THE USE OF ANAEROBICALLY DIGESTED CATTLE SLURRY AS A FERTILIZER FOR VEGETABLES[1]

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The anaerobic fermentation of animal waste has as end-products biogas (60% methane) and slurry, which may be used as fertilizer. The value of slurry as fertilizer for growing lettuce was compared with commercial urea fertilizer, fresh animal waste and a mixture of the partially digested slurry with urea added. Each form of fertilizer we' applied to provide the equivalent of 80, 120 or 200 kg N/ha. The experimental plots were 15 m^2, each with 80 lettuce plants which were harvested 70 d after sowing, counted and weighed. The mean yield of lettuce over all treatments was equivalent to 13.8 t/ha (fresh basis). There appeared to be a linear increase in lettuce production as application of N was increased, and there were no significant differences in the response to the different types of fertiliser. It was concluded that since there was no detrimental effect on the fertilizer value of the slurry due to its partial digestion, and as methane was also produced and parasite eggs destroyed during this process, the technology could be recommended for small scale cattle farms, where intensive vegetable production could increase family income.

Key Words: Cattle slurry, anaerobic digestion, fertilizer value

In intensive cattle production systems, there is considerable generation of excrete in the form of urine and faeces with an overall solids content usually between 10 and 12%. This "slurry" has to be disposed of, preferably in some economic and hygienic manner. The anaerobic digestion of this slurry is an attractive possibility, particularly as among the byproducts are biogas (60% methane and 40% carbon dioxide) and partially digested slurry, which contains 5-10% solids, usually with about 2% nitrogen in the dry matter (DM).

The application of this slurry as a fertilizer for vegetable crops, such as lettuce, is an attractive proposition, as it would be in agreement with the traditional system in Mexico of fertilizing these crops with sewage slurry. According to the experience in the Mienchu district of Szenchuan province in China (see Table 1), and from the data

Table 1:
Destruction of parasite egg in mesophylic anaerobic digestion (from McGarry and Stainforth 1978)

Source of sample	Eggs/100 ml	Viability (%)
Entrance	23,853	100
Exit	1,505	6.3

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published by McGarry and Stainforth (1978), it appears that an advantage of anaerobic digestion (prior to application) is to greatly reduce the disease risk of recycling human and animal wastes. It is possible to destroy up to 95% of parasite eggs and almost all dysinteric bacteria in digestors operating at a temperature between 30 and 35°C. North American experience with intensive fertilization of pastures with digested cattle slurries (Boran and Smith 1974 personal communication) shows that fertilization is advantageous provided the annual application of nitrogen is below 280 kg N/ha. For this reason, it is interesting to compare the yields of a vegetable crop capable of assimilating large quantities of N in the course of 4 or 5 crops annually. A further possible advantage of organic fertilizer may be the improvement of both clay and sandy soils which are low in humus.

For this experiment, urea and fresh cattle slurry were taken as controls, and the digested slurry as the experimental treatment. The trial, carried out in the state of Morelos, was set up as a demonstration of new technology for the intensive management of dairy cattle in areas where a high production of tropical forage such as sugar cane is possible, and where cattle production may be integrated with intensive agricultural cropping through the utilization of the animal waste.

Materials and Methods

Fertilizers: Three fertilizers were used: (A) fresh slurry from the experimental dairy ITA No 9 of Xoxocotla, Morelos, in which there were 30 cows fed with different forages including ensiled sugar cane; (B) partially digested slurry which was produced from an anaerobic digestor of 10 m capacity installed in the IIE at Palmira, Morelos, and transported in oil drums to Xoxocotla; and © commercial urea fertilizer (45%N). The organic fertilizers were analysed by Kjehdahl method in the diagnostic laboratory of Animal Pathology (SARH) in Yautepec, Morelos.

Seeds: The lettuce seeds were a local variety (Criolla) which is used traditionally in the region. The area cultivated was 800 m with a slope of approximately 7°. It was ploughed and harrowed twice and drawn into furrows with 65 cm spacing. These areas were further subdivided into blocks of 5 m long and 3 m wide, and the treatments were applied to these at random. The different fertilizers were applied 15 d before sowing and then covered manually with a fine layer of soil (5 cm). Planting was on 20 February 1978, the seeds being set at 25 cm intervals at 2-3 cm depth in the upper area of the furrow. Irrigation by hose was carried out at 3 d intervals.

The plants were sprayed at 8 d intervals with a mixture of Folidol M-50 and Dipterex. After 15 d, a marked irregularity in the development of the plants was observed, and as a consequence a redistribution of plants was carried out to fix the same population in each of the treatment blocks. The final population was 80 plants per 15 m (53,333 plants/ha Lettuce production was estimated at the end of the experiment on the basis of this plant density and the average fresh weight of the lettuces in each row was calculated.

Measurements: The plants were harvested from each plot 70 d after sowing, and were counted and weighed.

Results

The composition of fresh and digested slurry is given in Table 2. In Table 3 the estimated yields of lettuce (x ± SEx) for each treatment are shown. It can be seen that there was little difference in lettuce production between treatments and that the differences were not significant.

Table 2:
Nitrogen and phosphorus in fresh and digested cattle slurry (X ± SEx)

Sample (no)	Total solids (%)	Nitrogen (% in DM)	Phosphorus (% in DM)
Fresh slurry [1] (2)	6.99±1.3	1.99±.075	0.62±.18
Digested slurry (8)	4.56±1.1	2.59±0.10	1.44±.22

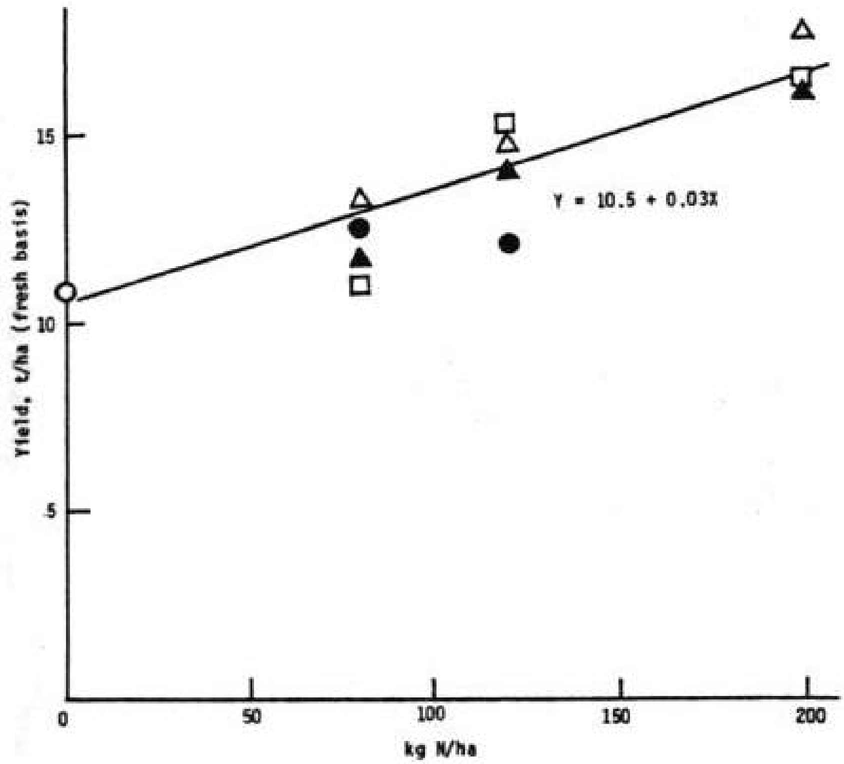
[1] Water was added to the original cattle slurry to give a similar consistency to that in the digested slurry

Table 3:
Effect of fertilization with urea, digested slurry, fresh cattle slurry or a 50:50 (N basis) mixture of the first two on the yield of lettuce

Treatment	Plants/15 m^2	Fresh lettuce (t/ha)
Control	75±8	10.9±1.5
Fresh slurry		
80 kg N/ha	76±12	11.1±.54
120	75±16	15.0±1.4
200	76±6	16.2±1.3
Digested slurry		
80	82±2	13±1.7
120	83±9	14.6±1.5
200	83±2	17.5±.61
Urea		
80	84±11	11.7±3.8
120	84±8	14.2±4.2
200	77±14	16.4±1.2
Mixture (1) and (2)		
80	81±13	12.5±.09
120	87±3	12.0±.45

The yield of lettuce when the mixture of digested slurry and 50% urea nitrogen was used was similar to the overall average when the N level was 80 kg N/ha; however, when this mixture supplied 120 kg N/ha, yield was reduced by 18% with respect to the overall mean (P<.001).

Figure 1:
Fresh lettuce yield according to fertilization with urea (△), fresh slurry (□), digested slurry (▴), a mixture of urea and digested slurry (•) or unfertilized control (◦)



The average yield (t lettuce/ha) in response to the level of N fertilization is shown in Figure 1, In general, there was a tendency towards a linear increase in lettuce production as application of N increased. However, there were no significant differences between treatments. The only exception was the combination of 50% urea and 50% N from partially digested slurry at the level of 120 kg/ha.

Discussion and Conclusion

The results show that there was no appreciable difference between urea, fresh slurry and partially digested slurry as N fertilizers for the intensive production of lettuce. Preliminary results from other experiments with other vegetable crops indicate similar results to those obtained here with lettuce. However, when fresh slurry was used in the production of maize, yields were low in comparison to those obtained with urea as a N source (Roberto Nunez, Colegio de Posgraduados de Chapingo, personal communication). This may be explained by the carbon nitrogen ratio, since the presence of high levels of carbon facilitates the assimilation of soluble N by the soil microflora and therefore reduces its availability to the plant.

In the case of vegetables with a short growing cycle (2-3 months), it may be that the rate of N absorption is sufficient to compete effectively with that of soil micro-organisms. In any event, this result permits the recommendation of the use of digested slurry for the growing of vegetable crops .

Taking as a basic assumption the production of 4 crops annually of vegetables with a total application of 200 kg N/ha, this would be equivalent to an annual usage of 678 m of digested slurry/ha which represents a daily usage of 1.86 m . In other words, a family size digestor of 10 m with a mean residence time of 30 d would be capable of fertilizing approximately 0.18 ha of vegetable crops under intensive cultivation. The important practical implication of this technology is that it may provide a means of utilizing digested slurry in small areas close to digestors.

In fact, since the cash flow in growing vegetables is generally high, it should be useful to add this production component to family farms with small cattle units of some 10 animals giving a daily production of about 150-200 kg/d of slurry. Diluted with water and partially digested, this quantity of slurry could maintain a high production of vegetables for the family.

References

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