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Comparison of effects of machine performance parameters and energy indices of soybean production in conservation and conventional tillage systems

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Introduction

Nowadays, agricultural systems are seeking economic, ecological and bioenvironmental goals for production of agricultural crops with protection and sustainability of the environment. Therefore, there is need to extend sustainable agricultural systems such as conservation agriculture. One of the principles of conservation agriculture is conservation tillage. Conservation tillage is a kind of tillage that retains crop residues on the soil surface or mixes it with soil using related machines. It could also affect on machine performance parameters. Energy consumption for producing one kilogram crop could be studied for conservation tillage. Several researchers have conducted studies on this issue for production of different crops including wheat, sunflower and forage crops. This study conducted to assess machine performance parameters and energy indices of conservation tillage systems for soybean cultivation in Golestan province.

Materials and Methods

This study was conducted to investigate the effects of conservation tillage systems on machine performance and energy indices in soybean production at the Gorgan research station of Golestan Agricultural and Natural Resource Research Center in 2012. The precipitation was 450 mm. Soil texture was silty clay loam. Treatments were four tillage methods, including no-till using row crop direct planter, no-till using grain direct drill, conventional tillage usin a disk harrow with working depth of 10-15 cm and minimum tillage using chisel packer with a working depth of 20 cm. Machine performance parameters and energy indices studied in a farm covered by wheat residues in a randomized complete block design (RCBD) with four treatments and four replications. Machine performance parameters consisted of field efficiency, field capacity, total field capacity and planting uniformity index were measured. Energy indices such as energy ratio, energy productivity, energy intensity and net energy gain were also calculated.

Results and Discussion

The results showed that no-tillage methods by grain drill and row crop planter had the lowest field efficiency (56% and 58.9%, respectively), but had the highest field capacity (0.76 and 0.71 ha h^{-1}, respectively), as the passage of implements in the field was less than that of conventional tillage. Peruzi *et al.,* (1996) also reported that required time for minimum tillage and no-till was 80% less than conventional tillage. No-till using grain drill with the total field capacity of 0.76 ha h^{-1} and conventional tillage with 0.33 ha h^{-1} had the highest and lowest field capacity among the treatments, respectively. Minimum tillage had the best horizontal distribution uniformity for seed placement on the row. No-till using seed drill had the highest energy ratio of 4.5 and yield of 3612 kg ha^{-1}, which were higher than the other treatments. No-till also produced 0.19 kg crop per each MJ energy consumption. It consumed the lowest amount of energy with 5.3 MJ for production of 1 kg soybean and had the highest net energy gain among treatments. Minimum tillage had the lowest consumption of energy with 2030.2 MJ ha^{-1} among the treatments. It had the lowest amount of net energy gain because of having lowest yield (2794 kg ha^{-1}). Zentner *et al*., (2004) and Razzaghi *et al*., (2012) also concluded that conservation tillage systems had the lowest amount of energy consumption compared to the conventional tillage.

Conclusions

The study of energy indices is important for producing agricultural crops to decrease energy consumption. Among the tillage methods, no-till method had the best indices about reducing energy consumption. Although

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the size of no-till grain drill will increase the weight and energy consumption of machine, but it well penetrates on the soil. Results showed that minimum tillage and no-till methods are proper alternatives for replacement of conventional method for producing soybean, according to the precise of planting and improvement of energy indices. However, the existing planters can be modified for row crops and increasing of planting accuracy indices with correct management of no-till methods at crop protection stages. It can also help to localize conservation tillage implements and speeding up new methods for reaching to sustainable energy and production resources.

Keywords: Conservation tillage, Conventional tillage, Energy indices, Soybean