Sustainable Lettuce Production

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Introduction

Yuma, Arizona is the "winter lettuce capital of the world" and large scale agribusiness predominates. Cultural management practices are typical of many intensive, chemical-dependent monoculture production systems. There is increasing grower concern and interest in sustainable and alternative production practices. However, there have been few attempts at a multidisciplinary long term systems approach to studying sustainable vegetable production in the desert southwest. Cultural management information for sustainable agriculture is difficult to find, especially tested methods that would allow efficient transition.

The natural biological relationships that occur in an environmentally compatible vegetable production system may offer additional benefits over and above the reduced use of synthetic fertilizers and pesticides. To investigate the potential advantages of sustainable vegetable production we have established conventional, organic and mixed organic/conventional plots within a fixed-location research block at the Yuma Valley Agricultural Center. This is the second year of our multidisciplinary investigation of the potential sustainability of three production systems. This research project was supported by a grant from the Arizona Iceberg Lettuce Research Council.

Materials and Methods

The three main plot production systems -conventional, organic, and mixed organic/conventional - have been established and maintained at the Yuma Valley Agricultural Center. The nitrogen fertilizer contribution from the previous Sesbania cover crop was estimated to be roughly 50lb N/A. Composted cow manure was applied at 6T/A and 10T/A to the mixed organic/conventional and organic plots, respectively, and disced into the soil. A preplant application of 500lb/A of 11-52-0 fertilizer was disced into the conventional plots. A split plot treatment consisting of a liquid formulation of a biological soil conditioner (methane-digested composted chicken manure) was applied to one-half of each main plot at 75gal/A; at 1%N, this contributed only 4lb N/A. Lettuce (Merit) was direct seeded September 24, 1990 and furrow irrigated; first emergence was October 1 and thinning October 22. Both the conventional and 'mixed' production systems received 100lb N/A AN20 injected October 29.

Results

Plant tissue samples were collected at thinning (Oct.22), before head formation (Nov. 9) and at first harvest (Dec. 18). Mineral nutrient concentrations did not differ between main or split plot treatments; seasonal mean nutrient levels across all treatments are presented in Table 1. Potassium, magnesium, calcium, iron and manganese concentrations all gradually decreased from thinning to harvest.

Composite soil samples for each treatment were prepared with an aliquot from each replication and soil microorganism populations determined before and after sidedressing with AN20. There were increased aerobic and anaerobic bacteria, actinomycetes and mold colony forming units (CFU) after sidedressing in the conventional and 'mixed' treatment areas which had received the liquid chicken manure soil conditioner (Table

2). There were no such 'before and after' effects in the organic plots; for both sampling dates however, there were consistently fewer aerobic bacteria CFUs and more anaerobic bacteria and actinomycetes in the soil conditioner amended areas of the plots.

Lettuce leaf tissue total nitrogen generally declined at harvest in all three production systems (Table 3). There was a consistent response to the added soil conditioner with slightly elevated total N in the first two sampling dates. Sidedressing boosted total N in the 'mixed' system lettuce almost to the level in the conventional plots. Nitrate levels increased as the season progressed in all treatments except the organic fertilizer alone. Lettuce responded to the soil conditioner in the conventional and 'mixed' fertilizer plots with increased nitrate levels throughout the season. Organic lettuce nitrate levels were low.

Yield data are presented in Table 4. Similar to last year (McGrady, et al, 1990) a greater total percentage of heads were harvested from the conventionally fertilized plots. There were significantly more heads harvested from plots amended with soil conditioner in both the 'mixed' and organic treatment areas. Average head weight was low in all plots.

Some added fertilizer was lost to an early heavy weed population, but the expected cover crop fertilizer contribution has not been realized. The soil conditioner appears have an effect on soil microorganism populations which in turn may be responsible for the increased nitrate and total N concentrations and the yield responses reported. Production system effects on soilborne plant pathogens are reported elsewhere (see Matheron, et al) in this 1991 Vegetable Report.

There was very little pressure from leafminers or lepidoptera in any of the plots (data not shown) sampled frequently throughout the growing season; we attribute this to the relatively late planting date. Since there is ample evidence in the literature to support plant-insect interactions in response to plant nitrogen levels, we intend to plant in early September to test the production systems' response to insect pressure.

References

McGrady, J.M., M. Butler, M. Matheron, M. Rethwisch, J. Matejka and P. Tilt. 1990. Sustainable vegetable production with modified cultural management. In: 1990 Vegetable Report. Univ. AZ Col. Agric. Series P-82: 29-31.

Matheron, M., J.McGrady, M. Butler, M. Rethwisch, J. Matejka, and P. Tilt. 1991. Effect of Sustainable Versus Conventional Fertilization Practices on Populations of Pythium and Fusarium on Roots of Lettuce in 1990 Field Test. In: 1991 Vegetable Report. Univ. AZ Col. Agric.

Table 1.

Seasonal nutrient fluctuations in lettuce (Lactuca sativa L. cv "Merit") at thinning (Oct. 22), pre-heading (Nov. 9) and early harvest (Dec. 18). Planted September 24, 1990 at the Yuma Valley Agriculture Center.

	K	Mg	Ca	Fe	Mn	Cu	Zn
	---------- % ----------			---------- ppm ----------			
Oct. 22 (WS)*	16.4	1.2	5.4	255	66	22	62
Nov. 9 (WL)	13.4	1.0	4.6	109	52	20	60
Dec. 18 (WL)	10.1	0.5	1.5	99	34	18	61

* WS = whole seedlings; WL = wrapper leaf.

Table 2.

Soil microorganism population before (10/29) and after (11/26) sidedressing with AN20. Organic plots were not sidedressed.

Production System Fertilizer	Microorganism							
	Aerobic (CFU/g)*		Anaerobic (CFU/g)		Actinomycetes (CFU/g)		Mold (Spores)	
	10/29	11/26	10/29	11/26	10/29	11/26	10/29	11/26
(alone)	$3.5x10^7$	$6.3x10^6$	$5.4x10^6$	$5.3x10^6$	$5.4x10^6$	$5.3x10^6$	5,000	$1.1x10^4$
Conventional (plus s.c.)**	$3.7x10^6$	$1.2x10^7$	$3.3x10^6$	$6.8x10^6$	$3.3x10^6$	$6.8x10^6$	2,000	$1.0x10^4$
(alone)	$4.6x10^6$	$7.8x10^6$	$6.0x10^6$	$1.8x10^7$	$6.0x10^6$	$1.8x10^7$	7,000	$1.3x10^4$
Mixed organic/ Conventional (plus s.c.)	$3.3x10^6$	$6.2x10^6$	$4.3x10^6$	$8.2x10^6$	$4.3x10^6$	$8.2x10^6$	5,000	7,000
(alone)	$7.1x10^6$	$2.4x10^6$	$5.0x10^6$	$3.8x10^6$	$5.0x10^6$	$3.8x10^6$	6,000	6,000
Organic (plus s.c.)	$2.3x10^6$	$1.6x10^6$	$8.4x10^6$	$7.8x10^6$	$8.4x10^6$	$7.8x10^6$	$1.1x10^4$	4,000

* CFU/g = Colony Forming Unit per gram soil

** s.c. = Soil conditioner, (75 gallons/acre) liquid methane - digested chicken manure containing < 1% total N.

Table 3.

Iceberg lettuce (*Lactuca sativa* L. cv "Merit") tissue % No_3N and % total N as affected by three production system fertilizer regimes with or without added soil conditioner.

Production System Fertilizer	$N0_3$-N (%) 10/22	11/9	12/18	Total N (%) 10/22	11/9	12/18
(alone)	.39	.66	.97	4.6	4.5	3.2
Conventional (plus s.c.)*	.42	.73	1.05	4.8	4.7	3.4
(alone)	.17	.52	.92	3.7	4.3	3.3
Mixed organic/ Conventional (plus s.c.)	.22	.67	.87	4.3	4.6	3.2
(alone)	.17	.41	.31	3.7	4.0	2.5
Organic (plus s.c.)	.25	.38	.39	4.3	4.0	2.7

* s.c. = Soil conditioner, (75 gallons/acre) liquid methane - digested chicken manure containing < 1% total N.

Table 4.

The effects of three production system fertilizer regimes, alone or with added soil conditioner, on harvestable head production and weight of iceberg lettuce planted September 24, 1990.

Production System Fertilizer	Heads cut (%) first harvest 12/18	Heads cut (%) total 12/18-12/27	Head weight (lbs) sequential 12/18-12/27	Head weight (lbs) once-over 12/28
Conventional (alone)	56.0	77.1	.81	1.15
Conventional (plus s.c.)*	52.4	77.7	1.02	1.23
Mixed organic/ Conventional (alone)	15.0	38.0	.60	.98
Mixed organic/ Conventional (plus s.c.)	46.0	67.3	.73	1.05
Organic (alone)	19.1	40.3	.43	.73
Organic (plus s.c.)	36.3	65.0	.52	.78

* s.c. = Soil conditioner, (75 gallons/acre) liquid methane - digested chicken manure containing < 1% total N.