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Efficacy evaluation of some herbicides and different nitrogen levels for weed management and yield attributes in wheat

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Abstract: Weeds pose serious threat to wheat productivity, and chemical means are usually employed to combat weed menace in field crops. A field study was undertaken at Agronomy Research Farm, Islamic Azad University during 2011-12 to appraise the efficacy of some dual-spectrum herbicides and different level of nitrogen fertilizer against weed growth, and their influence on growth and yield of wheat. Four commonly available dual-spectrum herbicides i.e. metsulfuron-methyl plus sulfosulfuron (Total), iodosulfuron plus mesosulfuron (Atlantis), mesosulfuron-methyl plus iodosulfuron-methyl (Chevalier) and (Topik+Granstar) were applied as early post-emergence application (30 DAS) at five nitrogen levels (0. 75, 150, 300 and 450kgha^{-1}). Weed free and weedy check (control) plots were included for comparison. The experiment was replicated forth in a randomized complete block design following factorial arrangement. Compared with the weedy check, application of herbicides in both growing seasons reduced weed biomass and increased wheat biological and grain yield. Among herbicide treatments, metsulfuron-methyl plus sulfosulfuron reduced weed dry matter by 95.5% in 450kgNha^{-1}, and the lowest weed dry matter was observed with this treatment. Maximum wheat biological yield was obtained in weed free check at 150 kgN ha^{-1}up to 450 kgha^{-1} that was not significantly different from metsulfuron-methyl plus sulfosulfuron at the same nitrogen levels. In comparison, among herbicide, maximum grain yield obtained with application of metsulfuron-methyl plus sulfosulfuron (Total) at the higher levels of nitrogen (300 and 450kgha^{-1}) followed by treatment receiving application of mesosulfuron -methyl plus iodosulfuron methyl (Chevalier) and then mesosulfuron plus iodosulfuron (Atlantis) herbicides. Topik+Granstar at all levels of nitrogen did not provide acceptable weed control in wheat.

Key words: *Herbicide; Nitrogen; Weed dry matter; Wheat*

1. Introduction

Herbicides and fertilizers are major input cost in Iran cropping system. Farmers are cognizant of these costs and thus are interested in alternative approaches to managing weed and improving soil fertility. The importance of nitrogen usage and effectiveness in wheat and other cereals productions has increased due to increase the cost of manufacturing and distributing of nitrogen fertilizer. Application of fertilizers to various crops is an important component of integrated weed management system (Blackshaw, 2005) and manipulation in fertilizer doses to crops can reduce the weeds' interference (Di Tomasso, 1995). Nitrogen is the major nutrient added to increase crop yield (Camra *et al.,* 2003). Crops and weeds have the same basic needs so the competition between them will affect the amount of soil nitrogen. Iqbal and Wright (1997) showed that the relative competitive abilities of wheat and weeds were influenced by nitrogen supply. The crop-weed competitive interaction can be altered by amount (Blackshaw *et al.,* 2003) time and method of nitrogen application (Blackshaw *et al*., 2004) and source (Blackshaw *et al*., 2005). Crop and weed biomass could be increased, unchanged or reduced with increased soil nutrient depending on the weed and crop (Jornsgard *et al*., 1996). Weeds utilize three to four times more nitrogen, potassium and magnesium than a weed free crop (Nayyar et al., 1994). Because of high competitive ability and high reproductive potential of weeds, it is imperative to check their infestation. Shad (1987) reported that yield losses due to weed are in proximity of 17 - 25 percent which in terms of wheat grain comes to about 2.43 to 3.57 million tons annually. 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. Moreover, the control is more effective as the weeds even within the rows are killed which invariably escape, because of morphological similarity to wheat, during mechanical control. Selective herbicides reduce the need for hand weeding. The effectiveness of herbicides is affected by time, rate and method of application. The objectives of the present studies

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were to determine the efficacy of different most effective and economical herbicides used to gather with different levels on nitrogen in controlling weeds and to detect their effect on the yield and yield components of wheat crop under conditions of Iran.

2. Materials and Methods

Field experiment was conducted in 2011-2012 at the Shoushtar Branch, Islamic Azad University, Iran (32^0 3´ N, 48^0 50´ E). The climate is arid and semi-arid with a mean annual rainfall of 321.4 mm and the average of annual minimum and maximum 9.5°C and 46.3°C, respectively. The soil was a clay loam texture, pH of 7.4, soil electrical conductivity was 3.2 $dsm^{-1}$and 0.4 % organic matter content. The available phosphorous and potassium were 10.4 and 155 ppm respectively. Plot size was 2 by 8 m, crop rows at 20-cm intervals. Seedbed preparation included moldboard plough followed by disking and land leveling. The experiment was performed in randomized complete block design in a factorial arrangement with four replications. Treatment consisted of five nitrogen level 0, 75, 150, 300 and 450 kg N ha^{-1} and four herbicide treatments *(*Total, Chevalier, Topik+Granstar and Atlantis) with two control plots weed-free and weed-infested throughout the crop cycle, respectively. Nitrogen fertilizer was applied to plots as urea (46 % N). All the phosphorous (100 kg P_2O_5 ha^{-1}), potassium (100 kg K_2O ha^{-1}) and 40 % of nitrogen according to the treatment level in each plot were broadcasted uniformly at the sowing time and mixed with soil. Remaining 60 % of nitrogen was divided into two topdressings: 40 % at the beginning of stem elongation and 20 % at the beginning of flowering stage. Throughout the growing season recommended irrigation practices were carried out. Weeds were cut at the soil level and dried at 80 °C to a constant weight. To determine the yield and yield parameters of wheat, an area of two square meters was harvested by sickle after physiological maturity and bagged separately. The recorded data was analyzed statistically by using MSTACT-C computer software and a comparison of recorded data was done on the basis of Duncan's multiple range tests at $p_{0.05}$.

3. Results and discussion

Weed dry matter

Weed biomass varied with nitrogen and herbicide treatments. In all nitrogen levels, herbicides reduced weed biomass compared with the weedy check. Total, decreased weed biomass by 95. 5% in nitrogen level of 450$kgha^{-1}$, compared with weedy check (Table2). Ahmadi and Nazari (2013) reported that metsulfuron-methyl plus sulfosulfuron (Total) reduced weed dry matter by 98 %. In terms of the effect on weeds dry matter, there was no significant difference among 450, 300 and 150$kgha^{-1}$ level of nitrogen under metsulfuron-methyl plus sulfosulfuron herbicide application. In comparison, the most ineffective herbicide in relation to weed dry matter reduction was Topik+Grabstar and this event was more severe at higher level of nitrogen. The highest weed dry mater was observed with weedy check at highest level on nitrogen (1160 gm^{-2}). Sheibani and Ghadiri (2011) also reported that the highest weed biomass was obtained from weedy check plots. Application of Chevalier herbicide (Mesosulfuron-methyl plus Iodosulfuron-methyl) decreased weed dry matter by 86.2 in highest level on nitrogen in compare to those respective weedy check treatment. However, there was no statically significant difference among nitrogen level except 150 $kgha^{-1}$ which cause to more reduction in weed dry weight (Table2), although this maybe return to use less nitrogen. Interestingly, the same results obtained in Atlantis (Iodosulfuron plus Mesosulfuron**)** application. According to our finding increased nitrogen application except in metsulfuron-methyl plus sulfosulfuron treatment was more beneficial for weed which was increased the competitive ability of weed and increased its biomass.

Number of Spikes per Square Meter

The results shown in Table 1 and Table 2 revealed that the effect of nitrogen levels, kind of herbicide and interaction effect of nitrogen and herbicide on spike number per m^2 were significant. The highest spike number (617.9 m^{-2}) was observed in weed free treatment which had not significant difference compare to metsulfuron-methyl plus sulfosulfuron (Total) at all levels of nitrogen except zero level. The lowest spike number (254.64 m^{-2}) was recorded in the weedy check at the highest level of nitrogen. Increasing nitrogen application was more beneficial for increased the wheat spike number just when the weed controlled by herbicide treatments. Opposite to that observed in herbicide treatments, in Topik+Granstar herbicide like weedy check treatment due to the lack of effectiveness of herbicide in weed control spike m^{-2} decreased with increased nitrogen (Table2).

Number of Grains per Spike and 1000 Grain Weight

The effects of herbicide treatments, nitrogen levels and their interaction on the grain number per spike were significant. Among the nitrogen levels, the maximum and the minimum of grain number per spike were produced in the application of 450 and zero $kgha^{-1}$ in metsulfuron-methyl plus sulfosulfuron (Total) and weedy check respectively (Table 2). The grain number per spike was decreased in the upper levels of nitrogen (300 and 450$kgha^{-1}$) when accompanied with Topik+Granstar or 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.

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
Replication	3	2613.96^{ns}	32.94^{ns}	131.14$^{××}$	3355902.6$^{××}$	2990980.1^{ns}	99.03$^{××}$	7505.59^{ns}
Herbicide	5	93811.1$^{××}$	615.09$^{××}$	154.66$^{××}$	22030168.8$^{××}$	95309731$^{××}$	22.24$^{××}$	1057972.21$^{××}$
Nitrogen	4	14856.69$^{××}$	126.4$^{××}$	36.26$^{××}$	2087359$^{××}$	4233293.6$^{×}$	27.16$^{×}$	154992.61$^{××}$
H×N	20	7520.84$^{××}$	30.21$^{××}$	21.98$^{××}$	1127552.8$^{××}$	3605839.8$^{××}$	12.92$^{××}$	6505.17$^{××}$
Error	58	2848.53	14.72	5.44	352895	1634334.6	9.12	3054.82
%CV		11.43	10.23	6.42	12.81	12.24	6.83	22.52

ns, ×× indicate an insignificant and significant differences at the P=0.01 level

The results indicated that if weeds are not controlled properly the negative effect of weed competition on the grain number of wheat was increased by increasing nitrogen level. No significant differences were found in grain per spike among 150, 300 and 450 kg N ha^{-1} under metsulfuron-methyl plus sulfosulfuron and Hand weeding treatments. According to Mohajeri and Ghadiri (2003) increasing nitrogen level from zero to 100 kg N ha^{-1} had a significant effect on increasing grain number per spike of wheat. While increasing nitrogen rate more than100 kg ha^{-1} had a non-significant effect on grain number per spike. This finding showed that extra dose of nitrogen had increased the growth and competitive ability of weed instead of wheat. The effect of nitrogen levels and herbicide treatments on 1000 grain weight was similar to their effect on grains per spike.

Table 2: Interaction effects of herbicide and nitrogen level on yield and yield components of wheat

Herbicides	Nitrogen levels	spike m^{-2}	grain $spike^{-1}$	1000 grain weight (g)	Grain yield (Kg ha^{-1})	Biological yield (Kg ha^{-1})	Harvest Index	Weed dry weight (g m^{-2})
Hand weeding	0	435.8e	36.1e	43.8d	5139.2b	11667.3c	44a	0
	75	483.9c	38.9c	46b	5290.1b	11675.5c	45a	0
	150	534.5a	47.5a	46.3b	6007.7a	12956.5a	46.3a	0
	300	609.7a	48.7a	49.6a	6758.3a	14505.5a	46.6a	0
	450	617.9a	48.5a	50.9a	7034.1a	14725.5a	44.8a	0
Weedy check	0	313.8j	24.3k	37.2i	2885.7h	7390.6j	39e	782.8c
	75	413.8f	30.8i	45.8b	3341.3g	7940.5h	42b	374.9f
	150	441e	32.7g	45.2b	3611.2e	8066.9h	44.8a	336.4f
	300	311.8j	27.3j	40.7f	2746.1h	6199.7k	44.3a	962.1b
	450	254.6k	22.3i	39.1g	2151.3i	4639.7i	46.4a	1160a
Total	0	470.6d	36.7c	42.4e	4393c	10812.8d	40.6c	166.3g
	75	517.6a	38.3c	46.9a	4682.6c	11688.4c	40c	103.8h
	150	518.1a	43.4a	49.1a	5429.5b	12928.9a	41.9b	73.4j
	300	571.2a	44.2a	49.2a	6608.9a	14006.2a	47.1a	60.4j
	450	580.1a	47.9a	52a	6857.7a	14244.2a	48.1a	53.7j
Chevalier	0	478.8c	35.8e	47.9a	4407.8c	9820.2e	44.8a	218.8g
	75	512.5b	39.4c	46.9a	4724.1c	10210.7e	46.3a	121.3g
	150	509.3b	39.3c	45.6b	4976.6b	10649.7d	46.7a	95.6j
	300	518.9a	40.5b	44.6c	4965.8b	10795d	46.2	146.9g
	450	502.9c	40.4b	46.3a	4890.6b	10942.8d	44.7a	161.7g
Topik+Granstar	0	378.5j	30.5i	42.5e	3490f	8093h	43.1a	390.3e
	75	438.9e	34.6f	44c	3857.4d	8864g	43.5a	233.5g
	150	420.1f	32.4h	42.4e	3712.2e	8433g	44a	217g
	300	388.5g	32.5h	37.9i	3344.3g	7792.4i	42.9a	482.1d
	450	330.4i	30.5i	38.3h	2941.3h	7396.3j	39.8d	572.7d
Atlantis	0	428.4e	35.5e	43.6d	4498c	10250e	43.9a	188.3g
	75	510b	39c	48.6a	4709.1c	11392.5d	41.3cb	103.1h
	150	509.1b	43.5a	48a	5309.6b	12087.3b	43.9a	97.7j
	300	494.3c	40.1c	47.2a	5233.9b	11521.9d	45.4a	124.2g
	450	507.6b	42.9a	49.4a	5086.7b	11602.3c	43.8a	124.6g

The same letters in each column indicate an insignificant difference at the P=0.01 level

Wheat biological yield

The effect of treatments on wheat biological yield was considerable. Relative to the weed free check, biological yield in the weedy check was reduced by approximately 37.5, and 57.3 and 68.5% at the nitrogen levels of 150, 300 and 450kgha^{-1}

respectively. All herbicide treatments improved wheat biological yields compared to the weedy check. However, metsulfuron-methyl plus sulfosulfuron consistently provided the highest biological yield (Table 2). Minimum biological yield of wheat was achieved with Topik+Granstar herbicide (Table 2). Improvements in various growth attributes of the wheat crop over control under the influence of weed control treatments suggest their effectiveness in lessening weed-crop competition, and hence resulting in better crop growth.

Grain yield

Wheat grain yield in metsulfuron-methyl plus sulfosulfuron at nitrogen level of 300 and 450 $kgha^{-1}$was 6608.9 and 6857.7 kg ha-1, respectively, without significant difference with higher level of nitrogen in weed free check in terms of grain yield (Table2). Maximum and minimum grain yield of wheat in this study were obtained from weed free and weedy checks. Izquierdo et al. (2003) reported that yield losses in some cereal crops due to competition with weeds can reach up to 80% depending on the infestation level. In comparison, among herbicide, maximum grain yield obtained with application of metsulfuron-methyl plus sulfosulfuron (Total) at the higher levels of nitrogen (300 and 450$kgha^{-1}$) followed by treatment receiving application of mesosulfuron -methyl plus iodosulfuron methyl (Chevalier) and then mesosulfuron plus iodosulfuron (Atlantis) herbicides. (Table2). 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. Application of Topik+Granstar at 450 and 300 $kgNha^{-1}$ decreased grain yield by 58.2 and 50.5% as compared to the weed free check during growing seasons, respectively. This could be due to poor weed control of this herbicide. Khaliq *et al*. (2011) also reported that wheat yields were negatively correlated with weed growth.

4. Conclusion

It is concluded that the most effective herbicide treatment was metsulfuron-methyl plus sulfosulfuron (Total) at 150$kgN\ ha^{-1}$up to 450$kgha^{-1}$ which provided maximum reduction in total weed dry matter. All herbicide treatments increased wheat biological and grain yield as compared with the weedy check. Maximum grain yield among herbicide treatments was observed with metsulfuron-methyl plus sulfosulfuron at 450$kgN\ ha^{-1}$. Topik+ Granstar at all levels of nitrogen did not provide acceptable weed control in wheat. Wheat herbicides such as metsulfuron-methyl plus sulfosulfuron are relatively inexpensive and available to farmers in many countries. However, because of the environmental concerns, lower application dose of these new herbicides is recommended for improving weed control in wheat fields.

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