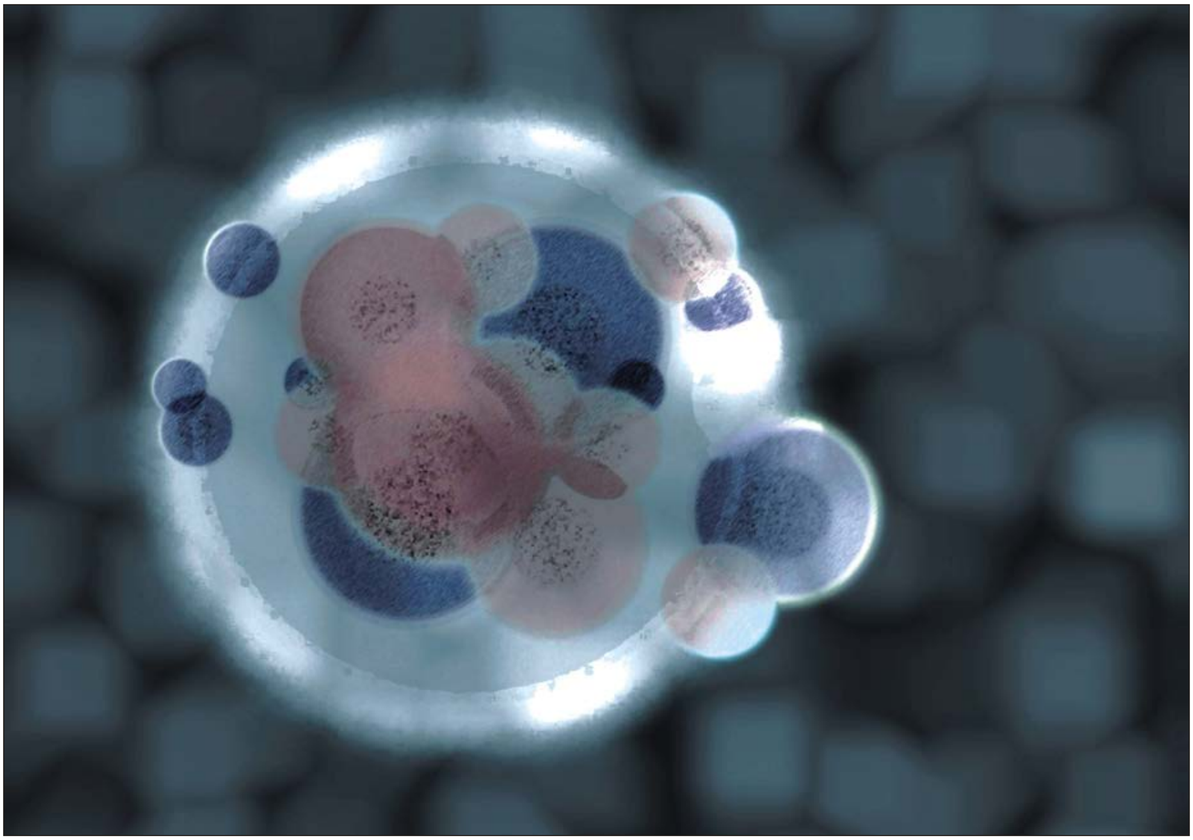

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The Effect of Soil Compaction on Emergence of Sugar Beet Seedlings

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Abstract: In the present study a plot experiment was conducted to evaluate the favourable soil compaction pressure, moisture and sowing method for optimum emergence of sugar beet. In research, two different sowing methods (compaction at soil surface; S_1, compaction at seed level; S_2), three different moisture contents (25, 50 and 75% of field capacity; M_1, M_2, M_3) and three different pressures (50, 100 and 150 kPa; P_1, P_2, P_3) were applied to three different textured soils (clay, clay-loam, sandy-loam; Sille, Karaaslan, Faculty). In all soils, S_2 sowing method was found more effective than S_1 sowing method. First seedling emergences were obtained from Karaaslan and Faculty soils with M_3 moisture applications in S_2 sowing method. The latest and lowest seedling emergences were seen in S_1 sowing method. In S_2 sowing method, seedling emergence was not significantly changed with increasing pressure level. Seedling emergence, whereas, was affected by different pressure applications in S_1 sowing method. $S_2M_3P_2$ application was found as the best media for seedling emergence.

Key words: Sugar beet, emergence, compaction, moisture, sowing method

INTRODUCTION

The percentage of sugar beet seedling emergence varies significantly with environmental factors, seed qualities and soil properties. Seedling emergence problem generally result from such factors as high crust strength[1,2], unfavourable soil moisture conditions[3] in the seed-zone and low soil temperature[4]. Rapid and uniform emergence of sugar beet seedling, whereas, enhances the probability of high yields.

Tillage treatments used in preparing sugar beet seedbed have to produce favourable soil physical conditions. But, rapid drying of soils after tillage treatments causes the rapid decrease in the moisture level of soils. Soils in dry climates also are often compacted after sowing to slow of the evaporation end extinguish moisture request of seed[5]. But, the type of compaction was more significant. The compaction at soil surface has negatively affected the seedling emergence depend on soil surface compacted. On the other hand, the compaction at seed level has improved soil- seed contact and decreased moisture loss in the depth of seedbed disturbing capillarity with loose soil that spread over seeds[6]. Seedling emergence has negatively affected by low soil moisture and insufficient soil-seed contact during sugar beet seeding in the conventional sugar beet production areas of Konya in Turkey. The present study, based on the experiment conducted in the laboratory, was carried out to establish the favourable soil compaction pressure, soil moisture and sowing method and to enhance the emergence of sugar beet seedlings.

MATERIALS AND METHODS

Soils: Soil samples used in this study were taken from the depth of 20 cm of three different areas (experimental land of the Agriculture Faculty of Selçuk University, Karaaslan Nursery and Sille district) of Konya province in Turkey. After air drying, soil samples were sieved using 6.3 mm mesh for pot-experiment. Selected physical and chemical properties of these samples were given in Table 4. Particle-size distribution was determined by the Bouyoucos Hydrometer method[7]; field capacity from moisture retention at pF 2.54 suction on disturbed samples by tension table method[8] and aggregate stability by wet-sieve method[9]. Soil pH was determined by pH meter with glass electrode for 1:1 soil-water suspensions; lime content by the Calcimeter method; organic matter content by the modified Walkey-Black method[10].

Experimental procedure: Two kilogram of soil samples were spread over trays. Soils were wetted using deionized water and mixed to rise to 3 different soil moisture contents (25, 50 and 75% of field capacity). Moist soil samples were transferred into plastic bags and left. After 1 day, samples were transferred into pots, 13 cm in diameter and 15.5 cm in height. Five seeds of sugar beet (Monogerm, S.901) were used for each pot.

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Two different sowing methods (compaction at soil surface, S_1 and compaction at seed level, S_2) were applied in pots. Soil samples were compacted at pressure levels of 50, 100 and 150 kPa. Pressures were applied with a hydraulic compaction device. In compaction at soil surface, pressures were applied after covered with soil on seeds. In compaction at seed level, seeds were covered with soil after pressure applications. To prevent moisture loss, all pots were covered by plastic. Experiment was conducted in a Randomized Complete-Block Design with three replications at 20±2°C. Emergence of sugar beet seedlings was recorded as daily during 20 days after sowing.

RESULTS AND DISCUSSION

There were more significant differences among different moisture applications. In all soils, no emergence was seen with M_1 moisture application regardless of the sowing method used. On the other hand, no emergence was seen with M_2 moisture application in S_1 sowing method. Similarly, with M_2 moisture application, no emergence was seen for faculty soil in S_2 sowing method. But, when the moisture level reached to M_3, seedling emergence was seen in all applications. Not surprisingly, moisture level had a significant effect on seedling germination and emergence (Table 1-3). Also, It was well known that germination capacity of sugar beet seed decreases considerably with the moisture level decreasing. Several researchers asserted that germination requires 65% moisture level of the field capacity[3,11]. Şeker[6] found that moisture levels of 60 and 80% were sufficient to germination in the compaction at seed level.

The first seedling emergence was obtained from Karaaslan and Faculty soils with M_3 moisture applications in S_2 sowing method (Table 2 and 3). Seedling emergence in Sille soil began after once day from other soils. This difference was not seen significant (Table 1). Because, the number of seedling emergence after two days (14 days after sowing) were same for all soils. For seedling emergence in Karaaslan was not significantly different between M_2 and M_3 moisture applications (Table 3). But, seedling emergence for Sille soil in M_2 moisture application was seen after four days than that in M_3 moisture application. In Sille soil, seedling emergence delayed and declined. The latest and lowest seedling emergences were obtained with S_1 sowing method (Table 1). For this sowing method; the first seedling emergence was seen in Karaaslan soil and the lowest seedling emergence was seen in Sille soil. Consequently, S_2 sowing method was found more effective than S_1 sowing method. It was considered that sowing method had two different effects on seedling emergence. The first effect was that compaction at soil surface causes soil strength. This strength could be strong enough to reduce or completely inhibit seedling emergence[2]. The other effect was that compaction at seed level causes the better soil-seed contact. There were the better moisture conditions for seedling emergence in seedbed. Seedling emergence in dry conditions also depends on amount of moisture further down from seed level[12]. On the other hand, number of seedling emergence and speed of emergence were affected by aggregate size of the seedbed. The increase of aggregate size delays emergence and reduces total emergence[13].

Table 1: The cumulative numbers of seedling emergence depend on days for different moisture and pressure levels in Sille soil

	Plant numbers											
	Sowing methods						Sowing methods					
	S_1			S_2			S_1			S_2		
	Moisture (% of field capacity)						Pressure (kPa)					
Day	25	50	75	25	50	75	50	100	150	50	100	150
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	3	0	0	0	3	2	3
14	0	0	0	0	0	4	0	0	0	4	4	4
15	0	0	0	0	0	4	0	0	0	4	4	5
16	0	0	0	0	0	4	0	0	0	4	4	5
17	0	0	0	0	3	4	0	0	0	4	5	5
18	0	0	1	0	3	5	1	0	0	4	5	5
19	0	0	1	0	3	5	1	0	0	4	5	5
20	0	0	1	0	3	5	1	0	0	4	5	5
21	0	0	1	0	3	5	1	0	0	5	5	5
22	0	0	1	0	3	5	1	1	0	5	5	5
23	0	0	1	0	3	5	1	1	0	5	5	5
24	0	0	1	0	3	5	1	1	0	5	5	5

Table 2: The cumulative numbers of seedling emergence depend on days for different moisture and pressure levels in Faculty soil

	Plant numbers											
	Sowing methods						Sowing methods					
	S_1			S_2			S_1			S_2		
	Moisture (% of field capacity)						Pressure (kPa)					
Day	25	50	75	25	50	75	50	100	150	50	100	150
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	2	0	0	0	2	3	2
13	0	0	0	0	0	3	0	0	0	3	4	4
14	0	0	0	0	0	4	0	0	0	3	4	4
15	0	0	0	0	0	4	0	0	0	4	5	4
16	0	0	0	0	0	4	0	0	0	4	5	4
17	0	0	2	0	0	4	0	2	0	4	5	4
18	0	0	2	0	0	4	0	2	0	4	5	4
19	0	0	3	0	0	4	0	3	0	4	5	4
20	0	0	3	0	0	4	0	3	0	4	5	4
21	0	0	3	0	0	4	0	3	0	4	5	4
22	0	0	3	0	0	4	0	3	2	4	5	4
23	0	0	3	0	0	5	0	3	2	4	5	5
24	0	0	3	0	0	5	0	3	2	4	5	5

Table 3: The cumulative numbers of seedling emergence depend on days for different moisture and pressure levels in Karaaslan soil

	Plant numbers											
	Sowing methods						Sowing methods					
	S_1			S_2			S_1			S_2		
	Moisture (% of field capacity)						Pressure (kPa)					
Day	25	50	75	25	50	75	50	100	150	50	100	150
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	2	0	0	0	2	3	1
13	0	0	0	0	2	4	0	0	0	2	3	2
14	0	0	1	0	3	4	0	1	1	4	4	3
15	0	0	1	0	4	4	0	1	1	4	4	4
16	0	0	1	0	4	4	0	1	1	4	4	4
17	0	0	1	0	4	4	0	1	1	4	4	4
18	0	0	2	0	4	4	0	1	1	4	4	4
19	0	0	2	0	4	4	0	1	1	4	4	4
20	0	0	2	0	4	4	0	2	1	4	4	4
21	0	0	2	0	4	4	0	2	1	4	4	4
22	0	0	2	0	4	4	0	2	1	4	4	4
23	0	0	2	0	4	4	0	2	1	4	4	4
24	0	0	2	0	4	4	0	2	1	4	4	4

Table 4: Selected physical and chemical properties of the soils

		Particle-size distribution							
Site	pH (1:1)	Sand (%)	Silt (%)	Clay (%)	Texture class	$CaCO_3$ (%)	Org. mat (%)	Field cap. (%)	Aggregate stability (%)
Faculty	7.8	54.0	30.0	16.0	SL	20.8	2.0	24.0	45
Karaaslan	7.6	30.5	41.0	28.5	CL	20.6	2.5	28.0	40
Sille	7.7	19.0	21.0	60.0	C	14.8	0.7	30.6	36

In S_2 sowing method, seedling emergence was not significantly changed with the increase of pressure level. This state was clearly seen in all soils. The effect of moisture in S_2 sowing method was found more effective than pressure.

Seedling emergence was affected by different pressure applications in S_1 sowing method. The number of seedling emergence with P_1 pressure application was only once in Sille soil. The number of seedling emergence did not change with the pressure reached from P_1 to P_2, but seedling emergence delayed. These results could be attributed to low-stability aggregates in Sille soil (Table 1). Aggregate stability, soil type and moisture are significant factors that affect compaction on soil surface. Aggregate stability in Sille soil was also lower than those other soils (Table 4). Low stability aggregates are not resistance to compaction. Therefore, strength of soil surface was increased[14]. The number of seedling emergence with P_2 pressure application in Karaaslan soil was two. The number of seedling emergence declined with the pressure reached from P_2 to P_3 (Table 3). But, there was a different result in Faculty soil. Also, the number of seedling emergence increased with the pressure reached from P_1 to P_2 (Table 2). The results of different moisture, pressure applications and sowing methods were signed that $S_2M_3P_2$ treatment was found as the best media for seedling emergence.

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