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Effects of Planting Depth on Germination and the Emergence of Field Bindweed (*Convolvulus arvensis* L.)

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Abstract: Effect of 13 planting depths on germination and the emergence of field bindweed were investigated under greenhouse conditions. Results showed that field bindweed seeds emerged from up to 6 cm depth. The highest emergence occurred in the first, second, third and fourth week after emergence from 0.5, 0.5, 1.0 cm and 1.5, 1.5 and 1.5 cm planting depth, respectively. At the end of the fourth week, 6.5 cm depth treatment had zero emergences. Increasing burial depth resulted in induced secondary dormancy.

Key words: Field bindweed, germination, planting depth

INTRODUCTION

In the last few decades, attention has focused on weed biology and its importance in the weed management. Principles for the management and control of weeds identifying and understanding the environmental factors affecting the biology of weeds are essential. This information, to understand the dynamics of weed particularly seed dynamics in soil is necessary and agricultural activities will improve. Knowledge of the ecology of seed bank and weed seeds can be beneficial in their longevity in the soil. Ecological factors not only play a pivotal role in secondary dormancy of seeds, but also it can even be induced inhibitory effect on germination. It is known that light, temperature, soil water content and amount of soil compaction are the main factors that may limit the germination of buried seeds (Pereja and Staniforth, 1985). In this situation, germination is limited by soil depth. Understanding the biological reasons for the inhibitory effect of depth, is still utterly unknown. But problems such as lack of light, reducing gas exchange and the presence of CO_2 produced by soil biological activities, reducing reservoir of seeds is notable.

Weed species also plays a pivotal role in this regard. Some weed species have the ability to grow in a wide range of planting depth, for example, it is clear that *Trianthema portulacastrum* are able to germinate from a depth of 9 cm (Balyan and Bhan, 1986), or *Morrenia odorata* easy germinate in depths less than 10 cm (Singh and Achhireddy. 1984). Studies also show that *Cirsium arvense* is capable to germinate from a depth of 6 cm (Wilson, 1979). Similar results were also reported on *Jacquemontia* (Shaw *et al*., 1987). On the other hand, some seeds should be near the soil surface to germinate.

Field bindweed (*Convolvulus arvensis* L.) is a persistent, perennial vine of the *Convolvulaceae* family which spreads by rhizome and seed (Whitson *et al*., 2000). *Convolvulus arvensis* has become well established in temperate regions of all major agricultural areas of the world. It has been reported as one of the world's ten worst weeds (Pushak *et al*., 1999). Field bindweed fruits usually contain 2 seeds, and the number of seed per plant varies between 25-300. Seeds are dark brown to black, and have rough surfaces. They are 0.5-1.2 cm long, and their shapes vary, depending on the number produced in the fruit; they are rounder when only one is produced and progressively thinner as more are produced (Lyons, 2009).

Seeds of this plant have high germination ability and this high germination has an important role in the spreading of the plant. Therefore, the objective of this study was to evaluate the influence of planting depth on the germination percentage of seeds of this weed.

MATERIALS AND METHODS

The experiment was carried out in April 2011 at biotech research center, University of Zabol, Zabol, Iran. *Convolvulus arvensis* plants were collected during the flowering stage from agricultural research station of University of Zabol, (36º38′ N and 59º7′ E), Iran, and before being used for bioassays, their germination potentials were examined at 25±1ºC in darkness and germination over 85% also guaranteed the viability of the seeds. The plant seeds were sterilized with 10:1 water/bleach (commercial NaOCl) solution for 5 min and subsequently washed with diluted water.

Plastic pots with 12 cm in diameter and 10 cm in height were filled out with 1.1 dm 3 of garden soil, and four seeds of *Convolvulus arvensis* were sown at a 13 different depth of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0 and 6.5 cm.

The pots were saturated with water by surface irrigation. During plant growth pots were irrigated daily by spraying with water until water drained from the bottom of the pot. Germination was measured daily for 28 days. All plants were harvested to determine shoot height,

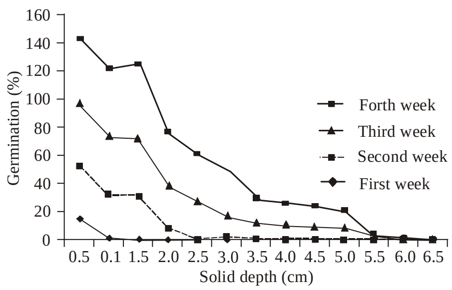

Fig. 1: Relationship between germination with depth at different times after planting

root length and dry weight of roots and shoots of seedlings. The tests were performed in a green house in four replicates. The minimum and maximum greenhouse temperature during the test was 22 and 30ºC.

Germination and seedling growth bioassays were conducted in a Complete Randomized Design (CRD) with four replications. The experiments were repeated twice and the pooled mean values were separated on the basis of Least Significant Differences (LSD) at a probability level of 0.05.

RESULTS AND DISCUSSION

The results showed that after the first week, planting depth of 0.5 cm has the highest percentage of germination (Fig. 1). At the second week, planting depths of 0.5, 1.0 and 1.5 cm were not statistically significant (Table 1). But this trend changed in the third week, and the highest germination percentage was observed at a depth of 1.5 cm and followed by the depths of 0.5 and 1.0 cm (Table 1). At the end of the experiment (after 4 weeks), the highest germination percentage was observed at a depth of 1.5 cm at depths of 1.0 and 0.5 cm were next in rank (Table 1). Germination decreased regularly with increasing depth of planting (Fig. 1). So that, in the fourth week, germination at a depth of 6.5 cm was zero.

Results in the first week are completely justified. The seeds in depth of 0.5 cm absorbed water and then seeds immediately began to germinate. The water still has not penetrated deeply in the soil. Water may gradually infiltrate into the soil and reaches greater depths and availability of water increases at this dept. Thus in the second week, the three depth of 0.5, 1.0 and 1.5 had similar germination percentage. In the third week, due to decreasing water at the soil surface and water penetration in to the deeper soil layer, the greatest percentage of germination was occurred at planting depth of 1.5 cm. Similarly, after the fourth week planting depth of 1.5 cm had the greatest germination percentage and followed by planting depths of 1.0 and 0.5 cm. The results of this experiment are somewhat consistent with those obtained on *Morrenia odorata* (Singh and Achhireddy, 1984). At this experiment, the greatest germination percentage was observed in this species at planting depth of 0.5 to 1.0 cm. The results of the present study showed that germination percentage reduced with increasing depth of planting. According to the studies on other weed species like *Ampelamus albidus*, *Asclepias syriaca* and *Cucurbita texana* germination decreased with increasing depth of planting (Coble and Slife, 1972; Evetts and Burnside, 1972; Oliver *et al.*, 1983; Soters and Murray, 1981). For example, *Cucurbita texana* seeds did not germinate, when planted at soil depth of 10 cm (Oliver *et al*., 1983), or Ampelamus albidus did not germinate at depths greater than 5 cm (Soters and Murray, 1981).

The main reason for the lack of germination in greater depths, however, is usually secondary dormancy in seeds. Induction of secondary dormancy is still not completely clear. Maybe it's because of low-gas exchange with increasing depth. This may be due to lack of O_2 or increase the amount of CO_2 that is produced in seed metabolism occurs. In other words, with increasing depth, the ratio of CO_2 to O_2 is reduced. Sometimes the behavior of seed germination with increasing depth can be dependent on the storage reservoir stored in the seed.

Experiments are shown in a number of species even in the absence of sufficient oxygen metabolism of seed is started, only when necessary energy is provided. Generally, studies had shown that apart from a few exceptions (Sorghum halepense, Abutilon theopherasti, *Galium aparine*, Geranium dissectum) weed seeds germinate from the soil seed bank only when they located at the top 10 cm soil layer. Apart from secondary dormancy in seeds, another reason for reducing germination in higher depth may be destruction of seeds and germinated seedlings (Benvenuti and Macchia, 1998).

It can be concluded that, in unsuitable conditions, such as soil compaction, flooding, or the placement of seed in high deep, the seed germination can be delayed. Because, in these conditions germination is harmful for germinated seedlings. Upon receiving the appropriate biological symptoms such as sufficiency light, favorable temperature, rainfall, or appropriate agronomic practice, such as proper seedbed preparation, the seed germination will begin the plant not until the risk for survival, to avoid risk to the survival of seedlings.

CONCLUSION

In conclusion, the current study showed that germination and emergence is reduced with increasing depth of planting. The main reason for the lack of germination in greater depths is secondary dormancy induction in the seeds. Seed dormancy was due to hardening of the gas exchange with increasing depth of sowing. Moreover, low germination with increasing depth of seed may be related to the energy stored in the seed.

Table 1: The number of germinated seeds at different depths

	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
First week	1.097a*	1.040b	1.010b	1.028b	1.000b	1.000b	1.000b	1.000b	1.000b	1.000bb	1.000b	1.000b	1.000b
Second week	1.232a	1.188a	1.183a	1.060b	1.010b	1.020b	1.000b	1.000b	1.000b	1.000b	1.000b	1.000b	1.000b
Third week	1.257ab	1.247ab	1.275a	1.188bc	1.163cd	1.160cd	1.102de	1.087de	1.058ef	1.000f	1.000f	1.000f	1.000f
Fourth week	1.257abc	1.280ab	1.315a	1.227bcd	1.205cd	1.190de	1.138ef	1.112f	1.087f	1.077fg	1.020gh	1.010h	1.000h

*: Values followed by the same letter within the same row do not differ significantly at p = 5% according to LSD

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