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The Impact of Some Seedbed Preparation Conditions on Corn Biometric Parameters

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Abstract
Field experiment was conducted during summer season of 2016 on corn crop (zea mays) grown on clay loam soil to investigate the effect of some seedbed preparation conditions: three soil moisture content at plowing Ɵ1, Ɵ2; Ɵ3 (8.1, 17.1; 26.4% w/w), three plowing depth d1, d2; d3 (10, 20; 30 cm) and two plowing speed s1, s2 (1.93, 10.33 kmh^{-1}) on some biometric parameters. Chisel plow was used for seedbed preparation. The experiment design was completely randomized block and split-split plot. Soil moisture content at plowing, plowing speed and depth were located in the main, sub main and sub-sub main plots, respectively. Surface irrigation (Basin) was used for irrigation. All other agricultural processes for corn crop management were used according to the recommendation of Ministry of Agriculture and land Reclamation. Corn crop was harvested 100 days after planting. The data on plant height (cm), root length (cm), stem diameter (cm) fresh weight of both shoots and roots (g $plant^{-1}$) and cob fresh weight (g cob^{-1}) were recorded. Data obtained were subjected to statistical analysis. Differences in the recorded data among treatments were significant at the 5% level in most cases. According to the recorded data values, the treatments used could be arranged in the flowing ascending orders: Ɵ3< Ɵ2< Ɵ1, d2< d1< d3 and s1< s2. It seemed that the optimum condition of seedbed preparation for corn crop grown on clay loam soil at the experimental location was (Ɵ1, d3; s2) ie. 8.1%, 30 cm; 10.33 kmh^{-1}.

Keywords: Soil moisture content, plowing depth, plowing speed, corn crop.

Introduction

Rising fossil fuel price and shortage of irrigation water are leading to increasing awareness to be both used efficiently in all our life aspects especially in the agricultural sector. Their use in good seedbed preparation is a must for improving seed germination, seedlings emergency and finally crop yield.

Seedbed preparation process is affected by the following:

1) Tractors used: type, weight, forward speed, contact area with soil surface, number of passes etc.,
2) Plant type (root depth, sensitivity to aeration, mechanism to grow on soil that has some of problems, season of growth etc.,
3) Climate condition,
4) Soil type (texture, structure, stratification, salinity, clay mineral etc., and
5) Conditions of seedbed preparation (soil moisture content at plowing, depth and speed of plowing etc**.**

Appah (2012) conducted field experiment to determine the effect of land preparation/ methods (No tillage; plowing followed harrowing) on maize growth grown on Acrisol under rainfed condition. He found that plowing followed by harrowing treatment produced better growth and yield in terms of plant height, stem girth, number of leaves plant $^{-1}$, dry matter, yield component. Ramazan et al. (2012) studied the impact of soil compaction on yield of maize planted on silty clay loam soil. They indicated that yield decreases with increasing tractor passes as compared to the control. They added that the wheat mulch treatment with moldboard followed rotavator was fruitful in increasing plant height and maize yield under non-irrigated conditions.Vaclovas Boguzas et al. (2013) carried out field experiment on maize crop (zea mays) grown on silt light loam soil under the following treatments:1) Conventionally (22- 25 cm) followed by moldboard, 2) Shallowly (12- 15 cm) plowed by moldboard, 3) deeply (25- 30 cm) plowed by chisel cultivator, 4) shallowly (10- 12 cm) tilled by disc harrow and 5) No till. Their results showed that all primary soil tillage (except for chiseling) had significant effects on maize biometric parameters. Deep chiseling had consistent influence on the biometric parameters of maize canopy, while no-till effect was significantly positive.Aikins et al. (2012) tested the effect of the following treatments: 1) disc plowing only, 2) disc plow followed by disc harrowing, 3) disc harrowing only and 4) no tillage on akposo maize crop grown on ferric Acrisol soil concerning biometric parameters. At harvest, the longest root, the highest dry matter and the highest cob fresh weight were obtained from disc harrowing only. The shortest route, the lowest dry matter yield, the lowest fresh and dry cob weight and the smallest seed index were found in the no tillage plot. The disc plowing followed by disc harrowing produced the highest cob dry weight and the highest seed index. They did not find significant difference in dry matter yield between disc harrowing only and disc plowing followed disc harrowing treatments.

Arhur (2014) investigated the effect of two tillage treatments: 1) disc plowing followed by disc harrowing, 2) no tillage and 3) three levels of NPK (15: 15: 15): 150,250,350 kg ha^{-1} on maize performance. At 10 weeks after planting he found that disc plow followed by disc harrowing achieved the highest (plant height, stem girth, number of leaves plant^{-1}, leaf area, root length, dry yield) relative to no tillage. The harvest index represents the preparation of plant dry biomass allocated into grains. Climatic and soil conditions are two of the most factors affecting harvest index. Ion et al. (2015) mentioned that using disc plowing recorded higher harvest index of maize crop. Versa et al. (1997) tested the effects of plowing depth (0, 40, 60; 90 cm) and annual tillage practices (reduced tillage; no tillage) on root growth of corn crop and production. They found about 35% of corn root in the 21-100 cm portion of soil profile below 60 cm depth in the deepest tillage, whereas less than 5% was below 60 cm in the control. They concluded that deep tillage of the soil increased root proliferation. They added that the greatest yield was always obtained with 90 cm tillage. Alam et al. (2013) examined the effect of three tillage (zero tillage, conventional tillage and deep tillage) and three cropping patterns (wheat follow, wheat mangobean and wheat dhaincha sesbania) on grain yield of wheat and rice crops. They found the highest grain yield was recorded in the deep tillage with wheat mangobean while the lowest one in the treatment zero tillage with wheat dhaincha sesbania cropping pattern and the lowest in zero tillage with follow based on. Tayel et al. (2016) found the best condition of seedbed preparation for fodder beet crop on sandy soil were: 6.68% w/w soil water content at plowing, 30 cm plowing depth and 9.6 Km h^{-1} plowing speed.

The objective of this study was to evaluate the effect of soil moisture content at plowing depth and plowing forward speed on the biometric parameter of maize (Zea maize L.) grown on clay loam soil.

Materials and Methods

A field experiment was conducted at the experimental station of the Soils, Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt. It was conducted during summer season of 2016 on corn crop (Zea mays L. cv. hybrid 360) grown on clay loam soil to investigate the effect of some seedbed preparation conditions: three soil moisture content at plowing Ɵ1, Ɵ2; Ɵ3 (8.1, 17.1; 26.4% w/w), three plowing depth d1, d2; d3 (10, 20; 30 cm) and two plowing speed s1, s2 (1.93, 10.33 kmh^{-1}) on some biometric parameters. Analytical data of the soil are presented in Table 1. Soil hydrophysical analyses were determined according to Klute, 1986.

Table 1: Mechanical and Hydrophysical analysis of soil

a) Mechanical analysis of soil.				
corse sand %	**fine sand %**	**Silt %**	**Clay %**	**texture**
8.4	19.2	36.8	35.6	clay loam

b) Hydrophysical analysis of soil.					
Bulk density gm.cm^{-3}	**Total Porosity %**	**Hydraulic conductivity cm.h^{-1}**	**Infiltration rate cm.h^{-1}**	**Field capacity* (%)**	**Wilting percentage* (%)**
1.33	49.81	1.7	5.4	42.2	18.5

*on dry weight basis

The experiment design was completely randomized block and split-split plot using three replicates. Soil moisture content at plowing, plowing speed and depth were located in the main, sub main and sub-sub main plots, respectively. Chisel plow was used for seedbed preparation. Superphosphate (15.5% P_2O_5), potassium sulphate (48%K_2O) and ammonium nitrate (33.5% N) were added at the rate of 150, 50 and 200 kg/fed., in sequence (one feddan ≈ acre = 4200 m^2). Phosphorus and potassium fertilizers were incorporated into the soil before sowing, while ammonium nitrate was divided into two equal doses before the first and the second irrigation. Corn seeds were sown on 20th of May2016. Surface irrigation (Basin) was used for irrigation. All other agricultural processes for corn crop management were used according to the recommendation of Ministry of Agriculture and land Reclamation. The crop was harvested at physiological maturity and yields recorded. Corn crop was harvested 100 days after planting.

The following parameters were considered to evaluate the growth response to the seedbed preparation conditions. Growth response included plant height (cm), root length (cm), stem diameter (cm) fresh weight of both shoots and roots (g plant^{-1}) and cob fresh weight (g cob^{-1}). The data from this study were statistically analyzed through analysis of variance (ANOVA) and least significant difference (LSD) at 0.05 probability level to make comparison among treatment means according to Gomez and Gomez (1984).

Results and Discussion

At 100 days after planting, corn crop was harvested. All the biometric parameter under study (plant height, root length, stem diameter, number of leaves plant^{-1}, root fresh weight plant^{-1}, straw fresh weight plant^{-1} and cob fresh weight were recorded Figs. (1-6)

1. **Plant height (cm)**
   Fig. (1) Indicated the main effect of soil moisture at plowing, plowing depth and plowing speed on plant height. The superiority of soil moisture (8.1% w/w), plowing speed (10.23 kmh^{-1}) and plowing depth (20 cm) was quite evident. It can be noticed that the treatment (10.33 kmh^{-1}) surpassed the treatment (1.93 kmh^{-1}). The highest (189.75 cm) and the lowest (137.39 cm) plant height were achieved in the treatment 10 and 30 cm plowing depth, respectively.
2. **Root length (cm)**
   Fig. (2) Illustrated the main effect of soil moisture content at plowing, tractor forward speed and plowing depth on root length. The treatment: soil moisture content at plowing (8.1% w/w), tractor forward speed (10.33 kmh^{-1}) and plowing depth (30 cm) surpassed the other treatments.
3. **Stem diameter (cm)**
   The main effect of soil moisture content at plowing, plowing speed and plowing depth treatment are plotted in Fig. (3). One can notice the main effect of treatments on stem diameter took the same trend of that on plant height and root length
4. **Number of leaves plant^{-1}**
   The main effect of the treatments under study on number of leaves plant^{-1} is given in Fig. (4). It seems that the response of the number of leaves plant^{-1} to studied conditions of seedbed preparation was similar that on plant height, root length, stem diameter.
5. **Root fresh weight plant^{-1}**
   The highest value of root fresh weight and the lowest one were recorded in the treatment soil moisture content at plowing (8.1; 26.4% w/w), plowing speed (1.93; 10.33 kmh^{-1}) and plowing depth (10; 20 cm), respectively.
6. **Straw fresh weight plant^{-1}**
   Concerning the main effect of the investigated, treatments on straw fresh weight plant^{-1}, the treatments (8.1% w/w; 30 cm; 10.33 Kmh^{-1}) were superior whereas (26.4% w/w; 20 cm; 1.93 kmh^{-1}) were inferior.
7. **Cob fresh weight (gm cob^{-1})**
   The main effect of the treatments on our hand on cob fresh weight took the same trend of straw fresh weight plant^{-1}.
   The data were subjected to the statistical analysis the differences in biometric parameters of corn crop planted on clay loam soil among the seedbed preparation conditions were significant at the 5% level. Shortly, according to the obtained values of the biometric parameter of corn the tested treatments could arrange on the following ascending orders: soil moisture content 26.4< 17.1< 8.1% w/w, plowing speed 1.93< 10.33 kmh-1 plowing depth 10<20<30 cm. Although, the difficulty of data discussion due to the many factors involved in seedbed preparation one can say that data obtained could be explained on the basis of the resultante Effect of these factors as indicated below:

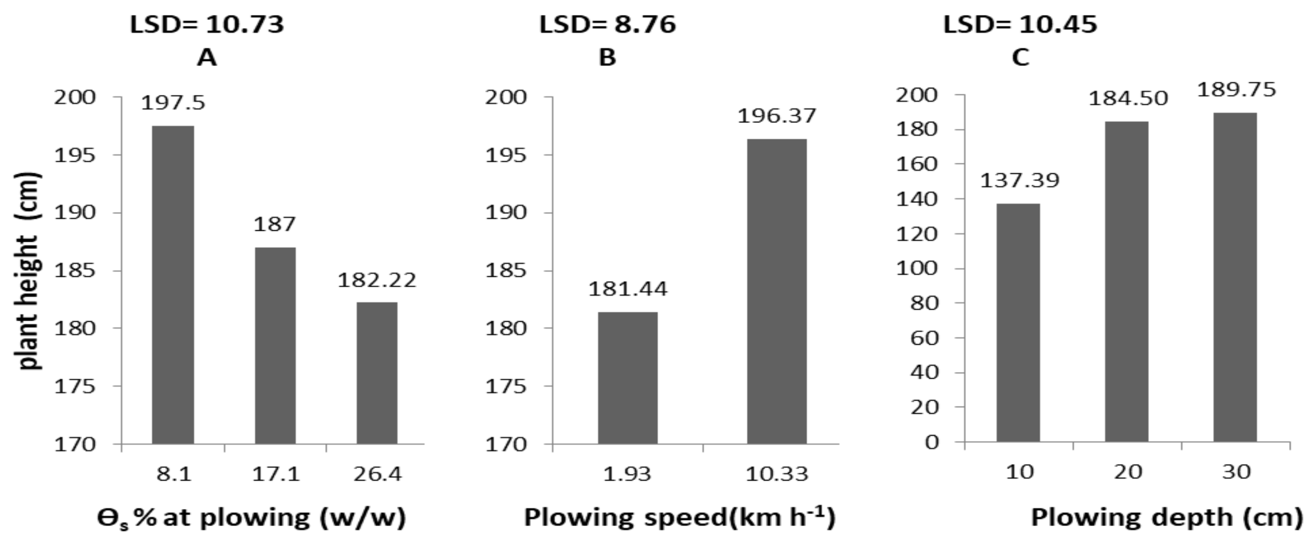

Fig 1: The main effect of soil moisture content at plowing (A), plowing speed (B) and plowing depth (C) on plant height after 100 days.

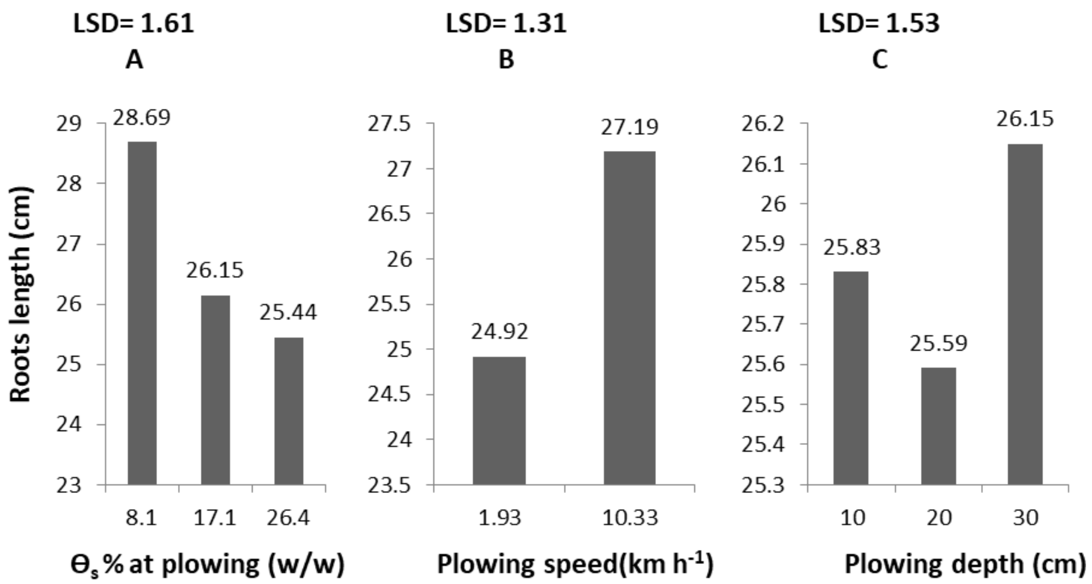

Fig 2: The main effect of soil moisture content at plowing (A), plowing speed (B) and plowing depth (C) on roots length after 100 days.

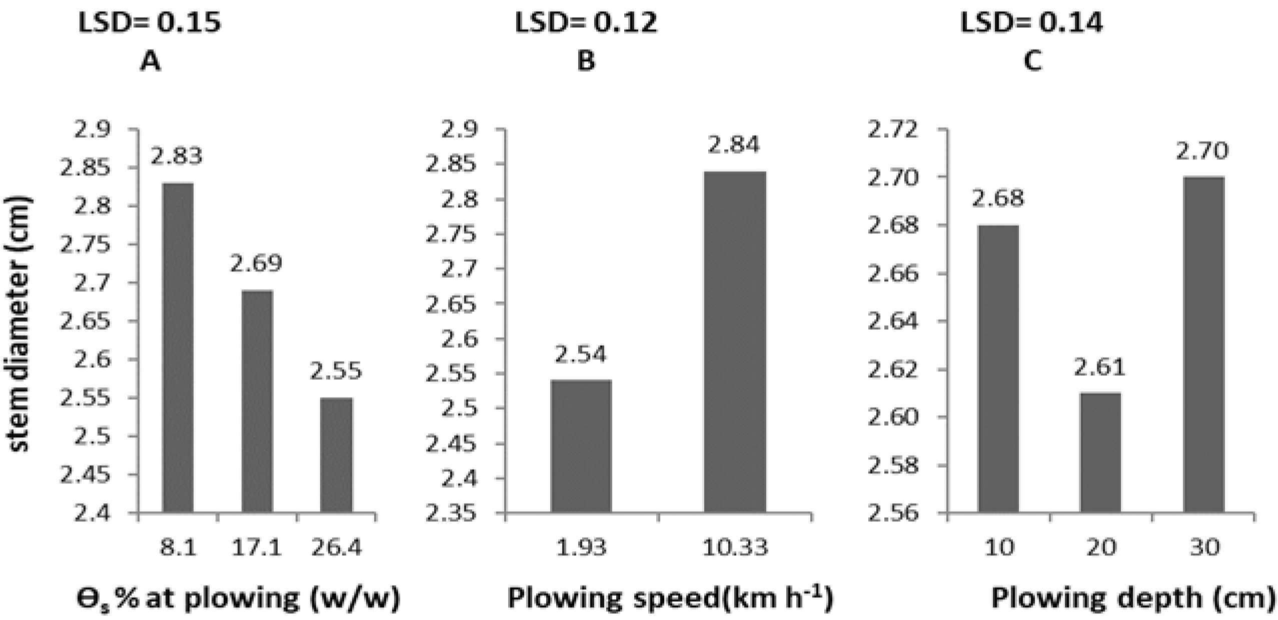

Fig. 3: The main effect of soil moisture content at plowing (A), plowing speed (B) and plowing depth (C) on stem diameter after 100 days.

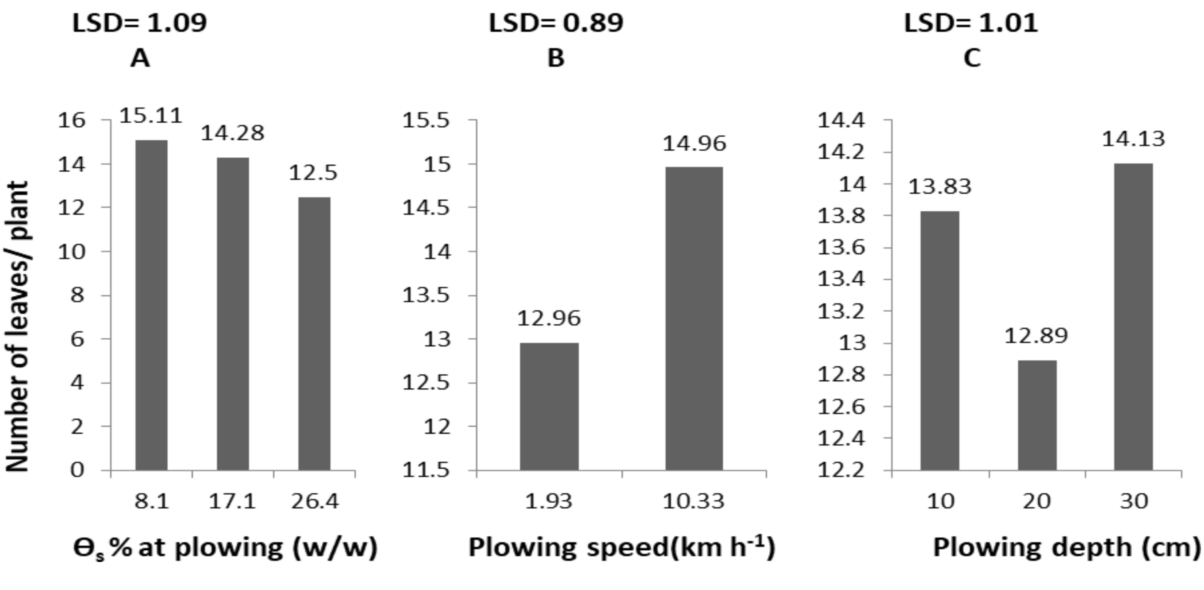

Fig 4: The main effect of soil moisture content at plowing (A), plowing speed (B) and plowing depth (C) on number of leaves after 100 days

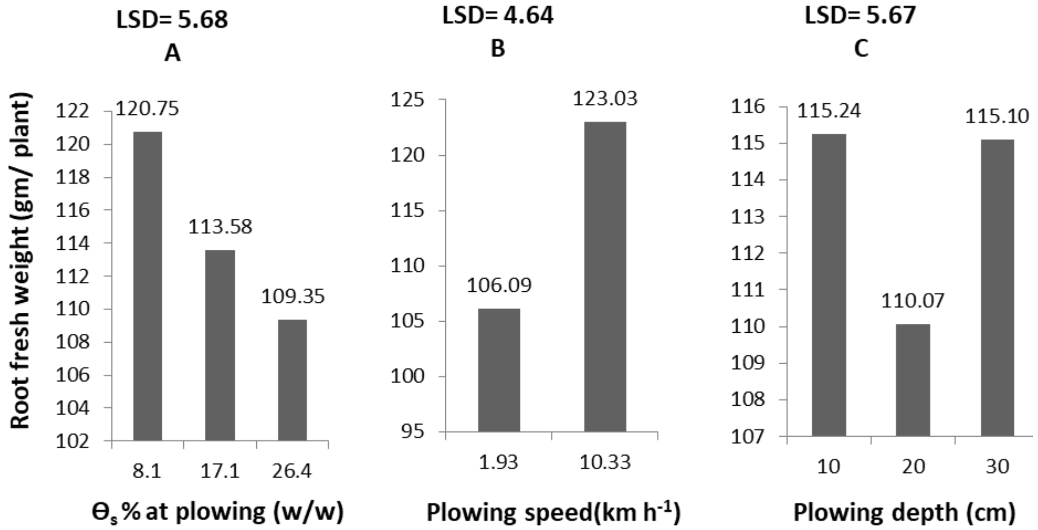

Fig 5: The main effect of soil moisture content at plowing (A), plowing speed (B) and plowing depth (C) on root fresh weight after 100 days.

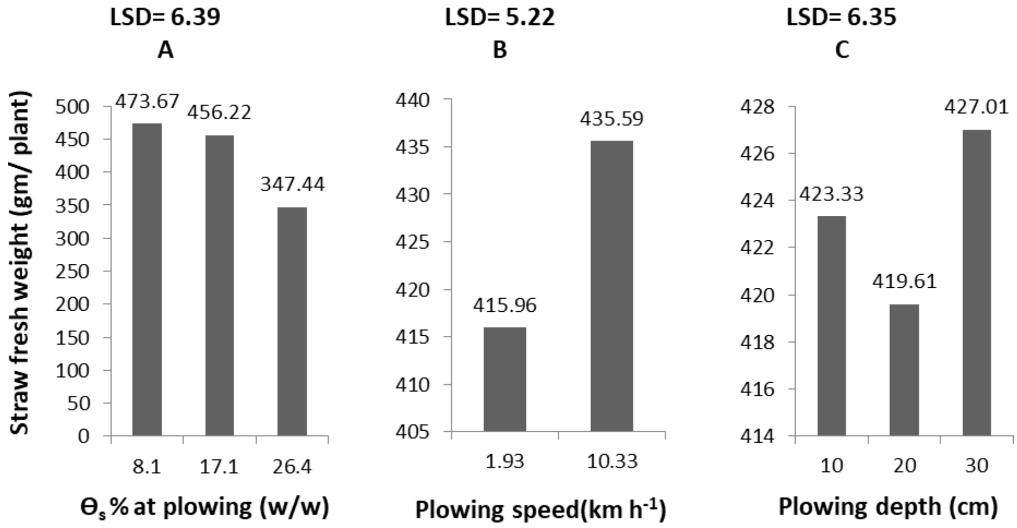

Fig 6: The main effect of soil moisture content at plowing (A), plowing speed (B) and plowing depth (C) on straw fresh weight (gm/ plant) after 100 days.

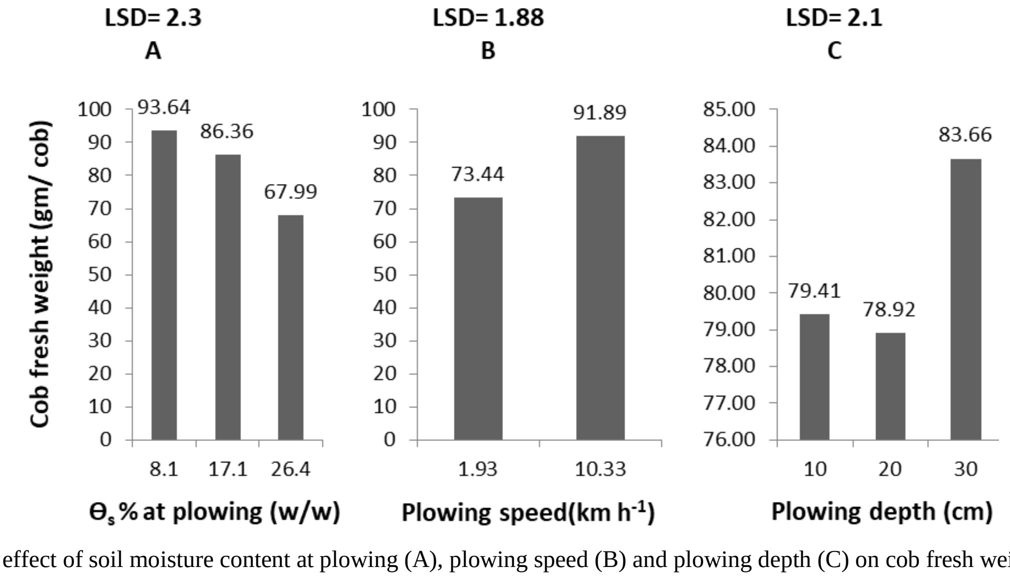

Fig .7: The main effect of soil moisture content at plowing (A), plowing speed (B) and plowing depth (C) on cob fresh weight (gm/cob) after 100 days.

1. The effect of soil moisture at plowing is due to force of cohesion and adhesion in the water films around soil particle and soil aggregates. Cohesion forces occur among particles of the same material while the

adhesion ones occur among particles of the different materials. Cohesion forces are more active at lower soil moisture content relative to the adhesion ones (Baver et al., 1972). At 8.1% soil this force keeps soil particles and soil aggregates in intimate contact. This increase of soil structure stability lessens the negative effect of plowing process on structure stability.

2. Increasing water films thickness at higher soil moisture content keeps soil particles and soil aggregates apart weakening soil structure.
3. plowing soil at higher soil moisture causing an increase in tractor wheel slip, (Tayel et al., 2015; $2016_{a\ and\ b}$); Nasr et al., 2016) and subsequently soil was puddled and compacted, then crops grown on such soil suffer many problems i.e.
   a. Water stress which leads to more absic acid in the roots. Its movement to the leaves causes a reduction in photosynthesis rate and photosynthesis products translocation.
   b. Increasing soil bulk density and decreasing total soil porosity has negative effects on soil resistance, fluid movement through soil layers, water and nutrient absorption and soil aeration.
   c. The technique used by plants grown on problem soil (compacted) will be on the expense of yield.
   d. Increasing plowing depth increased cohesion and adhesion forces (Korayem and Ismail, 1991).
   e. Increasing plowing depth increased root proliferation to obtain water, nutrient, and aeration and decreased soil resistance (Versa et al., 1997: Alam et al., 2013).
   f. Increasing plowing speed decreased soil bulk density and increased total soil porosity (Al-Ani and Al-Ani, 2010; Abdel-Galil, 2007; El-Shazly et al., 2008).
   g. Increasing plowing speed decreased the aggregates size and subsequently increased seeds contact with soil and this facilitated seed germination and seedlings emergence.
   h. Compacted soil caused losses in crop yield (Aridsson and Hakasson, 1992).

Conclusion

Understanding the effect of seedbed preparation conditions on the biometric parameters of the main crops under arid condition is a must. The effect of soil moisture content at plowing, plowing speed and plowing depth on corn (zea mays L.) grown on clay loam soil was evaluated in field experiment. The result of this study showed that:

1. Seedbed preparation at soil moisture content 8.1% w/w achieved the highest values of biometric parameter, whereas the lowest ones were obtained at 26.4%.
2. The obtained values of the biometric parameter at plowing depth 10.33 kmh^{-1} surpassed those at 1.93 kmh^{-1}.
3. Most the values of the biometric parameters at 30cm plowing depth exceeded those at 10 and 20 cm plowing depth.
4. The best conditions of seedbed for corn crop planted on clay loam soil are 8.1% w/w, plowing speed 10.33 kmh^{-1} and 30 cm plowing depth.
5. Plowing soil at 26.4% w/w led to puddled and compacted the soil.
6. Soil puddling and compaction led to prevent root hairs from development. This in addition to suberization xylem conductive tissues (epidermal and endodermal cells) will stress crop at the maximum water demand period.

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