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Evaluation of protein accumulation pattern in lentil seeds as affected by different period of weeds interference

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ABSTRACT: In order to study the effect of different periods of the presence of weeds on 1000-seed weight, protein percent, protein yield, seed yield and seed N content of lentil, the present study was carried out in research farm of University of Mohaghegh Ardabili, Ardabil, Iran on the basis of a Randomized Complete Block Design with three replications in spring of 2011. The treatments included the absence of weeds for 15, 30, 45, and 60 days after sowing date and the presence of them for 15, 30, 45 and 60 days after sowing date. The study had two control treatments, i.e. the absence of weeds in whole growing season (full absence of weeds) and the presence of them in whole growing season (full presence of weeds). At the end of these periods, the plots were sampled and then, the samples were transferred to the agronomy laboratory of Department of Agriculture. After extracting the protein of the seeds, its amount was measured by Bradford method on 595 nm wavelength. The analysis of protein data showed that weeds significantly affected protein yield at 1% probability level. The highest and lowest protein content of lentil seeds was obtained from the treatments of simultaneous growth of weeds and the absence of weeds, respectively.
Keywords: lentil, weeds, protein percent, protein yield.

INTRODUCTION

Cereals are widespread crops in arid and semi-arid regions. Lentil (Lens culinaris medic) is regarded as the most important pulse in the world with global cultivation area of 4 Mha and production of 4 Mt in 2005 (Brand et al., 2007). It has protein content and its cultivation dates back in the Near East to about 8500 years ago (Zand et al., 2004). Lentil seed has on average 26% protein and can be included in food regime of people especially that of low-earning stratum with complementary grains (FAO, 1988). Despite high importance of this crop in terms of its high protein content and its resistance against drought which allows its cultivation in rain-fed system (Anvar, 1993; Bagheri et al., 1997), it is weak in competition with weeds due to its low height and slow initial growth (Erman et al., 2004). So, it is regarded as a weak competitor to weeds at germination stage and it takes a long time for its plants to fully cover the earth (Tab, 2005). It can be said that weeds are unasked plants which are present in plant population and create adverse conditions for the growth and development of the crops and consequently, result in the loss of yield and/or the quality of the harvest (Mohammad-Doust Chamanabadi, 2011). Some of the damages induced by weeds can be listed as the consumption of the nutrients required by crops, allelopathy, radiation blockage, and shading which result in the loss of the yield of the crops. Therefore, weeds compete with crops on different resources such as water, light, and nutrients (Ahmadi et al., 2007). Proteins are a specimen of intracellular osmoprotectants which are affected by weeds. In a study on an indigenous variety of lentil in Turkey, Kaya et al. (1999) showed that total N, protein and water-soluble protein content was increased with seed yield. The yield of lentil is relatively low in Iran which can be related to the lack of sound and on-time control of weeds (Kanooni, 1995). Given that weeds reduce the seed yield, seed protein content is decreased with the increase in the period of the presence of weeds.

MATERIALS AND METHODS

The present study was carried out in research farm of Department of Agriculture of University of Mohaghegh Ardabili, Ardabil, Iran in spring of 2011 on the basis of a Randomized Complete Block Design with three replications. The treatments included different periods of the absence and presence of weeds, each one at five levels with 15-day intervals to each other (15, 30, 45, and 60 days). The first group of treatments included control (W1) in which the weeds were not controlled at all at whole growing season, the presence of weeds for 15 days after sowing (W2) after which the plots were manually weeded until the end of growing season, and the treatments of W3, W4 and W5 in which the weeds were left untouched for 30, 45 and 60 days after sowing, respectively, after which they were weeded until the end of the growing season. The second group of treatments included control (W'1) in which the weeds were controlled in whole growing season, W'2 in which the weeds were controlled only for 15 days after sowing and then, they were left untouched until the end of the growing season, and W'3, W'4, and W'5 in which the weeds were controlled for 30, 45 and 60 days after sowing and then, they were controlled. Replications were composed of 10 plots spaced 75 cm apart. The plots were composed of five sowing rows spaced 20 cm apart with on-row plant spacing of 3 cm. At the end of growth period, the plots were separately sampled. Then, protein content was measured by Gams et al. (1990)'s method. Afterwards, the amount of protein was measured using Bradford method by spectrophotometry for which the absorption in 595 nm was measured. Bovine serum albumin was used as the standard in the measurement of seed protein content. Then, protein yield and seed N percent were measured by the following equations, respectively:

$$\text{lentil seed protein yield} = \text{seed dry weight} \times \text{protein percent} \qquad \text{Eq. (1)}$$

$$\mathrm{N}\,(\%) = \mathrm{P}\,(\%) \times 6.25 \qquad \text{Eq. (2)}$$

where, N(%) shows seed N percent and P(%) shows seed protein percent. In addition, 6.25 is the constant of the equation. Seed yield was calculated by the dry weight of the seeds of two middle rows ignoring 0.5 m from both ends of the rows. Then, the data were analyzed by SAS software, means were compared by Duncan's Multiple Range Test and the graphs were drawn by MS-Excel software.

RESULTS

Analysis of variance revealed that different times of controlling weeds significantly affected seed protein yield at 1% probability level. Also, weeds influenced 1000-seed weight, seed yield, seed protein content, and seed protein and N percent (Table 1).

Analysis of variance of the treatments of the weeds interferences until pre-determined times showed that seed yield had significant differences among the treatments and these treatments significantly affected seed protein percent at 1% probability level. In addition, weeds brought about significant differences in protein yield and seed N content at 1% probability level (Table 2).

Thousand-seed weight

Thousand-seed weight under W'2 treatment was more affected by weeds than under other treatments, so that it was the lowest under that treatment. The highest 1000-seed weight was observed in the treatments of W'5 and W'1. The treatment of W'4 produced the lowest 1000-seed weight after the treatment of W'2 (Table 3). But the interference of weeds sharply decreased 1000-seed weight, so that the treatments of W1 and W5 resulted in 100% loss of 1000-seed weight and the highest 1000-seed weight was obtained from the treatments of W4, W3 and W2, respectively (Table 4).

Seed yield

It was found that the treatment of W'2 resulted in the lowest seed yield and the highest one was obtained from the treatment of W'1. The effect of weeds under the treatments of W'1 and W'4 was the lowest (Table 3). The treatments of W1 and W5 resulted in greater loss of seed yield than other treatments. Furthermore, the highest seed yield was observed in the treatment of W2 (Table 4).

Seed protein percent

All studied treatments resulted in higher seed protein than the treatment of W'2. Therefore, the more the weeds were controlled, the higher the seed protein content of lentil was (Table 3). Results indicated that under the treatments that the weeds were present and compete with lentil plants for longer time, protein percent was increased and in the treatments of the presence of weeds for more than 45 days, seed protein percent started to decrease after the onset of weeds control. The highest protein percent was observed in the treatments of W4 and W'1 (Table 4).

Protein yield

It was found that protein yield under the treatments of W'1, W'3, W'4 and W'5 was significantly higher than that under the treatment of W'2 (Table 3). In addition, it was shown for the treatments of the weeds interference that the treatments of W3, W2 and W4 had significant differences with the treatments of W1 and W5 (Table 4).

Seed nitrogen percent

Seed N percent was significantly decreased under the treatment of W'2 as compared to other treatments at 1% probability level, so that the treatments of W'1, W'5, W'4 and W'3 gave rise to the highest seed N percent, respectively (Table 3). Furthermore, like protein percent, seed N percent showed slighter decrease under the treatment of W'4 and seed N percent was 0 under the treatments of W1 and W5 (Table 4). The treatments of long-time interference of weeds resulted in the loss of whole lentil plants. Thus, lentil plants produced no yield due to the removal of whole plants.

DISCUSSION

Given that weeds are among factors strongly affecting the yield of the crops, they should be accounted for if an acceptable yield is expected (Mirshekari, 2003).

The extent of the competition of weeds depends on species, the extent of their presence, interference period and climatic conditions affecting the growth of weeds and crops (Erman et al., 2008). In a study on the effect of different periods of weeds interference on the yield of rapeseed, Yaghoobi and Siyami (2008) showed that the yield was decreased as the length of the interference of weeds was increased. Weeds competition reduced lentil yield as much as 84% (Al-thahabi et al., 1994; Kumar and Kolar, 1989). Weeds compete with crops to get soil moisture, nutrients and growth limiting factors in rain-fed regions. Lak et al. (2005) tried to determine critical period of weeds control in pinto bean fields and found that the increase in the accumulation of weeds dry matter due to their long-time presence in field resulted in the loss of final yield of pinto beans.

Also, Mishra et al. (2006) studied the effect of different densities of wild garlic (Allium ursinum L.) on lentil yield and reported that the increase in weed density reduced lentil yield so that as the number of weed plants increased from 25 to 800, the yield was decreased by 2.15 and 31.3%, respectively.

In a study on six indigenous Turkish varieties of lentil (Emre 20, Malazgirt 89, Kislik Kirmizi 51, Yesil Pul 11, Yesil Pul 21 and Firat 89), Karadavut and Genc (2010) showed that protein content was highly correlated with seed yield so that total protein content, water-soluble protein and seed N percent were increased with yield which is in agreement with our findings.

Thousand-seed weight is a component of lentil yield and any factor changing the yield will essentially affect 1000-seed weight. In the present study, 1000-seed weight under the treatment of W'4 was lower than that under the treatment of W'3 which can be related to the indirect damages of hand weeding to lentil plants or it can be said that the changes in seed number was less affected by environmental parameters and more affected by genetics in which case 1000-seed weight would be influenced too. Mostafaei et al. (1998) stated that the correlation between seed yield and 100-seed weight was positive but insignificant, that is, the increase in 100-seed weight did not significantly affect the yield.

Finally, given the importance of lentil, it is recommended to carry out similar studies in different parts of Iran where lentil is regarded as a major crop, so that it can be possible to determine the best time of controlling weeds for realizing the highest seed yield and protein. Despite the impact of weeds on these traits, most farmers in Ardabil region, Iran do not really control weeds because of their ignorance, whereas the highest levels of these traits can be realized by weeding at specific times. Also, regarding the method of controlling weeds it is recommended to conduct experiments in the research farms and present the results to the farmers.

CONCLUSION

The findings of the present study showed that the increase in the period of weeds interference resulted in the loss of yield which is consistent with the findings reported by Amini et al. (2006) and Mohammadi et al. (2004). Also, the loss of yield might have been caused by the loss of accumulated dry matter owing to the increased competition between lentil plants and weeds because weeds are stronger in competition than lentil plants (Boerboom and Young, 1995).

Also, a higher correlation was observed between seed yield and protein and finally, N, so that the increase in the period of weeds presence brought about the loss of seed, protein and N yield which can be associated with the loss of intracellular metabolites which are affected under biotic stresses like the presence of weeds (Karadavut and Genc, 2010).

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Table 1. Analysis of variance of 1000-seed weight, seed yield, seed protein, protein yield and seed nitrogen under the treatments of the absence of weeds

S.O.V.	df	Means of squares				
		1000-seed weight	Seed yield	Seed protein	Protein yield	Seed nitrogen
Replication	2	7.1405^{ns}	37.280^{ns}	3.2111^{*}	0.0336^{ns}	0.4179^{*}
Treatment	4	1987.392^{**}	527.7392^{**}	8.6357^{**}	5.2128^{**}	1.00578^{**}
Error	8	22.970	196.589	5.00395	0.16544	0.78895
C.V. (%)		10.42	20.451	21.2110	6.1027	18.3250

ns, * and ** show insignificance and significance at 5 and 1% probability levels, respectively.

Table 2. Analysis of variance of 1000-seed weight, seed yield, seed protein, protein yield and seed nitrogen under the treatments of the interference of weeds

S.O.V.	df	Means of squares				
		1000-seed weight	Seed yield	Seed protein	Protein yield	Seed nitrogen
Replication	2	3.7458^{ns}	36.7949^{ns}	1.3666607^{*}	0.03935^{ns}	0.19223^{*}
Treatment	4	2617.6382^{**}	767.5711^{**}	12.5167^{**}	4.19832^{**}	1.26359^{**}
Error	8	39.9648	24.013203	0.254238	0.0310125	0.03587
C.V. (%)		16.9807	27.75889	17.25637	13.60873	13.4519

ns, * and ** show insignificance and significance at 5 and 1% probability levels, respectively.

Table 3. Means comparison for 1000-seed weight, seed yield, seed protein, protein yield and seed nitrogen under the treatments of the absence of weeds for specific periods

Treatments	1000-seed weight (g)	Seed yield ($kg.ha^{-1}$)	Seed protein (%)	Protein yield ($kg.ha^{-1}$)	Seed nitrogen (%)
Full absence of weeds	58.133 a	1029 a	21.520 a	228.0 a	4.333 a
Absence of weeds for 15 days	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
Absence of weeds for 30 days	57.713 a	895 a	19.107 a	152.67 a	3.0667 a
Absence of weeds for 45 days	54.940 a	1038.3 a	19.167 a	210.33 a	3.0667 a
Absence of weeds for 60 days	59.020 a	776.7 a	22.543 a	163.33 a	3.6000 a

Table 4. Means comparison for 1000-seed weight, seed yield, seed protein, protein yield and seed nitrogen under the treatments of the interference of weeds for specific periods

Treatments	1000-seed weight (g)	Seed yield ($kg.ha^{-1}$)	Seed protein (%)	Protein yield ($kg.ha^{-1}$)	Seed nitrogen (%)
Full interference of weeds	0.0 b	0.0 c	0.0 b	0.0 b	0.0 b
Interference of weeds for 15 days	51.373 a	1272.3 a	15.463 a	208.33 a	2.4667 a
Interference of weeds for 30 days	51.917 a	773.3 ab	20.390 a	138.33 a	3.2333 a
Interference of weeds for 45 days	57.893 a	622.0 b	22.613 a	131.0 a	3.6200 a
Interference of weeds for 60 days	0.0 b	0.0 c	0.0 b	0.0 b	0.0 b

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