PROCEEDINGS

SOILS 2007

PEAT AND OTHER SOIL FACTORS IN CROP PRODUCTION

17th - 19th APRIL 2007

Kingwood Resort
MUKAH, SARAWAK

Editors:

Hamdan Jol
Goh Kah Joo
Che Fauziah Ishak
Lulie Melling
Osumanu Haruna Ahmed
Mahomadu Boye Jalloh
Alexander Sayok
Siva Balasundram

Proceedings co-sponsored by:

Peat Swamp Forest Project
UNDP
GEF

Jointly organised by:

In collaboration with:

PROCEEDINGS
SOILS 2007

PEAT AND OTHER SOIL FACTORS IN CROP PRODUCTION

Mukah, Sarawak
17^{th} - 19^{th} April 2007

Editors:
Hamdan Jol
Goh Kah Joo
Che Fauziah Ishak
Lulie Melling
Osumanu Haruna Ahmed
Mahomadu Boye Jalloh
Alexander Sayok
Siva Kumar Balasundram

Jointly organised by:

In collaboration with:

Proceedings co-sponsored by Peat Swamp Forest Project

2007 Malaysian Society of Soil Science

ISBN 978-967-9945-29-4

Perpustakaan Negara Malaysia Cataloging-in-Publication Data

Soil Science Conference of Malaysia (2007: Mukah, Sarawak)
Proceedings of the Soil Science Conference of Malaysia
April 17 – 19, 2007, Mukah, Sarawak, Malaysia /
editors Hamdan Jol, Goh Kah Joo, Che Fauziah Ishak, Lulie Melling, Osumanu Haruna Ahmed, Alexander Sayok, Mahomadu Boye Jalloh and Siva Kumar Balasundram.

ISBN 978-967-9945-29-4
1. Soil Science – Malaysia - Congresses
2. Soils – Malaysia - Congresses
I. Hamdan Jol II. Goh Kah Joo III. Che Fauziah Ishak IV. Lulie Melling V. Osumanu Haruna Ahmed VI. Alexander Sayok VII. Mahomadu Boye Jalloh VIII. Siva Kumar Balasundram IX. Title
631.4409595

Published by:

Malaysian Society of Soil Science (MSSS)
Locked Bag 254
43409 UPM Serdang
Selangor Darul Ehsan
Malaysia
www.e-msss.com

CHANGES IN SOIL PROPERTIES DUE TO DIFFERENT SOIL AND WATER CONSERVATION PRACTICES IN A SLOPING LAND OIL PALM ESTATE

Teh, C. B. S.[1], K.J. Goh[2], C.C. Law[1], T.S. Seah[1]

[1] *Department of Land Management, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*
[2] *Applied Agriculture Research, Locked Bag 212, Sg. Buloh Post Office, Sg. Buloh, Selangor, Malaysia*

ABSTRACT

The main objective of this study was to compare the relative effects of four treatments (control, Empty Fruit Bunch, Ecomat and silt pitting) on several soil chemical and physical properties over a period of six months. Soil properties from soil depth 0-150 and 150-300 mm were measured monthly for six months, and they were: pH, CEC, exchangeable Ca, Mg and K, total N, P and organic C, C:N ratio, bulk density, aggregation, and aggregation stability. The soil water content up to 1 m soil depth was additionally measured daily. Of the four treatments, EFB, followed by Ecomat, gave the highest improvement in almost all the soil chemical properties. One reason why EFB is better than Ecomat is that the latter has less nutrients than EFB. Analyses revealed that only bulk density was not affected by the four treatments. Aggregate stability in all treatments increased with time, of which EFB, Ecomat and silt pit treatments had comparable aggregate stabilities. EFB, however, generally had the lowest aggregation as compared to other treatments. This could be due to high soil water content in the EFB treatment and the lack of drying and wetting cycles to encourage soil aggregation. Both EFB and Ecomat were better in conserving water in the 0 – 0.6 m soil depth. EFB concentrated water more in the upper soil layers, whereas Ecomat tended to distribute the water more uniformly throughout the profile up to 0.7 m. Silt pit plots also concentrated water in the upper soil layers but its concentration of water was restricted to a shallower depth as compared to Ecomat and EFB. The control plots only conserved water in the upper layers during wet weather periods. This study showed that the silt pit treatment was not better than either EFB or Ecomat in improving the soil chemical and physical properties, as well as conserving soil water. The walls of the silt pits were found to be easily collapsible. This study concluded that EFB was the best overall treatment to improve soil properties and conserve soil water.

INTRODUCTION

New oil palm plantations are today increasingly being limited to marginal lands which include those in hilly, steepland areas. To reduce soil and water loss by erosion, terraces are often built. However, hill cutting activities to construct these terraces cause not only compacted soils, but also reduce soil fertility because the fertile, top soils are physically removed from the area.

Some oil plantations have today forsaken the hill terracing practice and are planting oil palms on non-terraced hill slopes of up to 15°. To reduce water and nutrient losses, one recent method used is silt pitting, where long, narrow trenches are dug into the soil somewhere between the planting rows so that these trenches collect water run-off. The idea is to enable these silt pits act as storage areas, preserving the soil nutrients that would otherwise have been lost through run-off, as well as supplying the collected soil water to oil palms in particular during dry weather seasons. The effectiveness of silt pits as a soil and water conservation practice, however, has not been studied rigorously in plantation crops.

Other methods to conserve water and improve soil fertility is the use of empty fruit bunches (EFB) as a mulch or soil cover. EFB, however, is both bulky and heavy. Thus, it incurs high transportation costs from the oil palm mill to the field. One recent development is to process and compress the EFB into a fibrous mat, called as *Ecomat*. Being much lighter, Ecomat is used to ease the handling problem of the bulky EFB in the fields. However, it has the disadvantage of low nutrient content due to losses during processing, and its effectiveness in alleviating compacted soils on terraces is still uncertain.

This study setup four different practices (treatments) to conserve soil and water in a steepland oil palm estate: control, EFB, Ecomat and silt pitting. The main objective of this study was thus to compare the relative effects of these four treatments on several soil chemical and physical properties important to plant growth over a period of six months.

MATERIALS AND METHODS

A field experiment was setup in an oil palm (*Elaeis guineensis*) site at Balau Estate (2.9325° N; 101.8822° E), Seminyeh, Selangor. The study area has a slope of 6°, and under the USDA Taxonomy classification, the soil is classified as a Typic Paleudult (Rengam series), and has a sandy clay texture (37% clay and 56% sand). The oil palm trees in the study area at the time of experiment were eight years old, and the trees were planted in a triangle system, with 8 x 8 m spacing between two palms.

The experimental design had four treatments and three blocks (replications). The treatments were control (normal field practice where pruned fronds were arranged on the soil surface), empty fruit bunches (EFB), Ecomat and silt pit. Each block was divided equally into four plots, where each plot measured 8 x 8 m and with a gap of 8 m between two plots. The number of palms per plot was one, and for each block, each treatment was randomly assigned to a plot. Each of the three blocks was located at different hill elevations.

The application of the EFB and Ecomat treatments and the construction of the silt pits begun in February 2006. In the middle of each EFB treatment plot, empty fruit bunches (rate of 300 kg EFB palm^{-1} year^{-1}) were heaped on the ground. Likewise, in the middle of each Ecomat treatment plot, the Ecomat carpets were arranged in a single layer on the ground. The silt pits were constructed by digging a trench along the hill contour, measuring 1 m wide, 4 m long and 0.5 m deep. The silt pits were located in the middle of each silt pit treatment plot.

Field data collection started in March 2006, continued every month until, August 2006. Soil samples from 0-150 and 150-300 mm soil depth were collected randomly at several points in a plot. The air-dried soil samples were then analysed for pH (1:2.5 soil to water ratio); cation exchange capacity (CEC) (using 1M ammonium acetate, pH 7.0; Lim, 1975), and the leachate was collected to determine the concentration of cations by atomic absorption spectrometry (Ca and Mg) and flamephotometer (K); total N (Kjedahl method; Bremner and Mulvaney, 1982), P (Bray and Krutz, 1945) and organic C (combustion method; McKeague, 1976), bulk density (core ring method; Blake and Hartge, 1986), aggregate stability (wet-sieving method; Kemper and Rosenau, 1986), and aggregation (dry-sieving method; Kemper and Rosenau, 1986). Soil aggregate stability and aggregation were expressed as mean weight diameter (MWD) in unit mm (Kemper and Rosenau, 1986).

The above data was analysed using ANOVA (analysis of variance) according to the experimental design of a split plot in time and space, with three replications and three main factors: the four treatments, the two soil depths (space factor) and the six monthly collection periods (time factor). Data analysis was by using the statistical software SPSS ver. 13 (SPSS Inc., Chicago).

Soil water content from every treatment plot was measured at soil depths 0.1, 0.2, 0.4, 0.6 and 1.0 m using a soil profile probe (PR1, Delta-T, Cambridge, England). Soil water measurements were done once a day, beginning in 1 March 2006 and ending in 14 May 2006. These measurement dates corresponded to day of year (DOY) 60 to 135 (where Jan 1 = 1, Jan 2 = 2, Feb 1 = 32, and so on). Rainfall data was collected using a portable weather station (Watchdog Model 700, Spectrum Technologies Inc., Illinois).

Lastly, the moisture characteristic of the soil was measured using the pressure plate and membrane technique (Richards, 1947) to obtain the volumetric water content at saturation point, field capacity point, and permenant wilting point.

RESULTS AND DISCUSSION

Changes in the soil chemical properties

The soil chemical properties analysed were pH, CEC, exchangeable Ca, Mg and K, and total N, P and organic C. As both C and N were measured, their C:N ratio was additionally calculated (**Table 1**).

ANOVA revealed that the interaction effect treatment × time × depth was significant at the 5% level of significance for the soil properties: CEC ($p < 0.001$), exchangeable Ca ($p < 0.001$), Mg ($p < 0.001$) and K ($p < 0.001$), total P ($p < 0.001$), total organic C ($p < 0.001$), and C:N ($p < 0.025$). This meant that the effect of the four conservation practices on these seven soil properties would vary according to time as well as soil depth. For total N, however, the interaction effect treatment × time was significant at the 5% level of significance ($p < 0.001$), and for pH, the interaction effects treatment × time and treatment × depth were significant at the 5% level of significance ($p < 0.017$ and $p < 0.009$, respectively).

As compared to other treatments, the EFB treatment produced the highest reading for soil pH and the highest amount for CEC, exchangeable Ca, Mg and K, total P, and total organic C. The Ecomat treatment generally gave the second highest reading for all soil properties. One reason why EFB is better than Ecomat in increasing almost all the soil chemical properties is Ecomat has a lower nutrient content than EFB. The disadvantage of Ecomat is the loss of nutrients from EFB when EFB is processed and finally compressed into a matting material (Ecomat).

The C:N ratios in both soil depths in all treatments remained below 20 throughout the study. The C:N ratio of soil organic matter generally ranges from 12:1 to 20:1. Any compost or other organic material which has a C:N ratio greater than 30:1 favours immobilisation, supplying C to the soil but may cause a reduction in plant-available N.

In contrast, organic materials with C:N ratios below 20:1 will favour N mineralisation and supply N to the soil. Results showed that the total soil N in the Ecomat treatment was higher than in the EFB treatment. This could be due to the lower C:N ratio for Ecomat than EFB. Thus, when added to the soil, Ecomat would favour more release of N through mineralisation as compared to the addition of EFB which has a higher C:N ratio. EFB generally has a high C:N ratio, ranging from 45:1 to 70:1 (Saletes *et al.*, 2004).

The soil C:N ratio in the EFB treatment was higher than in the Ecomat treatment. In the top soil, both EFB and Ecomat treatments showed a fairly constant soil C:N ratio with time; about 9:1 to 10:1 and 8:1 to 9:1 for EFB and Ecomat, respectively. In the subsoil, the soil C:N ratios in all treatments would decline with time. The silt pit treatment, in particular, had the highest C:N ratio, decreasing from about 19:1 to 12:1 in six months. The reason for the much higher C:N ratio in the silt pit treatment is unknown.

This study however showed that the silt pit treatment was not better than either EFB or Ecomat in improving the soil chemical properties. Moreover, the effects of the silt pit treatment were generally comparable to control, in particular for soil pH, CEC, exchangeable Ca and Mg, total P and organic C. This study also observed that the walls of the silt pits were easily collapsible, especially after heavy rainfalls. Thus, with time, the silt pits became increasingly shallower. This might explain why the effects of the silt pit and control treatments were generally comparable to each other.

Changes in the soil physical properties

The soil physical properties analysed were bulk density, aggregation, and aggregate stability (**Table 1**). ANOVA revealed that the interaction effect treatment × time × depth was significant at the 5% level of significance for only the aggregate stability property ($p < 0.001$). The interaction effect treatment × time was significant at the 5% level of significance for soil properties: aggregation ($p < 0.013$) and AWC ($p < 0.001$). For bulk density, however, only the depth effect was significant at the 5% level of significance ($p < 0.016$). This showed that bulk density was not significantly affected by any of the treatments.

In all treatments, aggregate stability increased with time. EFB, Ecomat and silt pit treatments generally had similar aggregate stability with each other, with the control treatment generally having the lowest aggregate stability. Aggregation, however, showed a general slow decline with time in all treatments. Soil aggregation is strongly affected by cycles of wetting-and-drying of the soil. During this study, the experimental site experienced heavy rainfall of over 720 mm in six months, without any long, continuous periods of dry weather. In the absence of any distinct wetting-and-drying cycles, soil aggregation may decline over time. The aggregation in the EFB treatment, in particular, would decline sharply after the second month. This sharp decline in the EFB treatment could be due to the high soil water concentration in the EFB treatment in particular in the 0 - 0.3 m depth (**Figure 1**), where the high water content may have cause large aggregate breakdowns.

Figure 1 shows the soil water profile up to 1 m soil depth in all treatments. The volumetric water content at saturation point, field capacity point and permenant wilting point were measured at 0.32, 0.17 and 0.13 m^3 m^{-3}, respectively. All treatments showed soil water content below the 0.8 m soil depth was at near saturation point, which was probably due to rise of water from the ground water table (below the 1 m depth). In addition, the soil water content in all treatments was consistently above the field capacity point. This was due to the heavy rainfall received throughout the study as well as the absence of a long spell of dry weather. As expected, after periods of rainfall, there was an increase in soil water content throughout the soil depth.

Most importantly, **Figure 1** shows that each of the four treatments had a distinct soil water profile. The distribution of water in the Ecomat treatment was rather uniform throughout the soil profile from 0 to 0.7 m. In the EFB treatment, the soil water content tended to decrease with depth until 0.6 m before the soil water content would increase due to the effect of the ground water table. In particular, the soil in the 0-0.3 m in the EFB treatment was generally the wettest, and the soil in the region of about 0.6 m the driest. As compared to Ecomat, EFB concentrated water in the upper soil layers, whereas Ecomat tended to distribute the water more uniformly throughout the profile up to 0.7 m.

Like EFB, silt pit also concentrated water in the upper soil layers, but its concentration of water was restricted to a shallower depth as compared to either EFB or Ecomat. In the control plots, the concentration of water occurred mostly in the lower soil layers below 0.5 m. It was only during wet weather periods (after DOY 90), as increasingly more rain is received by the soil, water would also be concentrated in the upper soil layers. Nonetheless, the soil water content in these wet upper layers in the control plots was generally the lowest as compared to the other three treatments. These results indicated that both EFB and Ecomat were better than silt pit and control to conserve water, in particular in conserving the water in the 0 – 0.6 m depth. This experiment is still on-going, in particular to determine the long term effects of the four treatments. As mentioned previously, heavy rainfall was received during this study, so the soils in all treatments were consistently above field capacity. We therefore hope that there would be dry weather spells that would enable us to determine the relative effects of EFB, Ecomat and silt pit in conserving water in dry, water-stressed field conditions.

CONCLUSION

This study found that EFB was the best overall treatment to improve soil properties and conserve soil water. Of the four treatments, EFB gave the highest improvement in almost all the soil chemical properties. Both EFB and Ecomat were better than silt pit and control in conserving water above the 0.6 m soil depth. Although the idea of silt pit is to trap soil nutrients and water, this study found that the silt pit treatment was generally comparable to control treatment in improving the soil chemical and physical properties. Silt pit also did not conserve water as well as EFB or Ecomat (though better than control). The walls of the silt pits were observed to be easily collapsible, especially after heavy rainfalls. Thus, over time, the silt pits became increasingly shallower.

REFERENCES

Blake, G.R. and Hartge, K.H. 1986. Bulk density. In: Klute, A. (ed). Methods of Soil Analysis. Part 1. Physical and mineralogical methods. 2nd. Edn. ASA-SSSA, Wisconsin, pp. 363-375

Bray, R.H. and Krutz, L.K. 1945. Determination of total organic and available forms of phosphorous in soil. Soil Sci., 59: 39–45

Bremner, J.M., and C.S. Mulvaney. 1982. Nitrogen - Total. In: Page, A.L., Miller, R.H. and Keeny, D.R. (ed). Methods of Soil Analysis. Agronomy Monograph 9, Part 2, 2nd. Edn. American Society of Agronomy, Madison, WI. pp. 595-624

Kemper, W.D. and Rosenau, R.C. 1986. Aggregate stability and size distribution. In: Klute, A. (ed). Methods of Soil Analysis. Part 1. Physical and mineralogical methods. 2nd. Edn. ASA-SSSA, Wisconsin, pp. 425-442

Lim, H.K. 1975. Working manual for soil analysis. Ministry of Agriculture. Ministry of Agriculture, pp. 25-65

McKeague, J.A. 1976. Manual on soil sampling and methods of analysis. Soil Research Institute of Canada

Richards, L.A. 1947. Pressure-membrane apparatus - construction and use. Agric. Eng., 28: 451-454

Saletes, S., Siregar, F.A., Caliman, J-P and Liwang, T. 2004. Ligno-cellulose composting: Case study on monitoring oil palm residuals, Compost Sci. Util., 12: 372-382

Table 1 Soil properties in all treatments (expressed as averages of three replicates)

Property (units)	Treatment	Depth (mm)	Month 1	2	3	4	5	6
CEC cmol(+) kg^{-1}	Control	0-150	6.39	6.44	6.97	6.94	7.01	7.03
		150-300	6.04	6.18	6.29	6.34	6.43	6.56
	EFB	0-150	7.49	7.49	7.80	7.55	7.56	7.59
		150-300	7.30	7.31	7.32	7.35	7.35	7.37
	Ecomat	0-150	7.15	7.16	7.19	7.20	7.26	7.27
		150-300	6.86	6.89	6.89	6.91	6.94	6.98
	Silt pit	0-150	6.71	6.83	6.95	6.92	6.98	7.38
		150-300	6.42	6.43	6.44	6.46	6.47	6.48
K cmol(+) kg^{-1}	Control	0-150	0.08	0.09	0.10	0.33	0.48	0.67
		150-300	0.07	0.08	0.10	0.32	0.41	0.56
	EFB	0-150	0.09	0.41	0.63	0.85	0.85	0.86
		150-300	0.08	0.30	0.57	0.72	0.72	0.74
	Ecomat	0-150	0.08	0.19	0.38	0.46	0.68	0.84
		150-300	0.07	0.11	0.27	0.47	0.57	0.63
	Silt pit	0-150	0.08	0.21	0.32	0.53	0.61	0.67
		150-300	0.08	0.18	0.29	0.43	0.48	0.58
Ca cmol(+) kg^{-1}	Control	0-150	0.10	0.15	0.29	0.43	0.59	0.63
		150-300	0.09	0.13	0.25	0.39	0.41	0.46
	EFB	0-150	0.10	0.24	0.48	0.51	0.64	0.71
		150-300	0.07	0.15	0.39	0.35	0.43	0.58
	Ecomat	0-150	0.10	0.18	0.29	0.46	0.58	0.68
		150-300	0.08	0.08	0.12	0.29	0.46	0.50
	Silt pit	0-150	0.11	0.18	0.35	0.39	0.52	0.63
		150-300	0.08	0.12	0.27	0.30	0.37	0.45
Mg cmol(+) kg^{-1}	Control	0-150	0.08	0.10	0.12	0.13	0.22	0.29
		150-300	0.08	0.09	0.08	0.14	0.15	0.15
	EFB	0-150	0.08	0.18	0.25	0.29	0.32	0.34
		150-300	0.07	0.08	0.16	0.20	0.21	0.25
	Ecomat	0-150	0.09	0.10	0.12	0.25	0.30	0.31
		150-300	0.08	0.08	0.09	0.14	0.16	0.20
	Silt pit	0-150	0.09	0.13	0.17	0.21	0.22	0.25
		150-300	0.08	0.09	0.10	0.12	0.12	0.16
P ug g^{-1}	Control	0-150	22.87	23.67	30.44	32.91	38.55	40.01
		150-300	14.00	14.31	15.92	26.38	29.59	33.85
	EFB	0-150	21.86	22.37	38.99	39.55	41.43	43.29
		150-300	19.56	21.40	22.96	31.39	35.63	36.72
	Ecomat	0-150	20.41	20.92	23.96	36.39	39.43	41.35
		150-300	19.01	19.61	22.62	29.41	30.67	35.96
	Silt pit	0-150	21.54	23.06	29.54	32.93	34.09	40.37
		150-300	15.58	17.60	20.30	24.76	30.88	32.69
N ug g^{-1}	Control	0-150	0.10	0.10	0.12	0.11	0.13	0.13
		150-300	0.09	0.09	0.10	0.10	0.12	0.12
	EFB	0-150	0.12	0.12	0.13	0.13	0.16	0.15
		150-300	0.09	0.10	0.12	0.11	0.13	0.14
	Ecomat	0-150	0.14	0.13	0.14	0.15	0.15	0.16
		150-300	0.10	0.11	0.12	0.13	0.14	0.14
	Silt pit	0-150	0.07	0.08	0.08	0.09	0.10	0.11
		150-300	0.07	0.06	0.08	0.08	0.10	0.11
C %	Control	0-150	1.16	1.14	1.18	1.17	1.15	1.15
		150-300	1.03	1.04	1.04	1.03	1.06	1.07
	EFB	0-150	1.18	1.20	1.35	1.44	1.57	1.73
		150-300	1.07	1.06	1.14	1.15	1.20	1.25
	Ecomat	0-150	1.11	1.18	1.27	1.23	1.29	1.42
		150-300	1.06	1.04	1.12	1.18	1.24	1.26

	Silt pit	0-150	1.12	1.16	1.17	1.18	1.24	1.30
		150-300	1.04	1.06	1.10	1.14	1.18	1.22
C:N	Control	0-150	12.02	11.07	9.81	10.98	8.81	8.67
		150-300	11.40	11.51	10.07	9.97	8.85	8.90
	EFB	0-150	10.12	9.71	10.14	11.13	10.04	11.26
		150-300	12.36	10.97	9.82	10.18	9.47	9.17
	Ecomat	0-150	8.13	8.88	9.28	8.41	8.41	9.08
		150-300	10.31	9.45	9.06	8.83	9.06	9.01
	Silt pit	0-150	18.11	17.05	17.14	13.67	13.71	12.35
		150-300	16.57	19.31	16.39	14.84	12.81	11.92
pH	Control	0-150	4.85	4.96	4.83	4.59	4.85	4.73
		150-300	4.95	4.13	4.64	4.27	4.79	4.80
	EFB	0-150	5.15	5.33	6.61	6.03	5.85	6.16
		150-300	4.94	4.80	5.04	5.16	5.49	5.69
	Ecomat	0-150	4.78	4.56	4.96	4.57	4.65	4.88
		150-300	4.57	4.17	4.51	4.33	4.46	4.61
	Silt pit	0-150	5.01	4.39	4.52	4.08	4.46	4.55
		150-300	4.87	4.28	4.44	4.39	4.63	4.57
Bulk density Mg m^{-3}	Control	0-150	1.54	1.60	1.74	1.63	1.63	1.62
		150-300	1.69	1.65	1.71	1.67	1.67	1.62
	EFB	0-150	1.58	1.52	1.55	1.58	1.56	1.53
		150-300	1.63	1.61	1.63	1.63	1.62	1.51
	Ecomat	0-150	1.65	1.59	1.59	1.63	1.59	1.59
		150-300	1.62	1.60	1.59	1.64	1.58	1.59
	Silt pit	0-150	1.63	1.61	1.69	1.60	1.66	1.62
		150-300	1.64	1.63	1.70	1.71	1.66	1.66
Aggregation mm	Control	0-150	3.04	3.46	2.89	2.74	2.65	2.60
		150-300	3.32	3.50	2.98	2.93	3.03	2.97
	EFB	0-150	3.09	3.45	2.34	2.27	2.64	2.66
		150-300	3.16	3.76	2.53	2.45	2.68	2.70
	Ecomat	0-150	2.86	3.30	2.68	2.82	2.76	2.83
		150-300	3.14	3.48	2.81	2.90	2.87	2.76
	Silt pit	0-150	2.75	3.16	2.59	2.70	2.44	2.51
		150-300	2.98	3.33	2.86	2.73	2.65	2.56
Aggregate stability mm	Control	0-150	1.21	1.23	1.25	1.29	1.33	1.38
		150-300	1.22	1.25	1.28	1.32	1.37	1.43
	EFB	0-150	1.29	1.28	1.35	1.43	1.49	1.56
		150-300	1.36	1.38	1.41	1.49	1.53	1.68
	Ecomat	0-150	1.26	1.36	1.40	1.38	1.40	1.43
		150-300	1.30	1.38	1.43	1.26	1.47	1.45
	Silt pit	0-150	1.24	1.30	1.34	1.37	1.44	1.53
		150-300	1.27	1.34	1.37	1.44	1.39	1.42

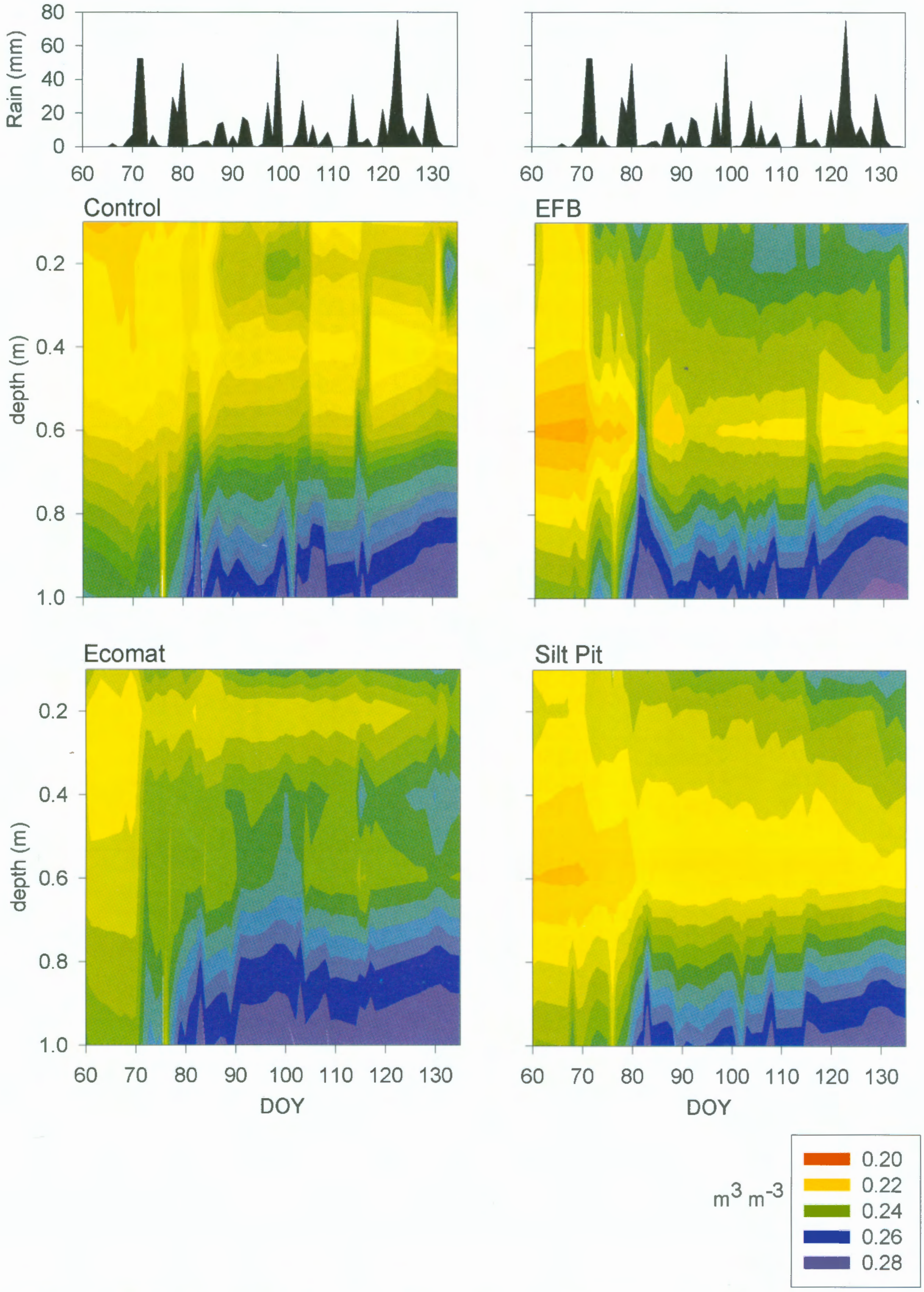

Figure 1 Soil water profile in all treatments (expressed as the average volumetric water content of three replicates)