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Original Article

Investigation of Phytotoxicity and Stability of Residuals, Nicosulfuron and Rimsulfuran on Wheat Grown on Two Soil Types

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ABSTRACT

Objective: This research was carried out as a greenhouse experiment in the form of a Completely Randomized Factorial Design (CRD) in three-run sequences. The research aimed at investigating the impacts of Nicosulfuron (Cruz) and Rimsulfuran (Titus) residues on the growth of wheat in two soil types which differed in their levels of organic compounds and salinity. **Methods:** Treatment of the experiment included six different doses of 0, 2, 4, 8, 40, 60 gr per hectare of rimsulfuran and 0, 0.1, 0.2, 0.4, 2, 3 liter per hectare of Nicosulfuron. **Results:** As per the results of the survey, an increase in the concentration of the herbicides caused a meaningful decline in the measured characteristics of the plant including the length and the wet and dry weight of the shoot and the root ($P<0.01$). According to I50 in other words a 50% inhibition of growth indicator, the weight of dry shoot showed the highest sensitivity to rimsulfuran in the soil coded B (1.26) and weight of dry root to Nicosulfuron in soil B (41.84).

INTRODUCTION

Sulfunyluares represent a new generation of herbicides which selectively control broad- and narrow-leaved weeds .These herbicides interfere with the biosynthesis of branched chain amino acids by inhibiting the action of acetolactate synthase (ALS) enzymes. However total amounts of herbicides applied in agricultural production has decreased by more than 30 million Kg since the introduction of ALS inhibitors (Mosavi and Saremi, 2005). But stability of these residual herbicides and their metabolites can affect sensitive plants species negatively during crop rotations across the coming agricultural seasons (Brown, 1990).

Approximately ten herbicide belonging to the different class have been used for chemical weed control on corn in Iran, among which Nicosulfuron and Rimsulfuran have been recently registered (Baghestani et al. 2006). Both instrumental bioassay methods can be used to measure the residue of herbicides (Moyer et al. 2001). Results of the studies were carried out by Moyer (1990) manifested a damage to fettle, canola, lentil, corn, pea, potato and sugar beet as a result of application of sulfosulfuran[3] and triasulfuran[4] on agricultural previously produced on the same land, whereas barley, wheat, bean and linseed were seen to be more tolerant to these herbicides.

Studies conducted in Canada also indicated a problem encountered in growing lentil seven years after the application 40 gr/hectare of chlorosulfuran on the same farm. Izadi Darbandi et al. (2012) investigated the sensitivity of some crops including pea, lentil, barley, wheat, bean and canola to residual herbicides (Nicosulfuron, rimsulfuran and furamsulfuran). The

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studies showed that these herbicides had a significant impact on characteristics such as the rate of biomass and survival of the shoot and the root 30 days after germination.

Only colza showed an increase in concentration of rimsulfuran residual in soil causing a meaningful decline in the above mentioned characteristics. According to the ED50 indicator, bean and barley were the most likely and most sensitive crops to Nicosulfuron and furamsulfuran residue in soil. On the other hand According to the ED50 indicator, barley and colza were the most likely and most sensitive crops to rimsulfuran residue in soil, (Izadi Darbandi et al. 2012). As per the most recent data from the Iranian Centre of Statistics, 12 types of herbicides from the sulfonylurea's family are commonly being applied on crops including sugar-beet, rice, corn, cotton and especially wheat (Mosavi and Saremi, 2005). This issue can lead to repeated usage of herbicides of this group in successive years or even in a specific agricultural season (Ramezani, 2010).

A limited number of studies carried out in the country have focused on the destructive potential of sulfonylureas on sensitive crops used in crop rotations. Thus this research was conducted with the aim to investigate how Nicosulfuron and rimsulfuran residue applied on corn could influence the autumn sugar-beet planted in rotation with corn.

2. MATERIALS AND METHODS

An experiment was performed in the form of a completely-randomized factorial design with three replications a greenhouse located in Torbat-e Heydarieh in 2013. Treatments of the experiment were included six different doses 0, 2, 4, 8, 40, 60 gr per hectare for rimsulfuran and 0, 0.1, 0.2, 0.4, 2, 3 liter per hectare for Nicosulfuron applied on sugar beet grown in two soil types. For this purpose, two types of soil were collected from different areas where the two above mentioned herbicides were not used last year.

The amount of effective herbicide and the volume of solution per hectare were determined considering the weight of the soil used. Different concentrations of herbicides were provided by preparing an initial solution of 5 % and then the required amount of herbicide was proportionately added. Then five seeds of sugar beet were planted in the prescribed soil depth. Irrigation was conducted evenly and slightly in a way that no waste water discharge was produced.

One week after sprouting, the number of seedlings was reduced to 3 and one month later, plants were cut off at the surface of the soil and the roots were rinsed and any soil was washed away. The length and weight of the fresh and dried shoots and roots were measured. The shoots and roots were then dried for 48 hours at 60 °C in a oven for dehydrating. A weighing scale with an accuracy of 0.001 gr was utilized to weigh the dried samples precisely. The concentration of herbicide which causes 50% inhibition, i.e. I50, was estimated by using three- and four-parameter sigmoid and four-parameter weibul equations (equation 1) using the Sigma Plot software and then was used in analyzing the outcomes of the survey: Equation 1

$$f(x,(b,c,d,e)) = c + \frac{d-c}{1+exp\{b\log(x)-\log(e))\}}$$

In this equation, e is the concentration of herbicide which causes 50% inhibition and c and d are the lower (at maximum dosage) and upper limit (at zero dosage) of the dose-response curve, respectively.

3. Results and Discussion

The results of the survey indicated a significantly lower rate in all the measured characteristics of sugar beet ($P<0.01$) with an increase in concentration of Nicosulfuron (from 0.1 to3 Lit per hectare) and rimsulfuran (from2 to60 Lit per hectare) residues in soil (Table 1).

Based on I50 index, the most sensitivity belonged to sugar beet after applying sulforon herbicide in soil A=0.03 (I50) and for Nicosulfuron in soil B=11/44 (I50). It can be concluded that sugar beet is sensitive to low density herbicides remaining in soil. The results showed that both herbicides can cause damage to sugar beet when planted after a corn harvest.

Table 1:

The mean square obtained from analysis of variance of characters under investigation in sugar beet

Variable	Dried root weight	Dried shoot weight	Fresh root weight	Fresh shoot weight	Main root length	Main stem length	Degree of Freedom
Soil type	2632.93**	401.75ns	5330.42**	531.29*	1507.0**	142.95**	1
Concentration of herbicide	5993.64**	3884.51**	224.10**	4222.06**	1089.21**	4144.98**	10
Soil Density	130.88ns	274.71ns	224.10**	191.03ns	62.72ns	12.25ns	10
Error	108.58	200.82	69.30	100.43	48.02	14.40	50
Total	971.52	732.18	819.23	698.84	214.63	436.59	71

ns: meaningfulness at the level of 5%, * meaningfulness at the level of 1%, and ** lack of meaningfulness

As per the results, an increase in the concentration of herbicides in the soil caused an increase in the rate of inhibition in all the measured characteristics. The highest rate of inhibition was seen to be related to the dose of 60 gr/ha of rimsulfuran and 3000 cc/ha of Nicosulfuron for weight of dried root of sugar beet, and these were equal to 90.544 and 87.190 respectively. This point should be taken into account when designing a crop rotation plan as well as when doing management of the above mentioned residual herbicides. Izadi Darbandi et al. (2012) indicated that the rate of growth and survival of the shoots and roots of the plants under study were significantly influenced by Nicosulfuron, rimsulfuran and furamsulfuran residues (Izadi Darbandi et al. 2012). This result corresponds with that of Parrish et al. (1995) studies on barley and pea. These researchers reported that increasing the amount of remaining sulfosulforon herbicide in soil caused an increase in the damage from them to the both plants which had been planted alternately after wheat. The impact of soil types on the length of shoot and root and dry and fresh weights of dry root was significant ($p<0.01$) and the impact of soil on the weight of fresh shoot is meaningful, too ($p<0.05$) while the impact of soil on the weight of dry shoot of beet was not significant. Szmigieleski et al. (2009) carried out an experiment to examine the Terazon sulfon of soil using the response of root and stem in some agricultural products. The results showed that stem growth is do a higher sensitivity than root growth and the toxicity of Terazon sulfon for plants is directly related to the percent of organic carbon and clay in soil. Our results showed that the mean inhibitory percentage of the respective characteristics of soil A was more than that of in soil B. This shows that the physical and chemical features of soil can have an impact on experimental values (Soil A has more organic contents than soil B). In this regard, Shikma (2005) reported that the prediction of damage from remaining herbicides in soil is highly dependent on climatic conditions and soil characteristics. He impact of soil density was significant only for the fresh root weight of sugar beet ($p<0.01$). In a similar way, for Rim solforon in all densities, and for Nicosulfuron in the density of 200, there was a significant difference between soil A and, as much as 5 percent. For the other densities of the two herbicides in soil, no significant difference was seen. According to the results, in sugar beet, the graphic response of the characteristics studied to the changes of density of two herbicides in soil was in a logistic model (1, 2), which conforms to results of other studies done.

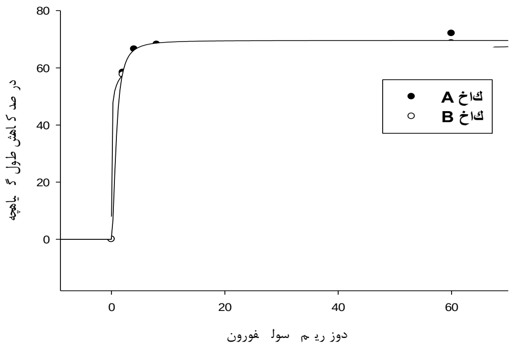

Figure 1:

A comparison of the percent of shoot length decrease in sugar beet with that of the control group after applying Rimsulfuran in different densities

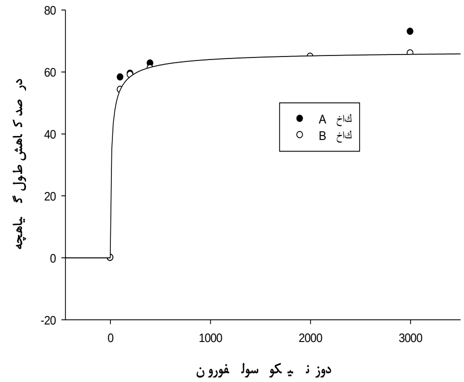

Figure 2:

A comparison of the percent of shoot length decrease in sugar beet with that of the control group after applying Nicosulfuron in different densities

Conclusion

The result of this study is similar with several other studies. Even the low use of Sulfonylurea herbicides does not guarantee a prevention of adverse environmental effects because small amounts of the same can have high levels of biological activity [1]. Considering the alkaline soil in most parts of Khorasan and higher stability of Sulfonylurea herbicides in such soils, it is important to consider it for corn production and observe the appropriate time intervals for planting crops sensitive to it. It is suggested that biological experiments need to be done in different conditions, especially in real conditions of farms on other products which are going to be planted alternately after applying these herbicides. And if the damage to the product is high, a change in the planting arrangement becomes necessary. If it is not possible to change the type of crops, then a less damaging herbicide to the soil should be used.

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