Conservation Farming Unit - Zambia

No Farmers no Future

COMPARISON OF MOISTURE RETENTION IN SOILS IN CONVENTIONAL HOE RIDGES AND SOILS IN PLANTING BASINS ON FARMERS DEMO PLOT AT TWIN PALM EXTENSION LUSAKA

by

Victor Shitumbanuma Dept. of Soil Science UNZA

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A study was carried out to compare moisture retention in soils on ridges and soils in permanent planting basins in the Twin Palm area of Lusaka after the area received a significant amount of rainfall that wetted the top soil. Results of the study show that soils in planting basins have significantly higher bulk densities than those on ridges. The results also show that soil in the basins contain a significantly greater volume of water than soil on ridges, indicating that the basins are more effective in capturing and storing water than ridges.

INTRODUCTION

The CFU has been encouraging hoe farmers in Agro Ecological Zone II to plant their crops in Min-Till basins as opposed to planting crops on annually split ridges as is the traditional practice in this region. Among other reasons this is because it is believed that the planting basins harvest rainfall more effectively in the zone where the seeds are planted and thus contributes to rapid germination, better emergence of the crop improved plant populations and less need for re-seeding.

The CFU recently established a demonstration plot adjacent to small scale farmers' fields in the Twin Palm extension in Lusaka with the view of demonstrating the benefits of using the practices being promoted by the CFU. The CFU demonstration plot consists of two fields, one has permanent planting basins prepared using the Chaka hoe, and another with ridges prepared by splitting the previous seasons ridges which is the traditional land preparation method throughout Malawi and in Eastern Zambia.

After the area received some significant rainfall which effectively wetted the top soil, it was decided to find out whether there were significant differences between the soil moisture contents of soils on the ridges and those of soils in permanent planting basins.

METHODOLOGY

Five undisturbed soil samples were randomly obtained from the ridges and basins in the two CFU plots using steel core ring samplers. The samples were collected at an approximate depth of between 2.5 and 7.5 cm from the surface of the soil. The

samples obtained were labeled and wrapped in polyethylene bags to prevent loss of moisture and were transported to the laboratory for analysis. The gravimetric moisture contents were determined by oven drying samples of the sample at 105° C overnight. The bulk density of the soils was also calculated from internal volumes of the core rings and the oven dry mass of the soils collected in the core rings.

The volumetric moisture contents of the soils were calculated from the gravimetric moisture contents using the bulk densities of the soils and the density of water using the equation below:

$$\theta v = \frac{\rho b \theta g}{\rho w}$$

Where: θv = Volumetric moisture content;
ρb = bulk density of soil,
θg = gravimetric moisture content
ρw = density of water

Further the moisture content was converted to the equivalent depth of water present in a 20 cm layer which is typical depth of the CFU planting basins.

The results of the measurements obtained from the laboratory tests and those derived from calculations of results of laboratory tests were then subjected to a t-test to establish whether there were significant differences in selected properties of soils obtained from ridges and planting basins. The analyses were carried out using the statistical software SAS Version 9.0 for Windows.

RESULTS

The results of the soil tests on the 10 soil samples obtained from ridges and planting basins are presented in Table 1 below. They indicate that soils obtained from ridges generally had lower bulk densities than soils obtained from planting basins. The gravimetric moisture contents of soils from ridges also appeared to be slightly lower than those of soils obtained from permanent planting basins. However the volumetric moisture contents and equivalent depths of water from soils obtained ridges appear to be much lower than those of soils from the planting basins.

Table 1. Values of the bulk densities and moisture contents of soil samples from Ridges and basins from a cultivated Field along the Twin Palm Road in Lusaka

Source	Sample ID	Bd (g/cm^3)	gravimetric Moisture content (%)	Volumetric Moisture content (%)	Equivalent depth of water ($mm\ H_2O$/20 cm soil depth)
Ridge	R1	1.17	13.1	15.2	30.4
Ridge	R2	1.22	11.7	14.2	28.4
Ridge	R3	1.18	10.0	11.9	23.8
Ridge	R4	1.18	9.7	11.5	23.0
Ridge	R5	1.19	10.4	12.3	24.6
Basin	B1	1.39	14.3	19.8	39.6
Basin	B2	1.35	12.4	16.7	33.4
Basin	B3	1.35	14.8	20.0	40.0
Basin	B4	1.40	10.3	14.4	28.8
Basin	B5	1.29	16.1	20.9	41.8

The mean values of selected properties of soils from ridges and planting basins are presented in Table 2. The results show that the average bulk density of soils from the ridges is significantly lower than that of soils from permanent planting basins.

The gravimetric moisture contents of soils from the ridges and the basins are not significantly different although the mean water content of the soils the basins is higher than that of soil from ridges. On the other hand, the volumetric moisture, and equivalent depths of water in the basins are significantly higher than those on the ridges.

Table 2. Mean Values of the bulk density and moisture contents of soil samples obtained from Basins and Ridges in a cultivated field along the Twin Palm Road in Lusaka.

Source of Soil	Sample Size	Bulk Density (g/cm^3)	Gravimetric water content ($gH_2O/100g$ soil)	Volumetric water content ($cm^3H_2O/100cm^3$ soil)	Equivalent depth of water/20cm layer (mm H_2O/20 cm soil)
Ridges	5	1.4	13.6	18.4	36.2
Basins	5	1.2	11.0	13.0	26.0
Sign at 0.05	NA	Sign	Non Sign	Sign	Sign

CONCLUSION

The results of this investigation show that soils in the basins have a higher bulk density than soils on ridges. They also show that soils in permanent basins contain a significantly greater volume of water than soils on ridges after a rainfall event, indicating that the permanent basins are more effective in capturing and retaining moisture than ridges.

APPENDICES:

TABLES OF STATISTICAL ANALYSES OF DATA OF SOILS FROM THE TWIN PALM DEMO PLOTS

Class Level Information

Class	Levels	Values
Treat	2	Basin Ridge

Number of observations 10

The ANOVA Procedure

Dependent Variable: Gravimetric moisture content (%)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	16.90000000	16.90000000	4.75	0.0609
Error	8	28.45600000	3.55700000		
Corrected Total	9	45.35600000			

R-Square	Coeff Var	Root MSE	grav Mean
0.372608	15.35831	1.886001	12.28000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treat	1	16.90000000	16.90000000	4.75	0.0609

t Tests (LSD) for gravimetric moisture content

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	3.557
Critical Value of t	2.30600
Least Significant Difference	2.7506

Means with the same letter are not significantly different.

t Grouping	Mean	N	Treat
A	13.580	5	Basin
A			
A	10.980	5	Ridge

The ANOVA Procedure

Class Level Information

Class	Levels	Values
Treat	2	Basin Ridge

Number of observations 10

The ANOVA Procedure

Dependent Variable: Volumetric moisture content (cm^3 H_2O/100 cm^3 soil)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	71.2890000	71.2890000	14.30	0.0054
Error	8	39.8800000	4.9850000		
Corrected Total	9	111.1690000			

R-Square	Coeff Var	Root MSE	Vol Mean
0.641267	14.23016	2.232711	15.69000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treat	1	71.28900000	71.28900000	14.30	0.0054

The ANOVA Procedure

t Tests (LSD) for Vol

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	4.985
Critical Value of t	2.30600
Least Significant Difference	3.2563

Means with the same letter are not significantly different.

t Grouping	Mean	N	Treat
A	18.360	5	Basin
B	13.020	5	Ridge

The ANOVA Procedure

Class Level Information

Class	Levels	Values
Treat	2	Basin Ridge

Number of observations 10

The ANOVA Procedure

Dependent Variable: Volumetric moisture content (cm^3 H_2O/100 cm^3 Soil)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	71.2890000	71.2890000	14.30	0.0054
Error	8	39.8800000	4.9850000		
Corrected Total	9	111.1690000			

R-Square	Coeff Var	Root MSE	Vol Mean
0.641267	14.23016	2.232711	15.69000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treat	1	71.28900000	71.28900000	14.30	0.0054

t Tests (LSD) for Vol

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	4.985
Critical Value of t	2.30600
Least Significant Difference	3.2563

Means with the same letter are not significantly different.

t Grouping	Mean	N	Treat
A	18.360	5	Basin
B	13.020	5	Ridge

The ANOVA Procedure

Class Level Information

Class	Levels	Values
Treat	2	Basin Ridge

Number of observations 10

The ANOVA Procedure

Dependent Variable: Equivalent depth of water (mm H_2O/20 cm soil depth)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	285.1560000	285.1560000	14.30	0.0054
Error	8	159.5200000	19.9400000		
Corrected Total	9	444.6760000			

R-Square	Coeff Var	Root MSE	depth Mean
0.641267	14.23016	4.465423	31.38000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treat	1	285.1560000	285.1560000	14.30	0.0054

t Tests (LSD) for depth

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	19.94
Critical Value of t	2.30600
Least Significant Difference	6.5126

Means with the same letter are not significantly different.

t Grouping	Mean	N	Treat
A	36.720	5	Basin
B	26.040	5	Ridge

The ANOVA Procedure

Class Level Information

Class	Levels	Values
Treat	2	Basin Ridge

Number of observations 10

The ANOVA Procedure: **Soil Bulk Density**

Dependent Variable: Soil Bulk Density ($g.cm^{-3}$)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.07056000	0.07056000	62.72	<.0001
Error	8	0.00900000	0.00112500		
Corrected Total	9	0.07956000			

R-Square	Coeff Var	Root MSE	Bd Mean
0.886878	2.636873	0.033541	1.272000

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treat	1	0.07056000	0.07056000	62.72	<.0001

The ANOVA Procedure

t Tests (LSD) for Bd ($g.cm^{-3}$)

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	8
Error Mean Square	0.001125
Critical Value of t	2.30600
Least Significant Difference	0.0489

Means with the same letter are not significantly different.

t Grouping	Mean	N	Treat
A	1.35600	5	Basin
B	1.18800	5	Ridge