Iran Agricultural Research, Vol. 33, No. 1, 2014
Printed in the Islamic Republic of Iran
Shiraz University

The Effect of Weed Competition on Germination Indices and Seed Vigor of Chickpea

J. HAMZEI[1], F. SALIMI[2*] and A. H. KESHTKAR[1*]**

[1]Department of Agronomy and Plant Breeding, College of Agriculture, Bu-Ali Sina University, Hamedan, I. R. Iran
[2]Department of Agronomy and Plant Breeding, College of Agriculture, Zanjan University, Zanjan, I. R. Iran

Received 6 July 2013, Accepted 10 May 2014, Available Online 21 September 2014

ABSTRACT- This experiment was carried out during the growing seasons of 2010 and 2011 at the Agricultural Research Farm of Bu-Ali Sina University, to study the effect of weed competition on subsequent germination and seed vigour of chickpea. 12 weed interference durations were evaluated in a randomized complete block design with three replications. Experiments consisted of two sets of treatments. In the first set, the crop was kept weed-free until 0, 14, 28, 42, 56 and 70 days after sowing and in the second set, weeds were permitted to grow within the crop until 0, 14, 28, 42, 56 and 70 days after sowing. Results of the two year experiments showed that the traits germination index, germination rate, mean germination time, percentage of germination, abnormal seedling percentage and seedling dry weight were affected by different duration of weed interference. Thereafter, the maximum value of germination rate and the minimum value of mean germination time belonged to the full weed-free condition. The increasing length of weed competition decreased seedling dry weight and increased abnormal seedling percentage. This finding is supported by a reduction in the seed weight. In other words, a decrease in seed storage contents resulted in a decrease in seedling growth and an increase in the percentage of abnormal seedlings.

Keywords: *Cicer ariethinum*, Competition, Seed germination, Seed vigour, Weed

INTRODUCTION

In physiological studies and investigations of a plant's response to growth circumstances, seeds are one of the best research subjects. Seed quality, which refers to sowing seeds

* Assistant Professor, Former Graduate Student and Assistant Professor, respectively
** Corresponding Author

with a high germination potential, is an effective contributing factor in the performance of crops (15).

Ensuring desirable plant density with high crop performance requires the use of seeds which can produce uniform and normal seedlings under harsh farm conditions (15). Moreover, plants with similar growth abilities can increase water and nutrient use efficiency and empower the seedlings when competing against weeds, especially at early growth stages (8, 11). Seed vigor is of great importance in accomplishing this goal. Several factors including genotype, environment, feeding of the maternal plant, ripening stage of seed at the harvest time, seed reserves, and pathogens affect seed vigor (2, 7, 8, 17). Another factor influencing seed quality and thus its vigor is the competition for resources between weeds and field crops (11). Reduction of light penetration in the presence of weeds and competition for absorption soil nitrogen are reported as the major causes of low performance and reduced seed quality of beans (4).

Saayman and Van De Venter (13) studied competitive effects of weeds on germination and seed vigor of corn. They discovered less abnormal seedlings and dead seeds in weed-free plots compared to those struggling with weeds. It was also reported that the competition increased the percentage of abnormal seedlings as compared dead seeds. In addition, they concluded that decline in the percentage of field green was more a result of seed vigor decline than a decline in germination percentage.

The result of another experiment conducted by Dabbagh Mohammady Nasab et al. (5) showed that interference of sorghum as a weed increased the number of abnormal seedlings produced by soybeans. It was also reported that competition with sorghum decreased the germination rate of soybeans.

Other researchers have also reported that weed competition decreased seedling vigor (10, 13). In severe interferences, seed vigor decline could be associated with the decreasing growth ability of seeds involved in the competition, shortage of available food elements and an increase in the competitor's shade (13). However, there is little information on the effect of environmental factors such as weed competition on subsequent seed vigour and quality of chickpeas. The aim of the present study was hence, to investigate the effects of weed competition on seed vigor of *Cicer arietinum* in laboratory conditions.

MATERIALS AND METHODS

The field trial was conducted during the growing seasons of 2010 and 2011 at the Agricultural Research Farm of Bu-Ali Sina University, Hamedan, Iran. The station is located in the west of Iran at an altitude 1690 meters above see level.

The field was prepared by plowing, leveling, and fertilizing for both years. 50 kg urea (45% N) per ha was used as a starter fertilizer based on soil analysis results. The soil type was clay-loam with an organic matter of 0.82%, pH 7.2, EC 0.40 dS m^{-1}. Total N percent and available of total P and K were 0.08, 58 and 241 mg kg^{-1}, respectively. Experiments consisted of two sets of treatments. In the first set, the crop was kept weed-free until 0, 14, 28, 42, 56 and 70 days after sowing. In the second set, weeds were permitted to grow within the crop until 0, 14, 28, 42, 56 and 70 days after sowing. The experimental design was therefore, a randomized complete block with 12 weed interference durations and three

replications for two successive years. The experiment plan was implemented through randomized distribution of treatments in each block using the table of random numbers (3, 9). Each block contained 12 experimental units, 3×4m each. In each plot, six rows were planted 50 cm apart and 4m in length. Irrigation was based on plant requirements. Seed sowing and the introduction of the weed factor were done manually. The dominant weeds observed at field were *Chenopodium album*, *Amaranthus retroflexus*, *Sinapis arvensis, Acroptilon repens* and *Polygonum aviculare*.

The Studied Traits

Testing Germination Percentage and Rate

Seed germination is defined as the ability to produce normal plants under desirable conditions (1). Mean germination time (MGT) was determined by counting the number of germinated seeds in a 7 day period at 25°C. For germination tests, 25 seeds were picked from each plot, sterilized with sodium hypochlorite up to 3-5 minutes and rinsed 3-5 times with distilled water. Soon after, the seeds were placed between two layers of Whatman No. 2 filter papers according to the Between Paper method and kept in a germinator for 7 days at 25°C. Germinated seeds with at least 2 mm long radicals were counted every day at a certain time. Mean germination rate ($\overline{R}$), MGT, and germination percentage were calculated following Ellis and Pieta- Filho (6):

$$MGT = \frac{\sum Dn}{\sum n}, \quad (1)$$

where MGT is mean germination time, D is number of days from beginning of the test and n is number of germinated seeds at each day. Mean germination rate was determined by inverting the relation (1):

$$\overline{R} = \frac{1}{MGT} = \frac{\sum n}{\sum Dn}, \quad (2)$$

where $\overline{R}$ is the mean germination rate.
Germination percentage in each plot was calculated on the basis of the total number of germinated seeds at the end of day 7.
Germination Index was also calculated according to Dabbagh Mohammady Nasab *et al.* (5).

$$GI = (7 \times n_1) + (6 \times n_2) + ... + (1 \times n_7), \quad (3)$$

where n is the number of germinated seeds at a certain day.

Testing Seedling Growth

High vigor seeds transport materials to growing embryo more rapidly, causing an increase in seedling dry weight. A test of seedling growth is associated with vegetative growth under field conditions; it is therefore, considered as an accurate test to determine seed vigor (8). For each plot four samples of 25 seeds were placed in between two layers of Whatman no. 2 filter paper, moistened and rolled as a tube. They were then placed in

a plastic bag, put in a beaker and left in a germinator chamber for 7 days at 25°C temperature. At the end of day 7, normal seedlings of each plot were separated from cotyledons and dried at 75°C for 24h to measure seedling dry weight. Normal seedlings are considered as seedlings possessing the essential structures that are indicative of their ability to produce useful mature plants under favourable field conditions. Abnormal seedlings are defined as all seedlings which cannot be classified as normal seedlings. On the other hand, a seedling that does not have all the essential structures or is damaged, deformed, and/or decayed to such an extent that normal development is prevented.

Statistical Analysis

Based on the statistical model of the experimental design, analyses of variances were separately run for each year. A combined analysis of variance for two the years were carried out after a homogeneity test. Means were compared through an LSD test. Data were analyzed using the SAS program for Windows (14), and graphs were drawn by Excel program.

RESULTS AND DISCUSSION

A combined analysis of variance for germination index (GI) indicated that GI was affected by different periods of weed interference (Table 1). A mean comparison of different periods of weed interference revealed the highest GI in the control treatment (WFC), while it had no significant difference from the WI-14 (weed interference up to 14DAS) and weed-free treatments up to 56 and 70 DAS. The least GI was found at the WIC (full weed interference) treatment, with no significant difference from weedy to 70DAS (Fig. 1). The GI of the weedy control showed a decline of 10.61% in that weed-free control. However, in response to the longer periods of weed interference, GI ranged from 236 to 264, showing no special trend. This confirms findings by the Dabbagh Mohammady Nasab et al. (5) study, which revealed a GI reduction of soybeans while the interference duration of sorghum increased.

Table 1. Combined analysis of variance for germination index (GI), germination rate (GR), mean germination time (MGT), germination percent (GP), abnormal seedling percent (ASP) and seedling dry weight (SDW) of chickpea at different interference durations.

S.O.V	GI	GR	MGT	GP	ASP	SDW
Year (Y)	ns	ns	ns	ns	ns	ns
Interference Duration (D)	*	*	**	*	**	**
Y×D	ns	ns	ns	ns	ns	ns

***, ** significance levels at 5 and 1 percent respectively**

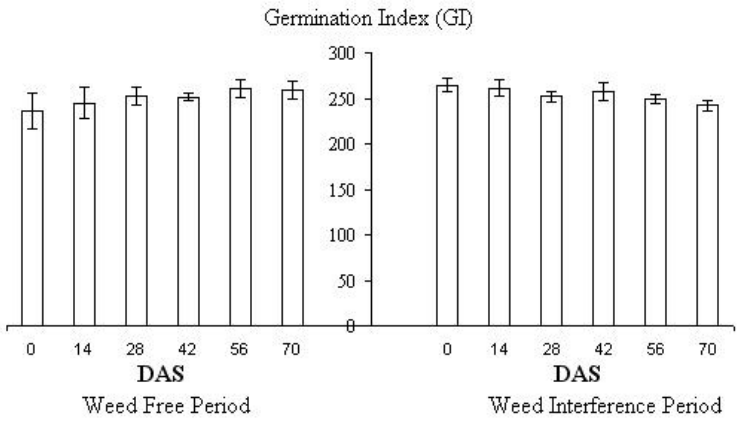

Fig. 1. Effect of weed interference durations on germination index (GI)

Germination Rate, Mean of Germination Time and Germination Percentage

According to the results of the combined analysis of variance (Table 1), different weed interference treatments had significant effects on germination rate (GR), mean of germination time (MGT) and germination percentage (GP). In comparison to the weed-free control (WFC), GR (Fig. 2), and GP (Fig. 4) decreased due to weed interference during the whole growth season by 18.18% and 15.20%, respectively, while MGT increased up to 23.59% (Fig. 3). The lowest GR and the highest MGT were obtained in the weed infested treatment by the end of the growing season, while the highest GR and the lowest MGT were achieved by the control treatment (weed-free for total experiment period). Similar results were obtained by Saayman and Van De Venter (13) who reported that both germination and vigour of corn seeds decreased with an increase in the duration of weed competition. They also observed an increase in the mean time of the emergence of corn seedlings, with an increase in the duration of weed competition, indicating reduced seed vigour.

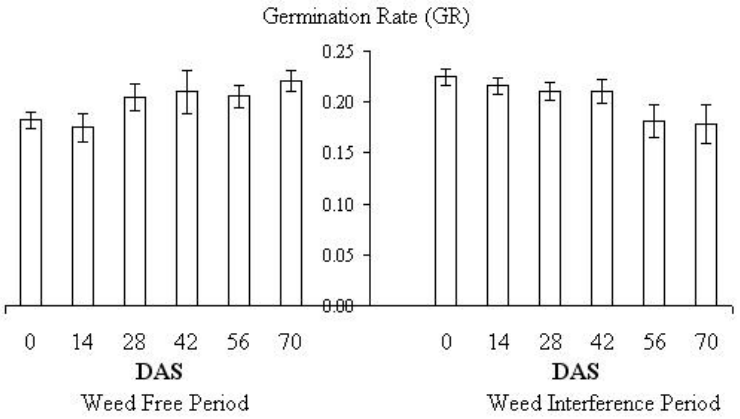

Fig. 2. Effect of weed interference durations on germination rate (GR)

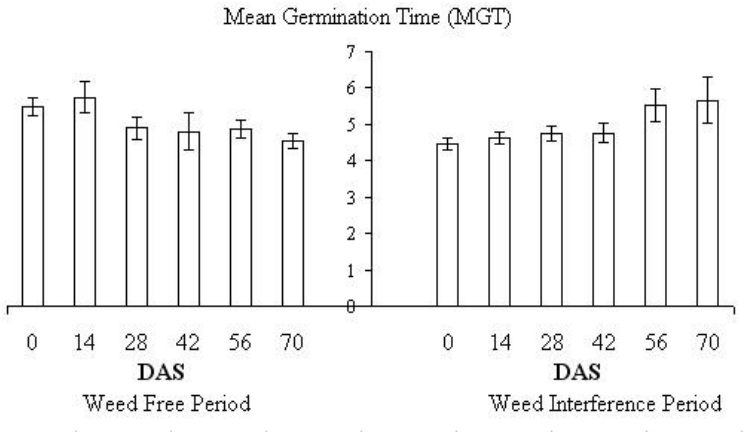

Fig. 3. Effect of weed interference durations on mean germination time (MGT)

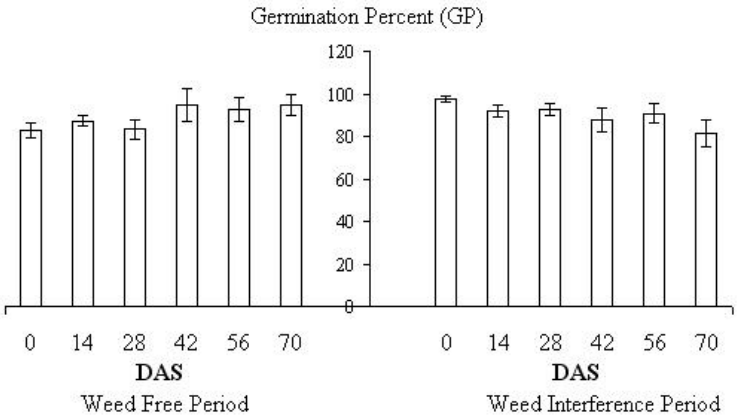

Fig. 4. Effect of weed interference durations on germination percent (GP)

Seedling Dry Weight and Abnormal Seedling Percent

The combined analysis of data for both experiment years indicated that abnormal seedling percentage and seedling dry weight were significantly affected by weed interference (Table 1), whereas normal seedling dry weights were significantly different (Fig. 6). A mean comparison showed that by increasing weed interference durations and decreasing weed-free durations, abnormal seedling percentage increased remarkably (Fig. 5). In other words, chickpea seeds of those treatments with lower weights (100-seed weight) produced seedlings with lower dry weights compared to other treatments. From the results, it is clear that the reduction of storage material of seeds is due to an increase in the weeds' interference duration, causing lower growth and more abnormal seedlings. Consequently, the percentage of abnormal seedlings increases, causing a decline in the seedlings' dry weight. Results also indicate that seedlings were completely dependent on seed storages at an early stage. It has been reported that an increasing in the number of abnormal seedlings is due to an increased competition between weeds and

crop plants (5, 13). It is also reported that when stress is intense enough to cause underdeveloped and wrinkled seeds, a reduction in seed vigour becomes evident (16). This means that the reduction of seed weight by environmental factors such as weed competition can depress seed vigor and quality indices. It has been reported that different seed sizes or food storage levels may be important factors influencing seed vigor (12). A regression analysis of periods of weed interference and the percentage of abnormal seedlings revealed that the latter increased sharply from sowing time until day 56, remaining constant afterwards (Fig. 5). On the other hand, in weed-free treatments, the percentage of abnormal seedlings decreased slowly at the early stages of weed interference compared to the later stages. The increase in dead seed percentages was smaller than that of the abnormal seedling percentage. Compared to the weed-free control, abnormal seedling and dead seed percentages of weedy treatments increased correspondingly by 84.66% and 14.84% during the entire period of the experiment. These results are in agreement with the findings of Saayman and Van De Venter (13) for maize.

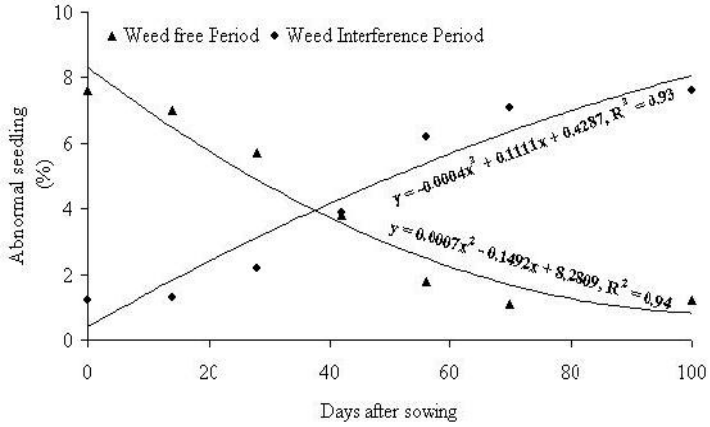

Fig. 5. Regression of weed-free and weed-interference period with abnormal seedling percentage

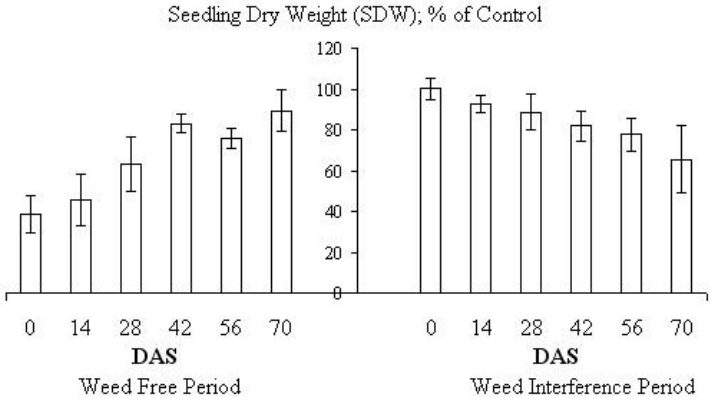

Fig. 6. Effect of weed interference durations on seedling dry weight (SDW)

CONCLUSION

Under the conditions of the current experiment, in comparison to the weed-free control, germination rate and germination percentage decreased due to weed interference during the whole growth season by 18.18% and 15.20%, respectively, while mean germination time increased up to 23.59%. Also, the increasing length of weed competition decreased seedling dry weight and increased abnormal seedling percentage. This finding is supported by a reduction in the seed weight. In other words, a decrease in seed storage contents resulted in a decrease in seedling growth and an increase in the percentage of abnormal seedlings.

REFERENCES

1. Bishnoi V. R. and J. C. Delouche. 1980. Relationship of vigour tests and seed lots to cotton seedling establishment. Seed Science and Technology 8: 341-346.

2. Chauhan B. S. and D. E. Johnson. 2008. Seed germination and seedling emergence of giant sensitive plant (*Mimosa invisa*). Weed Science 56: 244–248.

3. Cochran W. G. and G. M. Cox. 1992. Experimental Designs, Second Edition, New York, John Wiley and Sons.

4. Corre-Hellou G. and Y. Crozat. 2004. N_2 fixation and N supply in organic pea (*Pisum sativum* L.) cropping system as affected by weeds and pea weevil (*Sitona lineatus* L.). Eur. J. Agron. 22: 449-458.

5. Dabbagh Mohhamady Nasab A., A. Javanshir, H. Alyari and M. Moghaddam. 2004. Influence of weed (*Sorghum bicolor* (L.) Moench) interference duration on subsequent seed germination and vigor of soybean (*Glycin max* (L.) Merrill). Turk. J. Field Crops 8: 43-52.

6. Ellis R. H. and C. Pieta-Filho. 1992. Seed development of seed quality in spring and winter cultivar of barley and wheat. Seed Science Res. 2: 9-15.

7. Ghasemi-Golezani K. and C. Mazloomi-Oskooyi. 2008. Effect of water supply on seed quality development in common bean (*Phaseolus vulgaris*). Int. J. Plant Prod. 2: 117-124.

8. Ghasemi–Golezani K., H. Salehian, F. Rahimzadeh Khoei and M. Moghaddam. 1986. Effect of seed vigor on seedling emergence and grain yield of wheat (*Triticun aestivum*). J. Agri. Sci. Nat. Reso. 3: 48-55 (In Persian).

9. Gomez K. A. and A. A. Gomez. 1984. Statistical procedures for agricultural research. Second Edition, New York, John Wiley and Sons.

10. Hamzei J. 2007. Eco-physiological effects of weeds interference on grain yield and quality of three winter oilseed rape (*Brassica napus* L.) cultivars. Ph.D. thesis. Faculty of Agriculture, University of Tabriz, Tabriz, Iran.

11. Norsworthy J. K. and M. J. Oliveira. 2006. Sicklepod (*Senna obtusifolia*) germination and emergence as affected by environmental factors and burial depth. Weed Sci. 54: 903–909.

12. Perry D. A. 1980. The concept of seed vigour and its relevance to seed production techniques, pp. 584-591. In Hebblethwaite PD ***(ed.)*** Seed Production. Butterworths, London, UK.

13. Saayman A. E. J. and H. A. Van De Venter. 1996. Influence of weed competition on subsequent germination and seed vigour of *Zea mays*. Seed Sci. Tech. 25: 59-65.

14. SAS Institute. SAS / STAT. 1988. Guide for personal computer. Release 6.04. SAS Institute Inc., Cary, NC.

15. Tekrony D. M. and D.B. Eglin. 1977. Relationship between laboratory indices of soybean seed vigor and field emergence. Crop Sci. 17: 573-577.

16. Vieira R. D. and D. M. Tekrony. 1992. Effect of drought and defoliation stress in the field on soybean seed germination and vigor. Crop Sci. 32: 471-475.

17. Westgate M. E., J. R. Schussler, D. C. Reicosky and M. L. Brenner. 1989. Effect of water deficits on seed development in soybean: conservation of seed growth rate. Plant Physiol. 91: 980- 985.

اثر رقابت علف‌های هرز بر شاخص‌های جوانه زنی و قدرت بذر نخود

جواد حمزه‌ئی[1] ** **فاطمه سلیمی[2]** * **و امیر حسین کشتکار[1]** *

[1]بخش زراعت و اصلاح نباتات، دانشکده کشاورزی، دانشگاه بوعلی سینا، همدان ج. ا. ایران
[2]بخش زراعت و اصلاح نباتات، دانشکده کشاورزی، دانشگاه زنجان، ج. ا. ایران

چکیده- این آزمایش در سال‌های زراعی ۱۳۸۹ و ۱۳۹۰ به منظور مطالعه اثر رقابت علف‌های هرز بر شاخص‌های جوانه زنی و قدرت بذر نخود اجرا شد. دوازده نوع تداخل علف‌های هرز در یک طرح بلوک‌های کاملاً تصادفی با سه تکرار ارزیابی شدند. آزمایش شامل دو سری تیمار بود. در سری اول مزرعه تا ۰، ۱۴، ۲۸، ۴۲، ۵۶ و ۷۰ روز پس از کاشت عاری از علف‌های‌هرز نگه داشته شد و در سری دوم به علف‌های‌هرز اجازه داده شد تا با گیاه زراعی به مدت ۰، ۱۴، ۲۸، ۴۲، ۵۶ و ۷۰ روز پس از کاشت، رقابت کند. نتایج آزمایش دو ساله نشان داد که صفات شاخص جوانه زنی، سرعت جوانه زنی، میانگین مدت جوانه زنی، درصد گیاهچه‌های غیر نرمال و وزن خشک گیاهچه تحت تأثیر دوره‌های مختلف تداخل علف‌های هرز قرار گرفتند. بیشترین میزان سرعت جوانه زنی و حداقل مقدار میانگین مدت جوانه زنی به تیمار عاری از علف‌های هرز در کل دوره رشد تعلق داشت. با افزایش طول دوره تداخل علف‌هرز وزن خشک گیاهچه کاهش و درصد گیاهچه های غیر نرمال افزایش یافت. این امر با کاهش وزن دانه در اثر تداخل علف‌های‌هرز مرتبط است. در واقع، کاهش ذخایر بذر، به کاهش رشد و نیز رشد غیر طبیعی گیاهچه‌ها منجر گردید که در نتیجه آن وزن خشک گیاهچه‌ها کاهش و درصد گیاهچه‌های غیر نرمال افزایش یافت.

واژه های کلیدی: جوانه زنی، رقابت، علف‌هرز، قدرت بذر، نخود

* به ترتیب استادیار، دانشجوی کارشناسی ارشد و استادیار
** مکاتبه کننده