

GROWTH AND DEVELOPMENT OF THE WEED JOINTED GOATGRASS (*Aegilops cylindrica* Host) EMERGING FROM DIFFERENT DEPTHS

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Abstract

Jointed goatgrass is an overwintering plant from the Poaceae family. It is used as a gene donor for winter wheat in different breeding programs. Nevertheless, in some countries and in Bulgaria as well it has turned into a big issue as a weed in the winter wheat. The plants are resistant to most of the herbicidal substances registered for weed management in wheat. Therefore, different approach for control has to be performed. One of the options is to apply "weed seed burial method" - turning over the arable layer through plowing. A pot experiment for studying the germination depth and development of the jointed goatgrass was performed. The depths of placing the weed's seeds from 0 to 14 cm were studied. The period of emergence from each sowing depth, number and percent of germinated plants, total plant length, aboveground and root length, total plant weight, aboveground and root weight were evaluated. With increasing the depth, a delay of the germination and decreasing of the weed's biomass development was recorded. Plants sown on 12 and 14 cm did not emerge.

Key words: *Aegilops cylindrica*, weed, germination, growth.

INTRODUCTION

Aegilops cylindrica Host, also known as jointed goatgrass, is an annual monocotyledonous plant part of the Poaceae family. The weed is native to southern Europe and Russia, along with winter wheat and other cereals (Donald and Ogg, 1991). The weed species is capable of reducing winter wheat yields from 25 to 50% (Kennedy and Stubbs, 2007).

Due to the weed's relationship to winter wheat, it is very difficult to control. On the one hand, the seeds are similar in shape and size to those of wheat, which makes it difficult to remove by grain cleaning methods. On the other hand, the plants are very similar genetically. This makes chemical weed control extremely difficult (Donald and Ogg, 1991) and creates problems for farmers, who have to bear the losses of diminished yields and decreased grain quality (Kennedy and Stubbs, 2007).

Various studies have been conducted worldwide on methods for control of the Jointed goatgrass:

- Biological control

Donald and Ogg (1991) stated that selective control of *A. cylindrica* seedlings with phytotoxic microorganisms should be investigated. Several studies have evaluated the use of soil microorganisms for selective control

of the weeds. It was found that a great number of naturally occurring bacteria tested for their effect on *A. cylindrica* has inhibited the weed by more than 30% in the field (Kennedy and Stubbs, 2007).

- Mechanical control

According to (Westra, 1989), deep plowing is an effective mean for *A. cylindrica* suppressing. After fallow cultivation, plowing provided 95% weed control.

In a winter wheat-fallow rotation, fall or spring tillage with a chisel plow under a conventional tillage system reduced the infestation with *A. cylindrica* by nearly 50% (Evans et al., 1999).

In a study conducted by Anderson (1993), it was found that incorporating plant residues into the soil reduced the fresh weight of *A. cylindrica* by 70% to 85%.

- Agrotechnical control (crop rotations, variety selection, sowing rates)

Studies have been conducted to document the effects of crop rotation on *A. cylindrica* density in winter wheat. In a three-year crop rotation involving winter wheat, late spring crop, and summer fallow was 10% lower than *A. cylindrica* density found in a two-year crop rotation of winter wheat and fallow (Lyon and Baltensperger, 1995).

Adding sorghum or sunflower to a winter wheat-fallow rotation reduced *A. cylindrica* density more than other cultural practices studied by White et al. (2004).

Anderson (1997) reported that the tall winter wheta variety 'Lamar' provided higher suppression of the weed than the medium tall variety 'TAM 107' (Porter et al., 1987).

Kappler et al. (2002) conducted field trials to investigate the effect of winter wheat sowing density on the competitiveness of *A. cylindrica*. Increased wheat density reduces the reproductive capacity of the weed.

Yenish and Young (2004) investigated the effects of wheat height, sowing rate, and seed size on the competitiveness of *A. cylindrica*. They found that increased wheat sowing rate reduced grain density, total biomass, and ear biomass.

- Chemical control

Geier and Stahlman (1996) tested herbicides for selective control of the weed *A. cylindrica* in winter wheat. The researcher obtained limited success. The weed showed greater sensitivity to sulfosulfuron than winter wheat, but was two to three times more tolerant than *Bromus* spp. Overall, efforts to find herbicides that provide economically significant levels of control of *A. cylindrica* in conventional wheat have been unsuccessful.

Based on the above, the weed seems to be very difficult to control through herbicide applications. However, Newhouse et al. (1992) bred imidazolinone-tolerant winter wheat that allowed the use of *imazamox* for weed control, but Seefeldt et al. (1998) mentioned concerns about the possibility of resistant hybrids between winter wheat and the weed.

Prior to the development of imidazolinone-resistant winter wheat, herbicidal control of *A. cylindrica* in this crop was limited primarily to periods when the plants were harvested. Nonselective herbicides, particularly *glyphosate*, are effective for controlling the weed in fallow fields (Beck et al., 1995; Wiese et al., 1995).

Imazamox-tolerant winter wheat varieties were first introduced to the market in 2001 (Tan et al., 2005) and highly effective and selective control of *A. cylindrica* was achieved. Results from field trials showed that *imazamox* could control the weed up to 97% (Ball et al., 1999).

The aim of the current study was to establish the emergence depth of *A. cylindrica* Host and measure the biomass development of the weed.

MATERIALS AND METHODS

The pot experiment was conducted in 2025. For the purpose of the experiment relatively equal in shape and size seeds of the weed jointed goatgrass were used. The seeds were put in conditions to start germination and were sown after germinated.

For the purposes of the trial 19 litter pots were used. In each pot 10 seeds were sown. The sowing was performed in February.

The soil (Mollic Fluvisols) characteristics were:

- pH 6.3;
- 28.53 mg/kg Total N;
- 17.51 mg/100 g P₂O₅;
- 35.14 mg/100 g K₂O.

The pots were regularly watered depending on the soil moisture.

The trial was designed to evaluate the emergence depth of the weed and the following variants were evaluated:

1. 0 cm (Control);
2. 2 cm;
3. 4 cm;
4. 6 cm;
5. 8 cm;
6. 10 cm;
7. 12 cm;
8. 14 cm.

All variants were in five replications.

The evaluated parameters of the weed:

- Emergence after sowing, days;
- Emergence depth, cm;
- Number of emerged plants and percent of emergence;
- Total plant weight, g;
- Total plant length, cm.

For statistical analyses of collected data, Duncan's multiple range test (1955) of SPSS program was used. Statistical differences were considered significant at $p < 0.05$.

RESULTS AND DISCUSSIONS

The next few figures present the results of the pot experiment conducted to determine the depth of emergence. It should be emphasized that the experiment was conducted in February 2025. So

the weed plant did not have the period of full vernalization, due to which the plants form above-ground and root mass, but did not develop reproductive organs. The need of vernalization of the weed was described by Donald (1984) and Mallory-Smith et al. (2018). The author found that the weed has a quantitative requirement for vernalization in order to flower. This is the reason why there are no results obtained for the total number of tillers, the number of productive tillers, the length of the ears and the mass of the ears. Despite these statements the obtained results showed the great biomass development capacity that the jointed goatgrass possess. According to Donald et al. (1991) the optimal depth for germination and emergence of the weed is 1-3 cm. Therefore, as found by Morrow et al. (1982) the weed did not emerge from below 5 cm in greenhouse and 6 cm in laboratory. After conducting our experiment, it was found that the jointed goatgrass plants that develop from the soil surface at variant 1 (0 cm) sprout the fastest – in 6 days (Figure 1). Plants sprout more slowly from seeds sown at 2 and 4 cm (Variants 2 and 3) – 8 and 10 days after sowing, respectively. Plants placed at 6, 8 and 10 cm sprout for a period of 24 to 28 days.

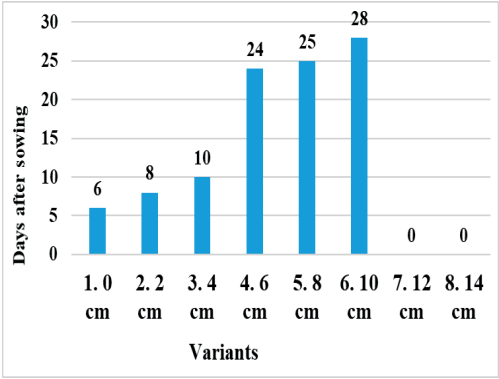


Figure 1. Emergence after sowing, days

Research has shown that the species can germinate from depths of up to 10-15 cm (Donald et al., 1991). In our study it was found that plants sown at 12 and 14 cm do not emerge

and the statement of the author was not confirmed. More information for the weed’s germination could be obtained from the Figures 2, 3.

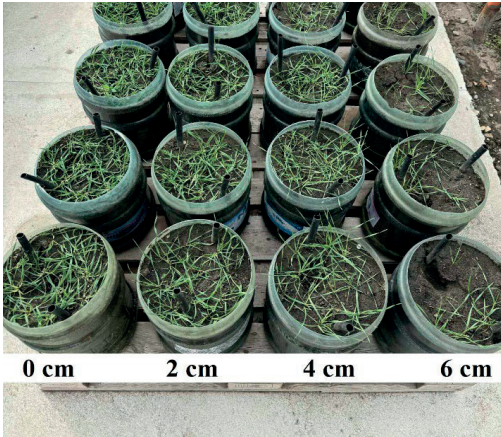


Figure 2. Emergence of the plants at variants from 1 to 4

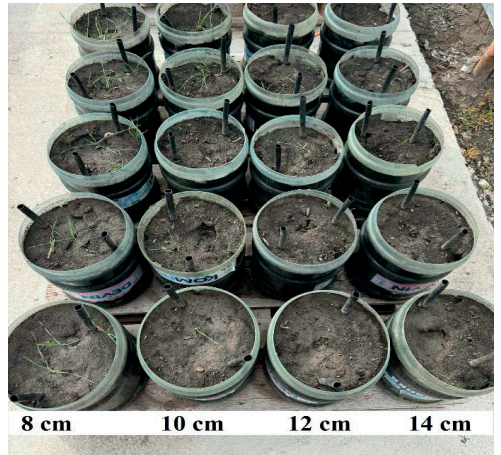


Figure 3. Emergence of the plants at variants from 5 to 8

Figure 4 shows the results related to the number of emerged plants from the different sowing depths. It was found that plants from variants 1, 2 and 3 (sown at 0, 2 and 4 cm) had 100% emergence (all 10 seeds sown). With increasing sowing depth, the percentage of emerged plants decreased from 68% (6.8 sprouted plants) in variant 4 (6 cm) to 18% (1.8 sprouted plants) in variant 6 (10 cm). The percentage of sprouted plants from 12 and 14 depths (Variants 7 and 8) was 0%.

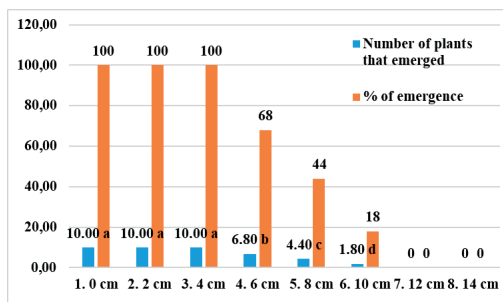


Figure 4. Number of emerged plants and percent of emergence

Numbers with different letters are significantly different according to Duncan's test ($p < 0.05$)

The weight of the formed, developed biomass of the weed is presented in Figure 5. The highest total weight of the biomass (roots + aboveground biomass) was measured in plants from variant 2 - 298.54 g, which emerged from 2 cm of depth, with the weight being relatively evenly distributed between that of the roots and aboveground mass.

The biomass of one plant in variant 1, where the plants develop from the soil surface, had a slightly lower weight - 273.93 g.

With increasing emergence depth, the weight of the plant biomass decreases and reaches 76.22 and 76.50 g in variant 5 and variant 6 respectively.

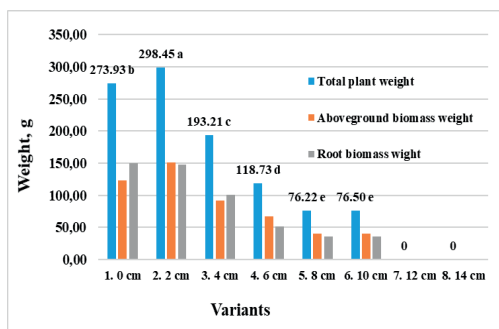


Figure 5. Total plant weight, g

Numbers with different letters are significantly different according to Duncan's test ($p < 0.05$)

The plants that develop from the soil surface were distinguished by the highest length – 76.00 cm. Plants that sprout from 2 and 4 cm in variants 2 and 3 had a length of 74.00 cm. With

increasing emergence depth, the length of the plants decreased – from 76.00 to 59.00 cm. It is worth noting that the plants form longer roots than above-ground mass (Figure 6).

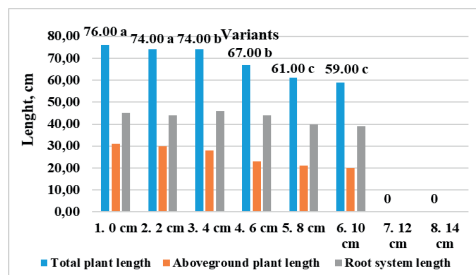


Figure 6. Total plant length, cm

Numbers with different letters are significantly different according to Duncan's test ($p < 0.05$)

The next figures (7-12) give greater idea of the weed jointed goatgrass biomass development.



Variant 1. Germination from 0 cm

Figure 7. Variant 1 (Control). Plants in the emergence stage from 0 cm



Variant 2. Germination from 2 cm

Figure 8. Variant 2. Plants in the emergence stage from 2 cm



Variant 3. Germination from 4 cm

Figure 9. Variant 3. Plants in the emergence stage from 4 cm



Variant 4. Germination from 6 cm

Figure 10. Variant 4. Plants in the emergence stage from 6 cm



Variant 5. Germination from 8 cm

Figure 11. Variant 5. Plants in the emergence stage from 8 cm



Variant 6. Germination from 10 cm

Figure 12. Variant 6. Plants in the emergence stage from 10 cm

CONCLUSIONS

The emergence of the weed was faster – 6-10 days after sowing for the depths of 0, 2 and 4 cm. The plants sown deeper emerge 25 to 27 days after sowing.

The seeds of the weed sown on 12 and 14 cm of depth does not emerge.

There was 100% of emergence of the plants sown from 0 to 4 cm of depth, while the percent of emergence decreased from 68 to 18 for the sowing depths of 6 to 10 cm.

The plants emerging from 2 cm of depth developed the highest total biomass, and were followed from those emerged on the soil surface. The length of the total biomass of the weed was the highest when the plants emerge from the soil surface. The results were followed by the 2 cm emergence depth.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to professor Tonyo Tonev, PhD for his support and idea exchange for the conducting and performing the current experiment.

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