Irrigation of Garden Vegetables with Fertile Fish Pond Water

Introduction

The use of fish pond water to irrigate vegetable crops is fairly widespread, particularly in the Orient, but there has been no systematic investigation of its effect on plants. In certain cases, fish pond water is used primarily because of convenience, but some agriculturists have made a conscious effort to irrigate with this source of nutrients, as opposed to unenriched water. The only mention of the practice in the literature (Potter, 1902) deals with the well-known farmer McGregor, who used fish pond water on his garden. Data as to McGregor's yields are not available, nor were controlled experiments carried out, but it is generally acknowledged that McGregor enjoyed considerable success.

In 1971 we decided to investigate in a systematic way the effect on plant growth of water enriched by fish. Lettuce and parsley were grown in fertile soil in flower pots. Half the pots were watered with tap water that had been allowed to stand for twenty-four hours to remove chlorine and had been brought to room temperature. The other half were watered with water from an aquarium containing a heavy algae bloom and a dense population of brown bullheads (*Ictalurus nebulosus*). Figure 1 illustrates two pots from this experiment. While the data from this pilot study were insufficient to justify statistical analysis, it certainly appeared that the fish tank water promoted growth of lettuce and parsley.

There are two possible ways in which aquarium water could enhance the growth of plants: Fish metabolites (and algae) could act as a fertilizer or they could retard evaporation, so that a greater percentage of aquarium than tap water is made available to the plants. Retardation of evaporation by fish was demonstrated by placing an aquarium containing brown bullheads beside a similar tank containing no fish. The water level in the fish tank dropped much less rapidly, apparently due to inhibition of evaporation by lipids.

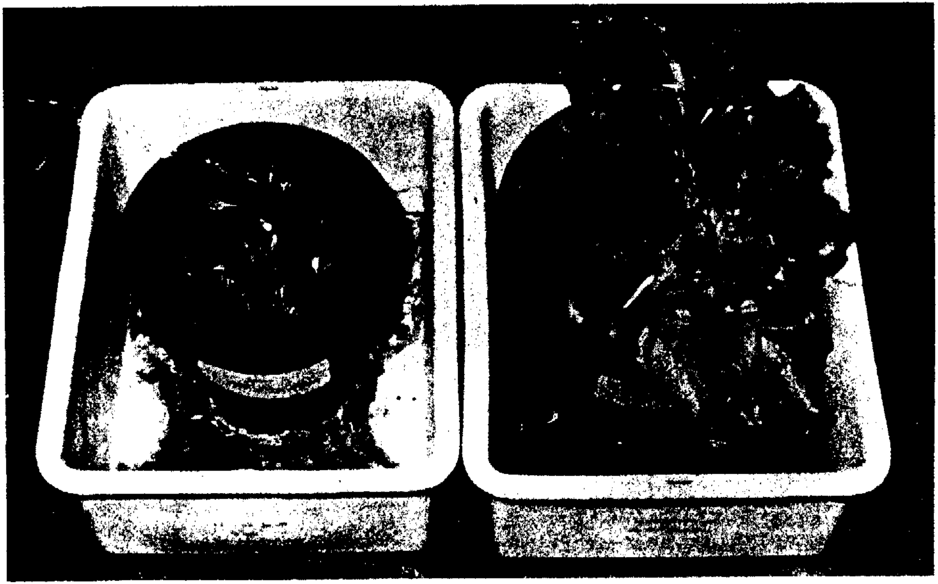

Fig. 1. The lettuce plants in the pot at the left were watered with tap water; the ones at the right, of the same age, were watered from a densely populated aquarium.

Methods

The informal pilot study just described was the inspiration for the controlled watering experiments carried out at New Alchemy's Cape Cod Farm in 1972 and 1973. The 1972 experiments in which zucchini and kale were used showed no significant differences in growth between plants watered with pond and tap water. However, the mean weight, minus roots and fruits, of both kale and zucchini was greater for plants watered with pond water. It was felt that the non-significance of the data was due to poor experimental design, and thus the experiment was rerun in 1973.

The 1973 study area was an oblong plot 102' x 16', on which were constructed three rows of twenty 3' x 3' raised hills. Half of the hills were watered with tap water and half with water from a highly fertile pond containing a dense population of fish (*Tilapia aurea, Tilapia zillii* and *Malacca hybrid tilapia*) and a heavy algae bloom. Three types of plant were selected for the experiment – a vine crop (Hybrid Zucchini, W. Atlee Burpee Co.), a root crop (Golden beets, Burpee) and a leaf crop (Bibb lettuce, Burpee). Location of each type of plant and the type of water applied to each hill were assigned on a random basis. The plot had been covered with a thin layer of compost the preceding fall and spring and was limed and rototilled before planting, but was otherwise untreated apart from the experimental watering.

Planting from seed was done on June 2. Prior to planting each hill was sprayed lightly with tap water to compact the soil slightly and promote the growth of natural microorganisms which might contribute to the stability of the hills. For the same reason, weeds, with the exception of tall, shading ones, were not removed from the sides of the hills, though the centers were kept weeded.

Lettuce seeds were scattered in the hills and the seedlings thinned to the four largest widely spaced plants on July 28. Beets were planted nine to a hill, evenly spaced, and thinned to the three largest plants on July 30. Zucchini were planted three to a hill and not thinned.

Watering was started on the day of planting and was carried out daily for the first week, after which it was cut back to twice a week. The amount of water applied was the same for all hills on any day, but the daily amount was determined empirically according to soil and weather conditions.

Results

Data were kept on rate of germination and the length of the longest leaf on each plant was measured periodically, but the only data which seem worthy of presentation are the harvest data. By far the most encouraging results were obtained with lettuce.

Harvesting of lettuce commenced when the first plant was seen to go to seed, on August 2. Subsequent harvests were made on August 5, 8 and 11. (Harvests were spaced to insure that the lettuce would be eaten, not wasted.) At each harvest the largest plant in each hill was selected unless there was serious crowding within the hill, in which case the plant which would best alleviate the crowding was removed. At each harvest the weight of edible material (total weight minus roots and dead leaves) was determined for each plant (Table 1 and Fig. 2). The mean edible weight of plants

MEAN EDIBLE WEIGHT OF BIBB LETTUCE WATERED WITH FISH POND WATER AND TAP WATER

Type of Water	Date	No. of plants	Mean Weight (g)
Pond	August 2	7	116.2
Tap	August 2	9	97.7
Pond	August 5	9	178.2
Tap	August 5	9	116.7
Pond	August 8	8	132.8
Tap	August 8	9	85.9
Pond	August 11	9	95.8
Tap	August 11	9	64.1
Pond	TOTAL	33	131.5
Tap	TOTAL	36	91.1

TABLE 1

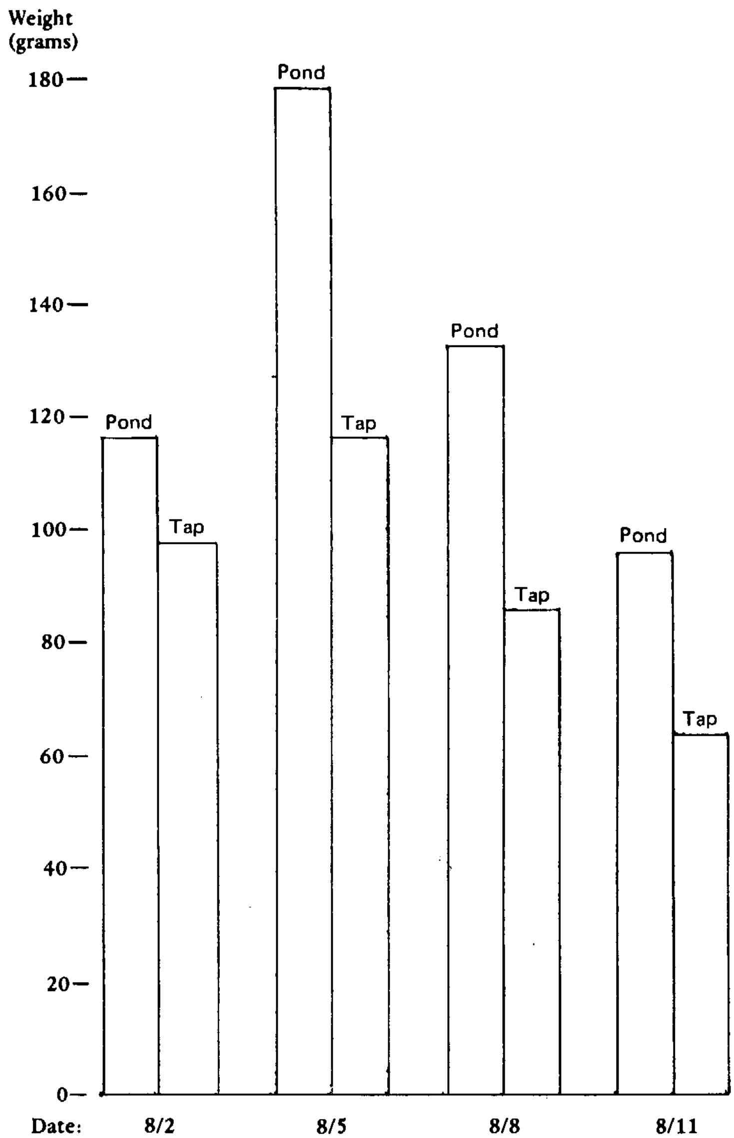

Fig. 2 – Mean edible weight of Bibb lettuce watered with fish pond water and tap water.

watered with pond water exceeded that of those watered with tap water by 44.3%. Due to the high variation in the weights of individual lettuce plants, an analysis of variance was not performed on the data. A non-parametric rank sum test (equivalent to the Mann-Whitney test) (Siegel, 1956) was carried out on the median weight of lettuce from each hill; the difference between the two treatments was significant at the 10% level and fell just short of significance at the 5% level.

The lettuce hills were replanted on August 10. For this late crop Grand Rapids (Greenhart Brand, Burpee) was the variety chosen. Planting and treatment were the same as before, except that the lettuce was thinned to five plants per hill, and on October 2 a temporary polyethylene greenhouse was constructed over the plot to protect against frost damage. On August 18 a second series of twenty hills (the hills originally planted to beets) were planted to lettuce. This was done to check the possibility that the lettuce hills randomly chosen to receive pond water were somehow more fertile, or otherwise more conducive to growth of lettuce, than those which received tap water. Harvest data for the Grand Rapids lettuce are given in Table 2 and Fig. 3. The greater weight of plants receiving pond water was more pronounced than in the Bibb lettuce. Mean edible weight of pond-watered plants exceeded that of tap-watered plants by 121.6% in the first planting and 67.9% in the second, or 90.9% overall. The data were analyzed

MEAN EDIBLE WEIGHT OF GRAND RAPIDS LETTUCE WATERED WITH FISH POND WATER AND TAP WATER

Type of water	Date	No. of plants	Mean weight (g)
Pond	October 29	9	21.0
Tap	October 29	10	14.1
Pond	October 31	10	23.3
Tap	October 31	10	16.1
Pond	November 2	10	27.0
Tap	November 2	10	9.6
Pond	November 4	10	26.4
Tap	November 4	10	6.4
Pond	November 6	10	15.4
Tap	November 6	9	4.1
Pond	TOTAL	49	22.6
Tap	TOTAL	49	10.2
Pond	November 8	10	26.2
Tap	November 8	10	20.7
Pond	November 9	10	27.8
Tap	November 9	10	16.9
Pond	November 10	9	27.8
Tap	November 10	10	14.1
Pond	November 11	9	21.6
Tap	November 11	9	10.2
Pond	November 12	8	12.2
Tap	November 12	8	6.4
Pond	TOTAL	46	23.5
Tap	TOTAL	47	14.0
Pond	GRAND TOTAL BOTH PLANTINGS	95	23.1
Tap	GRAND TOTAL BOTH PLANTINGS	96	12.1

TABLE 2

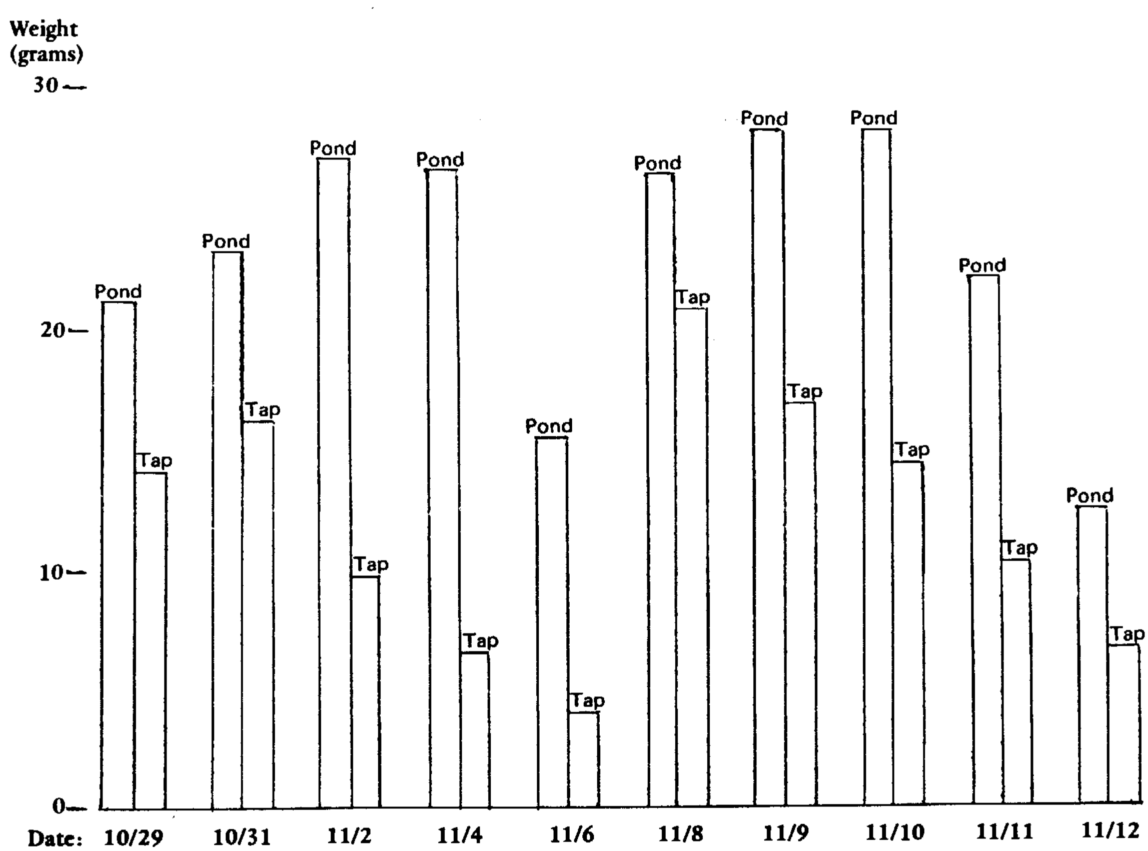

Fig. 3 — Mean edible weight of Grand Rapids lettuce watered with fish pond water and tap water.

WEIGHTS OF GOLDEN BEETS WATERED WITH FISH POND WATER AND TAP WATER

Type of Water	No. plants	Mean Weight (g) of tops	Mean Weight (g) of roots	Mean Weight (g) total	Ratio of Root:top
Pond	22	28.5	41.7	70.2	1.47:1
Tap	26	51.4	50.3	101.7	0.98:1

TABLE 3

as described for the Bibb lettuce. The difference in weight between treatments was significant at the 2.5% level for the first series. In the second series the results were similar to those for the Bibb lettuce. The difference was significant at the 10% level and barely missed being significant at the 5% level. When the data for the two series of Grand Rapids lettuce are combined, the results are significant at the 5% level.

The results achieved with the beets and zucchini do not parallel the lettuce data. Beets were harvested on August 15 and weight of roots and tops recorded (Table 3).

One might have expected the beets watered with pond water to have larger or proportionately larger tops; from Table 3 the opposite appears to be true. However, the differences shown were not statistically significant. To test the slight possibility that the non-significant differences observed in the beets were the result of some undetected difference between the beet hills randomly selected to receive tap water and those receiving pond water, the beet hills were used in the second planting of Grand Rapids lettuce (Table 2 and Fig. 3). The results of this planting favored pond water.

Zucchini fruits were checked daily and harvested as soon as they reach 180 mm. Due to the dense foliage a considerable number of zucchini fruits were overlooked for days at a time and harvested at a considerably larger size. On September 29 all the remaining zucchini plants were removed and total weight determined. Table 4 summarizes the zucchini data.

The apparent greater number of fruits and greater weight of vegetation in zucchinis watered with tap water is not significant and may be explained by the fact that, at the conclusion of the experiment, twenty-three of the original thirty tap water zucchini plants remained, but only eighteen of thirty which had received pond water. One of the chief causes of mortality in zucchini plants on Cape Cod is wind damage, which chiefly affects the larger plants. It may be that, had the zucchini plants been sheltered to protect against this selective destruction of large individuals, the pond water plants would have in fact exceeded the tap water plants in weight and fruit production.

FRUIT PRODUCTION AND WEIGHTS OF ZUCCHINIS WATERED WITH FISH POND WATER AND TAP WATER

Type of water	No. fruits (180 mm or more) harvested	Total weight (kg) (all fruits)	Mean weight (kg) (fruits between 180 and 250 mm only)	No. Plants at end of experiment (Sept. 29)	Mean weight (g) of whole plants
Pond	123	84.9	0.40	18	977.7
Tap	166	95.0	0.39	23	1103.2

TABLE 4

To provide another, and perhaps more meaningful, measure of production, the average weight of fruits was determined. Large fruits which had escaped detection for several days after reaching the minimum harvest size were not considered. The average weight of eighty-four fruits from plants which received pond water and one hundred and thirty-four fruits from tap water plants was virtually identical – 0.40 kg and 0.39 kg respectively.

Conclusions

Our results could perhaps be improved by repeating the experiment using paired hills rather than a randomized planting pattern. It would also be advisable to repeat our experiment with other leaf crops and to perform similar experiments with lettuce and other crops in a dry climate where watering is a more critical part of agricultural practice.

Acknowledging the need for more research should not impede the practical application of what has been learned. We have shown that the practice of watering with enriched fish pond water is not universally effective in increasing growth and production of garden vegetables, but we have also shown that it is effective with two varieties of lettuce. We tentatively conclude that it would be beneficial to most shallow-rooted, leaf crop vegetables, particularly those which, like lettuce, favor abundant moisture and high levels of nitrogen. It would certainly be worthwhile to further explore the technique described and other possible linkages of agriculture and aquaculture with the goal of developing new, highly productive, and ecologically-sound food-raising systems.

Acknowledgments

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– William O. McLarney

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