Researches on the Germination Biology of Some Common Weed Seeds in Turkey

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Bulletin USAMV series Agriculture 72(2)/2015
Print ISSN 1843-5246; Electronic ISSN 1843-5386
DOI 10.15835/buasvmcn-agr: 10407

ABSTRACT

Weeds in agricultural production is one of the most important factors affecting yield. They causes yield lose ranging from 25% to 35% by competing with cultivated plants especially for nutrient, water, light and place. This data show the significance of weeds in agricultural areas. It is necessary to control the weeds to remove their harm. Principally the meaning of control is to know their biology. With this research the germination biology conditions (minimum, optimum and maximum germination temperature, germination period and rate) of some common weeds that are widespread in the agriculture in Turkey have been examined. According to the research results, minimum, optimum and maximum germination temperatures were 7-10 °C, 30-40 °C and 43-45°C (no germination at 45 °C) for *Amaranthus retroflexus* L., respectively. These parameters for *Chenopodium album* L. were 0-2 °C, 15-25 °C and 40 °C; for *Alhagi camelorum* Fisch. (without fruit) they were 7-10 °C, 25-40 °C and 40-43 °C (no germination at 43 °C); for *Galium aparine* L. they were 0-2 °C, 5-25 °C and 25-30 °C (no germination at 30 °C); for *Taraxacum officinale* Weber. they were 0-2 °C, 10-30 °C and 40 °C; for *Heliotropium europaeum* L. they were 20-35 °C, 40 °C and 40-43 °C (no germination at 43 °C); for *Peganum harmala* L. they were 7-10 °C, 20-30 °C and 43-45 °C. There was no germination in *Alhagi camelorum* Fisch. seeds at any temperatures.

Keywords: *biology, germination, weed seed.*

INTRODUCTION

One of the most important factors affecting yield in agricultural production is weeds. Weeds are the natural plants of cultivated area and non-cultivated areas. Economically, they are the plants, which do more harmful than beneficial, in and outside the agricultural areas. Yet, it should not be ignored that weeds can be attached to culture over time. In addition to their harm, they also have some benefits. As is known, weeds continually compete with crop plants in terms of water, nutrient, place and light. Because of their several characteristics, weeds are often superior competitors to crop plants. If due precautions are not taken against weeds, they may cause 20-100% yield loss depending on the species of the crop plant (Özer, 1993).

Maturation and germination are the sequential events in a plant's life. The interval between these sequential events can range from a few hours to long years. The function of the seed is to protect the embryo until the plant grows and gives seed again. Under conditions in which there is no development, the seed can use its nutrient supply for a long time and show maximum resistance to negative environmental conditions (Güncan, 2006). A seed may occasionally go dormant periods from maturity to germination. Based on the characteristics of the plant species, this recession is called "dormancy", and it can be short-term or long-term or never occurs. Dormancy is very important for the continuity of weed population and their adaptation to the environment.

By researching germination-temperature relationships, the dormancy status of some weed species, which are widespread in the cultivated areas of Turkey, were determined through this study, and establishing the biological characteristics which can be employed in struggle against these weeds was purposed.

MATERIALS AND METHODS

In the study as the material, weed seeds were collected from Konya-Turkey in 2006, seven species of weed seeds were used.

Determination of weed seeds germination temperature, speed and duration

For each of the experiment performed in the mentioned studies, mature weed seeds employed in the research were planted into 9 cm diameter petri dishes having a two-stage filter paper. Fifty seeds were placed into the petri dishes and they were made wet with 5 ml of distilled water. In order to determine the germination temperature, the petri dishes were observed at 2, 5, 10, 15, 20, 25, 30, 35 and 40 °C, on the other hand, the petri dishes were observed for 28 days by putting them into incubators operating at a stable temperature (± 0.5 °C).

All experiments were conducted with four repetitions. From the beginning of the experiments, counting was done on the 1st, 3rd, 5th, 7th, 14th, 21st and 28th days, and the counting process finished at the end of the 28th day. During the counting, seeds having 0.5 cm radicle were accepted as germinated and taken out of the petri dish (Uygur 1991). When the humidity decreased in the petri dish, needed water was provided.

Statistical analyses of the findings collected in consequence of the researches were done through MSTAT-C statistical program according to the

randomized blocks experimental design. Mean values of treatments, whose differences were determined by means of F test, were classified by "LSD" significance detection.

RESULTS AND DISCUSSION

Determination of weed seeds germination temperature, speed and duration

Amaranthus retroflexus L. (Redroot pigweed)

As a result of trials performed to determine minimum, optimum and maximum germination temperature of *Amaranthus retroflexus* seeds, it was observed that while there was no germination at 2, 5, 7 and 45 °C, the germination was 10 % at 10 °C; 6.5% at 15°C; 27% at 20°C; 43.5% at 25°C; 73.5% at 30°C; 93% at 35°C; 84% at 40°C and 43.5% at 43°C. As it is understood from these values, minimum germination temperature of the weed was determined as 7-10°C, optimum germination temperature was determined as 30-40°C and maximum germination temperature was determined as 43-45°C (no germination at 45°C). When germination percentages obtained at different temperatures are taken into consideration, it is seen that germination at 20 and 30°C were statistically different in comparison with all other temperatures (Figure 1)

Germination temperatures indicate that the mentioned weed is adapted to hot climatic zones. Steckel et al. (2004) reported that the optimum temperature for the maximum germination of *Amaranthus* spp. seeds is higher than 20 °C, except for Prostrate pigweed (*Amaranthus blitoides* S.Wats.). Ghorbani et al. (1999) stated that minimum germination temperature of *Amaranthus* seeds is 5 °C and maximum germination is 35-40°C. In a research conducted in Cukurova Region

Tab. 1. Weed species used in the experiment;

Scientific Name	Bayer Code *	Common Name	Family Name
<i>Amaranthus retroflexus</i> L.	AMARE	Redroot pigweed	Amaranthaceae
<i>Chenopodium album</i> L.	CHEAL	Common lamb's quarters	Chenopodiaceae
<i>Alhagi camelorum</i> Fisch.	ALHPS	Camelthron	Fabaceae (Leguminosae)
<i>Galium aparine</i> L.	GALAP	Catchweed bedstraw	Rubiaceae
<i>Taraxacum officinale</i> Weber	TAROF	Dandelion	Asteraceae (Compositae)
<i>Heliotropium europaeum</i> L.	HEOEU	Common heliotrope	Boraginaceae
<i>Peganum harmala</i> L.	PEGHA	African rue	Zygopyllaceae

* European and Mediterranean Plant Protection Organization (EPPO) are responsible for management of the EPPO code system (previously known as Bayer codes)

of Turkey, it was reported that minimum, optimum and maximum germination temperatures for *Amaranthus retroflexus* were 10, 30 and 40°C respectively (Üremiş and Uygur, 1999).

***Chenopodium album* L.** (Common lamb's quarters)

In consequence of experiments performed on the mentioned weed, it was determined that the germination was 1.5% at 2,30 °C; 1% at 5, 35 and 40 °C; 3% at 10°C; 2.5% at 15°C; 5.5% at 20°C and 2% at 25 °C. The obtained findings show that minimum germination temperature of the seeds is 0-2°C, optimum germination temperature is 15-25°C and maximum germination temperature is 40°C (Figure 2).

According to the graphic the difference among the temperatures is considered to be statistically insignificant. As it is seen in the graph, germination rates are so low. These values display that seeds of the weed have high dormancy level (96-97%). In other words, it is possible to say that only 3-4% of *Chenopodium album* seeds falling into soil can germinate under optimal conditions. Germination temperatures indicate that the mentioned weed is adapted to mild temperate climatic zones. At optimum germination temperature, maximum germination rate was 5.5%. This result shows that seeds of lamb's quarters have high dormancy level.

In parallel with our results, Üstüner(2002) has reported that optimum germination temperature of seeds of *Chenopodium album* is 15-25°C, minimum temperature is below 5°C and maximum temperature is above 30°C. Jursik et al.,(2003) reported that seeds of lamb's quarters that mature at high temperature have a wide range of germination temperatures(2-40°C), and

Fig. 1. Germination rate of *Amaranthus retroflexus* L.

(* sign shows that the statistical difference between results represented with the same letter is not significant at level of %1)

seeds of lamb's quarters that mature at low temperature need at least 10°C to germinate. Besides researchers have determined that the greatest germination in the seeds of lamb's quarters is at the rate of 75% at 18°C, the least germination is at the rate of 4% at 5°C.

***Alhagi camelorum* Fisch.** (Camelthron)

In consequence of trials, it was determined that while no seeds germinated at 2, 5, 7, 43 and 45 °C, there was 4.01 % of germination at 10°C; 5.5% of germination at 15°C; 9.5% of germination at 20°C; 18.5% of germination at 25°C; 5.5% of germination at 30°C; 19% of germination at 35°C and 2.5% germination at 40°C. As it can be understood from these values, it was determined that minimum germination temperature of the seeds was 7-10°C, optimum germination temperature was 25-40°C and maximum germination was 40-43 °C(no seeds germinated at 43 °C) (Figure 3).

When germination percentages obtained at different temperatures are taken into consideration, 25 °C and 35 °C were found to be statistically significant. According to the results seen in the graph, seeds of *Alhagi camelorum* possess nearly 90% of dormancy. Germination temperature shows that the mentioned weed is adapted to hot climate zone. Germination speed changes depending on temperatures.

Ball and Robbins (1933) reported the optimum germination temperature of *Alhagi camelorum* seeds as 27°C. Üstüner (2002) stated minimum, optimum and maximum germination temperatures of *Alhagi camelorum* seeds as 10 °C, 15-20 °C and 40 °C respectively.

***Galium aparine* L.** (Catchweed bedstraw)

No seeds of *Galium aparine* germinated at 30, 35, 40 °C, but 100 % of germination occurred at 5, 10, 15, 20 °C ; 96.5% of germination occurred at 2°C and 91.5% germination occurred at

Fig. 2. Germination rate of *Chenopodium album* L.

25°C. Minimum germination temperature was determined as 0-2°C, optimum germination temperature was determined as 5-25°C and maximum germination temperature was determined as 25-30°C (no germination occurred at 30°C). When germination percentages obtained at different temperatures are considered, it is seen that the germination percentages at 5, 10, 15 and 20 °C are statistically different in comparison with all other temperatures. It is seen that the seeds of *Galium aparine* have 8% of dormancy (Figure 4).

Similarly, different researchers stated the minimum, optimum and maximum germination temperatures of *Galium aparine* as 2-3°C, 7-13°C and 20°C respectively (Louer, 1953; Özer, 1971; Uygur et al., 1986; Mennan, 1998).

***Taraxacum officinale* Weber (Dandelion)**

According to the results of the trials, 4.5 % of germination at 2°C; 13.5% germination at 5°C; 80% germination at 10°C; 80.5% of germination at 15°C; 76.5% of germination at 20°C; 67.30% of germination 25°C; 46.35% of germination at 30°C; 13% of germination at 35°C and 1% of germination at 40 °C were obtained. Based on the collected findings, it was determined that minimum germination temperature was 0-2 °C, optimum germination temperature was 10-30 °C and maximum germination temperature was 40°C. When the percentages of germination obtained at different temperatures are considered, the germination percentages at 10, 15, 20 and 25°C were found to be statistically significant (Figure 5).

Germination temperatures indicate that the mentioned weed is adapted to cool climate zone.

Fig. 3. Germination rate of *Alhagi camelorum* Fisch.

(* sign shows that the statistical difference between results represented with the same letter is not significant at level of %1)

In addition, 30 % of dormancy was observed in the seeds.

Watson et al., (2001) reported that germination occurred in the seeds of dandelion at temperatures between 4 and 30 °C, and the optimum germination was 23 °C. Cudney and Elmore (2000) reported that the seeds of common dandelion could germinate when the soil was wet and soil temperature was at least 10 °C.

***Heliotropium europaeum* L. (Common heliotrope)**

According to the results collected from the seeds of *Heliotropium europaeum*, while no seeds germinated at 2, 5, 10, 15, 25, 43 and 45 °C, 0.5% of germination was determined at 20, 30 and 35 °C and 29 % of germination was observed at 40 °C. Based on the obtained findings, it was established that the minimum germination of the seed was at 20-35 °C; optimum germination was at 40 °C and maximum germination was 40-43 °C (no seeds germinated at 43 °C). When compared with germination percentages obtained at different temperatures, the germination at 40 °C is considered to be statistically significant by comparison with all other temperatures (Figure 6).

Germination temperatures indicate that the weed is adapted to hot climate zone. When the graph is examined, it is seen that seeds have strong dormancy (70%). Üstüner (2002) has reported that minimum germination of *Heliotropium europaeum* seeds is at 15°C, optimum germination temperature is 25-40 °C and maximum germination temperature is above 40 °C.

***Peganum harmala* L. (African rue)**

According to the collected results, no seeds germinated at 2, 5, 7 and 45 °C, whereas it was

Fig. 4. Germination rate of *Galium aparine* L.

(* sign shows that the statistical difference between results represented with the same letter is not significant at level of %1)

observed that there was 10% of germination at 10°C; 12.5% of germination at 15°C; 41% of germination at 20°C; 77% of germination at 25°C; 59.25% germination at 30°C; 38 % of germination at 35°C; 9% of germination at 40°C and 11.5 % of germination at 43°C. As it can be understood from these values, it was determined that minimum germination temperature of seeds was 7-10 °C, optimum germination temperature was 20-30°C and maximum germination temperature was 43-45°C (Figure 7).

When compared with germination percentages obtained at different temperatures, the germination at 25 °C was considered to be statistically significant by comparison with all other temperatures. Considering the graph, it is possible to say that seeds of this weed have approximately 20-25% dormancy and this weed is adapted to arid regions.

Hussain and Nasrin (1985) report that optimum germination temperature of *Peganum*

harmala seeds is 25–30 °C. Bozoğlu (1999) has determined that minimum germination temperature of African rue seeds is 10–15 °C, optimum germination temperature is 25–35 °C and maximum germination temperature is above 35 °C.

Germination speed and duration change depending on the temperature for all weed species (Figure 8). While the first germination in *Amaranthus retroflexus* (AMARE) seeds at 10°C was observed on the 5th day, it was on the 3rd day at 15, 20 and 43 °C, and it was on the 1st day at 25, 30, 35 and 40 °C. It is seen that as the temperature rises, germination starts earlier. Germination duration at optimum temperature lasted for 21–28 days.

The first germination in *Chenopodium album* (CHEAL) seeds occurred on the 5th day at 2 and 25 °C; on the 14th day at 10 and 15°C; on the 3rd day at 20, 30 and 40°C and on the 1st day at 35°C. The

Fig. 5. Germination rate of *Taraxacum officinale* Weber

(* sign shows that the statistical difference between results represented with the same letter is not significant at level of %1)

Fig. 6. Germination rate of *Heliotropium europaeum* L.

(* sign shows that the statistical difference between results represented with the same letter is not significant at level of %1)

Fig. 7. Germination rate of *Peganum harmala* L.

(* sign shows that the statistical difference between results represented with the same letter is not significant at level of %1)

Fig. 8. Germination speed and duration of weed species

germination duration at optimum temperature was determined as 7-21 days.

While the first germination in the seeds of *Alhagi camelorum* (ALHPS) was discovered on the 14th day at 10 °C, the first germination was observed on the 3rd day at 15 and 20 °C and on the 1st day at 25, 30, 35 and 40 °C. It is seen that germination starts earlier as the temperature increases. The highest germination at optimum germination temperatures occurred on the 3rd day and germination duration lasted for 28 days.

Germination speed changes depending upon the temperature. The first germination of seeds of *Galium aparine* (GALAP) occurred on the 14th day at 2°C; on the 7th day at 5°C; on the 5th day at 10 and 25 °C; on the 3rd day at 15 and 20 °C. As the temperature increases, the germination starts earlier, but it slows down again at temperatures above 20°C. Among optimum germination temperatures, the highest rate of germination was determined on the 14th day at 5°C; on the other hand, the highest rate of germination was determined on the 5th day at 10, 15 and 20 °C. Germination duration at optimum temperatures was established as 14-28 days.

Germination speed changes depending on temperature. The first germination of the seeds of *Taraxacum officinale* (TAROF) occurred on the 21st day at 2°C; on the 14th day at 5 and 35°C; on the 7th day at 10 and 30 °C; on the 5th day at 15°C; on the 3rd day at 20, 25 and 40°C. As the temperature increases, germination begins earlier, but it slows down again at temperatures above 25°C.

The first germination in the *Heliotropium europaeum* (HEOEU) seeds were encountered on the 7th day at 20 °C; on the 28th day at 30 °C; on the 21st day at 35 °C and on the 3rd day at 40 °C. The highest level of germination at the optimum temperature occurred on the 14th day. It was found out that the germination at the optimum temperature lasted for 28 days.

The first germination in the seeds of *Peganum harmala* (PEGHA) was observed on the 21st day at 10 °C; on the 14th day at 15 °C; on the 5th at 20 and 40 °C; on the 3rd day at 25, 30, 35 and 43 °C. As the temperature rises, germination begins earlier, but it slows down again at temperatures above 35°C. Among the optimum germination temperatures, the highest level of germination occurred on the 14th day at 20 °C, on the 3rd day at 25 and 30 °C.

The germination duration was determined as 21-28 days at optimum temperatures (Figure 8).

CONCLUSION

The dormancy that seeds possess for the continuity of their generations functions as an insurance. Most of the weed seeds have the capacity to remain alive for many years without germination. Having the dormancy feature brings some advantages and disadvantages for weeds. As a matter of fact, weeds whose seeds do not have dormancy can be removed easily, and if they are left uncontrolled, they form a considerable majority. Nevertheless, several factors in nature become effective in terms of natural balance and prevent such a reproduction of weed seeds.

Identifying weed seeds causing considerable quality and quantity losses in cultivated area, determining their biology and lives are necessary to produce substantial solutions in the struggle against weeds. Additionally, they are important to form a basis for "Integrated Management Programs" and switch to prediction-warning systems.

Acknowledgements. This study was extracted from MSc thesis of Hüseyin Solak. Also we thanks to S.U.B.A.P. (The Scientific Research Coordination Office of Selçuk University, Turkey) for kindly supporting the project No. BAP 07201042

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