**INTRODUCTION**

Military vehicle use for training exercises in rangelands may result in one or more of the following adverse consequences:

1. Significant removal of vegetative cover
2. Destruction of soil aggregates
3. Soil compaction
4. Increased susceptibility to wind/water erosion

Military training lands require management to minimize ecological damage. WEPS (Wind Erosion Prediction System) (Wagner & Tatarko, 2001), with proper modifications, could be used to provide estimates of susceptibility to wind erosion from different training scenarios, allowing a manager to choose the timing and type of training regimes to reduce or eliminate adverse impacts on the environment. However, critical process parameters in WEPS originally developed for agricultural fields need to be adapted or modified to military lands. Among the parameters needing characterization are changes in bulk density and vegetation that occur under varying levels of military vehicle traffic.

**OBJECTIVE**

Determine from multi-pass trafficking of military vehicles the effects on the soil/vegetation state and assess the change in susceptibility to wind erosion.

**METHODS**

40m X 70m rectangular field plots were established at Fort Riley, Kansas on which vehicles were driven in a figure-8 pattern. Two vehicle treatments, “tracked” and “wheel”, were arranged in a randomized block design in three replications. The experiment was carried out on silty loam and silty clay loam soils. The tracked vehicle used was an M1A1 Abrams tank and the wheeled vehicle was a Humvee (Fig. 1). On each plot three sets of repeated trafficking passes were made on each plot (designated as: p1, p2, p3). For the “tracked” plots 1, 5 and 10 total passes were made and for the “wheel” plots 10, 25, and 50 passes.

In each of the figure-8 plots, samples were taken from four distinct segments of the vehicle tracks (relative sampling locations shown in Fig. 2). The sampling segments were designated as “center cross” (CC), “Assemblage Area” (AA), “straight section” (SS), and “curved section” (CS). At each sampling site bulk density, gravimetric soil water content, standing biomass, and total vegetative cover were measured. Standing biomass within a 0.25 m² quadrat was clipped to ground level, dried, and weighed. Residue cover was measured using a modified step-step method (Althoff, P.G., 2007). Statistical analysis was performed on all data using the SAS PROC MIXED procedure.

**RESULTS: BULK DENSITY**

The analysis of variance of bulk density indicates (Table not shown) that:

- The main factors of vehicle type, vehicle trafficking passes, location within the track and soil depth were significant (p≤0.05).
- Two-way interactions of vehicle X pass, pass X location, vehicle X depth, pass X depth, and location X depth were significant (p≤0.05).
- The three-way interaction of vehicle X location X depth was also significant (p≤0.05).

**RESULTS: BIOMASS**

The analysis of variance of biomass and cover shows (Table not shown) that:

- The main factors of vehicle type, vehicle trafficking passes, and location within the track were significant (p≤0.05).
- Two-way interactions of vehicle X location and pass X location were significant (p≤0.05).

**SUMMARY**

- Bulk density under the M1A1 Abrams tank were significantly higher than under the Humvee in all soil layers below 5 cm.
- As the number of passes increased the bulk density under the M1A1 tank showed significant increases; increases in the Humvee were much smaller.
- In general sampled bulk densities were higher in the curved portion of the vehicle tracks than in the straight sections.
- Bulk densities were lower in the spring than in the fall bulk due to over-wintering effects.
- The M1A1 tank reduced above ground residue cover and standing biomass at the curved track locations by roughly 70% and 90% respectively.

**REFERENCES**


**ACKNOWLEDGMENTS**

Funding for this project was provided by the Strategic Environmental Research and Development Program (SERDP); Philip B. Woodford and Chris Otto for help in coordinating field operations; vehicle drivers M. Cables, H. Frewer, and H. Deatherage; T.C. Todd of Kansas State University for statistical help; and all those involved in collecting and processing the field data.

**Fig. 1. Picture of an M1A1 Abrams tank (top left); Humvee (top right); portion of the tank track (bottom left); and the Humvee wheel track (bottom right)**

**Fig. 2. Diagram of figure-8 vehicle track and sampling locations**

**Fig. 3. Interactive effects of vehicle types and trafficking passes on bulk density in the silty clay loam soil. Bars with different letters are significantly higher than under the Humvee in all soil layers below 5 cm.**

**Fig. 4. Comparison between original soil texture data at the 0-5 cm depth and the data obtained using the Remy soil core sampler.**

**Fig. 5. Interactive effects of vehicle X depth on the silty clay loam soil. Bars with different letters are significantly higher than under the Humvee.**

**Fig. 6. Depth X Location interaction for the silty clay loam soil. Differences in bulk density at the 0-5cm and 5-10cm depth were significant (p≤0.05).**

**Fig. 7. Maximum reduction in cover occurred at the CI (curved inside) location under the M1A1 tracks. The M1A1 tank reduced above ground residue cover and standing biomass at the curved track locations by roughly 70% and 90% respectively.**

**Fig. 8. Cover steadily declined as the M1A1 tank passes through the cross (CC) location.**

**Fig. 9. Interactive effects of vehicle X Location interaction for the silty clay loam soil. Bars with different letters are significantly higher than under the Humvee.**

**Fig. 10. Standing biomass (% of undisturbed) at the straight (SS), center cross (CC), curve outside (CO), and curve inside (CI) locations at the 0-5, 5-10, and 10-15cm depth. Bars with different letters are significantly higher than under the Humvee in all soil layers below 5 cm.**

**Fig. 11. Vehicle X Location interaction. Maximum reduction in cover occurred at the CI (curve inside) location under the M1A1 tracks. The M1A1 tank reduced above ground residue cover and standing biomass at the curved track locations by roughly 70% and 90% respectively.**