competitive advantage to crop over weeds because crop plants will absorb limited resources at a faster rate. However, an increased seeding rate may not always increase the weed competitiveness of a crop, and greater intra-crop competition may arise. This may lead to negative effects on crop production, especially under stressful environmental conditions (Krikland et al., 2000). Therefore, an optimal seed rate, along with some weed control, is frequently practiced. For instance, Khaliq et al. (2012) showed that higher seeding density and herbicide tank mixture furnished effective weed control in direct seeded rice. The data regarding dry weed biomass are given in Table2. It is revealed from the data that dry weed biomass (DWB) was significantly affected by various herbicides application. The highest DWB (13.9 gm^{-2}) was recorded in weedy check followed by sulfosulfuron plus metsulfuron-methyl (Total) and sulfosulfuron (Apyrous). Similar to DWB, sulfosulfuron was very effective in reducing weed populations in compare to Total treatment. The reduction in weed density and dry biomass over control under herbicide treated plots is due to their phytotoxic effect. The results pertaining to weed density reduction were evenly reflected in the form of weed biomass suppression. Minimum weed density and biomass in sulfosulfuron plots are presumably due to control of both grassy and broadleaf weeds especially at the early growth stages.

4. Effect of seed rate on yield related to characteristics of wheat

4.1. The Number of spike m-2

A number of variables were significantly influenced ($p < 0.01$) by seed rate: spike m^{-2}, grain spike^{-1}, 1000 grain weight, grain yield, biological yield and harvest index (Table3). The number of spike per m^2 increased with the increase of the seed rate from 180 kg ha^{-1}, to 220 kg ha^{-1}. The highest number of spike per m^2 (420) was recorded at the seed rate of 220 kg ha^{-1}, which was statistically different from others. The lowest number of spike per m^2 was recorded at the 180 kg ha^{-1}seed rate. Increasing the seeding rate by increasing the number of plants has increased the number of spikes per square meter. Chen et al (2008) reported spike density increased with increasing seeding rates. The effect of herbicide on spike number per m^2 was significant. The highest spike number (400 m^{-2}) was observed in sulfosulfuron treatment which had not significant difference compare to metsulfuron-methyl plus sulfosulfuron (Total). The lowest spike number (380 m^{-2}) was recorded in the weedy check (Table3). The higher spike in herbicides treated plots maybe attributed to effective weed control and allocation of more resources to crop plants compared to weeds (Cheema and Akhtar, 2005).

Table 1: Analysis of variance of the traits under study

Variation Source	Degree freedom	Spike m^{-2}	Grain spike^{-1}	1000 grain weight	Grain yield	Biological yield	Harvest Index	Weed dry weight	Weed density
Replication	3	106.4^{ns}	4.1^{ns}	7^{ns}	396.6^{ns}	100.9^{ns}	3.2^{ns}	7.1^{ns}	5.3^{ns}
Herbicide	2	1943.4$^{××}$	256.1$^{××}$	140.2$^{××}$	184822.8$^{××}$	167392.1$^{××}$	570.5$^{××}$	322.5$^{××}$	595.1$^{××}$
Density	2	183412$^{××}$	89.9$^{××}$	70.9$^{××}$	18832.2$^{××}$	197818.6$^{××}$	349.1$^{××}$	163.5$^{××}$	266.1$^{××}$
H×D	4	226.3^{ns}	3.8^{ns}	11$^{××}$	5371.5$^{××}$	4933.1^{ns}	50.1$^{×}$	5.9^{ns}	3.7^{ns}
Error	24	108.7	6.2	2.4	1261.3	2593.2	12.8	2.4	14.7
%CV		12.7	16.2	14.3	17.1	14.4	8.4	19.6	19.9

Table 2: Mean effects of herbicide and plant density on weed number and weed dry weight.

Herbicide	No. weed m^{-2}	Weed dry weight (g m^{-2})
Apyrous	13.1^{c}	3.8^{c}
Total	18.2^{b}	6.3^{b}
Weedy check	26.6^{a}	13.9^{a}
Plant density		
450	24.2^{a}	11.8^{a}
500	19.2^{b}	8.4^{b}
550	14.6^{c}	3.6^{c}

Table 3: Mean effects of herbicide and plant density on yield and yield components of wheat.

H. treatments	Spike m^{-2}	Grains spike^{-1}	1000-grain weight (g)	Grain yield (g m^{-2})	Biological yield (g m^{-2})	Harvest index
Apyrous	400^{a}	40^{a}	37.3^{a}	590^{a}	1280^{a}	47^{a}
Total	395^{a}	37^{b}	37^{a}	540^{b}	1180^{b}	45^{a}
Weedy check	380^{b}	30^{c}	32.5^{b}	370^{c}	1040^{c}	35^{b}
P. density						
450	350^{c}	35^{b}	38.5^{a}	490^{b}	1030^{c}	47^{a}
500	375^{b}	38^{a}	36^{b}	545^{a}	1220^{b}	45^{a}
550	420^{a}	33^{c}	34^{c}	470^{b}	1250^{a}	38^{b}

4.2. The Number of grain spike-1

The highest number of grain spike^{-1}was produced at a medium seed rate (200 kg ha^{-1}), which was statistically different to the number of grain spike^{-1}in 180 kg and 220 kg ha^{-1}seed rate. With increased wheat plant density, beyond the optimal level, might lead to high dilution effect resulting in lower grain spike^{-1}. On the other hand, lower grain spike^{-1}at less-than-optimal densities is probably due to the inability to intercept maximum available light due to poor stand establishment. More number of grains spike^{-1} (40) was observed in sulfosulfuron treatment while lower grains spike^{-1} (30) was recorded in weedy check. The reduction of grain number per spike in the presence of weed was because of reduction in the spikelet number per spike (data not shown). Blackshaw et al. (1981) reported that increasing weed density decreased the spikelet number of wheat, floret fertility and grain number per spike through shading effect of weed. Also, Guillen-Portal et al. (2006) revealed that the grain number per wheat spike significantly decreased in the presence of weed.

4.3. The Weight of 1000 grains

The highest number of 1000 seed weight was observed in the seed rate of 180 kg ha^{-1}, illustrating a decreasing trend with an increasing seed rate. The data pertaining to 1000-grain weight (g) as affected by various herbicides indicated that the heaviest grains (37.3g) were recorded in sulfosulfuron treatment which had not significant difference with metsulfuron-methyl plus sulfosulfuron. The lowest spike 1000-grain weight was recorded in the weedy check (Table3). Mushabar et al. (2000), Ahmad et al.

(2001) and Shahid et al. (2005) also found heavier grains of wheat in treatments where manual and chemical weed control practices were adopted.

5. Grain and biological yield and harvest index

The maximum wheat grain yield was recorded in 200 kg ha^{-1} while the minimum grain yield was obtained in 220 kg seeds ha^{-1} (Table3). Increased wheat grain yield by increasing the amount of seeding rate reflects the increasing competitiveness of wheat in competition with weed. Increased seeding rate over of 200 kg ha^{-1} decreased wheat grain yield. Grain yield and yield components at higher densities decreased, due to the change of resource allocation to storage organs under conditions of competition (Satore and Slafer, 1999). The data given in Table3 revealed the maximum grain yield (590 g m^{-2}) in sulfosulfuron treatment that differed significantly from other treatments. It was followed by metsulfuron-methyl plus sulfosulfuron and weedy check with grain yields of 540 and 370 g m^{-2}, respectively. Higher grain yield in herbicide treated plots may be an outcome of efficient weed control achieved there. These results are in conformation with those of Baghestani et al. (2008), Chhokar et al. (2008) and Santos (2009) who reported that herbicides offer sizeable increase in crop productivity corresponding to their weed control spectrum. Negative correlation of wheat yield with weed density and biomass reflects negative implications of weed competition on final yield. Khaliq et al. (2011) also reported that wheat yields were negatively correlated with weed growth. Wheat biomass was significantly affected ($P<0.01$) by herbicides and plant density levels (Table1).The highest biological yield was found in the seed rate of 220 kg ha^{-1}, while the lowest values were in the seed rate of 180 kg ha^{-1}. However, the harvest index was the highest for the 180 kg ha^{-1}seed rate followed by the 200 and 220 kg ha^{-1}seed rate. Herbicide treatments improved wheat biological yields compared to the weedy check. However, sulfosulfuron consistently provided the highest biological yield (Table3). Minimum biological yield of wheat was achieved with weedy check. Similar effect of herbicide treatments was found on harvest index.

6. Interaction of seed rate and weeding regime on the crop characters of wheat

There was no significant variation in respect of crop characteristics among the treatment combinations, except for 1000 grain weight, grain yield and harvest index (Table4). The highest 1000 grain weight was recorded in seed 180 kg ha^{-1}with sulfosulfuron treatment, while the lowest was in 220 kg ha^{-1}seed with weedy check, which was not statistically different from 200kg ha^{-1}. With the aggravation of the conditions of competition within an inter-species by increasing crop density coupled with the intra-specific competition out in such a way decreases photosynthesis materials share spike and shorten the period of grain filling will be that, these factors can be decreased 1000-seed weight. Bavar (2008) reported that wheat grain weight decreased with increasing density. A weedy plot for an increased weed competition period resulted in decreased grain yield and harvest index in all seed rates. Sulfosulfuron treatment compared to metsulfuron-methyl plus sulfosulfuron and no-weeding treated plots resulted in the highest yield. The highest seed yield amounting 660 g m^{-2}was found when sowing was 200 kg ha^{-1}. In contrast, no-wedding regime resulted in lowest yield in all seed rates (Table4).

In conclusion, this study was prompted by the need for reliable effective methods for controlling weeds through alterations in agronomic practices. Our results support the use of increased crop-weed competition through increases in seeding rate. We hypothesized; either increasing the crop's competitive ability against weeds through manipulation in seeding rate and increasing weed removal through application of sulfosulfuron herbicide would provide superior weed management and recuperative the wheat crop yield.

Table 4: Interaction effects of herbicide and plant density on yield and yield components of wheat

H. treatments	Wheat density m^{-2}	1000 grain weight (g m^{-2})	Grain yield (g m^{-2})	Harvest Index
Apyrous	450	43^{a}	600^{b}	52^{a}
	500	39^{b}	660^{a}	48^{b}
	550	34^{d}	520^{c}	39^{c}
Total	450	40^{b}	510^{c}	49^{b}
	500	37.5^{bc}	600^{b}	49^{b}
	550	36^{cd}	510^{c}	39^{c}
Weedy check	450	33.5^{de}	350^{d}	38^{c}
	500	31^{f}	365^{d}	34^{d}
	550	31.5^{f}	365^{d}	34^{d}

References

Ahmad S., Cheema Z.A., Iqbal R.M. and Kund F.M.; 2001. Study of different weedicides for the control of broadleaved weeds in wheat. Sarhad J. Agric., 7(2), pp. 1-25.

Baghestani M.A., Zand E., Soufizadeh S., Beheshtian M., Haghighi A., Barjasteh A., Birgani D.G. and Deihimfard R.; 2008. Study on the efficacy of weed control in wheat (*Triticum aestivum* L.) with tank mixtures of grass herbicides with broadleaved herbicides. Crop Prot., 27, pp. 104-111.

Barroso J., Ruiz D., Escribano C., Barrios L. and Fernandez- Quintanilla C.; 2009. Comparison of three chemical control strategies for *Avena sterlis* ssp. *ludoviciana*. Crop Prot., 28, pp. 393-400.

Bavar M., 2008. Effects of planting date density on growth indices and yield component of hull- less barley. The Thesis of M.Sc. degree. Univ. Agri. Sci. Nat. Res. Gorgan, 62p.

Blackshaw R.E., Stobbe E.H. and Sturko A.R.W.; 1981. Effect of seeding dates and densities of green foxital (*Setaria viridis*) on the growth and productivity of spring wheat (*Triticum aestivum*). Weed Sci., 29, pp. 212-217.

Bruce J.A., Boyd J., Penner D. and Kells J.J.; 1996. Effect of growth stage and environment of foliar absorption, translocation, metabolism, and activity of nicosulfuron in quackgrass (*Elytrigia repens*). Weed Sci., 44, pp. 447–454.

Carlson H.L. and Hill J.E.; 1985.Wild oat (*Avena fatuva* L.) competition with spring wheat: plant density effect. Weed Sci., **33,** pp.176-181.

Cheema M.S. and Akhtar M.; 2005. Efficacy of different post emergence herbicides and their application methods in controlling weeds in wheat. Pak. J. Weed Sci. Res., 11(1-2), pp. 23-30.

Chen C., Neil K., Wichman D. and Westcott M.; 2008. Hard red spring wheat response to row spacing, seeding rate and nitrogen. Agron. J., 100**,** pp. 1296-1302.

Chhokar R.S., Singh S. and Sharma R.K.; 2008. Herbicides for control of isoproturon resistant little seed canary grass (*Phalaris minor*) in wheat. Crop Prot., 27, pp. 719-726.

Cudney D.W., Jordan L.S., Holt J.S. and Reints J.S.; 1989. Competitive interactions of wheat (*Triticum aestivum* L.) and wild oats (*Avena fatua* L.) grown at different densities. Weed Sci., 37**,** pp. 538-543.

Guillen-Portal F.R., Stougaard R.N., Xue Q. and Eskridge K.M.; 2006. Compensatory mechanisms associated with the effect of spring wheat seed size on wild oat competition. Crop Sci., 46, pp. 935-945.

Guillermo D.A., Pedersen P. and Hartzler R.G.; 2009. Soybean seeding rate effects on weed management. Weed Technol., 23, pp. 17-22.

Khaliq A., Matloob A., Mahmood S., Abbas R.N. and Khan M.B.; 2012. Seeding density and herbicide tank mixtures furnish better weed control and improve growth, yield and quality of direct seeded fine rice. Int. J. Agric. Biol., 14, pp. 499-508.