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Nutrient Risk Management Using Organic Manures in Radish Production at Rampur, Chitwan, Nepal

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Abstract: Nitrate leaching is a problem in medium textured Inceptisols of Chitwan district, Nepal. A field experiment was conducted in sandy loam soil of Agriculture and Forestry University, Rampur, Chitwan, Nepal from October 2016 to January 2017 to evaluate effect of different sources of organic manure in nutrient risk management. The experiment was carried out in a Randomized Complete Block Design with six treatments (Poultry manure, goat manure, FYM, biogas byproduct, recommended dose of fertilizer and control) replicated four times. Pyuthane Red variety of radish was used as a test crop. After analysis of primary nutrients of the organic manures, rate of manure was fixed on the basis of nitrogen content. The highest (49.41 Mg/ha) root yield was obtained from poultry manure application which was similar with recommend rate of fertilizer. The highest soil pH (4.722), moister content (15.82), CEC (10.41meq/100g soil) and soil porosity (49.33%) and the lowest bulk density (1.191g/cm^3) was obtained from poultry manure application. The highest organic matter content (1.01%) was observed from biogas byproduct application which was similar with FYM and poultry manure application. The highest infiltration rate (0.522 mm/sec) was obtained from FYM whereas the lowest was obtained from control plot. In 30 cm soil depth, the residual NO_3-N was highest (0.075%) from goat manure which was similar with poultry manure application where as in 60 cm soil depth highest (0.046%) NO_3-N was recorded from RDF which was similar with biogas byproduct and goat manure application whereas lowest (0.46%) was recorded from control which was similar with FYM and poultry manure application. The most of the soil properties were enhanced by application poultry manure and FYM. Furthermore, poultry manure played an important role in increasing nitrate nitrogen availability in upper depth and reduces the potentiality of nitrate nitrogen leaching to the lower depth. In addition, this study indicates the possibility of poultry manure application to enhance the physio-chemical properties of sandy loam soil of Chitwan.

Key words: Leaching, Nutrient risk, Organic manure, Radish

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1. Introduction

Continuous and indiscriminate use of chemical fertilizer and pesticides are the causes for depletion of soil organic matter, accelerated soil erosion, nutrient loss and imbalance and decreased soil micro-organism (Jordhal & Karlen, 1993; Logsdon et al., 1993). Agricultural lands are being degraded through depletion of soil organic matter, nutrient loss and imbalance, accelerated soil erosion, water logging and salinity in irrigated areas, degradation of soil structure leading to crusting and compaction of the surface soils, and decline in soil water and nutrient retention capacities (Lal, 2009). Soil erosion and loss of organic matter control has been proposed as critical to nutrient risk management (Liu et al., 2010). Nutrient risk management in sustainable manner aims at improving soil properties, maintaining and enhancing soil nutrients and crop production, reducing the level of nutrient risk, protecting the potential of natural resources and preventing the degradation of soil and water quality, while being economically viable , socially acceptable and environmentally friendly (FAO, 1993; Schjonning et al., 2004).

Most of the soil of Chitwan is sandy loam due to which nutrient depletion and drought related problems are the major risk factor. Sandy loam soils have low nutrient content, water holding capacity, cation exchange capacity, buffering capacity, soil aggregate formation and high infiltrability and hydraulic conductivity. Most of the rainfall occurs in rainy (>80% in June –Aug.) season and farmers faces many drought related problems in other season due to low water holding capacity of sandy soil which becomes a great risk of nutrient leaching. Limited studies on the effect of organic manure on nutrient risk management on radish grown in sandy soil, as well as yield and productivity are reported for Nepalese conditions. Likewise, due to lack of sufficient knowledge and appropriate technology, Nepalese farmers are growing radish without the knowledge of optimum quantity of nutrient requirement by this crop. Thus by improving physiochemical properties of soil nutrient risk factor can be manage effectively. Therefore, the main objective of this study were to make safe soil environment via viable nutrient risk management option by determining the effect of different sources of organic manure on soil properties, nitrate retention capacity in correlation with radish yield.

2. Methodology

The field experiment was conducted at the horticulture farm of the Agriculture and Forestry University (AFU), Rampur, Chitwan, Nepal. The experimental site was located at 27º 37' North Latitude and 84º 25' East Longitude (Thapa and Dongol, 1988) at an altitude of about 228 masl. The experiment was set in a randomized complete block design with six treatments (Table 2) and four replications. The area of each plot was 8 m^2 (4 m×2 m). As a test crop Pyuthane Rato variety of radish was planted in geometry PP x RR 30cm x 20 cm.

Recommended dose of chemical fertilizer 100:60:40 kg NPK/ha was incorporated in soil at the time of sowing. A full dose of P and K and half dose of N were applied as basal dose. The remaining 1/2 N was applied at 35 DAS during intercultural operation.

Table 1: Nutrient status of various organic manures.

Organic manures	pH	N (%)
Poultry manure	7.8	3.5
Goat manure	8	1.25
FYM	7.4	0.95
Biogas by-product	7.2	0.70

Note: Nutrients content in the organic manure was calculated on dry weight basis.

Table 2: Treatment description of the experiment.

SN	Treatments	Rate of N applied through organic manure (kg/ha)	Amount of manure equivalent to N (kg/plot)
T1	Poultry manure	100	5.71
T2	Goat manure		21.32
T3	FYM		33.68
T4	Biogas byproduct		57
T5	Recommended fertilizer		173.91gm
T6	Control	0	0

The quantities of organic manures for the experiment were calculated on the basis of their respective nitrogen content (Table 2). Two fold increase in manure quantity for each plot as only 50% of nutrients was released from organic manure in first season of application (Brady and Weil, 2005). The required amount of organic manures was well incorporated in soil one month before seed sowing.

Biomass and root yield was calculated from 1 m^2 plot which is then converted into Mg/ha. Soil sample from field before sowing and after harvesting of radish was taken from two depth 0-30 cm and 30-60 cm. Before research one composite sample from each block was taken. After the harvesting, soil samples were taken from individual plots and analyzed with standard methods (Table 3).

Table 3 Analysis methods for various soil parameters

S.N	Parameters	Analysis methods
1	Soil pH	Beckman electrode pH meter (Cottenie et al., 1982)
2	Soil moisture	Gravimetric method
3	Soil texture	Hydrometer method (Gee & Bauder, 1986)
4	Soil organic matter	colorimeter method (Graham, 1948)
5	Dry bulk density	Core ring method (Blake & Hartage, 1986)
6	Total nitrogen	Kjeldhal distilation (Bremner & Mulvaney, 1982)
7	Nitrate nitrogen	Nitrate sensor probe
8	Available phosphorous	Modified Olsen (Olsen, 1954) using spectrophotometer
9	Available potassium	Ammonium acetate extraction (Simard, 1993)
10	Cation exchange capacity (CEC)	Ammonium Acetate extract (Metson I,1956)
11	Infiltration rate	Double ring infiltrometer (Bouwer, 1986)

All data were subjected for normality test and found the data followed normality trend. F-test of the normal data carried out with the help of Genstat version 4. Duncan's multiple range test was carried out to separate means with 5% level of significance.

3. Results

Effect of organic manures yield of radish

The highest biomass yield (75.16 Mg/ha) was obtained from poultry manure application which was significantly higher than other treatment but at par with RDF. Lowest biomass yield (26.91Mg/ha) was obtained from control plot. Highest root yield was obtained from poultry manure (49.41 Mg/ha) which is similar to RDF and significantly different from Biogas byproduct and control (Table 4).

Table 4: Effect of organic manure on root diameter, root length and yield of radish

Treatments	Yield (Mg/ha)	
	Biomass	Root
Poultry manure	75.16[a]	49.41[a]
Goat manure	63.20[bc]	39.82[ab]
Farm Yard Manure (FYM)	60.98[bc]	40.64[ab]
Biogas by product	55.97[c]	34.75[b]
Recommended doses of fertilizers (RDF)	70.88[ab]	46.78[a]
Control	26.91[d]	15.28[c]
Grand Mean	58.9	37.8
Sem±	3.86	3.15
LSD (0.05)	11.63	9.49
C.V %	13.1	16.7

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance as determined by DMRT

Effect of organic manures on soil moisture content, soil pH, bulk density and soil porosity

Soil moisture content, soil pH bulk density, particle density and soil porosity was significantly affected by the application of various treatments (Table 5). At the time of radish harvest, moisture content of the plot treated with poultry manure was significantly higher than other treatments except biogas byproduct and FYM application. Poultry manure was superior to all the manure for holding highest moisture content (15.88%) which was followed FYM and biogas byproduct application. The lowest soil moisture content (15.03) was found in the control treatment. As compared with initial soil pH (4.45), application of organic manure increased soil pH but recommended fertilizer is responsible for decreased soil pH. Poultry manure was superior to all the manure for increasing soil pH (4.7) which was followed by biogas byproduct application (4.5). The lowest soil bulk density (1.191 g/cm^3) was obtained from poultry manure application and it was significantly lower than other treatments except FYM. Similarly, the highest porosity (49.33%) was obtained from poultry manure used which was similar with the FYM whereas the lowest (40.60%) porosity was obtained from control (Table 5).

Table: 5 Effect of organic manures on soil moisture content, soil pH, bulk density particle density and soil porosity

Treatment	Soil moister content (%)	soil pH	Bulk density (g/cc)	Porosity (%)
Poultry manure	15.82[a]	4.720[a]	1.191[a]	49.33[a]
Goat manure	15.08[bc]	4.505[ab]	1.264[b]	46.21[b]
FYM	15.60[ab]	4.475[b]	1.253[ab]	46.67[ab]
Biogas byproduct	15.60[ab]	4.522[ab]	1.259[b]	46.43[b]
RDF	14.96[c]	4.405[b]	1.336[c]	43.15[c]
Control	14.19[d]	4.475[b]	1.396[c]	40.61[c]
Grand Mean	15.21	4.517	1.2831	45.40
SEM±	0.2	0.0723	0.02134	1.284
LSD (0.05)	0.6028	0.2178	0.06432	2.737
C.V %	2.6	3.2	3.3	4

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance as determined by DMRT

Effect of different sources of organic manure in soil infiltration

Soil infiltrability is not significantly influenced by the sources of organic manures. The highest (0.0448 mm/sec) infiltration rate was found in FYM treated plot. Whereas lowest final infiltration rate (0.0258 mm/sec) was obtained from control plot (Figure 1).

Treatments	Equation	Final Infiltrability(mm/sec)	R^2
poultry manure	$y = 1.491x^{-1.405}$	0.037	$R^2 = 0.9946$
Goat manure	$y = 1.205x^{-1.366}$	0.033	$R^2 = 0.9982$
FYM	$y = 2.9552x^{-1.581}$	0.046	$R^2 = 0.9875$
Biogas byproduct	$y = 1.6129x^{-1.44}$	0.036	$R^2 = 0.992$
RDF	$y = 1.2647x^{-1.401}$	0.031	$R^2 = 0.9973$
Control	$y = 1.3863x^{-1.489}$	0.027	$R^2 = 0.9981$

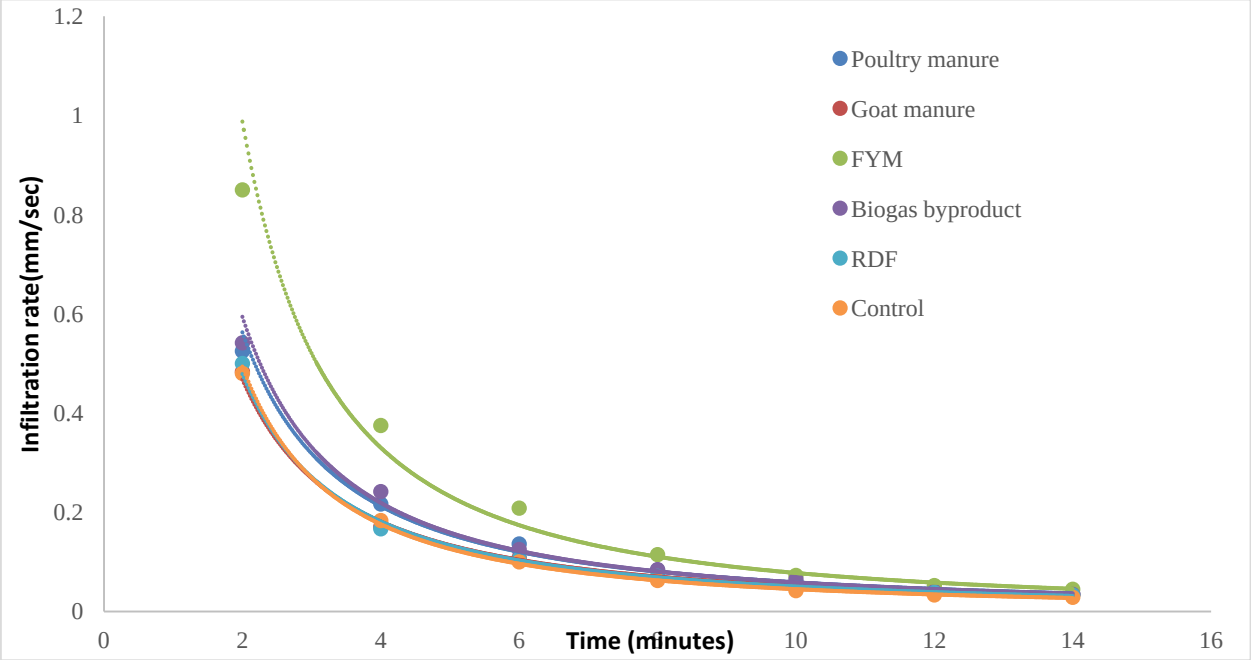

Figure 1: Soil infiltrability as influenced by different sources of organic manures.

Effect of organic manures on CEC, OM and nitrate nitrogen of soil

Application of organic manure has positive effect on CEC, OM content and residual nitrate nitrogen in soil (Table 6). The highest (10.408 meq/100gm) cation exchange capacity was found in plot with poultry manure application which was similar with goat manure and FYM application. Whereas lowest (7.950 m.eq/100g) CEC was recorded in control plot which was similar with RDF. The highest (1.01%) amount of OM content in soil was obtained from biogas byproduct application which was significantly higher than control, RDF and goat manure application but similar with FYM and poultry manure application. The lowest (0.776%) SOM content was obtained from RDF which was similar with control. Residual soil nitrate nitrogen in 30 cm depth was recorded highest (0.075%) in goat manure applied plot which was significantly higher than other treatments but similar with RDF and poultry manure. Similarly in 60 cm soil depth, highest amount (0.087%) of nitrate nitrogen leaching was recorded from RDF which was significantly higher than FYM, poultry manure and control plot but similar with biogas byproduct and goat manure application.

Table 6: Effect of organic manures on CEC, OM and nitrate nitrogen of soil

Treatment	CEC (meq/100g)	OM (%)	NO_3-N (30cm)	NO_3-N (60 cm)
Poultry manure	10.408[a]	0.9319[ab]	0.061[ab]	0.06[bc]
Goat manure	9.55[ab]	0.8864[b]	0.075[a]	0.073[ab]
FYM	9.225[ab]	0.967[ab]	0.045[bc]	0.048[c]
Biogas byproduct	8.975[bc]	1.01[a]	0.045[bc]	0.078[ab]
RDF	8.575[bc]	0.776[c]	0.065[ab]	0.087[a]
Control	7.950[c]	0.7761[c]	0.0348[c]	0.046[c]
Grand Mean	9.11	0.891	0.0542	0.0651
SEM±	0.385	0.0343	0.00693	0.00728
LSD (0.05)	1.162	0.1033	0.021	0.0219
C.V %	8.5	7.7	25.6	22.4

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance as determined by DMRT

4. **Discussion**

The lower values radish yield and soil physio-chemical properties obtained from control treatment as compared to other treatments could be as a result of initial low soil nutrients status that often characterizes continuous cultivation of land without fertilizer application. This finding was supported by Mohammed and Solaiman (2012). The highest root diameter, root length and yield of radish from poultry manure treatment could be due to the least value of C/N ratio of poultry manure also encouraged faster decomposition and quick release of nutrients for crop uptake and higher root yield parameters. This observation was supported by Ijoyah and Sophie (2009) who reported that the application of poultry manure increased cabbage yield. Costellanos and Pratt (1981) estimated that 60 per cent of the organic N in poultry manure was available. Due to its rapid mineralization, poultry manure was recognized as a valuable source of plant nutrients for crops. Espitiru *et al.* (1995) reported that the crop yield improvement due to addition of poultry manure was attributed to the presence of both readily available and slow release nitrogen. The application of RDF significantly increased the root diameter and radish yield than that of goat manure and biogas byproduct application and this could be due to the supply of readily available nutrients from the NPK fertilizer to the plant. This observation agreed with that of Makinde (2013) who reported that an increase in the readily available nitrate from the NPK fertilizer unlike the organic manure which must be mineralized before being utilized by crops. The increase in water holding capacity, bulk density and porosity of soil from the application of poultry manure might be due

to an increase in C content of the soil increases aggregation, decreases bulk density, increases water holding capacity, and hydraulic conductivity (Biswas and Khosla, 1971; Gupta et al., 1977; Weil and Kroontje, 1979).

The increase in soil pH from poultry manure application might be due to higher calcium content which decreased the activity of Almunium (Hue, 1993; Materechera and Mkhabela, 2002). Decrease in nitrate leaching in lower soil depth from FYM and poultry manure application agreed with that of Yanwang *et al.* (2002). Higher amount of nitrate leaching was obtained from biogas byproduct agreed with that of Schröder et al. (2005). Also, Tong et al. (1997) reported higher rate of nitrate nitrogen leaching which polluted underground water particularly with the continuous use of chemical fertilizers compared to the organic fertilizers. The findings are further supported by several researcher (Adekiya and Agbede, 2009; Akani and Ojeyniyi, 2007).

5. Conclusion

Among the various treatment poultry manure was the best source of organic manure resulting higher root yield of radish by improving soil moister content, soil pH, bulk density, soil porosity, CEC, nitrate nitrogen availability and reducing the leaching of nitrate nitrogen in lower depth. Hence, poultry application was recommended in sandy soil to reduce risk by improving soil properties. This research was conducted in winter season so that further long term research is necessary in other seasons for strong recommendation.

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References

[1]. Adekiya, A.O., & Agbede, T.M. (2009). Growth and yield of tomato as influenced by poultry manure and NPK fertilizers. *Emirates J. food Agric.* 21 (1), 10-20.

[2]. Akanni, D.I., & Ojeniyi, S.O. (2007). Effect of different levels of poultry manure on soil physical properties, nutrient status, grwth and yield of tomato. *J. Agron.* 1:1-4.

[3]. Allison, S.D., Czimczik, C.I., & Treseder, K.K. (2008): Microbial activity and soil respiration under nitrogen addition in Alaskan boreal forest. Global Change Biology, *14*: 1156–1168.

[4]. Badgley, C.J., Moghtader, E., Quintero, E., Zakem, M.J., Chappell, K., Aviles-Vazquez, Samulon, A., & Perfecto, I. (2007). Organic agriculture and the global food supply. *Renewable agriculture and food systems* 22: 86-108

[5]. Biswas, T. D., & Khosla B K. (1971). *Building up of organic matter status of the soil and its relation to the soil physical properties*. p. 831-842, Vol. I. *In* Proc. mt. Symp. Soil Fert. Eval. New Delhi. India.

[6]. Brady, N.C., & Weil, R.R.(2005). The nature and properties of soils. Thirteen editions.

[7]. FAO. (2015). Status of world soil resources. An explanatory note. FAO World Soil Resources Map at 1:25000000 scale, Rome.71 p. available at

[8]. Costellanos, .SJ.Z., & Pratt, P F. (1981). Mineralization of manure, nitrogen correlation with

[9]. Ebhin Masto, R, & Chhonkar, P.K., Singh, D., & Patra, A.K.. (2006). Changes in soil biological and biochemical characteristics in a long-term field trial on a sub-tropical inceptisol. *Soil Biology and Biochemistry, 38*: 1577–1582.

[10]. Espiritu, B.M., Palacappc, M.G., Camtera, JJL, & Wllavar, L. (1995). Studies on chemical and microbiological parameters for organic fertilizers as basis for quality standards: *Terminal Report* (November, 1994 to May, 1995), College Leguna, Philippines.

[11]. Eyhorn, .F, Heeb, M., & Wieidmann, G. (2002). *IFOAM Training manual for organic agriculture in the Tropics: Theory, transparencies, didactic apporach*. International Federation of Organic Agriculture Movements (IFOAM), Research institute of organic agriculture (FiBL), CABI Bioscience, Agrecol Afique (Senegal), Agrecol Andes (Bolivia) and INOCERT (India).

[12]. Gupta, S. C., Dowdy, R H., & Larson, W.E. (1977). Hydraulic and thermal properties of a sandy soil as influenced by incorporation of sewage sludge. *Soil Sci. Soc. Am. Proc.* 41:601-605.

[13]. Hue, N.V. (1993). Correcting soil acidity of a highly weathered ultisol with chicken manure or sewage and sludge. *Commun. Soil Sci. plant Anal.* 23: 241-264.

[14]. Ijoyah, M.O., & Sophie, V.L. (2009). Effect of different levels of decomposed poultry manure on the yield of cabbage (Brassica Oleraceae L). *Agro Sci. J. Trop Agric Food Environ Ext* 8(1):20–23

[15]. Karlen, D.L., Wollenhaupt, N.C., Erbach, D.C., Berry, E C., Swan, J.B., Eash, N.S., & Jordahl, J.L. (1994). Crop residue effects on soil quality following 10-years of no-till corn. *Soil and Tillage Research*, *31*(2), 149-167.laboratory indices. *Soil Science Society of America*, 45: 254-357.

[16]. Lal R.(2009). Soils and world food security. *Soils Tillage Res.* 102, 1–4.

[17]. Liu, X.B, Zhang, X.Y., Wang, Y.X., Sui, Y.Y., Zhang, S.L., Herbert, S.J., & Ding, G. (2010). Soil degradation: a problem threatening the sustainable development of agriculture in Northeast China. *PLANT SOIL ENVIRON, 56*, (2): 87–97

[18]. Logsdon, S.D., Radke, J.K., & Karlen, D.L. (1993). Comparasion of alternative farming systems.1. Infiltration Techniques. *Am. J. Alter. Agric.* 8:15-20

[19]. Makinde A. (2013). Effect of inorganic fertilizer on the growth and nutrient composition of moringa. *J Emerg Trends Eng Appl Sci.* (JETEAS) 4(2):34–343.

[20]. Materechera, S.A.,& Mkhabela, T.S.(2002). The effectiveness of lime, chiken manure and leaf litter ash in ameliorating acidity in soil previously under black wattle (Acacia mearnsii) plantation. *Biores. Technol.* 85: 9-16.

[21]. MoAD. (2008). *Nepalese standards of organic agriculture.* Ministry of Agriculture and Cooperative (MoAC), Government of Nepal, Kathmandu, Nepal.

[22]. Mohammed, R.H., & Solaiman, A.H.M. (2012). Efficacy of organic and inorganic fertilizers on the growth of cabbage (Brassica Oleraceae L). *Int J Agric. Crop Sci.,* 4(3):128–138. ISBN 2227–670X.

[23]. Schjonning, P., Elmholt, S., & Christensen, B.T. (2004). Soil quality management, synthesis. In: Schjonning, P., Elmholt, S., Christensen, B.T. (Eds), *Managing Soil Quality: Changes in Modern Agriculture.* pp. 315-333.

[24]. Schröder, J.J., Jansen, A.G., & Hilhorst, G.J.(2005). Long-term nitrogen supply from cattle slurry. *Soil Use and Management, 21*: 196–204.

[25]. Thapa, R.B., & Dongal, D.R. (1988). A preliminary survey of bee flora at IAAS and its vicinity. IAAS Research Report. Pp. 59-65.

[26]. Tong, Y., Ove, E., Dianquing, L, & Harald, G. (1997). Effect of organic manure and chemical fertilizers on nitrogen uptake and nitrate leaching in a Eum orthic anthrosols profile. *Nutr Cycl Agroecosyst* 48(3):225–229.

[27]. Weil, R.R., & Kroontje, W. physicai conditionon or a Davidson clay loam after five years of heavy poultry manure applications. *J. Environ. Qual.* 8:387—392.(1971).

[28]. Yanwang, K., & Yakushido, K. (2002). Changes in nitrate N content in different soil layers after the application of livestock waste compost pellets in a sweet corn field. *Soil Sci. Pl. Nuti.,* 48(2): 165-170.