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EFFECTS OF PLANTING DEPTHS ON EMERGENCE AND GROWTH OF *Abelmoschus esculentus (*L) Moench

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Abstract
The studies were conducted in a Glass House at Botanical Garden, B. Z. University Multan, Pakistan. Laboratory and field experiments were performed to test the emergence and seedlings morphology of *Abelmoschus esculentus* seeds buried at varying planting depths. The results revealed that with an increase in planting depth, the percentage emergence of the seedlings decreased markedly. At planting depths; 0, 5 and 10 mm, 100 % emergence occurred while, at 20 and 40 mm depths the percent emergence declined up to 90% and 72%. Planting depth significantly affected the shoot length, fresh and dry weight of shoots in *A. esculentus.* The study indicated that deep burial of seeds resulted in retarded seedling growth of the species.

Keywords: *Abelmoschus esculentus*, emergence, growth, planting depths, seedlings morphology.

INTRODUCTION
Planting depth is an important criterion in seedling emergence [Watt and Whalley 1982, Cox and Martin 1984]. A relatively deep seed placement minimizes water stress experienced by the establishing seedlings [Cox and Martin 1984]. However, this depth must be within the physical capacity of the coleoptile extension for the given seed resources. Seed germination as influenced by the position of the seeds in the soil have been conducted by several workers to analyze the role played by burial depths seed bank dynamics [Watt and Whalley 1982, Lambert *et al.* 1990, Scott *et al.* 1985, Malik *et al.* 2007].

The main aim of the experiment was to investigate if the physical characteristics of the soil were involved in both buried seed ecology and emergence dynamics.

Sowing depth surprisingly affects seedling emergence, which is species dependent. In dry conditions, deep planting might be successful in crop emergence. Gupta [1980] showed that under cool soil conditions, deeper plantings cause significant emergence delays in corn. For normal conditions, depending on soil and weather conditions, an ideal planting depth is 1½ to 2 inches deep. Keeping in view, the importance of depth of planting, the present study was carried out to investigate the effects of varying planting depths on emergence and seedling growth of *A. esculentus*.

MATERIALS AND METHODS

EFFECT OF PLANTING DEPTHS ON SEEDLINGS EMERGENCE

Effect of different planting depths on seedlings emergence of *A. esculentus* was studied in a Glass House, Botanical Garden, Bahauddin Zakariya University, Multan, in the plastic pots of 12 cm diameter.

Five healthy seeds were sown at 0, 5, 10, 20 and 40 mm depths. Each depth (treatment) had 6 replicates. The soil in the pots was well moistened with water. The pots were arranged in a completely randomized block design. The position of the pots was changed daily when recording the emergence of seedlings. The experiment was started on 30th April, 2007 and terminated on 10th May, 2007.

EFFECT OF PLANTING DEPTHS ON GROWTH OF *A. esculents*

In another experiment, five healthy seeds of *A. esculentus* were set to germinate at different planting depths of 0 mm, 5 mm, 10 mm, 20 mm, 40 mm. Each treatment (depth) had six replicates. Thus the experiment involved a total number of 30 pots. The pots were watered with 500 ml tap water to establish the seedlings. The pots were irrigated with appropriate amount of tap water. After 14 days, the seedlings were thinned to one seedling per pot for further growth. Visual observations regarding the general appearance of the plants were made regularly. Growth measurements including length of shoots and roots, fresh weight of the shoots and roots and oven dried weight of the shoots and roots were made after a three weeks of growth and two months (harvests I and II), respectively. The data obtained in both the experiments was subjected to ANOVA [Steel and Torrie 1996].

RESULTS

EFFECT OF PLANTING DEPTHS ON SEEDLINGS EMERGENCE

Table 1 shows that the emergence of seedlings started on the 2nd day after the start of the experiment in 0, 5, 10 and 20 mm planting depths while at 40 mm planting depth, the emergence of the seedlings initiated on the 3rd day. The emergence percentage was greater at 5 and 10 mm of the planting depths while it was lower at 40 mm planting depth. The emergence of seedlings was 100% at 0, 5 and 10 mm planting depths at the time of the termination of experiment as compared to those sown at 20 and 40 mm planting depths i.e. 90% and 72% seedlings emergence.

EFFECT OF PLANTING DEPTHS ON GROWTH OF *A. esculents*

Table 2 reveals that among various treatments, there were significant differences in fresh and oven dried weight of shoot but there were no significant differences among the various treatments with regard to the length of shoots, roots and fresh and dry weight roots in various planting depths at harvest I. The results of harvest II indicated that there were significant differences in shoot length but there were no significant differences in the root lengths and fresh and dry weight of shoots and roots. To summarize, it can be stated that on the whole, the seedlings grown at 5 and 10 mm planting depths performed better regarding various growth attributes as compared to those grown in other planting depths.

DISCUSSION

The results of the present studies showed that the maximum percentage emergence of the seedlings was observed at 5 and 10 mm depths and it was much higher at 5 mm depth. The fresh and oven dried weight of the seedlings of *A. esculentus* was much higher at 10 mm depth. At 20 and 40 mm depths the fresh and oven dried weights of shoots and roots decreased. These findings are in line with those obtained by Lambert *et al*. [1990] who observed that the emergence of the seedlings of *Astreba lapacea* was higher at 10 and 25 mm depths. The results further showed that maximum growth was observed at 5 and 10 mm depths and the least growth at 20 and 40 mm depths.

Influence of soil depth on plant growth has been observed by Watt and Whalley [1982] and Benvenuti *et al.* [2001] who stated that the depth does not appear to have much or any effect on seedling germination but not too surprisingly depth does play a role in seedling emergence. The effect of depth on seedling emergence also appears to be species dependent. In addition, a relation has been reported between depth-mediated inhibition and seed weight [Benvenuti *et al*. 2001] because until a plant emerges, it relies on stored food in the seed. The deeper the seed, the more stored food it takes to reach the surface. Needless to say,

Table 1: Percentage emergence of *Abelmoschus esculentus* at different planting depths (mm). (Values are means of 6-replicates with their standard errors).

Depth	Days after sowing									
(mm)	1	2	3	4	5	6	7	8	9	10
0	0.0	13.3±0.21	26.6±0.33	33.3±0.21	46.6±0.22	48.3±0.16	50.0±0.34	86.6±0.21	100.0±0.00	100.0±0.00
5	0.0	43.3±0.55	50.0±0.56	66.6±0.42	73.3±0.36	86.3±0.33	90.0±0.22	100.0±0.00	100.0±0.00	100.0±0.00
10	0.0	30.0±0.21	53.3±0.33	60.0±0.36	76.6±0.49	83.3±0.50	98.0±0.36	100.0±0.00	100.0±0.00	100.0±0.00
20	0.0	24.3±0.75	33.3±0.21	36.6±0.16	56.6±0.16	76.6±0.16	86.6±0.22	90.0±0.22	90.0±0.22	90.0±0.22
40	0.0	0.0±0.00	16.6±0.31	23.3±0.30	40.0±0.25	50.0±0.34	53.3±0.33	66.6±0.10	72.3±0.51	72.3±0.51

Table 2: Growth measurements per 5 seedlings of *Abelmoschus esculents* at different planting depths (H-I and H-II). (Means of 6-replicates with their standard errors).

Depth (mm)	Harvest No.	Shoot length (cm)	Root length (cm)	Fresh weight of shoot (gm)	Dry weight of shoot (gm)	Fresh weight of root (gm)	Dry weight of root (gm)
0	H-I	24.80 ±0.12	6.30 ± 0.02	0.31 ± 0.04	0.06 ± 0.01	0.06 ± 0.00	0.06 ± 0.00
	H-II	32.00 ±0.46	7.42 ± 0.34	3.11 ± 0.24	0.36 ± 0.06	0.26 ±0.06	0.06 ± 0.01
5	H-I	26.20 ±0.23	6.13 ± 0.41	0.89 ± 0.02	0.07 ± 0.01	0.04 ± 0.01	0.01 ± 0.00
	H-II	31.30 ±1.53	7.42 ± 0.34	2.25 ± 0.56	0.52 ± 0.04	0.64 ± 0.12	0.04 ± 0.00
10	H-I	27.20 ± 0.64	9.70 ± 0.21	0.33 ± 0.03	0.05 ± 0.00	0.06 ± 0.00	0.02 ± 0.00
	H-II	34.20 ± 0.96	9.90 ± 0.03	1.64 ± 0.39	0.54 ± 0.01	0.13 ± 0.04	0.05 ± 0.00
20	H-I	23.50 ± 0.35	6.16 ± 0.84	0.28 ± 0.02	0.04 ± 0.00	0.03 ± 0.00	0.01 ± 0.00
	H-II	29.70 ± 0.57	8.80 ± 0.21	1.80 ± 0.61	0.23 ± 0.02	0.11 ± 0.01	0.03 ± 0.00
40	H-I	22.70 ± 0.80	5.23 ± 0.62	0.27 ± 0.02	0.04 ± 0.01	0.03 ± 0.00	0.01 ± 0.00
.	H-II	31.20 ± 0.43	6.30 ± 0.61	1.60 ± 0.18	0.25 ± 0.07	0.08 ± 0.00	0.03 ± 0.00
L.S.D	H-I	N.S	N.S	1.04	0.14	N.S	N.S
(0.05)	H-II	6.99	N.S	N.S	N.S	N.S	N.S

N.S = Non-Significant.

small seeds do not have a lot of stored food and may never reach the surface if planted deep. The germination of very small seeds is almost completely inhibited even at extremely shallow burial depths may be due to predation and other environmental factors. This phenomenon appears to be of notable importance as a survival strategy of population dynamic because it tends to protect a considerable portion of the seed bank against a risky germination that would be unlikely to result in successful emergence. Conditions unfavorable to emergence arise as a consequence of the normal tillage operations performed in an agro-ecosystem, which tend to distribute the majority of annually produced seeds through the soil profiles [Grundy *et al*. 1996]. Thus, seeds germinated from an excessive depth would undergo a heterotrophic stage (during pre-emergence growth) that would be too protected for their limited energy reserves. It appears that the decrease in germination with increasing burial depth might be due to poor gas exchange in soil. This is a crucial point as germinating seeds produce volatile toxic metabolites resulting from the onset of fermenting metabolism (acetaldehyde3, methanol and acetone), [Holm 1972] in so far as fermentation is possible based on the degree of hypoxia inevitable induced by limited soil oxygen exchange. The seed burial at elevated depth results in an analogous ecological situation independent of soil physical characteristics.

The present results showed that the plants performed better overall growth at 10 mm planting depth as compared to deep sowing. These findings also suggest that the rate of seedlings emergence and growth was decreased by the increasing burial depth. The present findings also agree with Holm [1972], Watt and Whalley [1982], Cox and Martin [1984], Malik *et al.* [2007]. However further work under field condition is required to see what would happen under natural agronomic practices.

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