International Journal of Sciences

Research Article Volume 6 – January 2017 (01)

Long Term of Cattle Manure Amendments and its Impact on Triticale (X. *Triticosecale Wittmack*) Production and Soil Quality

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ABSTRACT: Organic amendment is a good alternative to improve soil fertility to maintain or increase crop forage and grain production. After several times of organics application (crop cycles) is important to follow soil physical and chemical parameters to avoid soil pollution such as salinity and nitrate. The main objective of this study was to maintain good triticale forage production and soil quality after seven years in plots where two factor were studied:caw manure amendments; 0, 40, 80, 120 and 160 t ha $^{-1}$ and one chemical level with 150-100-00 kg ha^{-1} of Nitrogen, Phosphorus and potassium, respectively just to compare manure amendments. After This time to decrease soil salinity and high levels of nitrate triticaleforage was planted in the same plots using two varieties without manure and chemical fertilizer application. Triticale variables measured were green forage and soil parameters such as; Electrical Conductivity (EC), Organic Matter (OM), Hydrogenpotential (Ph) and Nitrates (NO^{-3}). Results indicated that triticale forage production was high in all plots were caw manure was applied after three years than the control and chemical fertilizer level, Also, the chemical soil parameters such as salinity, and nitrate decrease to adequate levels of 4 mmhos cm $^{-1}$ in salinity and less than 20 ppm of nitrates. Triticale forage production was better in all plots with caw manure application with more than 25 Mg ha^{-1} that's is the triticale average production in this region and more of 100 % than the control and chemical fertilizer plots. According to these resultscaw manure amendments is a good alternative to get high triticale forage production and maintain a good soil quality.

Keywords: Manure, Pollution, Nitrate and Salinity

INTRODUCTION

In Mexico, a production of 61 million tons of manure (INEGI, 1997) considering only the feedlot cattle and partial barn, where the main basins of this important residue are the Laguna Region, the Juarez Valley and other areas of the estimated northern and northeastern Chihuahua.(Cortez, 2007).

Dairy cattle manure and other organic fertilizers used in agriculture has the potential to be a cost-effective source of nutrients for crops. Land application determines an increase in fertility as well as improved physical properties. (Alexander, 1980).

This organic waste is accumulated in the places where these are generated or applied commonly to score some agricultural land, which can cause degradation of the quality of soil and groundwater. (Allison, 1995). The amount of manure nutrients available in the soil for plants, is perhaps one of the most common questions without exact answer because of the many physical, chemical and biological factors involved in the process of decomposition of organic materials.(Lozano,2002). One of the most precise ways is by evaluating the decomposition of manure in the field directly (Flores et al., 2003).

Published at: http://www.ijsciences.com/pub/issue/2017-01/
DOI: 10.18483/ijSci.937; Online ISSN: 2305-3925; Print ISSN: 2410-4477

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Use of this fertilizer is unquestionably beneficial, but there are difficulties to predict its effect in every situation due to the great variability of the material covered and the differences created by the previous management (Jimenez et al., 2004). In this sense a characterization of these materials is necessary to predict their nutrient to crops (Cadahia Sims., 1998; Griffin et al,) this prediction is important because it may cause environmental pollution when applying excessive doses, either excessive loss from gas losses N (denitrification processes and ammonia volatilization loss as NO3- leaching (Aguirre, 1987;. Infagro et al, 2002).

Producers who have this fertilizer use indiscriminately applying a high dose of 200-250 tons per hectare per year, making it necessary to carry out analysis of the salt balance and soil quality without forgetting that the key is to avoid inappropriate use of a resource to protect the quality of soil and water. (Flores, 2001; payne, 1973).

The fodder produced in the spring-summer cycle, are not enough to feed livestock during the winter season, it bordered to the producers to look for alternatives to help them supplement the food supply, both in quantity and quality this season.(Rowell,2001).

The ComarcaLagunais the most important dairy region of Mexico and Latin America good alternative that has been used to replace alfalfa as a protein source, high yields and less water consumption is growing forage triticale. (Vazquez, 2007). This is a winter crop, which has included in the diets of dairy cattle because this crop brings a high potential for biomass production (10.59 Mg ha-1 of dry matter), with adequate nutritional value (16.76 % PC), very tolerant to adverse environmental factors such as low temperatures, which can yield plenty of fodder for months with low temperatures (December, January and February), also has more tolerance that all traditional cultures to deficiencies of water, nutrients and adequate resistance to pests and diseases (Bejar and Ammar, 2002). Based on the above context the objective of this study was to determine the optimal amount of manure that the soil is able to biodegrade in a year of application. (Leblanc, 2007).

MATERIALS AND METHODS

Geographic location

The Laguna Region is located in the north-central part of the Mexican Republic. (Schnitzer,1990).This is between the meridians 102 ° and 104 ° 47' 22' west longitude and 24 ° 22' and parallel 26 ° 23' North latitude. The average height above sea level is 1,139 m. It consists of a hilly expanse and other flat where agricultural and urban areas, comprising an area of 4, 788, 750've-1 are located. (Márgez, 2003).According to Koeppen classification modified by Cervantes (1981): The climate is dry desert or warm steppe with summer rains and cool winters. The average annual temperature is 21 ° C, with an average annual evaporation of about 2,396 mm (Weiner. 2002). The rainfall is 258 mm (Weiner. 2002). In the region the predominant clay soils are heavy duty, medium sandy loam (Weiner. 2002). Soil type I was used is clay type, which interferes with ground mineralization as reported by some researchers (Vazquez and Valenzuela (2001). This research was conducted in the experimental agricultural field of the Faculty of Agriculture and Animal Husbandry-UJED, which is located at km 28 of the Gomez Palacio-Tlahualilo, Durango road., to nearby Venice ejido, municipality of Gomez Palacio, Durango. (NWC, 1999).

Soil characteristics and manure

Three random samples of soil and manure were collected to determine the conditions in which the soil and manure was before the establishment of the experiment, analyzes were performed in the laboratory of FAZ-UJED. (SAGARPA, 2002).

Establishment of Experiment

The experiment was conducted in the fall-winter cycle of the years 2008, 2009 and 2010after planting corn every year since 1978. Initially, since 1078 the experiment was established with doses of bovine manure of 0, 40, 80, 120 and 160 Mg ha^{-1} with characteristics shown in Table 2 and further treatment with chemical fertilizer 150-150-0 kg ha^{-1} of nitrogen, phosphorus and potassium, respectively. These treatments were distributed in field under a randomized block design arrangement in strips with each group contained three replicates and experimental unit of eight meters wide by eight meters long with. Statistical analysis was performed with the Statistical Analysis System software package Ver. 9.

After 2004 manure doses were reduced by 50% because it was detected in corn through the soil analysis increased salinity levels higher than 4 cm mmhos cm^{-1} (Table 3). This action was not enough to down steadily salinity to permissible values that is lower than the 4 mmhos cm^{-1} so it was decided to plant a crop with total coverage of soil surface and to consume the maximum amount of salts with good yields and high quality of forage mainly with protein content similar to alfalfa but, with less water to make it attractive for dairy protein producer in the region. This was the triticale forage crop which is excellent fodder for milk production in the region where they

have more than 500, 000 head of cattle for this purpose making it the most important dairy region of Latin America. Triticale sowing was carried out since 2008 after planting corn in summer but with absolutely no manure applied in each plotwhere the organic fertilizer was applied since 1978 . Thus the way not only to had a high protein forage and performance but a forage crop that absorb as much salts and improve soil quality and simultaneously take advantage of all the residual nitrogen accumulated in it was sought.

Harvest

Harvesting took place at 110 days after planting date when the crop was in boot stage and about 10% flowering, harvesting 1 m^2 per experimental unit to determine its performance. The variables were evaluated in soil: organic matter (OM) with Walkley and Black method (Page et al, 1982), Electrical Conductivity extract with resistivity, pH with pH meter extract, and nitrates (NO^{-3}) with colorimetric(Page et al, 1982). The variables evaluated on the ground allow us to determine what the best treatments were. Forage yield and plant height also were measured to evaluate treatments of manure applied.

RESULTS AND DISCUSSION

Production of green forage

The production of green foragewas statistical different for treatments of manure in the three years of evaluation (Table 1 and Figure 1), with higher production in the treatment of 40 Mg ha^{-1} with 55.2% more than in the control for the year 2008. This results being statistically equal treatment to other except the control who obtained lower production. In 2009 29.7% more forage yields was obtained in the treatment of 20 Mg ha-1 of bovine manure applied and resulting statistically equal to 40, 80 Mg ha^{-1} and the chemical fertilizer treatment.. In 2010 output was 74.3% more in the treatment of 60 Mg ha^{-1} of bovine manure which showed statistically equal to treatment of 20 Mg ha^{-1} of bovine manure. Also, the treatments of 40 and 80 Mg $ha^{-1}$of manure applied were statistically equal with 57.86% from thecontrol who showed a lower yield, chemical fertilizer was higher than the control but less than all cattle manure treatments reaching 36.8% more yield forage compared with the control. These results clearly indicated that the manure increase forage yields after several times that was applied in soil so it is good alternative to farmers to save money in chemical fertilizer and to get good yields in this region, similar results was found by Salazar et. al. 2003; 2002.

Table. 1 Means for corn yield per year of study.

Contents	FD	YearsPv> F		
		2008	20092010	
R (Replications)	2	0.0076	0.1415	0.5951
FA (TriticaleVarieties)	1	0.0698	0.0864	0.1100
FB (Manure Levels)	5	0.0480**	0.0512*	0.0007**
DMS (Triticale Varieties)		10.23	4.95	15.45
DMS(ManureLevels)		9.65	8.15	6.79

** Statistically significant at the 5 % and * Statistically highly significant at 1%

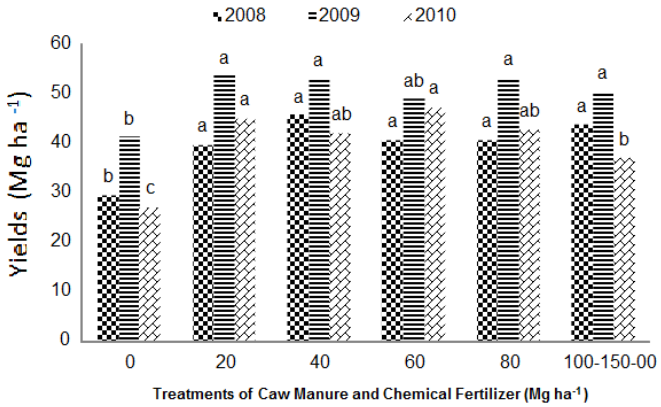

Figure 1. Yield of maize forage per year and manure treatment.

Soil and Manure Characteristics

Table one shows the soil test before starting the original experiment in 1998. It shows that the ground has normal characteristics of the soils in the region with a low content of organic matter (OM), alkaline pH and low salt Electric Conductivity (EC) less than 4 mmhos cm^{-1} and very low levels of nitrate (NO_3), ammonium (NH_4), phosphorus (P_2O_5), potassium (K^+), that had very low fertility to 120 cm depth. Regarding the manure (Table 2) and after analyzing its features in a pile of accumulation at different depths up to 50 cm, a total range of nitrogen was found from 1.27 to 1.51 with wide variations in other nutrients as P_2O_5, K^+, $Ca2^+$, Mg^{2+}, Na^+, Mn^{2+}, Fe^{2+}, Zn^{2+}, $Cu^+$and Bo; which allows for a quantitative support to calculate the quantity of nutriment applied when different amounts are added to the soil. This does not mean that these values when multiplied by the dry residue of the plant gives the amount of nutrient available to it, that for this to happen you must go through a process of mineralized and part of what is available after this process It is immobilized, or volatilized leaching so extensive care should be taken to determine the amount of nutrient available for biodegradation of manure after application in soil.

Table 3 shows the chemical characteristics of the soil after application of manure for 9 years in the different treatments of manure at two depths: 0-15 and 15-30 cm, where increased EC, MO, NO^{-3}, K^+, Ca^{2+} and Na were observed mainly in treatments from 40 to 160 t ha^{-1} of manure applied. The average EC levels were higher than four mmhos cm^{-1} permissible in a farm field and the contents of MO with more than 5% macronutrient levels over 150 PPM and so with other micronutrients prompting that doses to decline in the following years to 50%. Not finding an acceptable decrease in the concentration of these parameters on the floor it was decided to plant in winter triticale with complete, high soil extraction but without applying manure for three years after planting corn in summer.

Table 2.- Soil Chemical Characteristics Before the caw manure Application. C.A.E.-FAZ-UJED 1998.

Soil Depth cm	PH	C.E. dS m^{-1}	M.O. %	NO_3 mg kg^{-1}	P mg kg^{-1}	K mg kg^{-1}	N-NH_4
0-15	8.41	1.36	1.93	14	7.5	1360.0	9.8
15-30	8.25	1.33	1.58	7	6.5	892.5	12.95
30-60	8.20	1.20	1.24	3	11.0	572.5	13.65
60-90	8.24	3.16	0.89	4	3.5	410.0	14.35
90-120	8.14	3.93	0.27	2	3.5	202.5	12.95

Table 2.-Manure Chemical Characteristics C.A.E.-FAZ-UJED 1998.

Sample NUmber	Prof. Cm	%N total	P X	K %	Ca %	Mg %	Na %	Mn Ppm	Fe Ppm	Zn Ppm	Cu Ppm	Bo Ppm
1	0-15	1.51	0.356	3.27	3.38	0.71	0.97	560	10960	200	49	390
2	15-30	1.39	0.388	3.32	3.47	0.76	1.02	620	12300	198	45	450
3	30-45	1.3	0.344	3.4	3.41	0.72	1.07	600	11250	206	53	410
4	45-60	1.27	0.358	3.3	3.31	0.71	0.98	590	11200	198	47	400

Table 2.- Soil Chemical Characteristics After the caw manure Application. C.A.E.-FAZ-UJED 2007.

Manure Treatments	pH		CE MMHOS cm-1		MO %		NO Mg L-1		K Mg L-1		Ca Mg L-1		Na Mg L-1	
	*	**	*	**	*	**	*	**	*	**	*	**	*	**
0 t ha $^{-1}$	7.32	7.48	1.91	1.47	1.35	1.21	18	17	14	115	9.2	8.0	13.2	6.5
40 t ha $^{-1}$	7.11	7.23	3.77	3.08	1.44	1.72	83	76	14.7	3.3	23.2	16.2	17.2	14.4
80 t ha $^{-1}$	4.93	7.14	6.20	3.26	5.52	2.07	136	87	15.4	11.3	31.2	14.5	35.4	15.5
120 t ha $^{-1}$	4.92	6.99	6.22	6.42	5.52	5.92	70	83	97	15.4	30.4	27.6	33.4	35.9
160 t ha $^{-1}$	6.8	6.92	6.28	5.2	6.62	2.42	158	102	17.8	20.3	22.4	13.6	32.5	22.9
150-100.0	6.24	6.42	1.74	1.62	1.93	1.51	3	21	15	1.5	11.6	10.4	17.2	8.6

*Soil depth 0-15 cm **Soil depth 15-30 cm

Figures 2, 3, 4 and 5 show the average concentration of Ph, MO,$NO^{-3}$and CE for the treatment of manure after planting triticale because with these parameters where found high and very variable concentrations in years prior to 2010. They can be seen as the MO, CE and NNO^{-3} decreased to acceptable levels considerably lower than the 4 mmhos cm^{-1} in EC demonstrating that culturing with full coverage and decreased the dose applied to the soil manure allowed preserve the quality of soil and maintain acceptable fertility to plant any crop.

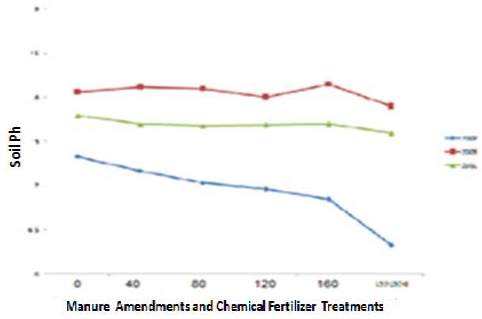

Figure 2. Average distribution of Ph in Soil per Treatment of CawManure and Chemical Fertilizer amendments on Triticale from 2010to 2012. FAZ-UJED.

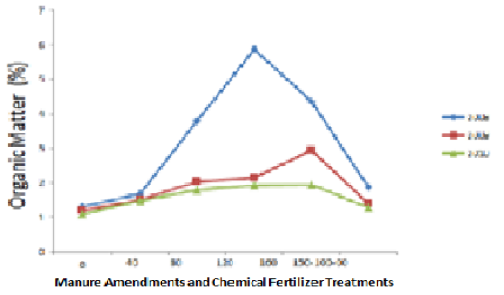

Figure3. . Average distribution of Organic Matter in Soil per Treatment of Caw Manure and Chemical Fertilizer Amendments on Triticale from 2010 to 2012. FAZ-UJED

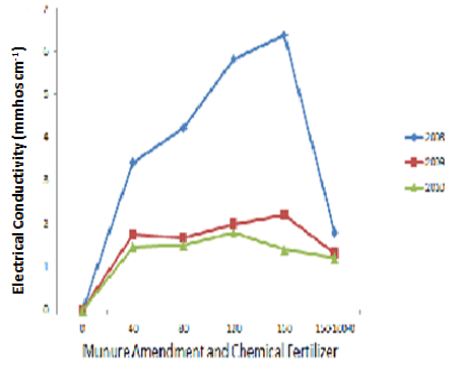

Figure 4. Average distribution of Electrical Conductivity in Soil per Treatment of Caw Manure and Chemical Fertilizer amendments 0n Triticale from 2010 to 2012. FAZ-UJED.

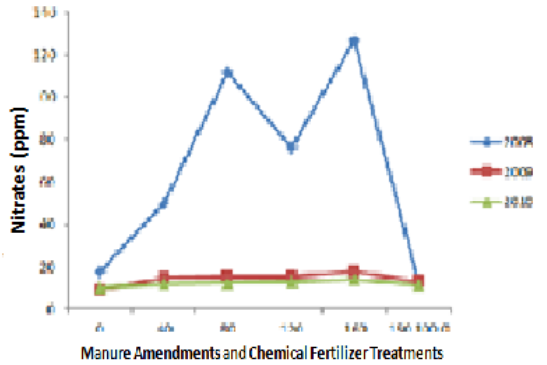

Figure 5. . Average distribution of of Nitrates in l Soil per Treatment of Caw Manure and and Fertilizer Amendments on Triticale from FAZ-UJED

Additionally and for detecting the concentration especially MO, CE and nitrates throughout the soil profile up to 1.50 cm deep, Figures 6, 7, 8 and 9 show these observed results. As the EC and Nitrates are highly soluble show high concentrations after the 30 cm depth, away from the area of maximum absorption due to the high concentrations found in the first 30 cm in the first 9 years of the experiment which, consequently, ample care should have especially nitrates, as these to be found in high concentrations after the first 30 cm because they are a potential contamination of the underground aquifer in this and other regions Salazar, et.al 1998.

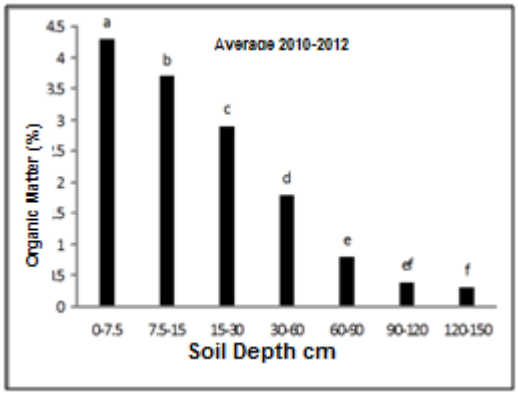

Figure 6. Average distribution of Organic Matter in Soil depths from 2010 to 2012. FAZ-UJED.

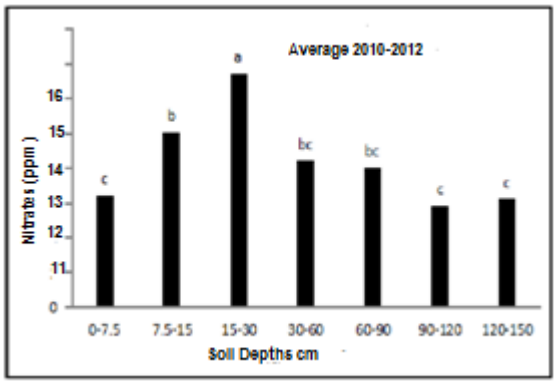

Figure 7. . Average distribution of Nitrates in Soil Depths from 2010 to 2012. FAZ-UJED.

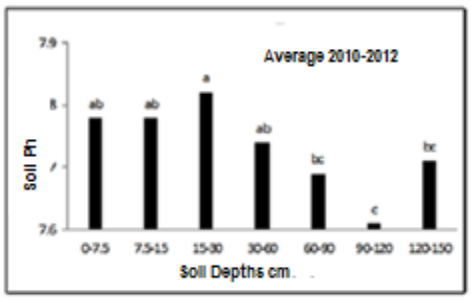

Figure 8. Average distribution of Ph inSoil depths from 2010 to 2012. FAZ-UJED.

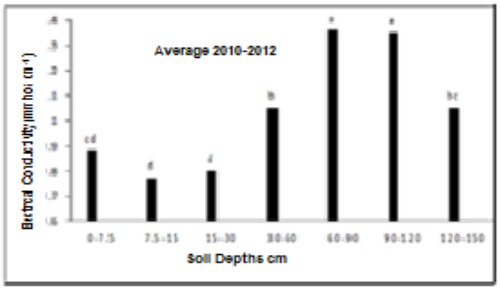

Figure 9. . Average distribution of Electrical Conductivity in Soil Depths from 2010 to 2012. FAZ-UJED.

DISCUSION

According to the results found cow manure amendments are important to improve soil crop forage production bath special care is necessary to take to maintain good soil quality with respect to salinity and high concentration of nitrates. Triticale forage crops with all soil surfers cover is a good option to take up high concentration of salt and nitrate after several years. In this study three years after seven of applied cow manure consequently, the soil salinity and nitrate were decreased a lower levels than the maximumpermissible of 4 mmohos cm^{-1} in salinity and less than 20 ppm of nitrates, Triticale forage yields also were higher than 100 % in all plots were caw manure was applied than the control and chemical fertilizer treatments. That means that soil must be monitored over time when organic amendments are used to avoid soil pollution due to high mineralization of organic amendment that induce to more salinity and nitrate concentration in soil mainly.Additionally, soil nitrate and organic matter were higher in the first centimeters of depth (15) due to more mineralization at this depth than in the others soil depth un decreasing at 150 cm and because the solubility of nitrate and salt after 30 centimeters high concentration were found so soil monitoring of these parameters are important to avoid possible aquifer pollution in the future.

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