Shrimp Biosolids from Aquaculture Are a Valuable Fertilizer Amendment for Bell Pepper Production

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Summary: Shrimp biosolids (SB) has potential for use in production of bell peppers in a field situation. Bell peppers are moderately sensitive to salt and even though SB contains high levels of salt, no expression of salt damage occurred. In this area of the Southeast, we experience about 52 inches of rainfall a year which is spread out over all months. SB cannot be used alone as a complete fertilizer, but it must be used in conjunction with commercial fertilizer. Since SB has a very high organic matter content, it is expected that minerals soils with low organic matter may contain residual fertility that may contribute to successive crops planted in the same location.

Introduction: Co mmercial shrimp lagoons are used to cultivate shrimp rather than fishing for wild shrimp in saltwater estuaries and waterways. Normally, the lagoons are drained into holding lagoons after the crop is harvested and a rich sediment of shrimp fecal matter and composed shrimp feed remain on the bottom of lagoons. Normally the SB are bulldozed out of the ponds and sent to landfills. SB soil tests indicate that the material is nutrient-rich and it has been hypothesized that this “compost” may be useful in vegetable production. In preliminary greenhouse experiments presented at the past National Pepper Symposium, it was reported that the extremely high sodium levels in SB caused considerable pod damage and it was questionable whether it should be used in field pepper production (Dufault, Hopkins and Sandifer, 1996). The goal of this work was to discover the practical value of SB as a fertilizer for bell peppers in a field setting. The objective of this experiment was to screen a range of SB rates used with or without a commercial nutrient source to determine yield and quality and to determine practical merit of SB in commercial pepper production.

Methods: ‘Camelot’ bell peppers were seeded Mar. 10, 1997 in Speedling (1" x 1") trays and grown in the greenhouse until field planting on Apr. 21, 1997. Field plots were prepared on a sandy loam soil with the following nutrient status: 7.1 pH, and (in pounds per acre) , P - 330, K - 151, Ca - 1046, Mg - 163, Zn - 7.7, Mn - 19, Cu - 4.6, B - 0.3, and S - 8. This soil had a CEC of 4.9 meq/100g, 0.5% organic matter, and nitrate nitrogen of 10 ppm. Each experimental plot was 10 feet long with rows 6 feet apart. Each plot contained 10 plants spaced one foot apart within the rows at 14,520 plants per acre. There were two experimental factors: SB and Osmocote as the commercial fertilizer source. We chose Osmocote (14-14-14) for field production because it is slow release and one application was expected to last the growing season to avoid split applications. There were four rates of SB and four rates of Osmocote. An animal waste analysis of SB indicated the following (in pounds per ton): ammonium N - 0.0, organic N – 13.52, available N - 8.11, P2O5 - 21.37, K2O - 5.23, Ca - 22.2, Mg - 10.78, S -10.14, Zn - 0.36, Cu - 0.04 , Mn - 0.23, Na - 11.23. A mineral soil analysis test on SB indicated a EC of 2.1 mmhos/cm which is an extreme salt hazard with undiluted SB. SB and Osmocote were applied in the in the field by depositing the experimental rates to individual planting holes and then rotovated and mixed into the soil to a six-inch depth. The SB treatment rates were 0, 0.55, 1.1, and 1.7 lbs. per plant which is equivalent to 0, 4, 8, and 12 tons SB per acre. Osmocote rates were 0, 0.53, 1.06 and 2.12 ounces per plant or 0, 67, 134 and 269 lbs. N per acre, respectively. These four rates of SB and Osmocote were factorially combined to produce 16 unique N-P-K fertility treatments (Table 1). Bell peppers were harvested on June 23 (only thick-walled, fancy grade pods) and then July 10 when all pods were harvested from the plants. The pods were graded according to USDA standards as US Fancy, Number 1, Number 2 and cull. Marketable fruit in this study were defined as the total of US Fancy, Number 1 and 2 pods.

Results: In previously reported greenhouse work (Dufault, Hopkins and Sandifer, 1996), SB was found to cause considerable pod injury and quality defects. The field work reported in the present study showed no quality defects due to SB, not even at the highest rate of 12 tons per acre. The data was analyzed considering each of the sixteen fertility treatments as a unique fertility system. Marketable yield (pod weight and number per acre) increased with increasing SB rate used with increasing Osmocote (Table 2). Increasing Osmocote rate without the addition of SB was limited in its ability to increase yield, but with the addition of low SB (4 tons/acre), pod yield increased by over 3500 pounds per acre and 10,000 more pods per acre. Increasing SB rate to 8 to 12 tons/acre did not significantly increase pod number or weight more than the lowest SB rate. Increasing either the SB rate or Osmocote rate increased the production of the largest Fancy quality pods, but this effect appeared to be greater with increasing Osmocote than with SB.

SB cannot be used alone as a complete fertilizer, but it must be used in conjunction with commercial fertilizer. Used without any Osmocote, the yield (pods/acre) at high SB were over 40% less than using high SB with the medium Osmocote rate (134N-58P-112K lbs/acre) (Table 2). Likewise, the pods/acre with the highest rate of Osmocote alone were over 25% less than when high Osmocote was combined with 4 tons SB/acre.

In conclusion, the cultural system that enhanced yield without excessive fertilizer or SB use delivered a total of 371N-122P-185K per acre from both sources. This fertility system was composed of 4 tons SB/acre with Osmocote at 269N-87P-168K lbs/acre.

Table 1. N-P-K in pounds per acre for 16 fertility treatments derived from Osmocote (14-14-14) and shrimp biosolids (SB).

	Osmocote (N-P-K lbs / acre)			
SB (Tons/acre)	0	67-29-56	134-58-112	269-87-168
	N-P-K lbs / acre			
0	0-0-0	67-29-56	134-58-112	269-87-168
4	102-35-17	169-64-73	236-93-129	371-122-185
8	204-70-34	271-99-90	338-128-146	473-157-202
12	306-105-51	373-134-107	440-163-163	575-192-219

Table 2. Marketable number of pods and pounds per acre for 16 fertility treatments derived from Osmocote (14-14-14) and shrimp biosolids (SB).

	Osmocote (N-P-K lbs / acre)			
SB (Tons/acre)	0	67-29-56	134-58-112	269-87-168
	Lbs/acre			
0	264 h[z]	5159 e-g	6684 d-f	9217 c
4	3176 g	6740 d-f	9063 c	12907 ab
8	3716 g	7163 c-e	7590 cd	13924 a
12	4776 fg	7374 cd	11757 b	13887 ab
	Pods/acre			
0	1274 h	22022 e-g	23842 d-f	28028 de
4	15106 g	24752 d-f	31486 b-d	38038 ab
8	16562 fg	28210 c-e	26936 de	38766 ab
12	21476 e-g	26390 de	36400 a-c	41496 a

[z] Mean separation by LSD at $P = 0.05$.

Literature Cited

Dufault, R. J., S. Hopkins and P. Sandifer. 1996. Potential of shrimp biosolids from aquaculture lagoons as a soil amendment for bell pepper production. Proc. Nat. Pepper Conf. 96-97.