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Fabrication and evaluation of a reservoir tillage machine to reduce runoff from farms with sprinkler irrigation systems

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Introduction

Nowadays, in a lot of farm land due to reasons such as high density, heavy textured soils, steep terrain and a large body of water at each irrigation, rapid and complete absorption of water in the soil does not happen and runoff will be accrued. Improvement of infiltration reduces runoff and thus increases available water capacity. The main methods used to increase the infiltration area: The use of soil amendments, soil management by tillage and conservation farming. These methods may be used separately or together. Reservoir tillage is the process by which small holes or depressions are punched in the soil to prevent runoff of water from irrigation or rainfall. The objective of this study was to develop and evaluate a new reservoir tillage machine for runoff control in the fields.

Materials and Methods

Fabricated machine has four main units include three-point hitch, toolbar, frame and tillage unit. Tillage unit was a spider wheel with 6 arms that has 6 Wedge-shaped blades, mounted on them. Each tillage unit mounted on a frame and the frame is attached to the toolbar with a yoke. The toolbar was attached to the tractor by three-point hitch. The movement of tractor caused blades impact soil and spider wheel was rotating. Spider wheel rotation speed was depended on the forward speed of the tractor. Blades were created mini-reservoirs on the soil surface for "In situ" irrigation water or rainwater harvesting. Theoretically distance between basins, created by reservoir tillage machine, fabricated in this study was 57 and 68 cm for Arm's length of 30 and 40 cm respectively.

For the construction of machine, first the plan was drawn with SolidWorks software and then the parts of the machine were built based on technical drawings. First tillage unit was constructed and its shaft was based in two bearings. Six of the arms were positioned at 60 degrees from each other around tillage units and connected by welding. For evaluation of machine performance, two factors contain of machine speed (in three levels of 5, 7.5 and 10 km h^{-1}) and Arm's length (in two levels of 30 and 40 cm) were evaluated. The machine was evaluated based on a completely randomized block factorial design with three replications. Effects of these factors on depth, distance and volume of basins and runoff were evaluated.

Results and Discussion

Mean comparisons of depth, distance and size of reservoirs in different machine forward speed and different Arm's length are summarized in Table 1 and 2. The results showed that the effect of arm length and forward speed on changes in the depth and volume of the reservoirs were significant at the probability level of one percent but changes of the distance between the reservoirs was only affected by Arm's length. The results also showed that increasing the forward speed from 5 to 10 km h^{-1} and increase the Arm's length from 30 to 40 cm increased depth, distance and volume of reservoirs. Reservoir tillage practices were control runoff in all plots.

Conclusions

In this research project, a reservoir tillage machine was built and assessed. Tillage unit of this machine is similar to the spider wheel. By this machine the small holes generated in the ground periodically. For evaluation of machine performance, effect of two factors, including machine speed and arm's length on depth, distance and volume of the basins were evaluated. The results showed that increasing the ground speed from 5 to 10 km h^{-1} and increase the arm's length from 30 to 40 cm increased depth, distance and volume of reservoirs. Reservoir tillage practices were controlled runoff in all plots.

Keywords: Reservoir tillage, Runoff, Sprinkler irrigation

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