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Test the Effect of Some Methods of Breaking the Dormancy on the Germination and Growth of Johnson Grass Seed *(Sorghum halepense (*L.*)* Pers.*)*

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Abstract:- Johnson grass is one of the most serious weeds for agricultural crops in many countries of the world. The reason for this risk is due to its biological properties, like reproducing by seeds and rhizomes. Although it produces a large amount of seeds, its germination rate is very low and supports the seed bank in the soil. The reason for this low rate is the dormancy imposed by the impermeable coat of the seed. In this study, several methods of breaking dormancy of Johnson grass seeds were tested. Diverse eight treatments were applied: concentrated sulfuric acid, mechanical scratch, gibberellic acid, concentrated sulfuric acid + gibberellic acid, mechanical scratch + gibberellic acid, 24-hour immersion in distilled water, exposure to low temperatures (2°C) and control. Germination ratio, mean germination time, aerial part length, root length and seedling weight were calculated. There were significant differences in germination percentage between some methods. The highest germination rate was in the treatment of sulfuric acid + gibberellic acid (56.7%) and the lowest was in control treatment (3.3%). Mean germination time also differed between the treatments and the fastest germination was obtained in treatment of mechanical method + gibberellic acid (2.8 days), while the slowest was in the control (7.5 days). The seedlings growth indices were not affected by the treatments except that there were some significant differences in the length of the seedlings aerial parts.

It was noted that the best ways to break dormancy of Johnson grass seeds depend on its effectiveness in removing the seed coat and then gibberellic acid can increases germination rate and speeds it up.

Keywords:- *Breaking Dormancy, Germination, Johnson Grass.*

I. INTRODUCTION

Johnson grass belongs to Poaceae family, a perennial weed, reproduces by seeds and rhizomes. It is one of the 10 worst weeds worldwide, dispread in tropical and temperate regions and has been described as a major weed in 50 crops in 53 countries. It has been invaded over millions of hectares worldwide [1, 2]. Johnson grass has many features that contribute to its invasion and distribution. This species reproduces by rhizomes and seeds, produces thousands of seeds, produces a large amount of rhizomes that have buds each of them give a new plant, does not need insects for pollination and has a high competitive ability may be due to allelopathy effect [3, 4, 5, 6]. It causes 57-88% yield loss in economically important agricultural products [2].

Although Johnson grass produces a large number of seeds up to 30 000 per plant [7], the germination rate is low, at best, it may reach 10% due to the dormancy imposed by the seed coat [8] and up to 60-70% of the seeds can remain viable after 25 years in the soil [9].

A dormant seed is one that does not have the ability to germinate in a specified period under normal physical environmental factors that favorable for its germination. The block to seed germination can be caused by one or more of this dormancy types: physiological, morphological, morphophysiological, physical and a combinational of physical and physiological dormancy [10]. Dormancy can be also classified as primary dormancy which indicate to the natural dormancy possessed by seeds when they are separated from the mother plant and secondary dormancy which refers to a dormant case that occur in non-dormant seeds by unfavorable conditions for germination [11].

In the case of Johnson grass, dormancy is largely imposed by mechanical restriction attributed to the impermeable seed coat that contains tannin compounds responsible for its reduced permeability to water [8, 12]. Also Abscisic acid and gibberellic acid play an important role in the germination of sorghum seeds. Increasing the concentration of abscisic acid reduces the percentage of germinated seeds, while the seeds were able to get over dormancy in this case by increasing the concentration of gibberellic acid [18]. Thus it can be considered that the dormancy in Johnson grass belong to combination of physical and physiological dormancy type.

The annual production of seeds and the large part of them stay as dormant seed support the seed bank in the soil and add to the rhizomes formed in the soil in large quantities that make the control of this weed very difficult. The study of seed dormancy and the factors that control it are useful in estimating the time and density of weed germination, and therefore in preparing effective control programs [10]. There are many ways to break dormancy of Johnson grass seed, such as chemical scratching by using concentrated sulfuric acid, sodium hypochloride and potassium nitrate. In addition to mechanical scratching and immersion in hot water and immersion in water for 24 hours, in different environmental conditions (heat and lighting). The results were different even within the same method [14, 15, 16, 19, 20].

In this study we tested some of these methods in addition to a new method, which is treatment with gibberellic acid after treatment with concentrated sulfuric acid and mechanical scratching.

II. MATERIALS AND METHODS

This experiment was carried out in the laboratories of the Kahramanmaras Sutcu Imam University, Agriculture Faculty, Department of Plant Protection in 2020. Johnson grass seeds were collected in the fall of 2019 from the lands of the Agriculture Faculty in Kahramanmars. The seeds were kept in paper bags at room temperature until they were used. Before using the seeds they were disinfected with NaOCl 1% solution and then washed with distilled water. Petri dishes with 11.5cm diameter and 1cm depth with filter papers inside were used. The germination room was set to 28 ± 1°C and 12:12 hours of lighting and darkness.

The applied treatments for dormancy breaking of Johnson grass seeds were as shown in Table (1). The experiment was designed as a completely randomized design, and each treatment were replicated 3 times. Data were subjected to analysis of variance ANOVA and LSD ($p < 0.05$).

Treatment	Explanation
Sulfuric acid (T1)	Treatment with concentrated sulfuric acid for 15 minutes
Mechanical method (T2)	Mechanical scratching with sandpaper
Gibberellic acid (GA) (T3)	Treatment with gibberellic acid 200 ppm for 20 minutes
Sulfuric acid + GA (T4)	Treatment with gibberellic acid for 20 minutes after sulfuric acid for 15 minutes
Mechanical method + GA (T5)	Treatment with gibberellic acid for 20 minutes after mechanical scratch with sandpaper
Keeping at 2° C (T6)	Keeping the seeds at 2° C for two weeks then at a temperature of 20° C for two weeks too
Immersion in water (T7)	Immersion in distilled water for 24 hours in room conditions
Control (T8)	Only distilled water

Table 1:- The treatments applied for dormancy breaking of Johnson grass seeds

After applying the treatments to the seeds, in each petri dish 30 seeds were placed and watered with 8 ml distilled water for each dish and added 2 ml as needed. After that, the number of germinated seeds was recorded daily and the germination percentage was calculated for every petri dish according to the following formula:

Germination rate = (germinated seeds number/ total number of seeds) ×100

For calculate the mean germination time (MGT), the following formula was used for every petri dish:

$$MGT= (\sum(Dn))/N$$

Where n = number of seeds germinated on each day, d = number of days from the beginning of the test, and N = total number of seeds germinated at the termination of the experiment [17]. The experiment lasted for two weeks and then the weight of the fresh seedlings, the length of the root and aerial part length were recorded.

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III. RESULTS

The effect of treatments of breaking dormancy in Johnson grass were variable in germination ratio and mean germination days between hormonal, physical, chemical and mechanical methods as shown in Figure (1).

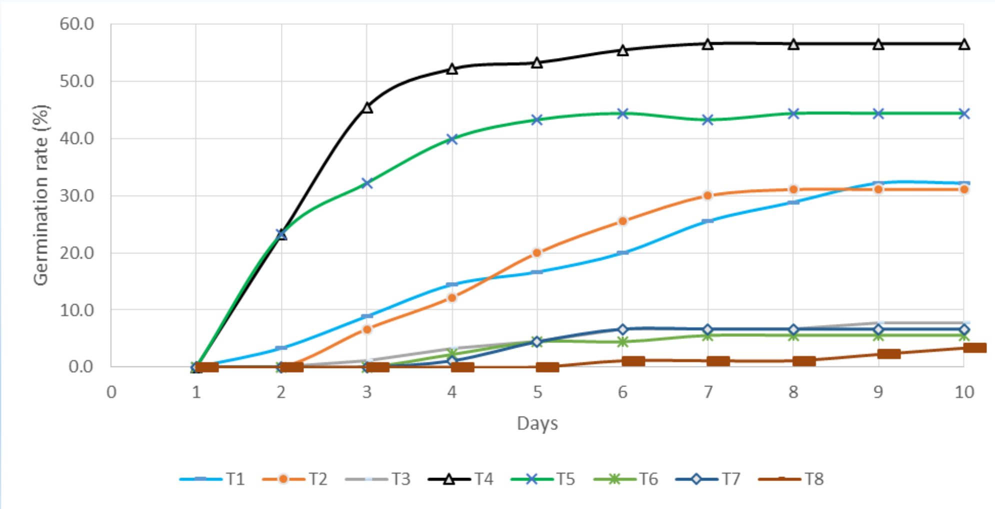

Fig 1:- Germination rate and germination days for Johnson grass breaking treatments

There were significant differences in germination percentage between treatments, where the highest germination rate was in treatment of sulfuric acid + gibberellic acid Figure (2), followed by mechanical method + gibberellic acid with 56.7% and 44.4%, respectively.

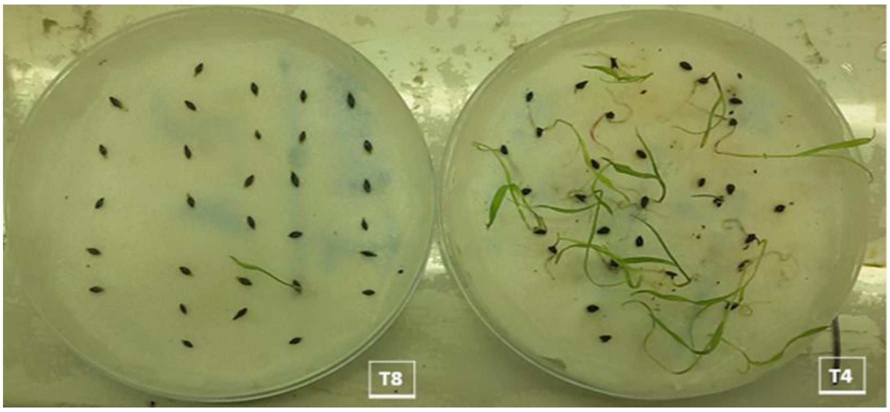

Fig 2:- Control germination (T8), sulfuric acid + gibberellic acid treatment (T4)

The lowest germination percentage occurred in the control by 3.3% and there was no significant difference between the control and each of the treatments; keeping at 2° C, gibberellic acid and immersion in water Table (2).

Treatment	**Germination rate (%)**	**Mean germination time (day)**	**Weight (mg)**	**Root length (cm)**	**Aerial part length (cm)**
T1	32.2^{c}	5.3^{b}	21.7	2.9	4.6^{a}
T2	31.1^{c}	5.0^{b}	22.4	3.2	5.3^{b}
T3	7.8^{d}	5.9^{b}	23.1	3.2	5.3^{b}
T4	56.7^{a}	2.9^{c}	25.1	3.5	5.1^{b}
T5	44.4^{b}	2.8^{c}	25.0	3.4	6.3^{c}
T6	5.6^{d}	5.0^{b}	22.3	3.4	5.6^{bc}
T7	6.7^{d}	5.3^{b}	21.7	3.1	5.2^{b}
T8	3.3^{d}	7.5^{a}	24.5	3.6	5.7^{bc}

Table 2:- Effect of dormancy breaking treatments on seed germination, mean germination days and growth of Johnson grass seedlings.

^{a,b,c} - means followed by the same letter within the column are not significantly different at $P<0.05$.

There was no significant difference between all treatments in terms of root length and seedlings weight. The average seed weight ranged from 21.7 mg in the treatment of sulfuric acid to 25.1 mg in the treatment of gibberellic acid + mechanical method. Whereas, the average root length ranged between 2.9 cm in the treatment of sulfuric acid and 3.6 cm in the control Table (2).

The mean lengths of the aerial parts of the seedlings varied between the treatments, there was a significant difference between the treatment of sulfuric acid and other treatment, and there was no significant difference between the treatments (T5,T6,T8) and the treatments (T2, T3, T4, T6, T7, T8). The average length of the aerial part ranged between 4.6 in the treatment of sulfuric acid and 6.3 in the treatment of the mechanical method + gibberellic acid Table (2).

IV. DISCUSSION

In this experiment, the mean germination rate in the control, which was 3.3%, was similar to the results of previous researches [16, 13], while [15] found that the germination percentage in the control reached 12.8%. The big difference may be due to the difference in the ecotype.

The highest germination percentage was obtained from treatment with gibberellic acid after sulfuric acid. This treatment was not used before and reached 56.7%, which is a high percentage compared to the various treatments in previous experiments, as the germination percentage did not exceed 35.83% [16, 13]. Other study showed that the highest percentage of germination obtained from the mechanical scarification with a sandpaper (64.8%), but when compared to the control of this experiment (12.8%) the percentage obtained in our experiment is higher.

The use of gibberellic acid before removing the seed cover did not differ significantly from the treatment of the control, while it had a significant effect in increasing germination after removing the seed coat. This is evident when comparing sulfuric acid treatments and the mechanical method in which the germination ratios were 32.3% and 31.1%, respectively, with the same treatments after their treatment with gibberellic acid were 56.7% for sulfuric acid and gibberellic acid and 44.4% for the mechanical method and gibberellic acid. Gibberellic acid plays an important role in germination of sorghum seeds, as it has been shown that gibberellic acid has caused sorghum seeds to overtake the effect of abcisic acid that inhibits germination and increases their susceptibility to germination [13].

Germination rate in mechanical treatment according to Krenchinski et al. was 64.8% and this percentage is greater than that obtained in the current experiment (44.4%) the reason may be for the effectiveness of the method used and /or the difference in the ecotype of Johnson grass seeds [15]. The results of water immersion and conservation at a temperature of 2 ° C did not differ significantly from the results of the control (6.7 and 5.6, respectively). This is due to the impermeable seed coat which prevents water from entering the seed. This differs from the results of Baličević, et al. in case of immersion in water for 24 hours as the germination rate was 16.7% and corresponds to the results of Šapčanin et al which was 5%. As was shown from the treatment of preserving at a temperature of 2 ° C, it did not affect the germination [16,13]. This may mean that the seed coat is the main factor in the dormancy of Johnson grass seeds. Likewise, the pigmented seeds have a lower germination rate, which means increasing the hardness of the seed coat and increasing the amount of tannin in it [8, 11].

The mean germination time, it was faster in both the treatment of sulfuric acid + gibberellic acid and the mechanical method + gibberellic acid were 2.8 and 2.9 days, respectively, while mean germination time for the control was 7.5 days where the other treatments (T1, T2, T3, T6, and T7) ranged between 5-5.9 days. These results show that removing the seed coat increases speed of germinated, also that treatment with gibberellic acid after removing the coat gave the highest rate of germination speed, which means that gibberellic acid does not only increase the germination percentage, but it also shortens the germination period.

There was no significant difference between the length of the roots and the weight of the seedlings between the treatments. However, the length of the aerial part differed slightly and was shorter in the treatment of sulfuric acid. Perhaps the reason is due to the effect of the acid on the seed viability. The longest aerial parts were observed in the treatment of the chemical method and gibberellic acid.

V. CONCLUSIONS

The results of this experiment showed that the treatment with gibberellic acid for 20 minutes after treatment with sulfuric acid for 15 minutes gave the best results and did not affect the biological properties of the seedlings. The results of the mechanical method were also high, but the effectiveness of the method was not sufficient to remove the seed coat adequately. We recommend conducting experiments to determine the optimum concentration and exposure time for both sulfuric acid and gibberellic acid.

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