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QUANTIFYING ADDITIONAL BENEFITS OF IRRIGATED PLASTICULTURE ON VEGETABLE PRODUCTION: CARBON DIOXIDE ENRICHMENT

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Background. Over the past 25 years, plasticulture, or the use of polyethylene mulch to cover the soil, and use of drip or trickle irrigation have increased substantially in commercial vegetable production systems. Previously documented benefits of plasticulture include: more favorable soil water and temperature regimens; improved water and fertilizer-use efficiencies; reduced nutrient leaching; reduced soil and wind erosion; higher crop yields; increased plant growth and development leading to earlier crop production; cleaner and higher quality produce; weed suppression; and disease control. Because carbon dioxide is the substrate for photosynthesis, atmospheric carbon dioxide concentration is an important environmental factor affecting plant growth and yield. To date, very little research has been conducted that is aimed at quantifying the effects of plasticulture on soil respiratory carbon dioxide flux.

Research Findings. A specially designed soil carbon dioxide flux chamber was attached to a portable photosynthesis meter in order to compare carbon dioxide efflux under a wide range of agricultural soil situations including a flooded rice paddy (Fig. 1), a drained, but water-saturated rice paddy (Fig. 2), bare soil (Fig. 3), and recently transplanted cantaloupe crop grown with plasticulture (Fig. 4). Carbon dioxide efflux was several fold higher with plastic mulch than any of the other soil environments (Table 1). Particularly on calm days with low wind speeds and early in the season when the transplants are small, this high rate of carbon dioxide evolution could significantly raise the atmospheric carbon dioxide concentration around the plant and result in a stimulation of photosynthesis and plant growth. Further research is needed in order to separate specific effects of soil temperature, moisture, and organic matter content for vegetable crops grown with plasticulture.

Application. Quantifying the physical effects of plasticulture as well as crop physiological responses will provide needed information for more efficient management of vegetable crops.

Table 1. Comparison of respiratory carbon loss from agricultural soils.

Source	Carbon dioxide efflux ± S.E.
Flooded rice paddy	0.2 ± 0.003
Drained rice paddy	2.5 ± 0.08
Bare soil	5.7 ± 0.15
Plastic mulch	45.5 ± 1.2

Fig. 1. Carbon dioxide flux measurements on flooded rice paddy.

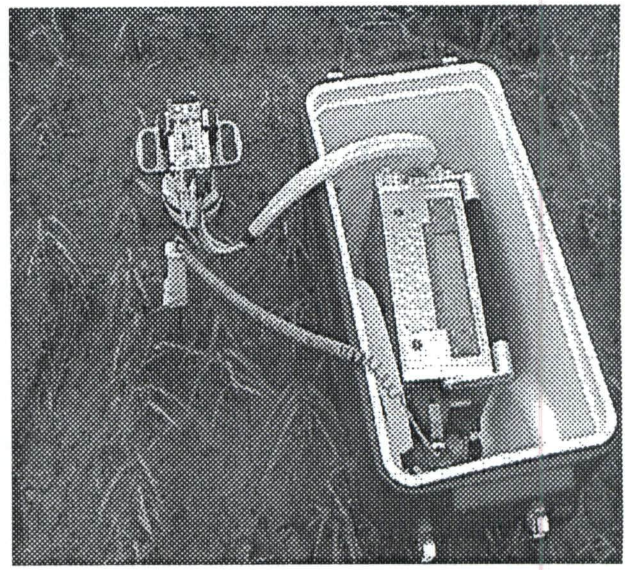

Fig. 2. Carbon dioxide flux measurements on a drained (saturated) rice paddy.

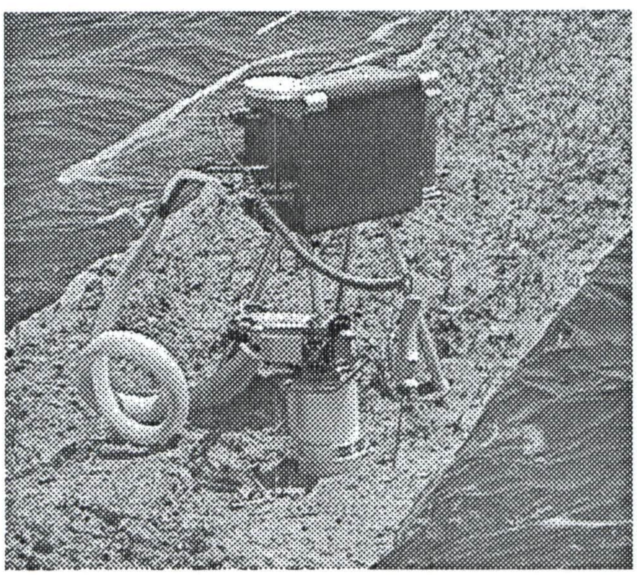

Fig. 3. Carbon dioxide flux measurements on bare soil.

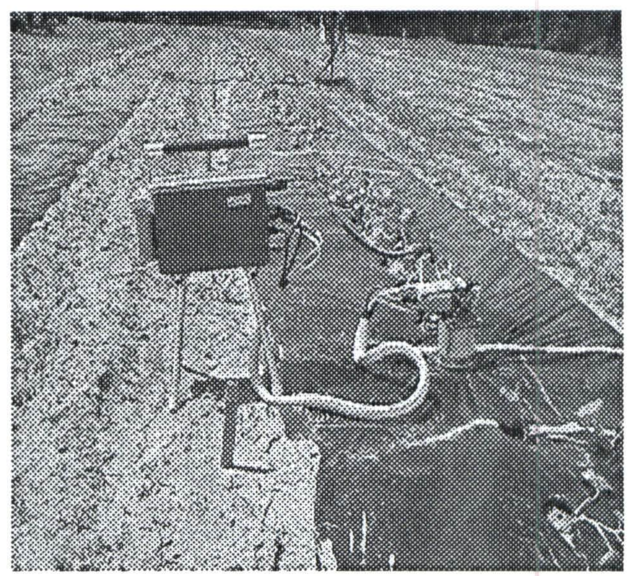

Fig. 4. Carbon dioxide flux measurements under black plastic mulch.