Improving surface irrigation design and management

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5The main objectives of the current work are:1-Determining the influence of culture practices on soil mean weight diamter (clod size), soil roughness and infiltration rate parameters.2-Studying the combined influence of cultural practices, and inflow rate on the performance of surface irrigation systems (both furrow and border irrigation).3-Carring out recomnendations for improving the efficiency of surface irrigation system and increasing the net return from unit of water used under both methods.Two field experiments were carried out in clay soil at research farm of the Rice Mechanization Centre (RMC), Meet El-Deeba, Kafr El-Sheikh, Agric. Eng. Res. Institute during two successive agricultural seasons of 2001/2002 and 2002/2003. Two crops were planted, corn as summer cropfollowed by wheatas winter crops.An area of 2.57 feddans was divided into three large bloks; each of 40 m wide and 90 m length contained 3 strips. Three mechanical pulverization levels were applied for each replicate to make different clod sizes that give different soil mean weight diameter. Each strip was divided into three sub-strips of 3 m wide and 90 m length. Three-inflow rates (l/s/m width) were delivered for each sub strip. Hence, each large block was divided into 9 sub-strips. Each sub-strip was considered for one specified treatment. Each treatment contained four furrows. A separator of1.5 m wide was left between each to treatments to avoid the interaction of inflow. The experiment was arranged in split plot design with three replicates. Plot size for each irrigation method (furrow and border) was (3m x 90 m). The area of each plot was 270 m2 nearly 1 / 15.5 feddan.I. Effect of seedbed preparation treatments on soil physical properties (soil mean weight diameter and soil roughness):1.Average soil mean weight diameter of corn experiment (furrow irrigation) ranged from (43.85, 34.99 and 24.96 mm for T 1, T2 and T3 respectively at season 2001), while, (41.96, 31.74 and 21.15 mm for T1, T2 and T3 respectively at season 2002). The lowest average soil mean weight diameter was 21.15 mm for T3 treatment at season 2002 and the highest one 43.85 mm for T1 treatment at season 2001.2.Average soil mean weight diameter of corn experiment (border irrigation) ranged from (42.12, 33.49 and 22.13 mm for T1, T2 and T3 respectively at season 2001/2002), while, (40.26, 30.42 and 20.31 mm for T 1 , T2 and T3 respectively at season 2002/2003). The lowest average soil mean weight diameter was 20.31 mm for T3 treatment at season 2002/2003 and the highest one 42.12 mm for Ti treatment at season 2001/2002.Summary & Conclusion3.Soil surface roughness values were increased as the soil mean weight diameter level increased.4.Average soil surface roughness of furrow (corn)and border (wheat) experiment ranged from 0.043 — 0.097 and 0.039 — 0.083 for different tillage treatments respectively.5.For all tillage treatments the average soil surface roughness for season 2001 was higher than average soil surface roughness for season 2002.6.The soil surface roughness was reduced significantly by T3 treatment for wheat (border) experiment in both seasons compared to T2 and Ti treatments.7.Soil surface roughness in wheat experiment was less than soil surface roughness in corn filed for the first and the second season this is expected sin a wheat cultivation is follow corn in the crroping rotation.II. Effect of seedbed preparation treatments on infiltration characteristics:1.Different seedbed preparation treatments have clear effects on infiltration especially under treatment of plowing with T3 treatment.2.Accumulative infiltration values are less after harvesting (end of the season) compared to after tillage practices (at the beging of the season) for both experiments of furrow and border.Summary & Conclusion3.Kostiakov-Lewis intake

parameters (K1), (KZ), (n) and (a) were higher for Ti treatment compared to T2 and T3 treatments after tillage practices and harvesting for two seasons in both furrow and border experiments.4.Increasing soil mean weight diameter result in increasing in (K1), (K7), (n) and (a) for two seasons in both corn and wheat experiments.5.The infiltration rate (I, mm/h) was influanced by the soil mean weight diameter (SMWD, mm) and the following formula was obtained to discrip this relationship as resulted from corn experiment during season 2001 after tillage practices with R2 >0.9:I [-0.744 + 0.001 x (SMWD)]= [694.415 + 0.417 x (SMWD)] x T as well asZ = [12.800 + 0.004 x (SMWD)lx T[0414+ o.00l x (smwD)6.Values of the constant-depth term (f0) after tillage practices and harvesting for two seasons in both corn and wheat experiments are affected by soil tillage treatments. However, T3 treatment gave lowest values of (f0) compared to Ti and T2 treatments in both seasons after tillage practices and harvesting.Summary & ConclusionIII. Effect.of irrigation inflow rates and seedbed preparation treatments on advance and recession times:1.Water advance time was influanced by both the inflow rate and seedbed preparation treatments as well as by density of wheat growth.2.The T3 treatment reduced the advance time compared with Ti and T2. Also, high flow rates Q3 reduced the advance time compared with low Q1 and medium Q2 flow rates in both corn and wheat experiments.3.In corn and wheat experiments, the recession time decreases as inflow rates increases and as soil mean weight diameter decreases.4.In corn and wheat experiments, the faster advance times belong to combination between Q3 and T3 treatments.5.In corn experiment, the minimum average of recession time, 60.73 min was obtained for Q3, and T3 treatment. Meanwhile, the maximum average of recession time, 86.70 min was obtained for Q1, and T1 treatment.6.In corn experiment, the average time required for water advance to reach the end of the furrow were 77.34, 74.59 and 71.74 min for T 1 , T2 and T3 treatments respectively.7.In wheat experiment, the average time required for water advance to reach the end of the border were 86.08, 82.57 and 79.46 min for Tl, T2 and T3 treatments respectively.Summary & Conclusion8.When increasing flow rate by 77 % i.e. from 1.8 to 3.2 l/s/m, the average of water advance to time reach the end of the border are decreased by 48.63% under Ti treatment and decreased by 49.08% under T3 treatment.9.In wheat experiment, the minimum average of recession time, 72.31 min was obtained for Q3, at the T3 treatment. Meanwhile, the maximum average of recession time, 99.24 min was obtained for Q1 at T1 treatment.IV. Effect of irrigation inflow rate and seedbed preparation treatments on surface irrigation performance parameters: A. Corn experiment (furrow):1. Average volumes of applied water (two seasons) for Ti, T2 and T3 treatments are 2728.45, 2631.42 and 2530.79 m3/fed at Q1 respectively. These values at Q2 are 2657.18, 2496.53 and 2363.88 m3/fed respectively. Meanwhile, at Q3, the values are 2535.72, 2389.44 and 2261.53 m3/fed respectively. Combination between Q3 and T3 treatment used less amount of water (2261.53 m3/fed or 53.85cm) as average of two seasons than the combination among other treatments.2. Increasing flow rate from 1.8 l/s/m to 3.2 1/s/m improvedapplication efficiency by 2.01%, 3.26% and 4.27% at Tl, T2 and T3 treatments respectively. Also, combinations between Q3 and T3 treatment resulted in higher application efficiency (83.22%) as average of twoSummary & Conclusion172seasons than the combination among other treatments. The minimum one was 77.30% under the combinations between Q1 and Ti treatment.3.Increasing flow rate from Q1 to Q3 improved distribution uniformity by 18.71, 20.84 and 18.97% at T1, T2 and T3 treatments respectively. Also, decreasing soil mean weight diameter from nearly 40 mm to 20 mm improved distribution uniformity by 6.34 % at Q1, 2.94 % at Q2 and 6.58 % at Q3. Highest distribution uniformity was 91.78 % at the combination between Q3 and T3 treatments, while, lowest distribution uniformity was 72.57% obtained at the combination between Qi and T1 treatment.4.Low-quarter distribution uniformity increased with increasing irrigation flow rate at the two seasons at all seedbed preparation treatments i.e. increasing flow rate from Q1 to Q3 improved it by 44.02, 37.091 and 33.98 % at T1, 1’2 and T3 treatments respectively. Meanwhile, decreasing soil mean weight diameter from nearly 40 mm to 20 mm improved Low-quarter distribution uniformity by 12.02 % at Q I, 5.08 % at Q2 and 4.21 % at Q3. The highest low-quarter distribution uniformity was 87.26% at combination between Q3 and T3 treatment as average of two seasons. The lowest value of the low-quarter distribution uniformity was 58.14% at combination between Q1 and Ti treatment.5.Actual water infiltration depth (mm) at seasons 2001 and 2002 for

irrigation runs at all stations decreased withSummary & Conclusion.173increasing flow rates and decreasing soil mean weight diameter.B. Wheat experiment (border)•1.Average volumes of applied water (two seasons), for TI,12 and T3 treatments were 2234.67,2143.64 and 2062.96m3/fed at Q1 respectively. These values at Q2 were2118.32, 2003.75 and 1946.78 m3/fed respectively. Meanwhile, at Q3, the values were 2046.05, 1956.03 and 1882.55 m3/fed respectively.2.Increasing flow rate from 1.8 l/s/m to 3.2 l/s/m improved application efficiency by 2.2%, 1.77% and 2.43% at. Tl, T2 and T3 treatments respectively. Combinations between Q3 and T3 treatment resulted in higher application efficiency (76.25%) as average • of two seasons than the combination among other treatments.3.Increasing flow rate from Q1 to Q3 improved distributionuniformity by 18.83, 18.38 and 16.88 % at T1, T2 and T3treatments respectively. Combinations between Q3 andT3 treatment results in the highest distribution efficiency(90.81%) among other treatments.4.Increasing flow rate from 1.8 l/s/m to 3.2 l/s/m improved low-quarter distribution uniformity by 18.36, 18.31 and 16.97 % at Ti, T2 and T3 treatments respectively. Combination between Q3 and T3 treatment resulted in the highest value of the low-quarter distribution uniformity (90.78%) among other treatments.5. Combination between Q3 and T3 treatment consumptiveless amount of water (1416.28 m3/fed or 33.72 cm) as average of two seasons than the combination among other treatments. Average volumes of water consumptive use (two seasons) for Tl , T2 and T3 treatments were 1580.72,1550.31 and 1505.47 m3/fed at low flow rate Q1 respectively. C. General results from corn and wheat experiments:1.Combination of Q3 and T3 reduced the applied water to emphasize the saving of the applied irrigation water to corn and wheat crops by about 17% compared to combination among other treatments.2.Increasing flow rate and decreasing soil mean weight diameter (SMWD) improved application efficiency, uniformity distribution and low-quarter distribution uniformity.3.Averages actual water infiltration depth at border irrigation was higher than that for furrow irrigation.4.Soil moisture after irrigation was higher in the upper 15 cm soil layers than in the next layers for all seedbed preparation treatments at all irrigation water flow rates. The opposite trend was observed for soil moisture before irrigation. No effect was observed on soil moisture due to. While, increasing soil mean weight diameter decreased soil moisture content in the first layer of soil.5.Results showed that the (SMWD) has more effect on Summary & Conclusion175application efficiency than inflow rate (Q). While, inflow rate showed more effect on distribuation efficiency than (SMWD). Meanwhile, the irrigation flow rates and (SMWD) have nearly the same affect on the amount of water applied (AW). The applied water (AW, m3/fed) could be a funcations of (SMWD, mm) and (Q, l/s/m). The following relationship was obtained from wheat experiment during two seasons with R2 = 0.924:AW = 2094.345 + 8.233 x SMWD — 124.556 x QV. Effect of irrigation inflow rate and seedbed preparation treatments on yield and yield components: A. General:1.Statistical analysis (ANOVA) showed that irrigation inflow rate and seedbed preparation treatments and their interaction have highly significant effect on grain yield and yield components under study for corn and wheat crops for both two growing seasons.2.The T3 treatment gave higher mean grain yield (corn and wheat) in both the growing season compared to TI) and T2 treatments. Also, It was noticed that there was an increase in grain yield (corn and wheat crops) with increasing irrigation flow rate. B. Corn crop:1. There were increase in grain yield ear weight and length,plant height and WUE with increasing inflow rate and reducing SMWD. It recorded the highest grain yield ofSummary & Conclusion6.135 ton/fed as average growing two seasons. The increments in grain yield under the T3 treatment at irrigation flow rate Q 1 were 7.61% and 5.50 % above the yield of the treatments Ti and T2 respectively as average of two growing seasons. These values at irrigation flow rate Q2 were 6.45% and 3.85 % above the yield of the TI and T2 treatments respectively as average of two growing seasons. Also, these values at irrigation flow rate Q3 were 16.41% and 6.84 % above the yield of the TI and T2 treatments respectively as average of two growing seasons.2.The T3 treatment recorded the highest values of ear weight compared to other Ti and T2 treatments under any irrigation flow rate treatments. The overall averages of ear weight were 381.55 g as average of two growing seasons.3.The T3 treatment recorded the highest values of ear length compared to other Ti and T2 treatments under any irrigation flow rate treatments. The overall averages of ear length were 22.348 cm as average of two growing seasons.4.Mean values of corn plant height were 322.061, 312.067 and 303.033 cm for T3, T2 and Ti treatments and 320.317,

313.544 and 303.300 cm for Q3, Q 1 and Q2 respectively as average of two growing seasons.5.Water use efficiency (WUE) was higher in general under the T3 treatment than that of the corresponding figures of Ti and T2 treatments. Values as average of two seasonswere 1.86,2.08 and 2.22 kg/m3 water applied for T1, T2 and T3 treatments respectively under low flow rate Q 1. Meanwhile, values were 1.98,2.24 and 2.59 kg/m3 water applied for T1, T2 and T3 treatments respectively for Q2. Also, values were 2.19,2.41 and 2.86 kg/m3 water applied for T1, T2 and T3 treatments respectively under high flow rate Q3. C. Wheat crop:1.It was noticed that grain yield, weight of 100- kernel, biological yield and plant height were increased with increasing inflow rate from Q1 to Q3 and with reducing SMWD from 40-20 mm (by T1, T2 and T3) and at T3 compared with Tland T2 treatments. It recorded the highest grain yield of 3.078 ton/fed as average of two growing seasons. The increments in grain yield under the T3 treatment at irrigation flow rate Q1 were 16.21% and 7.3% above the yield of the Tl and T2 treatments respectively tot' the average two growing seasons. Meanwhile, the increments in grain yield under the T3 treatment at irrigation flow rate Q2 were 14.65% and 8.43% above the yield of the Tl and T2 treatments respectively for the average two growing seasons. Also, the increments in grain yield under the T3 treatment at irrigation flow rate Q3 were 14.89% and 7.93% above the yield of the T1 and T2 treatments respectively for two seasons.2.Pronounced increase in 100-kernel weight was observed when the irrigation flow rate is Q3 compared to Q1 andSummary & ConclusionQ2. The overall averages of 100-kernel weight 41.242 g for two seasons.3.The T3 treatment and Q3 recorded the highest plant height (110.8 cm) as average of the two seasons. The overall averages of plant height were 102.747cm as average of two growing seasons.4.The biological yield were 2.226 kg/m2 as average of two growing seasons. Pronounced increase in biological yield was seen when the irrigation flow rate was Q3 compared to other water flow rate Qland Q2.5.Water use efficiency (WUE) values as average of two seasons were higher in general under T3 treatment than that of the corresponding figures of T1 and T2. Values were 1.14,1.28 and 1.43 kg/m3 water applied for T1, T2 and T3 treatments respectively under. Q I . Meanwhile, values were 1.24,1.38 and 1.55 kg/m3 water applied for T 1, T2 and T3 treatments respectively under (Q2). Meanwhile, values were 1.39, 1.55 and 1.74 kg/m3 water applied for T1, T2 and T3 treatments respectively underQ3.6.The following formula could be used as obtained during two seasonsFor corn crop: Yield = 6.006 — 0.039 x SMWD + 0.398 x QR2 = 0.962.For wheat crop: Yield = 2.9392 — 0.02 x SMWD + 0.228 x QR2 = 0.890.Summary & ConclusionFinally, from the above mentioned results, it could be concluded that high flow rates about 3.2 l/s/m and reduced soil mean diameter to values around 20 mm obtained by T3 treatment considered a suitable "practices to optimize water use and increase surface irrigation efficiency in clay soils of Nile Delta in Egypt for corn and wheat crops. However, combination between these treatments reduced water consumptive by 17 % and increased yield by 28% and 31% in corn and wheat production respectively compared to low flow rates about 1.8 l/s/m andreduced soil mean diameter to values around 40 mm obtained by Ti treatment.ui, & Conclusion