Effects of Rainfall Events on Soil in Orchard Field under Herbicide Treatment.

1. Temporal Characteristics in Soil Physical and Chemical Properties

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The periodic application effects of two different herbicides on soil physical properties were observed in a slightly hilly orchard of pear tree located on the southeastern flank of the Palbong Mountain in Gongju Chungnam: (1) bare surface vegetation; (2) glyphosate-treated plot; (3) paraquat-treated plot. The slope of experimental plots ranged from 5.5% to 10.2% at an altitude of 125 m and 896 m² (28 m x 32 m) in area. The total respective rainfall events were 47, 52, 52 times during experimental period from 2006 to 2008, while approximately 65 percent of daily rainfall intensity from 2006 to 2008 was less than 20 mm a day. The organic matter contents on the surface 15 cm soil ranging from 1.23% to 1.84% in 2006 were changed into from 1.35% to 2.28% in 2008 in the order of control > glyphosate > paraquat > bare plot in 2008, indicating that the herbicide treatment influenced the accumulation organic matter in soil. The changes in soil particle contents showed that the loss of soil particles in top 5 cm soil depth was greater in a bare soil than in other treatments such as control, glyphosate, and paraquat-treated plot. The net changes in the bulk densities showed that there were little variations between May of 2006 and Nov. of 2008 even though there were some losses of the soil particles. The soil strength of the glyphosate-treated bare plots was much greater than those of other plots such as control, glyphosate, and paraquat plots. However the soil strengths in control plots were lower than those in the plots of glyphosate and paraquat treated ones.

Key words: Rainfall, Soil Properties, Soil strength, Orchard, Herbicides

Introduction

Orchard soil groundcover management systems (GMS) facilitate routine orchard operations, create optimal conditions for growth and productivity of fruits tree, and conserve soil resources. Oliveira and Merwin (2001) reported that bulk density was lower and soil porosity, greater under Mulch than those of other GMSs. Infiltration was more rapid under Mulch than other GMSs. GMS treatments and related management practices at this orchard had also substantially different long-term effects on soil physical conditions (Haynes, 1981; Poesen and Lavee. 1994).

Surface soil organic matter content, bulk density, cone index, macroscopic capillary length and hydraulic conductivity showed significant differences between tillage systems and positions. Haynes (1981) found that the pH of the surface soil (0 to 10 cm) was significantly lower in the herbicide strip than in the grassed alley. He also found that the decrease in pH in the surface soil of the herbicide strip was also accompanied by a large decrease in the base saturation and a consequent significant increase in exchangeable acidity.

Soil erosion by water occurs when bare-sloped soil surface is exposed to rainfall. When the rainfall intensity exceeds the rate of soil intake, or infiltration rate, soil-surface runoff takes places (Nearing et al., 1999; Martínez et al, 2006). Runoff-prone soils have been shown to be particularly vulnerable to soil erosion by surface runoff during the summer time (Salako et al., 2006). Seasonal losses of soil as impacted by rainfall event along with management practices are not well quantified for these soils. Soil erosion can occur in two stages: 1) detachment of soil particles by raindrop
impact, splash, or flowing water; and 2) transport of detached particles by splash or flowing water. Therefore, soil erosion is a physical process requiring energy, and its control requires certain measures to dissipate this energy (Sands et al., 1979; Salako, 2002).

Field studies at a range of scales provide an understanding of the transport process and pathways for soil losses from the orchard areas. However, this data is expensive to collect and it is often impractical to compare management strategies over a variety of soils and climatic conditions. Therefore, simulation models can extend observed data to provide the potential soil loss for off-site losses over a broad range of scenarios.

The main objectives of this investigation were to assess and to link, the changes of soil physical properties at the orchard field under sporadic and periodic runoff during the rainy season. From this investigation, we expected to figure out processes involved in soil loss by runoff for the different surface coverage and practices at the orchard area.

**Material and methods**

Average annual rainfall of the investigation site established on orchard field located in runoff-prone soils in Banghungri Woosungmyon Gongjucity Choongchungnamdo was approximately 1270 mm with a localized heavy rain from late June to end of August.

The experimental plots, located on 5 to 6% slope which was reprioruled, was in area of 896 m² (28 m x 32 m) consisted of for four rows of pear trees. This site was divided into total 12 plots for three replications of one control and three of bare and two herbicide-treated plots. Each plot (70 m²), bounded on four sides by plastic borders which were set to depth of 30 cm, consisted of pear tree planted area (10m x 0.5 m), treated area (2.5 m x 10 m), and buffer zone (4.0 m x 10.0 m). Pear trees were aligned in the slope direction, and mean tree canopy radius was 0.5 m. The plant-cover plot for herbicide applications, 2.5 m wide, ran across the slope. Herbicides were only applied over the plant-cover area next to the pear trees and the rest of the area between the pear trees were left with weeds which were sometimes removed by a mower during the investigation period.

Paraquat (N,N'-Dimethyl-4,4'-bipyridinium dichloride) and glyphosate (N-phosphonomethyl glycine) were applied as pre- and post-emergence herbicides to control weeds over the plots. Herbicides were applied at 307g 10a⁻¹ and 57.8g 10a⁻¹ for glyphosate and paraquat, respectively (Fig. 1). Herbicide treatment methods and periods were as follows as shown in Table 1.

**Daily precipitation** To measure the daily precipitation we installed four rainfall gauges (Rainwise Weather Stations PORTLOG USA) to collect the rain on each treatment plot for 24 hour's period during a rainy day. During the field experimental periods for three years from