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Determination of some attributes of lentil (*Lens culinaris*) with higher effect on yield via step by step regression analysis

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Abstract

Stepwise regression includes regression models in which the choice of predictive variables is carried out by an automatic procedure. In order to determination of some growth attributes of lentil (*Lens culinaris*) with higher effect on yield an experiment was conducted. All data were statistically analyzed based on RCBD using MSTAT-C software. The means of the treatments were compared using the least significant difference test at * $P < 0.05$. Based on data obtained, when lentil cultivated on 5th March and sprayed with Lorox on 4-6 weed leaves stage, grain yield increased up to 1578 kg ha^{-1}, but in those seeds sown on the same time and sprayed with Lorox on 2-4 weed leaves stage yield reduced to 1157 kg ha^{-1}. To formulate the relationship among five independent growth variables measured in our experiment for lentil crop with a dependent variable, multiple regression analysis was carried out. Furthermore, the stepwise regression analysis was also carried out for the data obtained to test the significance of the independent variables affecting the grain yield. The stepwise regression analysis verified that the number of secondary branches and pods per plant and weeds biomass had a marked increasing effect on the lentil grain yield.

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Introduction

In statistics, stepwise regression includes regression models in which the choice of predictive variables is carried out by an automatic procedure (Draper and Smith, 1981). Weeds are the most omnipresent class of pests that interfere with crop plants through competition and allelopathy, resulting in direct loss to quantity and quality of the product (Gupta, 2006).

Chemical weed control seems indispensable and has proved efficient in controlling weed (Kahramanoglu and Uygur, 2010). In Iran, herbicide usage accounts for 41% of the total pesticide consumption. Out of total imports of herbicides into the country 30% were used on pulse crops. Providing a weed-free environment from the time of planting to canopy closing is important for strengthening the native groundcover's competitive ability against weed invasions. Selective herbicides kill specific targets while leaving the desired crop relatively unharmed (Kellogg *et al.*, 2010).

There are normally many groups of damaging weeds in lentil fields. Dose-response studies are an important tool in weed science. The use of such studies has become especially prevalent following the widespread development of herbicide resistant weeds (Seefeldt *et al.*, 1995).

With decreasing of herbicides application up to 60% of recommended dose grain yield reduced 60%, 6% and 36% in Sulfosulfuron, Sulfosulfuron+Met-sulfuron and Iodo-sulfuron+Meso-sulfuron, respectively, as compared to the 100% of recommended dose treatment. A mix stand of grassy and broad-leaved weeds is reported to cause 48% yield loss of wheat (*Triticum aestivum* L.) (Khan and Haq, 2002).

The plant breeders need to information about yield related characteristics in some of legume crops for possibility of breeding activities. The present study was aimed to determination of some attributes of lentil (*Lens culinaris*) with higher effect on yield via step by step regression analysis.

Materials and methods

Experimental location

The experiment was conducted at the Research Station of Varzgan, East Azarbaijan, Iran, in a sandy loam soil with pH of 7.6 and organic matter of 1%. Varzgan is located in the north-west of Iran and the climate is semiarid and cold; in spite of dispersed precipitation in summer, it's arid and average annual precipitation is 270 mm. The experimental field had been in a corn-potato rotation cycle for the last two years.

Materials studied

Lorox agricultural herbicide is an important tool for growers faced with combating resistant weeds. Lorox, provides a different mode of action versus ALS inhibitor herbicides and a different behavior mechanism versus triazines. This makes it an invaluable tool in controlling herbicide resistant weed populations. It is registered for use on potatoes, carrots, lentil, soybeans, and some of other crops in Iran. Lorox provides broad-spectrum control of grasses and broadleaf weeds.

Cultivation activities

The experimental area was ploughed in the fall and manured with 7 t ha^{-1} and then disked and plotted before sowing the seeds. Based on soil analysis field was fertilized with 50 kg ha^{-1} urea, 80 kg ha^{-1} P_2O_5 and 40 kg ha^{-1} K_2O. In this study, post-emergence herbicide; Linuron, was used in concentrations of 1000 cc ha^{-1}, 1250 cc ha^{-1} and 1500 cc ha^{-1} as recommended dose to control weeds in its 2-4 and 4-6 leaves stages. This herbicide has been previously tested safe on well established lentil plants. The treatments were laid out in a split plot factorial experiment with 3 replicates.

Inoculated lentil seeds with *Rhizobium legominosarum*, was sown at 85 seeds m^{-2} in 25-cm rows in 5th March as (early sowing date) and 5th April (as conventional sowing date). At maturity in 11th July, lentil plants at the center 1-m^2 portion of each plot were hand harvested.

Statistical analysis

All data were statistically analyzed based on RCBD using MSTAT-C software. The means of the treatments were compared using the least significant difference test at * $P < 0.05$.

Results and discussion

Observed weed species in the Experiment

Narrow and broad leaves weed species in our experiment were *polygonum aviculare, Raphanus rahanistrum*, *Daucus carota*, *Scandix pecten-veneris*, *Avena fatua*, *Galium spurium*, *Centaurea depressa*, *Silene conoidea*, *Hordeum vulgare* and *Capsella bursa-pastoris*.

Table 1. Interaction of sowing date and spraying time on some of traits in lentil and weeds biomass.

Treatments		number of pods per plant	grain yield kg ha^{-1}	weeds biomass g m^{-2}
Sowing date	Spraying time			
5th March	2-4 weed leaves stage	28.6a	1249a	0.62a
	4-6 weed leaves stage	24.9ab	1042b	0.99a
5th April	2-4 weed leaves stage	22.2bc	606c	1.99b
	4-6 weed leaves stage	17.8c	638c	2.09b

Means comparison

There is no significant difference between spraying times of linuron on number of pods per plant of lentil in early sown (5th March) and 30 days later (5th April) dates. Completely developed pods per plant were averaged 26.5 and 20 pods in 5th March and 5th April (Table 2). Muehlbauer (2002) reported that in expected sowing of lentil yield could be improved 20-30% due to seedlings better establishment and yield attributes increase.

Table 2. Correlation coefficients of studied traits in lentil and weeds.

	Stem height	Number of secondary branches	Number of pods per plant	100 seed weight	Grain yield	Weeds biomass
Stem height	1					
Number of secondary branches	0.27	1				
Number of pods per plant	0.29	0.56**	1			
100 seed weight	-0.20	0.09	0.17	1		
Grain yield	0.22	0.31	0.43*	0.55**	1	
Weeds biomass	0.14	0.22	0.20	-0.08	0.30	1

Based on means of data obtained, when lentil cultivated on5th March and sprayed with lorox on 4-6 weed leaves stage, grain yield increased up to 1578 kg ha^{-1}, but in those seeds sown on the same time and sprayed with lorox on 2-4 weed leaves stage yield reduced to 1157 kg ha^{-1}. Whereas, in late sown lentils on 5th April at both spraying times yield reduced significantly (Figure 1).

Numerous herbicide molecules at lower than-recommended rates are effective enough to provide satisfactory weed control without sacrificing yields and increasing weed infestation in the following years (Khaliq *et al.*, 2011; Zhang *et al.*, 2000). Reduced herbicide doses seem to offer a promising tool for decreasing herbicide usage across the globe. Zhang *et al.* (2000) reviewed use of reduced herbicide doses and concluded that weed control efficiency tends to be lower and more erratic at reduced doses than at recommended doses, although it was commercially acceptable in most cases.

In our experiment weeds above ground biomass ranged from 2.1 g m^{-2} in 5th April sowing time and 4-6 weed leaves stage up to 0.62 g m^{-2} in 5th March sowing time and 2-4 weed leaves stage (Table 2). It seems that early sowings could be effective in weeds control in lentil fields. In late sown lentils weeds did not suitably controlled. But in early sown crop farmers could decrease weeds damage by application of 1250 cc ha^{-1} linuron (Table 2). This study resulted that in early sown lentils herbicide application can be economized.

Table 3. Standard regression coefficients, T values and probability level of traits in model.

	Number of secondary branches	Number of pods per plant	Weeds biomass
Standard regression coefficients	+0.499	+0.555	+0.475
T values	+2.009	+2.813	-3.039
Prob.	0.001	0.001	0.005

Indiscriminate use of herbicides for weed control during the past few decades has resulted in serious ecological and environmental problems, such as resistance and shifts in weed populations (Heap, 2007), and greater environmental and health hazards (Rao, 2000).

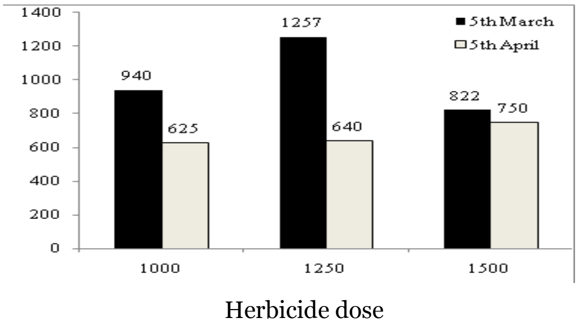

Fig. 1. Interaction of sowing date and herbicide dose on grain yield.

Regression analysis

In this study, to formulate the relationship among five independent growth variables measured in our experiment for lentil crop with a dependent variable, multiple regression analysis was carried out for the stem height (X_1), number of secondary branches (X_2), number of pods per plant (X_3), 100 seed weight (X_4) and weeds biomass (X_5); and grain yield (GY) as a dependent variable. The multiple regression equation for grain yield is as follows:

$$OY = 200.000 + 1.021(X_1) + 12.854(X_2) + 0.458(X_3) + 14.546(X_4) - 10.587(X_5) \quad (1)$$

Furthermore, the stepwise regression analysis was also carried out for the data obtained to test the significance of the independent variables affecting the grain yield. The stepwise regression equation is as follows:

$$GY = 110.054 + 8.800\,(X_2) + 5.874 - 4.199\,(X_5);\ R^2 = 76 \quad (2)$$

Conclusion

The stepwise regression analysis verified that the number of secondary branches, number of pods per plant and weeds biomass had a marked increasing effect on the lentil grain yield.

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