



Wet–dry cycles affect dissolved organic carbon in two California agricultural soils

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Abstract

During California's hot, dry summers, irrigated soils are subjected to frequent wet–dry cycles and surface layers dry to near air–dry conditions between irrigations. We investigate whether wet–dry cycles enhance soil dissolved organic carbon (DOC) concentrations. This research follows up on previous observations of higher DOC concentrations in the surface (0–2 cm) than deeper (2–15 cm) soil layer late in the growing season, even when soils were moist throughout the profile. We also investigate whether DOC contents correspond to other measures of C available to microorganisms. All measurements were made on soils stabilized at -0.03 MPa water potential for 48 h at 25°C to avoid the initial pulse of microbial activity which follows re-wetting of dry soils. After 3 months during the summer field season, DOC concentrations increased 2.5-fold in the surface 0–2 cm layer and 1.20 to 1.35-fold in the 2–15 cm layer in soils under both organic (N inputs of cover crop and manure) and conventional (inorganic N inputs) management for irrigated tomatoes. In microcosms exposed to wet–dry cycles for 3 months, DOC concentrations increased by 70%, while in microcosms maintained at -0.03 MPa for 3 months DOC remained constant. The increase in DOC in both field and microcosm soils exposed to wet–dry cycles indicates that wet–dry cycles contribute to higher background DOC contents. The greater DOC increase in the field than microcosms may be due to evaporation causing upward movement of water and concentrating DOC at the soil surface, or to greater C availability in the field due to the presence of plant roots. Respiration and microbial biomass C (MBC) remained constant or declined slightly in both soil layers and microcosm treatments over the growing season, counter to the trends in DOC concentration. Therefore DOC contents measured under moist soil conditions do not appear to consistently indicate C availability to microorganisms. The percentage of labile DOC, as measured by a bioassay, declined in the surface layer of the organic field soil and in organic and conventional soils in both microcosm treatments over the 3 month experiment, possibly indicating that roots were a continuing source of labile DOC in the lower field layers. Reflecting the higher organic inputs to the organic than conventional soil, DOC, MBC and respiration rates were 2–2.5 times higher in the organic than conventional soil throughout the experiments, however the percentage of labile DOC was approximately twice as high in the conventional soil as in organic soil. © 1999 Elsevier Science Ltd. All rights reserved.

1. Introduction

In previous studies of irrigated California agricultural soils, DOC was concentrated in the surface relative to the underlying soil layer, even when both layers were moist (Lundquist, 1997). Although research has shown that DOC concentrations (expressed on a weight C to weight dry soil basis) are higher in soils

maintained under air-dry than moist soil conditions (Davidson et al., 1987; West et al., 1992; Zsolnay, 1996), and in field soils exposed to long-term drought (Rolston and Liss, 1989; Zsolnay and Görlitz, 1994), our research has shown that upon re-wetting of air-dry soils, DOC contents decrease over a period of several hours to stable, baseline amounts which remain constant under moist soil conditions (Lundquist, 1997). DOC in moist soils remains in constant amounts over periods of days to months (Cook and Allan, 1992a;

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Boyer and Groffman, 1996). West et al. (1992) demonstrated that DOC remained relatively stable over a broad range of soil moisture contents, and DOC concentrations increase only when soil approached air-dry conditions. In California's hot, dry summers, irrigated soils experience substantial wet-dry cycles, especially at the soil surface. These cycles may be responsible not just for temporary elevations of DOC when soil is near air-dry, but also for higher background DOC concentrations.

When air-dry soil is re-wetted, there is a burst of respiration (Birch, 1958; Birch, 1959; Soulides and Allison, 1961; Funke and Harris, 1968). Our own studies have also shown a pulse of respiration and an increase in MBC and decrease in DOC within 12 h after re-wetting air-dry soils (Lundquist, 1997). In the current study we wanted to avoid this pulse of activity which occurs immediately after re-wetting air-dry soil, and we wanted to measure more stable amounts of DOC in moist soil. Therefore all measurements were made 48 h after re-wetting soils to field capacity (-0.03 MPa) and incubating them at this water potential at 25°C .

DOC has been proposed as an indicator of the C available to soil microorganisms (Burford and Bremner, 1975; Boyer and Groffman, 1996); however the factors controlling its concentration and bioavailability are not well understood. In some studies, DOC concentrations correlated well with heterotrophic microbial processes such as respiration and denitrification (Burford and Bremner, 1975), while in others it did not (Beauchamp et al., 1980; Davidson et al., 1987; Cook and Allan, 1992a). A large portion (50–85%) of DOC, as measured by bioassays, is not degraded even after incubations of 90–134 d (Zsolnay and Steindl, 1991; Qualls and Haines, 1992b). The availability of DOC to microorganisms may decrease with time after adding organic materials to soil. Cook and Allan (1992a,b) found that soil respiration rates declined during a 210 d incubation, but amounts of DOC remained constant or increased, with an apparent increase in refractory N-containing compounds in the DOC. Studies of forest A and AB soil horizons have shown that a large portion of potential DOC is readily adsorbed to solids (Qualls and Haines, 1992a), and so DOC contents may be controlled by dissolution or desorption from the solid phase. Zsolnay (1996) emphasized spatial heterogeneity in the bioavailability of DOC, in particular that DOC in micropores (<0.2 μm) may not be accessible to soil microorganisms. DOC extraction methods which differ in the degree of soil disruption, extraction solution or extraction temperature, may therefore extract DOC of differing bioavailability, and harsh methods may even hydrolyze insoluble organic C.

We have observed that by late summer DOC becomes more concentrated in the surface than the 2–15 cm layer underlying it, even when soil is moist throughout the soil profile and the DOC content is stable (Lundquist, 1997). Because of the hot, dry conditions in California's Mediterranean climate, the surface layer of soil (approximately 0–2 cm) dries to nearly air-dry conditions following irrigation, while soil below maintains a more stable water content. We have investigated two hypotheses to explain this concentration: (1) that DOC is concentrated at the surface due to evaporation and upward movement of water and (2) that DOC is generated in place due to soil wet-dry cycles. We also compare the effects of wet-dry cycles on DOC in soils from conventional and organic farming systems that differ in the amount of added organic matter and sources of N, and we compare DOC content to other measures of C availability to microorganisms including a bioassay for labile DOC, soil respiration and soil microbial biomass C (MBC).

2. Materials and methods

Soils were sampled under tomatoes in organically and conventionally managed farming systems at the University of California at Davis Long Term Research on Agricultural Systems (LTRAS) project in Yolo County, CA. Each system is present in three replications of a randomized complete block design. In the organic corn-tomato rotation, winter cover crops and animal manure are used as fertility sources. In the conventional wheat-tomato rotation, inorganic fertilizer is used. Average annual dry matter inputs to the two systems are 23 and $6.4 \text{ Mg ha}^{-1} \text{ y}^{-1}$ to the organic and conventional systems, respectively. Farming treatments began in the fall of 1993. The soil types at LTRAS are Yolo silt loam, a fine-silty, mixed, nonacid, thermic Typic Xerorthent and Rincon silty clay loam, a fine montmorillonitic, thermic Typic Haploxeralf. Both soil types were present in most field plots.

DOC and other measures of C availability at two depths were measured near the beginning of the growing season, 20 May, 1996, and at the end 12 August, 1996. On each sampling date, twenty 2 cm dia. cores, 0–15 cm depth, were collected on the outer 30 cm of tomato beds from random locations throughout a 12×12 m area within each field plot for each treatment. Each core was divided into a 0–2 and a 2–15 cm section. Within a 20 cm radius of each 0–15 cm core, 5 additional 0–2 cm cores were collected in order to have sufficient soil for analyses. Cores from each depth in each plot were bulked and mixed thoroughly.

Soils were sampled to determine gravimetric water content and were stored overnight at 4°C . The soils

were then adjusted to a gravimetric water content of $0.24 \text{ g H}_2\text{O g}^{-1}$ soil, or approximately -0.03 MPa , based on a moisture retention curve determined with a pressure plate apparatus. Soils were incubated in 500 ml jars at 25°C for 48 h with a loose covering of parafilm to minimize evaporation. This 48 h period was chosen to allow the soils to stabilize following addition of water. In previous studies (Lundquist, 1997) on Yolo silt loam, DOC concentrations, elevated due to air-drying, returned to stable, lower amounts and MBC increased to stable, higher contents 3 h after re-wetting air-dry soil. Respiration rates, elevated following re-wetting of air-dry soils, also declined approximately 50% in the first 27 h following re-wetting. Van Gestel et al. (1993) also found that microbial biomass recovered by 1–2 d after re-wetting air-dry soil.

A gentle DOC extraction method was used which consisted of a 2:1 deionized water to moist soil extraction, 15 min gentle shaking, centrifugation, and filtration through a $0.2 \mu\text{m}$ polycarbonate membrane filter (Burford and Bremner, 1975). The extracts were frozen until analysis of organic C using a Shimadzu TOC 5050 (Shimadzu, Columbia, MD). Carbon from filtered blanks was subtracted. Microbial biomass C was measured by the fumigation extraction method (Vance et al., 1987; Sparling and West, 1988; Tate et al., 1988), and the extracts were analyzed as for DOC. MBC is reported as the difference in C between fumigated and non-fumigated samples without conversion to total MBC. Respiration was measured by placing 5 g of soil into 60 ml bottles, sealing the bottles, and incubating them at 25°C for 24 h. Headspace CO_2 was then analyzed on a Horiba PIR-2000 (Horiba Instruments, Inc., Riverside, CA), and the initial CO_2 content from an empty sealed bottle was subtracted. A bioassay to estimate relative amounts of labile C in the DOC utilized a bacterial isolate, identified as *Pseudomonas putida* by cellular fatty acid analysis (Hewlett Packard Microbial Identification System, Five Star Laboratories, Branford CT). The bacterium was grown in 20 ml 1/10 tryptic soy broth and was washed and re-suspended in 100 ml phosphate buffer four times, to remove soluble organic C. To flasks containing 3.6 ml of DOC extract and 0.4 ml of mineral salts medium concentrated 10 fold (Mu and Scow, 1994), 100 μl of the culture was added to achieve a final cell density of $10^7 \text{ cells ml}^{-1}$. The flasks were sealed and incubated on a rotary shaker for 2 h. Accumulated CO_2 in the headspace was measured using the Horiba PIR-2000. CO_2 in the headspace of control flasks, prepared like the DOC samples but with deionized water in the place of DOC, was subtracted to give the amount of CO_2 evolved from metabolism of the DOC. The bioassay was conducted over a short period to capture biodegradation of the labile pool of DOC. Tests of the bioassay method had

shown an initially rapid 1–2 h period of CO_2 evolution, followed by a much slower phase of CO_2 evolution. This assay was intended as a relative and not total measure of labile DOC. A pure culture was used to permit standard comparisons with future bioassays, and CO_2 dissolved in solution was not measured. The organic soil had a pH of 7.0 (measured in saturated paste), and the conventional of 6.8, and the mineral salts medium was phosphate-buffered. Therefore differences in dissolved CO_2 due to pH were unlikely.

The data were analyzed as a three-way factorial experiment in a randomized complete block design with the factors of farming system, soil depth and sample time. Because of the many two and three-way interactions, the data also were separated by farming system and analyzed as a randomized complete block design with four treatments: May 0–2 cm, May 2–15 cm, August 0–2 cm and August 2–15 cm. These treatment means were separated using Fisher's protected LSD, $P < 0.05$.

In another experiment soil microcosms were compared. The three treatments included: (1) soil sampled 20 May, 1996, (2) soil maintained continuously moist for 94 d or (3) soil subjected to wet–dry cycles for 94 d. These microcosm treatments will be referred to as May, continuously wet, and wet–dry, respectively. Soil was collected on 20 May, 1996 by sampling approximately 150, 2 cm dia. cores, 0–15 cm deep, from the same $12 \times 12 \text{ m}$ areas as the field samples, but in only one organic and one conventional plot of one field block at the LTRAS project. These soils were thoroughly mixed, tested for gravimetric water content and adjusted to $0.24 \text{ g H}_2\text{O g}^{-1}$ soil. Soil from each farming system treatment was divided equally into 12, 1-l jars, and the jars were divided randomly into three groups of four jars for the May, continuously wet and wet–dry microcosm treatments. Each jar contained 290 g dry weight of soil, reaching a depth of approximately 4 cm within each jar. The May microcosms were sampled concurrently with the May field samples after 48 h incubation at 25°C , the continuously moist microcosms were maintained at $0.24 \pm 0.005 \text{ g H}_2\text{O g}^{-1}$ soil at 25°C for 94 d, and the wet–dry microcosms were placed open in a greenhouse. In the greenhouse (average daily high and low temperatures of 35°C and 20°C) the soils were allowed to air-dry to approximately $0.04 \text{ g H}_2\text{O g}^{-1}$ soil, and then were re-wet to $0.24 \text{ g H}_2\text{O g}^{-1}$ soil. This wet–dry cycle was repeated 8 times during the 94 d experiment. This wetting frequency is similar to the frequency of irrigation cycles in the field, and this degree of soil drying is also similar to that experienced in the 0–2 cm soil layer in the field. At the end of this period, the wet–dry soils were moistened to $0.24 \text{ g H}_2\text{O g}^{-1}$ soil and incubated at this water content for 48 h at 24°C . Then both the continuously wet and wet–dry soils were thoroughly

mixed and analyzed as described above for the field samples.

Data for the microcosm study were analyzed as a two-way factorial, completely randomized design with the factors of farming system and microcosm treatment. Because of many significant interactions, the data were also analyzed separately for the organic or conventional soils by completely randomized design analysis of variance followed by mean separation using Fisher's protected LSD, $P < 0.05$.

The wet-dry and continuously wet microcosm treatments were intended to mimic the field 0–2 and 2–15 cm layers, respectively. Therefore the results from these respective treatments are compared in Section 3. Results from the May microcosm treatment using soil from 0–15 cm are compared with results from the 0–2 and 2–15 cm layer May field samples. We felt this comparison was appropriate because April tillage of the soils had minimized potential differences between 0–2 and 2–15 cm layers in May. Also the May microcosm and May field samples were collected at the same time.

3. Results and discussion

3.1. Effects of soil moisture conditions or soil layer on DOC

In May field samples DOC concentrations were not significantly different in the surface than in the deeper layer in both farming systems (Fig. 1a). By August, DOC concentrations had increased approximately 2.5-fold in the 0–2 cm layer of both farming system soils. DOC in the 2–15 cm layer increased 1.17 to 1.35-fold in the organic and conventional treatments, respectively, although the increase was significant only in the latter. Similar, but less pronounced, changes occurred in the microcosms (Fig. 1b). In both farming system soils, DOC increased approximately 1.70-fold in the microcosm soils exposed to wet-dry cycles. The two experiments (field and microcosm) differed in several respects. One factor was the potential for DOC transport from lower soil layers to the surface in the field but not in the microcosm soils. Temperature and moisture conditions differed between the two experiments, and tomato plants were present in the field but not in the microcosms. Thus, it was not possible to directly attribute the larger increase in DOC observed in the field surface soil to evaporation of water from the soil surface causing upward transport of DOC in the field but not in the microcosm soils. However, at least part of the increase in DOC in the field may have resulted from the effects of soil drying and re-wetting, as the DOC increase in the wet-dry microcosms was roughly half that in the field 0–2 cm layer.

Three, not necessarily mutually exclusive, explanations for this increase in background DOC contents due to wet-dry cycles are: (1) Severe wet-dry cycles greatly decreased microbial populations thus reducing microbial utilization of the DOC. This explanation is contradicted by the similar or higher amounts of MBC and respiration in the soils exposed to wet-dry cycles than those exposed to more continuously moist conditions, e.g., August 0–2 cm as compared to 2–15 cm layer, and the wet-dry compared to continuously wet microcosms (Tables 1 and 2). (2) The severe wet-dry cycles enhanced turnover of MB and condensation of microbial products, thus increasing the amount of recalcitrant, soluble organic C. Large (18–63%) decreases in microbial biomass have been reported in soil drying from moist to air-dry conditions (Bottner, 1985; West et al., 1992; Van Gestel et al., 1993). (3) Wet-dry cycles disrupted soil structure thereby making previously sequestered carbon more available as DOC. Studies have shown water stable aggregates to decline by 20–60% in soils exposed to wet-dry cycles when compared to soils maintained moist (Soulides and Allison, 1961; Degens and Sparling, 1995). Disruption

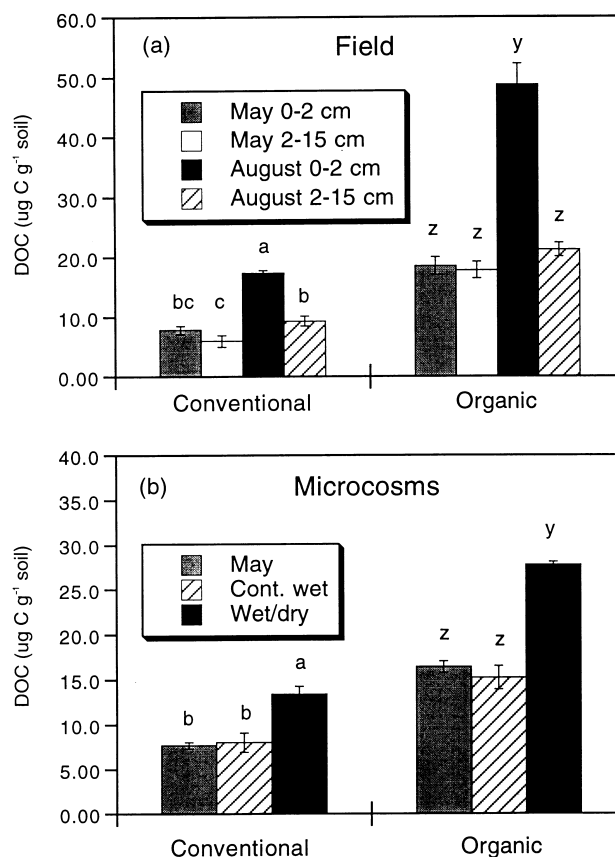


Fig. 1. DOC concentrations in field (a) and microcosm (b) soils. Error bars are \pm one standard error, $n = 3$. Bars with different letters are significantly different at $P < 0.05$ where organic or conventional soils were analyzed separately for both field and microcosm experiments.

of soil aggregates could expose insoluble soil organic matter which would otherwise be protected from microbial attack. Disruption might also increase the surface area of soil with adsorbed DOC potentially in equilibrium with soil solution DOC.

3.2. Additional measures of C availability to microorganisms

In addition to changes in the amount of soil DOC, the proportion of labile DOC was measured with a bioassay (Tables 1 and 2). By August, the proportion of labile DOC in the field soils declined in the surface but not in the deeper layer. In the microcosms, however, the proportion of labile DOC declined to a similar extent in both the continuously moist and wet–dry treatments. The decline in labile DOC over the season could have been due to a lack of recent organic inputs in the microcosms. The absence of a detectable decline in labile DOC in the deeper field layer may have been due to the renewal of labile C pools by plant roots and root exudates (Zsolnay, 1996). Fewer plant roots would be expected in the surface layer because of severe drying.

In the field MBC was not different between May and August, but variability in the MBC measurements

was high (Table 1). MBC declined in the microcosms between May, when the samples were collected, and 94 d later. Again, contribution of organic C by plant roots may have helped to maintain a larger MBC in the field than the microcosms.

In the field samples from the organic treatment, soil respiration was highest in May for both soil depths, intermediate in the August 0–2 cm depth, and least in the August 2–15 cm depth (Table 1). The same trend was observed in the microcosm treatments for both the organic and conventional soils, with respiration highest in the May, intermediate in the wet–dry, and lowest in the continuously moist microcosms (Table 2). No significant differences occurred in the conventional soil in the field. Repeated air-drying and re-wetting has been shown to enhance rates of organic matter decomposition (Sørensen, 1974), but when soils are air-dry there is virtually no decomposition (Birch, 1958). Therefore the ability of wet–dry cycles to enhance or retard organic matter decomposition may partially depend on the length of the intervening period when soil is air-dry. The higher respiration in the soils exposed to wet–dry cycles than to more constant moisture conditions may have been due to utilization of organic substrates that gradually built up when soil was dry due to limited microbial consumption of or-

Table 1

(A) DOC and other measures of C availability from field samples. (B) Results of randomized complete block three-way analysis of variance with the factors of farming system, depth and sampling time

	Bioassay (% respired)	Respiration ($\mu\text{g CO}_2\text{-C g}^{-1} \text{h}^{-1}$)	MBC ($\mu\text{g C g}^{-1}$ soil)
<i>(A) Conventional</i>			
May			
0–2 cm	7.54 (0.94) ^a	0.207 (0.026) ^a	71.6 (5.1) ^a
2–15 cm	6.24 (1.81) ^a	0.275 (0.020) ^a	59.2 (3.4) ^a
August			
0–2 cm	3.80 (0.57) ^a	0.231 (0.036) ^a	49.1 (10.4) ^a
2–15 cm	6.62 (1.31) ^a	0.221 (0.034) ^a	61.2 (6.7) ^a
<i>Organic</i>			
May			
0–2 cm	2.90 (0.58) ^y	0.709 (0.004) ^x	173.3 (38.3) ^x
2–15 cm	3.11 (0.18) ^y	0.616 (0.013) ^{xy}	147.1 (10.5) ^x
August			
0–2 cm	0.75 (0.06) ^z	0.573 (0.064) ^y	139.5 (4.4) ^x
2–15 cm	2.28 (0.51) ^y	0.360 (0.006) ^z	103.3 (4.9) ^x
<i>(B) Three-way analysis of variance</i>			
Farming system	***	***	***
Depth	NS	*	NS
F.S. × depth	NS	**	NS
Time	*	***	*
F.S. × time	NS	*	NS
Depth × time	*	*	NS
F.S. × depth × time	NS	NS	NS
Block	*	NS	NS

*, **, *** Indicate significance at $P < 0.05$, 0.01 and 0.001, respectively. Values in columns followed by different letters are significantly different at $P < 0.05$ within the conventional or organic farming system treatments. Values are mean (standard error), $n = 3$.

Table 2

(A) DOC and other measures of C availability from soil microcosms. (B) Results of completely randomized design two-way analysis of variance with the factors of farming system and microcosm treatment

	Bioassay (% respired)	Respiration ($\mu\text{g CO}_2\text{-C g}^{-1} \text{h}^{-1}$)	MBC ($\mu\text{g C g}^{-1}$ soil)
<i>(A) Conventional</i>			
May	5.33 (0.78) ^a	0.270 (0.013) ^a	70.7 (4.0) ^a
Continuously wet	2.27 (0.43) ^b	0.127 (0.004) ^c	38.8 (3.7) ^c
Wet-dry	2.25 (0.11) ^b	0.227 (0.009) ^b	53.3 (2.0) ^b
<i>Organic</i>			
May	3.64 (0.42) ^x	0.726 (0.040) ^x	115.1 (1.3) ^x
Continuously wet	1.44 (0.22) ^y	0.236 (0.005) ^y	84.7 (4.3) ^y
Wet-dry	1.05 (0.11) ^y	0.504 (0.068) ^z	81.9 (4.1) ^y
<i>(B) Two-way analysis of variance</i>			
Farming system	**	***	***
Microcosm type	***	***	***
F.S. × microcosm	NS	***	*

*, **, *** Indicate significance at $P < 0.05$, 0.01 and 0.001, respectively. Values in columns followed by different letters are significantly different at $P < 0.05$ within the conventional or organic farming system treatments. Values are mean (standard error), $n = 3$.

ganic substrates while the soil was air-dry (Orchard and Cook, 1983).

If we assume that the respiration rate is an indicator of C availability to microorganisms, the ratio of respiration-to-DOC can be used to indicate changes in available soil C relative to DOC. This ratio was similar for all soil samples in May (Fig. 2), ranging from 2.7 to 4.8% h^{-1} . The ratio decreased and was similar among all late season samples (1.2 to 2.4% h^{-1}). We did not calculate linear regressions for the two sample times (Fig. 2) because the relationship between respiration and DOC in soils exposed to wet-dry cycles or continuously moist conditions may have been due to different factors. For example, wet-dry cycles may

increase availability of both DOC and insoluble C substrates as discussed above. The decline in the field was similar to that in the microcosms despite the contribution of plant roots and exudates as microbial substrates in the field. Cook and Allan (1992a) found significant positive relationships between respiration rates and DOC in soils with 12–62 yr of forest succession following agricultural use. They found that respiration rates reached a plateau at high DOC concentrations as was suggested in the August field samples in our study. Also as observed in our study, Cook and Allan (1992a) found that the respiration rate relative to DOC concentration shifted down with longer incubation times (up to 210 d).

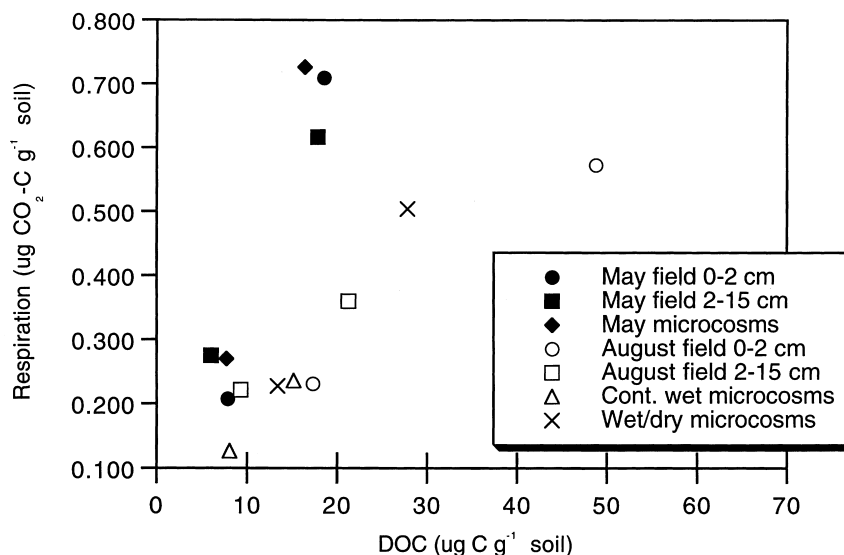


Fig. 2. Respiration rate as a function of DOC concentration in field and microcosm soils.

The lack of correspondence in seasonal trends between MBC, respiration and DOC appears to indicate that DOC measured under moist soil conditions is not a sensitive measure of C availability to microorganisms. The low amounts of labile DOC detected in the bioassay demonstrate that a large proportion of DOC may be resistant to microbial attack.

3.3. Effects of organic or conventional farming system on DOC

DOC, MBC and respiration were significantly higher in the organic than conventional soil after only 3 yr of higher organic inputs to the organic soil. The same relative differences in these variables were found both in May, soon after cover crop incorporation, and three months later (Fig. 1, Tables 1 and 2). Dissolved organic C, MBC and respiration were approximately 2.5 times higher in the field and 2 times higher in the microcosm organic than conventional soils for a given sample date or microcosm treatment. The smaller difference between organic and conventional soils in the microcosms than field may have been because the microcosm soil was collected from one organic plot that was later determined to have lower DOC, MBC and respiration than the field average for all organic plots. The large changes in MBC, DOC and respiration after only 3 y of different farming system treatments observed in our study may have been because these soils had initially low SOM contents, coupled with substantially larger organic inputs to the organic than conventional soil.

Microbial biomass has a short turnover time relative to the larger pool of soil humus (Stevenson, 1994). Therefore, MB responds more rapidly than total soil organic matter (SOM) to practices involving management of organic inputs, as has been observed by Powlson et al. (1987), Janzen et al. (1992), Biederbeck et al. (1994), Scow et al. (1994) and Lundquist (1997). At the LTRAS site in 1995, the total soil SOM at 0–15 cm depth was 1.76 and 1.46 percent in the organic and conventional soils, respectively. Therefore, total SOM was approximately 1.20-fold higher, while MBC was 3.00–3.50-fold higher in the organic than conventional soil. Differences in DOC between the organic and conventional soils were very similar to those in MBC. Therefore, like MB, DOC appears to have a short turnover time.

The proportion of labile DOC as measured by the bioassay was lower in the organic than conventional soil in both field and microcosm samples. Two explanations may account for this result: (1) the organic soil microbial community may deplete labile DOC to a greater degree than the conventional microbial community and (2) the type of organic inputs to the two soils may influence the lability of DOC. There were

not only much greater organic inputs to the organic soil, but a much wider range of substrates was added, especially of materials resistant to breakdown such as composted manure.

In summary, baseline amounts of DOC increased in field and microcosm soils subjected to wet–dry cycles. DOC did not appear to be a good indicator of C availability to microorganisms. The proportion of labile DOC declined during the season, and there was a lack of correspondence between changes in DOC and changes in respiration rates or MBC. Types of organic matter inputs, microbial activity and extent of physical disruption of soil aggregates may all play a role in determining pool sizes and availability of DOC.

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