IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 5, Issue 2 (Sep. - Oct. 2013), PP 45-50
www.iosrjournals.org

Response of Watermelon to Five Different Rates of Poultry Manure in Asaba Area of Delta State, Nigeria.

Enujeke E.C.
Department Of Agronomy, Delta State University, Asaba Campus

Abstract: *Field experiments were conducted in 2011 and 2012 cropping seasons in the Teaching and Research Farm of Delta State University, Asaba Campus, Nigeria to evaluate the response of watermelon to five different rates of poultry manure. The study was carried out in a Randomized Complete Block Design (RCBD) with three replicates. Rates of poultry manure in tons per hectare were 0, 5, 10, 15, 20, while the parameters investigated were vine length, number of leaves per plant, number of branches per plant, and fruit weight of watermelon. Data collected were subjected to analysis of variance (ANOVA), and means separated using Duncan Multiple Range Test (DMRT). The results of the study showed that plants that received highest rate of poultry manure (20 tha^{-1}) were superior in the parameters tested with vine length of 177.5 cm at 8 weeks, mean number of leaves of 3.71 mm, number of branches/plant of 5.77, and mean fruit weight of 1309.43 tha^{-1}). Based on the findings of the study, it was recommended that farmers in the study area apply 20 tha^{-1} of poultry manure for increased growth and yield of watermelon.*
Keywords: *Growth and yield of watermelon, rates of poultry manure, Asaba, Nigeria*

I. Introduction

Watermelon (*Citrullus lanatus Thumb*) is a member of the cucurbitaceae family. It is believed to have originated from the Kalahari and Sahara deserts in Africa (Jarret, et al., 1996). In Nigeria, its cultivation which was originally confined to the drier savannah regions of the North, is now gradually gaining ground in the southern parts of the country. It is a crop with huge economic importance to man. The fresh fruit is relished by many people across the world because it is known not only to be low in calories but highly nutritious, sweet and thirst-quenching (Mangila et al., 2007). It is commonly used to make a variety of salads, most notably fruit salad (Wikipedia.com., 2010). It is a popular cash crop grown by farmers during summer due to its high returns in investment, especially those residing near the urban areas. Watermelon contains Vitamin C and A in form of the disease fighting beta-carotene. Potassium is also available in it, which is believed to help in the control of blood pressure and possibly prevent stroke (IITA, 2013).

In spite of the increasing relevance of watermelon in Nigeria, yield across the country is not encouraging because of rapid reduction in soil fertility caused by both continuous cropping and negligence of soil amendment materials (Enujeke, 2013). One of the ways of increasing the nutrient status of the soil is by boosting the soil nutrient content with the use of such organic materials as poultry manure, cow dung, compost manure or other animal wastes with or without inorganic fertilizers (Dauda et al., 2008). Poultry manure is the richest known animal manure (Enujeke et al., 2013, Lombin et al, 1992, Mangila et al., 2007), and it is essential for establishing and maintaining the optimum soil physical condition for plant growth.

Cheap and effective as a good source of N for sustainable crop production, application of 10-50 tha^{-1} of poultry manure improves the soil physical properties by reducing soil temperature and bulk density, and increasing the total porosity (Ewulo et al., 2008; Agbede et al., 2008). High rates of poultry manure improves moisture available which results in improved nutrient release to plants for increased growth and yield (Adekiya and Ojeniyi., 2002., Ewulo, et al 2008). According to Agbede et al., (2008), poultry manure increased plant N,P,K, Ca and Mg status in leaf of Sorghum. The manure increased plant height, leaf area, stem girth, number of roots, root weight, shoot weight, 100 seed weight and grain weight in the years of evaluation. Poultry manure had positive effects on growth and yield of watermelon because the manure released essential elements associated with high photosynthetic activities which promotes growth and yield (John et al., 2004). Dauda, et al., (2008) attributed the vigorous growth and fruit yield observed in watermelon to increased supply of nutrient elements from higher rates of poultry manure. Similar reports were made by Aliyu, (2010) with respect to higher yield of egg plant resulting from application of higher rate of manure. The nutrient composition of poultry manure as reported by DIPA (2006) is 1.0-1.8% N, 0.4-0.8% P, and 0.5-1.9% K. The nutrient composition of poultry manure used in this study, however, was 1.4% N, 0.6% P, and 0.6 % K.

At present, there are no recommended standards with respect to rate of poultry manure, for the enhancement of yield of watermelon in the study area. The objective of this study, therefore, was to identify the most appropriate rate of application of poultry manure for increased growth and yield of watermelon in Asaba area of Delta State, Nigeria.

II. Materials and Methods

Description of experimental site -

Field experiments were carried out at the Research and Teaching Farms of Anwai Campus of the Delta State University. The experimental site is located within latitude 06°14'N and longitude 06°49'E of the equator. The experiment was conducted during the 2011/2012 cropping seasons in a typical humid environment that is characterized by a bimodal rainfall pattern with peaks in July and September and an interrupted dry spell in August otherwise called (Harmattan). The annual mean rainfall is about 1,650 mm, the mean annual temperature is 37.3°C and a mean relative humidity of 73.2% (NIMET, 2011). By nature of its geomorphological settings, the study area falls within the classification of Ancient metamorphiccrystalline basement complex formation which are more acid than base (Egbuchua, 2007). They are essentially gneisses and pegmatites that gave rise to coarse-textured soils that are deficient in dark ferromagnessium minerals (Egbuchua, 2007).

The topography is undulating with pockets of hills and land use is typically based on rain - fed agriculture with root, tuber, spices, pulses and vegetables prominently cultivated. The vegetation is of rainforest origin but has been drastically reduced to derived savanna due to continuous use of the land.

Field studies

A land measuring 323.2 m^2 (32.0m x 10.1m) was selected for the study and prepared by using a tractor to plough and harrow the land. It was marked out according to the experimental layout. Fifteen plots of 6.0m x 2.7m each were made and composite samples collected from the plots at 0-15 cm depth in order to assess the initial physio-chemical properties of the soil.

Laboratory studies

The composite soil samples collected from the individual plots were air-dried in a room temperature of 27°C for three days, crushed and sieved using 2mm aperture. The parameters evaluated include the particle size distribution by hydrometer method (Gee and Bauder, 1986). The pH was determined using Pye Unican model MK2 pH meter in a 1:2:5 soil/water suspension ratio. Organic carbon was determined by Walkley-Black wet oxidation method (Nelson and Sommers, 1982). Total nitrogen was determined by micro-Kjeldahl distillation technique as described by Breminer and Mulvaney (1982). Available phosphorus was determined by Bray No. 1 method (IITA, 1979). Exchangeable potassium was determined by flame photometer, while cation exchange capacity (CEC) was determined by Amnonium acetate saturation method (Roades, 1982).

The chemical analysis of the poultry manure used for the experiment was also evaluated using appropriate methods as described in the IITA manuals (1979).

Experimental Design

The experiment was carried out in a Randomized Complete Block Design (RCBD) with three replicates. Rates of poultry manure in tons per hectare were 0, 5, 10, 15 and 20. The manure was incorporated into the soil 2 weeks before planting.

Seed collection and planting

Watermelon seeds (Sugar baby) were collected from Agro – Allied Company, Ibadan, and sown on the plots at 4 seeds per stand at a depth of 2.5 cm, using a spacing of 90cm x 75cm, with 1 m Alley pathways.

Weeding

Regular weeding was done around the base, along and ahead of the vines using hoe.

Data Collection

Fourteen middle stands were used as sample population. Data collected were vine length, number of leaves/plant, number of branches/plant, and fruit weight at maturity. Vine length was measured with tape from the base to the growing tip of the plant. Number of leaves/plant and number of branches/plant were determined by direct counting. Fruit weight was measured using a weighing scale, after harvesting at 75 days from planting.

Statistical Analysis

Data collected was subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT) according to Wahua (1999).

III. Results

Initial Soil Properties

The data on the initial physico-chemical properties of the soils used for the study is presented in **Table 1.** The particle size fracture showed that the soils were sandyloam in texture and low in fertility as reflected by the low content of organic matter (15.5 gkg^{-1}), and total nitrogen (0.87 gkg^{-1}). Soil pH was strongly acid with a mean value of 5.3. The available phosphorus (P) and water soluble, potassium (K) with mean values of 5.35 $mgkg^{-1}$ and 0.17 $cmolkg^{-1}$ were seemingly low based on the ratings of FMANR, (1996) for the ecological zone. The low fertility status of the soils is a true reflection of most ultisols of humid environment that are strongly weathered of low activity clay mineralogy and high acidity due to intense precipitation with its associated erosion and leaching in the environment.

Table 1: Initial phyisco-chemical properties of the soils used for the study

Parameters Measured	Values obtained
Particle size fractions (%)	
Sand	85.0
Silt	9.6
Clay	4.4
Textural class	Sandyloam
pH (H_2O)	5.3
Organic matter gkg^{-1}	15.5
Total Nitrogen (gkg^{-1})	0.87
Available P ($mgkg^{-1}$)	5.35
Exchangeable K ($Cmolkg^{-1}$)	0.17
CEC ($Cmolkg^{-1}$)	10.13

Effects of poultry manure on vine length (cm) of watermelon

The response of vine length of watermelon to poultry manure in 2011 and 2012 cropping seasons is shown in Table 2. Vine length gradually increased from 4-8 weeks after sowing. At 4 weeks after sowing, plants that received 20 tha^{-1} of poultry manure had the highest vine length with mean value for 2011 and 2012 as 70.5 cm. Plants that did not receive manure had the lowest vine length with mean value of 14.1 cm for 2011 and 2012. During the 6th week after sowing, plants that received 20 tha^{-1} of poultry manure also had the highest vine length with mean value of 130.7 cm for both years of evaluation, while plants in the control plot had the lowest vine length with mean value of 23.3 cm for 2011 and 2012. The trend did not change during the 8th week after sowing. Plants that received 20 tha^{-1} of poultry manure were superior in vine length over other plants, with mean value of 177.5 cm. The superiority in vine length of watermelon based on rate of poultry manure received in tons/hectares was 20>15>10>5>0.

Table 2: Effects of poultry manure on vine length (cm) of watermelon in 2011 and 2012

	Weeks after sowing								
	4			6			8		
	Vine length (cm)								
	2011	2012	Mean	2011	20012	Mean	2011	20012	Mean
Rates of poultry manure tons /ha									
0	14.0_e	14.2_e	14.1_e	22.4_e	24.2_e	23.3_e	40.8_e	48.4_e	44.6_e
5	30.8_d	44.2_d	37.5_d	66.2_d	88.6_d	77.4_d	108.2_d	122.8_d	115.5_d
10	40.2_c	62.2_c	51.2_c	88.4_c	102.4_c	95.4_c	120.4_c	138.2_c	129.3_c
15	52.0_b	68.6_b	60.3_b	96.2_b	126.2_b	111.2_b	146.6_b	166.2_b	156.4_b
20	58.6_a	82.4_a	70.5_a	122.6_a	138.8_a	130.7_a	168.4_a	186.6_a	177.5_a

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

Effects of poultry on number of leaves/plant of watermelon

The response of number of leaves/plant of watermelon to poultry manure in 2011 and 2012 is shown in Table 3. There were gradual increases in number of leaves/plant from 4-8 weeks after sowing. Plants that received 20 tha^{-1} of manure were outstanding in number of leaves/plant with mean value of 29.2 at the 4th week of 2011 and 2012, while plants in control plot had the lowest number of leaves/plant with mean value of 10.5. During the 6th week after sowing, plants that received 20 tha^{-1} of manure also had the highest number of leaves/plant with mean value of 31.6 for 2011 and 2012. Plant grown without manure had the lowest number of leaves/plant with mean value of 13.5 for both years investigated. At 8th weeks after sowing, plants that received 20 tha^{-1} of poultry manure were also superior to other plants with respect to number of leaves /plant(37.1). Plants grown without poultry manure had the lowest number of leaves/plants with mean value of 16.3 for 2011 and 2012. The superiority in number of leaves/plant of watermelon based on rate of poultry manure received in tons/hectare was 20>15>10>5>0.

Table 3. Effects of poultry manure on number of leaves/plants of watermelon in 2011 and 2012

	Weeks after sowing								
	4			6			8		
	number of leaves/plants								
	2011	2012	Mean	2011	20012	Mean	2011	20012	Mean
Rates of poultry manure tons /ha									
0	10.2_e	10.8_e	10.5_e	12.8_e	14.2_e	13.5_e	16.0_e	16.6_e	16.3_e
5	16.2_d	16.6_d	16.4_d	20.4_d	24.8_d	22.6_d	26.0_d	27.4_d	26.7_d
10	19.8_c	23.2_c	21.5_c	24.6_c	28.0_c	26.3_c	27.0_c	30.2_c	28.6_c
15	24.2_b	26.6_b	25.4_b	27.2_b	29.8_b	28.5_b	30.4_b	32.8_b	31.6_b
20	28.0_a	30.4_a	29.2_a	30.4_a	32.8_a	31.6_a	36.0_a	38.2_a	37.1_a

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

Effects of poultry manure on number of branches/plant of watermelon

The effects of poultry manure on number of branches/plant of watermelon in 2011 and 2012 is shown in Table 4. Number of branches/plant gradually increased from 4-8 weeks after sowing. At 4 weeks after sowing in 2011 and 2012, plants that received 20 tha^{-1} of manure had highest number of branches/plant with mean value of 4.76, while plants in the control plot had the lowest mean value (1.72) for 2011 and 2012. Similar trend was observed during the 6^{th} week, when plants that received 20 tha^{-1} of manure were superior in number of branches/plant with mean value of 4.95, while plants in the control plot had the lowest mean value (2.65). During the 8^{th} week, plants that received 20 tha^{-1} of poultry manure also had highest number of branches/plant with mean value of 5.77 for 2011 and 2012; while plants in control plot had the lowest number of branches/plant with means value of 4.40. The superiority in number of branches/plants of watermelon based on the rate of application of poultry manure in tons/hectare was 20>15>10>5>0.

Table 4. Effects of poultry manure on number of branches/plants of watermelon in 2011 and 2012

	Weeks after sowing								
	4			6			8		
	number of branches/plants								
	2011	2012	Mean	2011	20012	Mean	2011	20012	Mean
Rates of poultry manure tons /ha									
0	1.42_e	2.02_e	1.72_e	2.62_e	2.68_e	2.65_e	3.88_e	4.20_e	4.04_e
5	2.64_d	3.42_d	3.03_d	3.76_d	3.98_d	3.87_d	4.14_d	4.66_d	4.40_d
10	3.26_c	3.84_c	3.55_c	4.40_c	4.82_c	4.61_c	4.94_c	5.12_c	5.03_c
15	4.16_b	4.44_b	4.30_b	4.78_b	4.86_b	4.82_b	5.22_b	5.64_b	5.43_b
20	4.60_a	4.92_a	4.76_a	4.92_a	4.97_a	4.95_a	5.60_a	5.94_a	5.77_a

Means with the same letter(s) under the same column are not significantly different
($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

Effects of poultry manure on fruit weight (tons/hectare) watermelon

The response of fruit weight of watermelon to poultry manure in 2011 and 2012 is shown in Table 5. Plants that received 20 tha^{-1} of manure had highest fruit weight of 1226.46tha^{-1} in 2011, while plants in the control plot had the lowest fruit weight (245.20 tha^{-1}). In 2012, plants that received 20 tha^{-1} of manure were also superior in fruit weight with value of 1392.40 tha^{-1}, while plants in the control plot had the lowest fruit weight with value of 302.24 tha^{-1}. The superiority in fruit weight based on the rate of application of poultry manure in tons/hectare was 20>15>10>5>0.

Table 5. Effects of poultry manure on weight of fruits of watermelon in 2011 and 2012.

	Weight of fruits (tha^{-1})		
	2011	2012	Mean
Rates of poultry manure tons /ha			
0	245.20_e	302.24_e	273.72_e
5	422.80_d	486.80_d	454.80_d
10	794.60_c	842.26_c	818.42_c
15	998.44_b	1184.10_b	1091.30_b
20	1226.46_a	1392.40_a	1309.43_a

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

IV. Discussion

Effect of poultry manure on vine length of watermelon

Plants that received 20 tha^{-1} of poultry manure had higher vine length than other plants possibly because higher rate of manure improved moisture availability which enhanced nutrient release to plant for increased vine growth. This is similar to the findings of Adekiya and Ojeniyi (2002), and Ewulo *et al.,* (2008) who reported that higher rates of poultry manure increases moisture availability which leads to release of more nutrients for increased plant growth. It is also consistent with the findings of John *et al.,* (2004) who reported that poultry manure released essential elements associated with high photosynthetic activites which promoted growth and yield of watermelon.

Effects of poultry manure on number of leaves/plant of watermelon

Higher number of leaves/plant was produced by watermelon stands that received 20 tha^{-1} of poultry manure possibly because the manure established and maintained soil physical condition for plant growth. This is consistent with the reports of Lombin *et al.,* (1992), Mangila *et a.l,* (2007), and Enujeke *et a.l*, (2013) which indicated that poultry manure (the richest known animal manure) is essential for establishing and maintaining the optimum soil physical condition for plant growth. It is also synonymous to the findings of Agbede *et al.,* (2008), and Ewulo *et al., (2008)* who reported that poultry manure is not only cheap and effective source of N for sustainable crop production, but improves soil physical properties by reducing temperature, bulk, density, and increasing total porosity, if higher rates are applied.

Effects of poultry manure on number of branches/plant of watermelon

Plants that received 20 tha^{-1} of poultry manure were superior with respect to higher number of branches/plant over their counterparts possibly because higher rates of manure supplied more nutrient elements for vigorous growth. This is similar to the findings of Dauda *et al.,* (2008) Agbede *et al.,* (2008) who attributed the vigorous growth of watermelon to increased supply of nutrient elements from higher rates of poultry manure. It is also consistent with the report of Enujeke (2013) who indicated that higher rates of poultry manure increased growth parameters of maize.

Effects of poultry manure on weight of fruits of watermelon

Higher fruit weight was obtained from watermelon plants that received 20 tha^{-1} of poultry manure possible because higher rates of manure not only improved the soil conditions for crop establishment, but also released adequate nutrient elements for yield enhancement. This is in harmony with the reports Aliyu (2000), Adekiya and Ojeniyi (2002), Mangila *et al.,* (2008), and Agbede *et al.,* (2008).

V. Conclusion and Recommendations

This study was carried out to evaluate the response of watermelon to five different rates of poultry manure in Asaba Area of Delta State, Nigeria. It was conducted in a Randomized Complete Block Design (RCBD) with three replicates. Rates of poultry manure in tons per hectare were 0, 5, 10, 15, 20. The parameters assessed to achieve the objective of the study were vine length, number of leaves/plant, number of branches/plant and fruit weight of watermelon. The result of the study showed that plants that received 20 tha^{-1} of poultry manure were superior in the parameters tested. Based on the findings of the study, it was recommended that farmers in the study area apply 20tha^{-1} of poultry manure for increased growth and yield of watermelon.

References

[1]. Adekiya, A.O. and Ojeniyi, S.O. (2002). Evaluation of tomato growth and soil properties under methods of seedling bed preparation in an Alfisol in the rainforest zone of southwest Nigeria. Bioresource Technol. 96: 509-516.

[2]. Agbede, T.M., Ojeniyi, S.O. and Adeyemo, A.J. (2008). Effect of Poultry Manure on Soil physical and chemical properties, growth and grain yield of sorghum in Southwest, Nigeria, Am.-Eurasian J. Sustain. Agric. 2(1): 72-77.

[3]. Aliyu, L. (2000). The effects of organic and mineral fertilizer on growth, yield and composition of pepper (*Capsicum annum L*). Biol. Agric. Hort. 18: 29–36.

[4]. Bremmer, J. M. and C. S. Mulvaney (1982): Total nitrogen In: Page A. L. Miller, R. H. and Keeney, D. R. (ed.) Methods of soil analysis. Part 2. Agron 9, Madison. W.I. p. 149-157.

[5]. Dauda, S.N., Ajayi, F.A. and Ndor E. (2008). Growth and Yield of Watermelon (*Citrullus lanatus*) as Affected by Poultry Manure Application. Journal of Agriculture & Social Sciences.; 121–124. http://www.fspublishers.org (accessed 2009 November 10).

[6]. DIPA (2006). Handbook of Agriculture: facts and figures for farmers, students and all interested in farming. Directorate of Information and Publications of Agriculture. *Indian Council of Agricultural Research,* New Delhi, p. 435.

[7]. Egbuchua, C. N. (2007) Pedological characterization and fertility evaluation of some wetlands soils in Delta State. Ph.D Thesis (unpublished). Delta State University, Abraka, Nigeria.

[8]. Enujeke E.C., Ojeifo I.M, and Nnaji G.U (2013) Residual effects of organic manure and inorganic fertilizer on maize grain weight and some soil properties in Asaba area of Delta State. *International Journal of Advanced Biological Research* 3(3):433-442. Society for Science and Nature, India.

[9]. Enujeke, E.C. (2013). Effects Of Poultry Manure On Growth And Yield Of Improved Maize In Asaba Area of Delta State, Nigeria. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*. 4, (5): 24-30. International Organization of Scientific Research, India.

[10]. Ewulo, B. S. Ojeniyi, S. O. and Akanni, D. A. (2008). Effect of poultry manure on selected soil physical and chemical properties, growth, yield and nutrient status of tomato. African Journal of Agricultural Research Vol. 3 (9), pp. 612-616,. http://www.academicjournals.org/AJAR (accessed 2009 November 10).

[11]. FMANR-Federal Ministry of Agricultural and Natural Resources (1996) Soil fertility investigation (In 5 volumes); Fertility ratings. Produced by the Federal Ministry of Agriculture, Lagos, Nigeria.

[12]. Gee, G. W and J. W. Bauder (1986) Particle size analysis p. 404-407. In A Klute (ed) Methods of soil analysis. Part 1 (2^{nd} ed.) Agron. Monogr. 9. ASA and SSSA. Madison W.I. USA.

[13]. IITA International institute for Tropical Agriculture (1979) Laboratory manual for soil and plant analysis. Manual series 7, IITA, Ibadan, Nigeria.

[14]. IITA, (2013). Growing watermelon commercially in Nigeria- an illustrated guide. International Institute of Tropical Agriculture (IITA), pp1-16.

[15]. Jarret, B., R. Bill, W. Tom and A. Garry, 1996. *Cucurbits Germplasm Report*, pp: 29-66. Watermelon National Germplasm System, Agricultural Service, U.S.D.A.

[16]. John, L.W., Jamer, D.B. Samuel, L.T. and Warner, L.W. (2004). Soil Fertility and Fertilizers: An Introduction to Nutrient Management, Pearson Education, India pp: 106–53.

[17]. Lombin, L.G; Adeputu, J.A and Ayetade, K.A (1991). Complementary use of organic manures and inorganic fertilizers in arable crop production. *Proceeding of National organic fertilizer seminar held in October 20^{th} -22^{nd} at University of Ibadan,* Ibadan. Pp 146 -162.

[18]. Mangila, E., Tabiliran, F.P., Naguit., M.R.A and Malate, R (2007). Effects of Organic Fertilizer on the Yield of Watermelon. Threshold 2. January-December, 2007, pp 27-35.

[19]. Nelson, D. W and I. E. Sommers (1982) Organic Carbon. In Page A.L. Miller, R. H. and Keeney, D. R. (ed) Methods of Soil analysis. Part 2 Agron, Monogr. 9 ASA and SSSA, Madison, W.I. USA.

[20]. NIMET-Nigerian Meteorological Agency (2011) Climate information Bulletin (2011-2012) Asaba, Delta State, Nigeria.

[21]. Roades, J. D. (1982) Cation Exchange Capacity. In Page, A. L. Miller, R. H. and Keeney, D.R. (eds) Methods of soil analysis. Part 2 Agron. Monogr. ASA, SSSA, Madison, W.I. USA.

[22]. Wahua, T.A.T (1999). Applied statistics for scientific studies. Afrika-Link Books, Nigeria, pp. 250 -287.

[23]. Wikepedia encyclopedia (2010). Growth and Yield performance of watermelon. www.wikipedia.com./production guide of watermelon.da.gov.ph2010 http://www.da.gov.ph/2010 .