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Weeds Response to Application Times and Doses of Herbicide in Different Red Bean Cultivars

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ABSTRACT

This study was conducted to evaluate the effect of different application times and doses of bentazon on weeds growth in different red bean (Phaseolus calcaratus) cultivars. Three factors were studied in split factorial in the form of a randomized complete block design with three replications. The main factor was red bean cultivar (Naz and Derakhshan), the sub factor was time of herbicide application (one sprayed at the third trifoliate stage and another sprayed 15 days after the first spray), and the sub-sub factor was herbicide application dose (1.5, 2.5, 3 and 3.5 li/ha). Results indicated that the treatments significantly affected most of the measured traits. The best weed control was obtained in Naz cultivar. Spraying 3.5 li/ha bentazon at the third trifoliate stage was the most effective herbicide treatment which reduced weeds infestation and increased red bean yield and yield components.

Key words: bentazon, cultivar, herbicide dose, *Phaseolus calcaratus*, weed.

INTRODUCTION

Weed management is an important agronomic practice, if carried out by hand, takes 40% of time of small holder farmers. This is the case especially in developing countries that industrialization process is happening. In contrast, chemical methods are effective tools which can compensate for the low labor. Today, it is understood that chemical herbicides are not free of problem, so researcher are working on integrated weed management, which brings together all the possible methods of weed control [12, 19]. Zargar et al. (2011) reported that integrated weed management reduced weeds infestation and decreased the need for herbicides [15].

Integrated weed management is a method which takes advantages of so many different methods to suppress weeds in a more natural way. One of the methods used in integrated weed management is the cultural method such as the selection of highly competitive cultivars. These cultivars must be able to suppress weeds growth and be able to grow well under weed infested conditions. Although these two features are vital, none of them are taken into consideration today by the farmers [11]. During the past decades, plant breeding programs had only focused on the improvement of high yield cultivars which can grow and yield better under weed-free conditions, but nowadays researchers represent that high yield is only possible when a clever combination of weather, soil, plant and management is used. A vast number of experiments have concluded that different cultivars vary greatly in their ability to complete weeds [2, 6, 21]. Cousens and Mokhtari (1998) reported that there is a large variability in the tolerance of wheat cultivars to competition with *Lolium rigidum* [17].

Another factor studied in this experiment, in addition to the selection of more competitive cultivar, was the chemical method. In fact, times and doses of bentazon (a photosynthesis II inhibitor herbicide) application were studied. Time of herbicides application is the key factor which greatly affects their efficiency. This is because weeds are more sensitive to herbicides at some stages and crops may also be sensitive to herbicide at some stage [9].

The recommend doses (full doses) of herbicides are determined for the maximum weed control, the nearest to 100% control. But reduced dosed which are lower than the full dose may also control weeds sufficiently and give desirable yield [5]. Fernandez et al. (2000) represented that reduced doses may give comparable yield to that obtained in the full dose application [4]. Hamill and Zhang (1995) reported that application of reduced dose of herbicides can reduce weeds density below the economic threshold [3]. Talgre et al. (2004) also concluded that application of 25 to 40% of the recommended dose efficiently controlled weeds without significant yield loss [10].

The aim of this study was to increase the efficiency of weed management in two red bean cultivars by the selection of proper time and dose of bentazon application.

MATERIALS AND METHODS

This experiment was conducted in 2010 at a personal research farm in Shahriar, Iran (50^{o} 50' E, 35^{o} 40' N and 1135 m above the sea level). The long term meteorological data records classify this area as a semiarid climate with dry warm summers and humid cold winters. This study was conducted in a split factorial experiment in the form of randomized complete block design with three replications and three factors:

Red bean cultivar: two red bean cultivars called Naz and Derakhshan, as the main factor.

Time of herbicide application: two times of herbicide application including (1) the third trifoliate stage and (2) 15 days after the third trifoliate stage, as the sub factor.

Dose of herbicide application: four doses of bentazon including 1.5, 2.5, 3 and 3.5 li/ha, as the sub-sub factor.

After preparing the experimental field according to the conventional method, red bean seeds were planted. The weed free controls were created by repeated hand removal. At the two mentioned stages (the third trifoliate, and 15 days after the third trifoliate) bentazon was sprayed in four required doses along with 300 li/ha water. Weeds sampling was conducted 15 and 30 days after spraying, by the means of a 1 m × 1 m quadrate. The natural weed infestation at the field included redroot pigweed (*Amaranthus retroflexus* L.), black nightshade (*Solanum nigrum*

L.) and perennial sowthistle (*Sonchus arvensis* L.). At the end of the growing season, red bean yield and yield components were measured.
For statistical analysis, first, the increasing or decreasing effect of treatments was calculated as percentage, compared with the control. Then, all data were analyzed using SAS (2002) [20] and MSTAT-C, and means were compared according to Duncan's multiple rang test.

RESULTS AND DISCUSSION

Weed density. Results indicated that cultivar significantly affected *A. retroflexus* and *S. arvensis*. This means the two cultivars had different competitive ability with weeds; Naz was more competitive than Derakhshan (Figure 1). Other researchers have also reported the variable ability of different cultivars to complete with weeds [2].

Time of herbicide application had also significant effect on *A. retroflexus* and *S. arvensis*, but had no effect on S. nigrum. S. nigrum has probably shown same response to the time that herbicide was applied. Spraying bentazon at the third trifoliate stage was more effective than spraying 15 days after the third trifoliate (Figure 2). This verifies that bentazon is more effective when applied at early growth stages that weeds are more sensitive. Motley et al. (2004) also concluded that growth stage greatly affects the efficiency of herbicide [9].

Dose of bentazon significantly affected *A. retroflexus* and *S. arvensis*; *S. nigrum* showed no response to dose. Increasing the dose of herbicide application from 1.5 to 3 li/ha increased weed control and 3.5 li/ha controlled weeds by 100% (Figure 3). In another experiment, Barros et al. (2009) concluded that although the full dose was better, reduced doses were also effective and controlled weeds desirably [7]. They suggested that to increase the efficiency of reduced doses, herbicide must be applied at early growth stages of weeds.

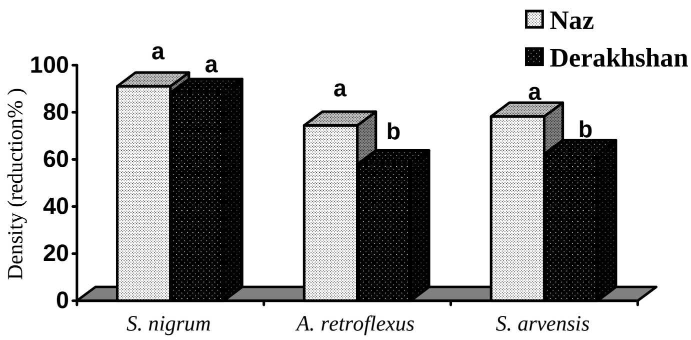

Figure 1. Effect of cultivars on reduction of weeds density.

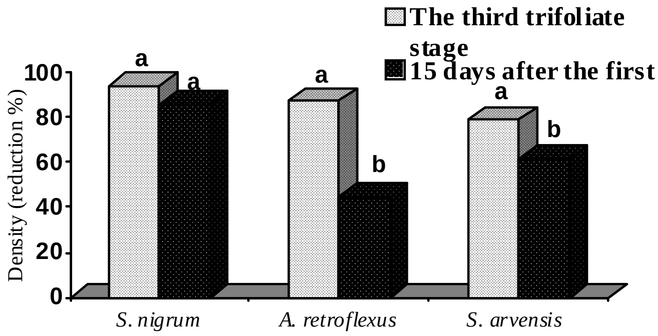

Figure 2. Effect of times of herbicide application on reduction of weeds density.

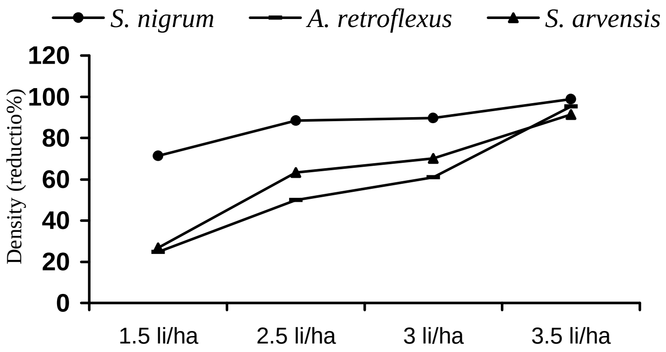

Figure 3. Effect of doses of herbicide on reduction of weeds density.

Weeds biomass. Results indicated that cultivar had significant effect on *A. retroflexus* biomass. Mean comparison showed that Naz and Derakhshan reduced this weed's biomass by 78.2% and 58.6%, respectively (Figure 4). By cultivating more competitive cultivars which compete better with weeds and grow better under weed infested conditions, it is possible to reduce the need for chemical herbicides. Here, Naz cultivar have had more dense canopy and faster growth; leaving lower space and light for weeds to grow.

Time of herbicide application significantly affected *A. retroflexus* and *S. arvensis* biomass. According to the mean comparison, spraying at the third trifoliate stage was more effective and reduced *A. retroflexus* and *S. arvensis* by 79.2% and 93.1%, respectively (Figure 5). In another experiment [1], Auskalnis (2003) tested the effect on reduced herbicide doses on weed and concluded that when weeds are at their early growth stages, even reduced dosed of herbicides can control them efficiently. Minotti and Sweet (1981) reported that application of a suitable herbicide at the early growth stages controls weeds efficiently and makes crop the winner of competition [16].

Dose of herbicide significantly affected *A. retroflexus* and *S. arvensis*. Increasing the dose of herbicide application from 1.5 to 3.5 li/ha enhanced the percent of weed biomass control; weeds biomass control was nearly 100% in 3.5 li/ha. Knezevic et al. (2003) reported that although the full dose of herbicide caused the highest weed control, 25% of the full dose also resulted in an acceptable weed control [13].

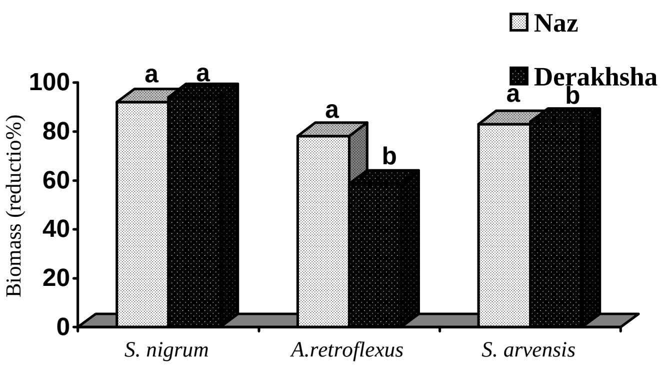

Figure 4. Effect of cultivars on reduction of weeds biomass.

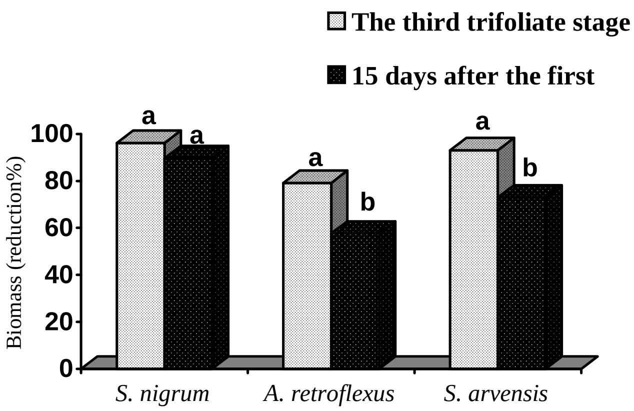

Figure 5. Effect of times of herbicide application on reduction of weeds biomass.

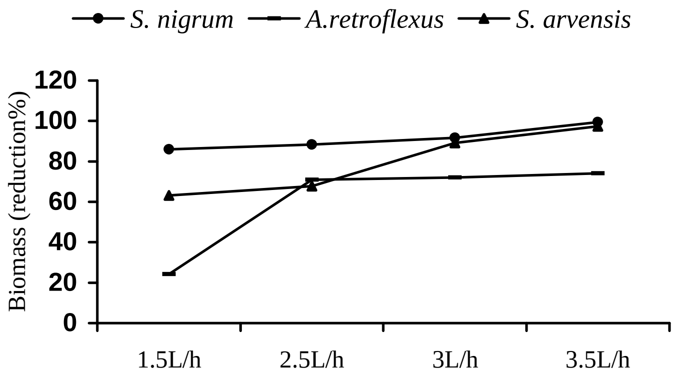

Figure 6. Effect of doses of herbicide on reduction of weeds biomass.

Red bean yield and yield components. Cultivar significantly affected 100 kernels weight, main stem pods weight and main stem grains weight. Mean comparison indicated that Naz was better than Derakhshan in most cases (Table 1).

Table 1. Effect of the treatments of red bean yield and yield components

Treatments	% of improvement						
	100 kernels weight	Yield	Main stem's pod weight	Lateral branch's pod weight	Main stem's grain weight	Lateral branch's grain weight	Pod weight
Naz	8.9a	45.3a	56.5a	62.6a	49.8a	44.1b	42.7a
Derakhshan	5.6b	43.3a	26.2b	44.8a	35.7b	56.9a	46.8a
Spray at the 3rd trifoliate stage	7.8a	42.5a	41.6a	51.6a	46.1a	52.2a	48.6a
Spray 15 days after the 3rd trifoliate stage	6.6b	46.5a	36.2b	55.0a	39.0b	49.8a	41.0b
1.5 li/ha	6.0c	36.6b	31.0b	33.3b	49.4b	22.8e	43.2b
2.5 li/ha	4.5d	37.9b	39.4b	26.9c	43.1b	29.2d	40.0b
3 li/ha	7.1b	42.0ab	41.0b	35.3b	43.9b	33.4c	45.4b
3.5 li/ha	8.2a	45.8a	54.4a	55.5a	65.6a	66.0a	60.9a

Means in a column followed by the same letter are not significantly different at P≤0.05

Results also represented that time of herbicide application significantly affected main stem pods weight, main stem grains weight, pods weight and 100 kernels weight. Spraying bentazon at the third trifoliate stage was more effective on the mentioned traits (Table 1). These results prove that spraying herbicides at early growth stages reduces weeds infestation and improves crops growth and yield. Other researchers reported that red bean yield would reduce if weed control do not take place before the 5-7 weeks after planting [8, 18].

Finally, dose of herbicide application had also a significant effect on all the measured traits (Table 1). In most cases, increasing the dose from 1.5 to 3.5 li/ha ended in better yield. Popp et al. (2000) reported that application of reduced doses of herbicide controlled weeds and gave desirable soybean yield [14].

CONCLUSION

Results of this experiment showed that Naz is better cultivar than Derakhshan for weed competition and yield production. Among the herbicide treatments, weed control was the best when 3-3.5 li/ha bentazon was sprayed at the third trifoliate stage; resulting in the highest yield.

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