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Effect of blade vibration on mulch tillage performance under silt clay loam soil

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Introduction: Mulch tillage system is an intermediate system which covers some of disadvantages of no tillage and conventional tillage systems. In farms in which tillage is done with a chisel plow, runoff and soil erosion have a less important relation to moldboard and disk plow and naturally absorption of rainfall will be developed. Thus, the mulch tillage system is an appropriate alternative to conventional tillage and no tillage (Backingham and Pauli, 1993). The unwanted vibration in machinery and industry mainly processes most harmful factors, for example: bearing wear, cracking and loosening joints. And noise is produced in electrical systems by creating a short circuit (Wok, 2011). Self-induced and induced vibration are used in tillage systems. Induced vibration is created by energy consumption and self-induced vibration is created by collision among the blades and soil at the shank (Soeharsono and Setiawan, 2010). A study by Mohammadi-gol *et al.* (2005) was conducted. It was found that on the disk plow, plant residues maintained on the soil are more than that of moldboard plow. 99% frequency and amplitude, speed and rack angle of blade directly affect soil inversion and indirectly affect preservation of crop residue on the soil. The effect of vibration frequency and rack angle of blade to reduce the tensile strength is also clear. Moreover, in contrast to previous studies when speed progressing is less than (λ), not only the relative speed (λ), but also frequency can reduce the tensile strength (Beiranvand and Shahgoli, 2010; Awad-Allah *et al.*, 2009). Therefore, aim of this study was to determine the effect of vibration and the speed of tillage on soil parameters and drawbar power in using electric power.

Materials and Methods: To perform this test, three different modes of vibration (fixed, variable and induced vibration) and two levels of speed in real terms at a depth of 20 cm were used for farming. The test was performed with a split plot and randomized complete block design and three replications, and the fixed factors were: the depth of tillage: 20 cm, soil moisture: 16 to 17 percent and rack angle: 15 degrees; and the variable factors were the rate of progress in both 4.5 and 7.5 kilometers per hour and six levels of frequency, 1 fixed (zero) 2 variables (self-induced), 3 (positive19) and 4 (negative19), 5 (positive37) and 6 (negative37) Hz were performed. An electric generator was used to create vibration power. The equation (1) was used to calculate the vibration power:

$$P = \sqrt{3}\, VI\cos\emptyset \qquad (1)$$

Where P: Electric power (W), V: voltage (V), I: current (amps) and Ø: phase angle (degrees) between the voltage and current. After the calculation, the required power of 19 Hz was calculated to be 0.6, and the required power of 37Hz, was calculated to be 0.75 kilowatts, respectively. The sample of mean weighted diameter, after tillage in each plot, was about 10 kg soil (0 to 20 cm depth) with 3 replicates and through the equation (2), mean weight diameter was calculated as follows:

$$MWD = \sum_{i=1}^{n} X_i W_i \qquad (2)$$

Where MWD: Mean weight diameter (cm), Xi: Two Elk consecutive mean diameters (cm) and Wi: weight ratio of the soil remaining on the sieve to the total weight of the sample. In order to calculate the specific energy tension due to the width of tillage (28 Cm), equation (3) was used.

$$E = (P_1 + P_2) \times T \qquad (3)$$

Where E: tensile special energy in kilojoules per square meter, P_1: drawbar pulling power required in kW, P_2: the vibration according to equation (1) based on kilowatt, T: tillage time in one square meter per second.

Results and discussion: According to analysis of variance (Table 2) interaction effects of frequency and speed to keep the residue are significant at 1%, and this situation was shown well in Fig.2 Therefore, in practice, with increasing frequency in both induction and self-induction vibration, the tillage blades created a groove at the soil surface with less turmoil, and this would maintain the maximum residue on the surface of the soil.

As is clear from Fig.3, treatment of the frequency of 37+ (code 5) in both the first and second average forward speed is highest in remaining residue with 85% and 74%, respectively (Liu and Chen, 2010) and (Awad-Allah *et al.*, 2009). By

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applying induced vibrations, a significant reduction in tensile strength occurs, because it reduces the time to deal with the blade of soil tillage and soil fractures with blows of the blade. It is clear that vibration reduces slip and real wheel speed is progressing, and following it, the increase in tensile strength occurs and it should not be considered due to the in efficiency of vibration tillage, since vibration may increase the depth of tillage, with the same vertical force component (Sahaya *et al.,* 2009). Specific energy (plus drawbar and vibration) are shown in Figure.5 and the lowest energy consumption in both the first and the second speeds was on treatment of frequency +19, being 18.9 kJ m and 23.2 kJ m to first and second speeds, respectively.

Conclusions: In general, both factors (vibration and speed) affected tillage parameters and energy consumption and induced vibration caused by the system of unequal mass and electrical power properties was very easy to change phase vibration and transfer of power. This study was designed because of the significant effects on the important parameters of quality by vibration frequency of tillage and different frequencies to control the way in which tillage parameters are controlled. We can take it as a precision tillage that introduced variable control rate of percent residue on the soil, clod mean weight diameter that is suitable for the cultivation combined with reduced energy consumption.

Keywords: Clod, Frequency, Residue, Tension power, Tillage, Vibration