Effect of pendimenthaline on physicochemical properties of soil

2 authors:

Solomon Bankole Oyeleke
Federal University of Technology Minna

Oluwafemi Oyewole
Federal University of Technology Minna

ISABB Journal of Food and Agriculture Science Vol. 1(2), pp. 36-39, November 2011
Available online at http://www.isabb.academicjournals.org/JFAS
ISSN 1937-3244©2011Academic Journals

Full Length Research Paper

Effect of pendimenthaline on physicochemical properties of soil

Oyeleke, S. B.*, Oyewole, O. A. and Dagunduro, J. N.

Department of Microbiology, Federal University of Technology, Minna, Nigeria.

Accepted 1 November, 2011

A field study on the effect of herbicide (Pendimenthaline) on physicochemical properties of soil was conducted between August to September (2010) on a sandy-loamy soil located at Federal University of Technology, Crop Science Farm Gidan-Kwano, Minna. Samples were collected randomly from the experimental farm before and after application of herbicide, on which cowpea was cultivated. Herbicide (pendimenthaline) was applied at below recommended rate, recommended rate and above recommended rate. Effects of the herbicide on physicochemical properties of soil pH, percentage organic matter and cowpea yield reveals significant changes in soil pH that was observed in soil treated with herbicide at recommended rate and above recommended rate (P<0.05). There was a reduction in percentage organic matter in all the soil. Cowpea yield was highest in site treated with herbicide at above recommended rate and lowest in the control site. The results revealed that herbicide is an integral part of farming for bumper harvest yield.

Key words: Herbicide pendimenthaline, physicochemical, cowpea, recommended rate.

INTRODUCTION

The global drive for sustainable agricultural system involves optimizing agricultural resources to satisfy human needs at the same time maintaining the quality of the environment and sustaining natural resources (Akobundu, 1987). In achieving this optimization, use of herbicide is of great importance. Herbicides are substances or cultured biological organism used to kill or suppress the growth of unwanted plants and vegetations (Cork and Krueger, 1992). Most agronomic situations involve a sequence of herbicide, fungicide, and insecticide application. On the other hand, use of pesticidal combinations has become a standard practice in the production of many agricultural crops. One of the most important processes influencing the behavior of a pesticide in the environment is its degradation in soil. It is known that due to several pesticide applications in one vegetation season, the pesticide may be present in mixtures with other pesticides or xenobiotics in soil (Swarcewicz and Gregorczyk, 2011).

Pendimethalin (3,4-Dimethyl-2,6-dinitro-*N*-pentan-3-yl-aniline) is a selective herbicide used to control most annual grasses and certain broadleaf weeds in field corn, potatoes, rice, cotton, soybeans, tobacco, peanuts and sunflowers. It is used for both preemergence, that is before weed seeds have sprouted, and early postemergence. Incorporated into the soil by cultivation or irrigation is recommended within 7 days following application. Pendimethalin is available as an emulsifiable concentrate, wettable powder or dispersible granule formulations (Extoxnet, 1993). The aim and objective of this research is to examine the effect of pendimentaline on the physicochemical properties of soil before and after application.

MATERIALS AND METHODS

Determination of pH of soil control and treated soil

The pH of both soil and agricultural wastes was determined using pH meter (Crison micro pH 200 Model). 5 g of the samples was suspended in 25 ml of distilled water and homogenized. The pH meter was standardized at pH 7.0 using phosphate buffer solution after which the pH of the samples were determined in duplicates.

Determination of nitrogen of soil control treated soil

The Macro kjedhal method was used for determination of nitrogen

*Corresponding author. E-mail: droyeleke@yahoo.com.

Table 1. Physicochemical properties of control and pendimenthaline treated soil.

Soil treatment	pH	Nitrogen (%)	Phosphorus (ppm)	Organic carbon (%)	Exchangeable acidity (Cmol/kg)
T_1	5.59	0.05	16.13	1.52	0.42
T_2	5.56	0.29	12.65	1.30	0.40
T_3	5.94	0.36	12.02	1.26	0.36
T_4	5.84	0.12	13.37	1.29	0.37

T_1 - Control, T_2 - 0.5 kg/L (below recommended rate); T_3- 1.5 kg/L (recommended rate), T_4- 2.5 kg/L (Above recommended rate); ppm: parts per million.

content of the samples. 250 mg of the soil sample was put in a clean, dry Kjeldah flask containing 6 ml concentrated H_2SO_4, one catalyst tablet and some pumice stones. The flask was heated gently to avoid splashing until the liquid became clear with a pale straw colour. The heating was continued for further 2 h. The liquid digest was then cooled and transferred carefully into 50 ml volumetric flask using distilled water to rinse out but leaving the pumice stones behind. The volume was made up to 100 ml with distilled water in a 100 ml standard flask. 10 ml of the digest was transferred with a pipette into the seromicro nitrogen still and 10 ml of 40% NaOH solution was added to the digester.

Distilled ammonia was liberated into 5 ml boric acid solution containing 4 drops of mixed indicator in the conical flask. The indicator turned green and distillation continued for 2 more minutes. The distillate was titrated with the standard hydrochloric acid and the end point was reached when the indicator changed from green through grey to designed red. The amount of acid consumed was noted. A blank run through the whole procedure and the burette reading was subtracted form that in titration above to get a corrected volume of standard HCl. The formula stated as follows was used to calculate the amount of Nitrogen in the sample:

Amount of Nitrogen = $V_1 - Vo/10 \times$ weight of sample (0.25 g)

Where: V_1 = titre value for the sample, V_o = titre value for the blank.

Determination of phosphorus of soil control treated soil

The phosphorus content of the sample was determined using Murphey and Riley (1962) method. 4.5 g of air-treated soil passed through 2 mm sieve were weighed into a 50 ml centrifuge tube and 30 ml of extracting solution was added. The solution was shaken for 1 min on a mechanical shaker and centrifuged at 2,000 revolutions per minute for 15 min. The suspension was decanted into a clean container. 5 ml of the extract was pipetted into 5 ml volumetric flask and distilled water was added to bring the volume to approximately 40 ml, 8 ml of antimony potassium tartarate was added and mixed thoroughly. The absorbance or optical density of the coloured solution was read at 882 nm wavelength after 30 min using a spectrophotometer (Spectronic 20).

Determination of organic carbon of soil control treated soil

The organic carbon was determined by the method outlined by the Tropical Development Institute TSRI (1984). The crucibles were dried in the oven at 160℃ for about 20 min cooled i n a desiccator and weighed. This was continued until constant weight was attained (W_1) 5 g of each samples were put in the crucible and re-weighed (W_2). The samples in the crucibles were heated at 500℃ in a muffle furnace for about 7 h. The crucibles were transferred into a desiccator, cooled and re-weighed (W3). The percentage organic carbon was calculated thus:

% Organic Carbon = $W_3 - W_1 \times 100/W_2 - W_1$

Determination of exchangeable acidity (Cmol/kg)

To determine the exchangeabkle acidity (cmol/kg), van Reeuwjk's (2002) method was used. 25 ml of aliquot of percolate into a 250 ml Erlenmeyer flask and 3 to 5 drops of phenolphthalein solution was addded. NaOH solution (0.025 M) was titrated until the colour turns just permenently pink. The exchangeable acidity was calculated as follows:

Exchangeable acidity (Cmol/kg solution)= (a-b) × M × 4 100 × MCF/S

Where: a= ml NaOH needed for percolation, b= ml of NaOH needed for blank, M= molarity of NaOH solution, S= air-dry sample weight in gram, 4= aliquot factor, MCF= mositure correction factor.

RESULTS

Physicochemical properties of controlled and treated soil

The result of the physicochemical analysis of the control and herbicide treated soils is shown in Table 1. The pH of the control soil was 5.69, while that of treated soil ranged from 5.56 to 5.94. The Nitrogen, phosphorus and organic carbon levels of the soil varied. Control soil had higher phosphorus and organic carbon, while the treated soils had higher nitrogen, throughout the period of research.

Physicochemical properties of control and pendimenthaline treated soils

Table 2 shows the pH of the control soil (T1), soil treated with pendimenthalin below recommended rate of 0.5 kg/L (T2), recommended rate level of 1.5 kg/L (T3) and above recommended rate (T4). The highest mean pH was recorded in T3 (5.94) followed by T4 (5.84) while the least mean pH was recorded in T2 (5.56). There was a significant difference ($P<0.05$) in the pH between T1, T2 and T3, T4 but there was no significant difference ($P>0.05$) between T1 and T2 and between T3 and T4. Table 3 shows the % nitrogen of the control soil (T1), soil treated with pendimenthalin below recommended rate of0.5 kg/L (T2), recommended rate level of 1.5 kg/L (T3)

Table 2. pH of control soil and pendimenthaline treated soil.

Soil treatment	Weeks				
	2	4	6	8	Mean
T_1	5.60	6.07	5.53	5.57	5.69**
T_2	5.77	5.37	5.73	5.40	5.56**
T_3	6.20	5.60	6.17	5.80	5.94*
T_4	5.57	5.40	5.73	5.87	5.84*

* Significant; ** Insignificant.

Table 3. Total nitrogen content (%) of control soil and pendimenthaline treated soil.

Soil treatment	Weeks				
	2	4	6	8	Mean
T_1	0.05	0.05	0.07	0.07	0.57**
T_2	0.06	0.56	0.44	0.13	0.29*
T_3	0.11	0.66	0.56	0.13	0.56**
T_4	0.13	0.11	0.12	0.13	0.12*

* Significant; ** Insignificant.

Table 4. Organic matter (%) of control soil and pendimenthaline treated soil.

Soil treatment	Weeks				
	2	4	6	8	Mean
T_1	1.44	1.45	1.64	1.64	1.52*
T_2	1.56	1.37	1.15	1.15	1.30*
T_3	1.56	1.14	1.17	1.17	1.26*
T_4	1.56	1.13	1.33	1.33	1.29*

* Significant; ** Insignificant.

and above recommended rate (T4). The highest mean nitrogen was recorded in T1 (0.57%) followed by T3 (0.56%) while the least mean nitrogen was recorded in T4 (0.12%). There was no significant difference (P>0.05) between T1 and T3 and between T2 and T4 but there was a significant difference (P<0.05) between T1, T3 and T2, T4.

Table 4 shows the % organic matter of the control soil (T1), soil treated with pendimenthalin below recommended rate of 0.5 kg/L (T2), recommended rate level of 1.5 kg/L (T3) and above recommended rate (T4). The highest mean % organic matter was recorded in T1 (1.52) followed by T2 (1.30) while the least mean % organic matter was recorded in T3 (1.26). There was no significant difference (P>0.05) in the level of % organic matter of the various soil treatments. Table 5 shows the mean % Phosphorus of the control soil (T1), soil treated with pendimenthalin below recommended rate of 0.5 kg/L (T2), recommended rate level of 1.5 kg/L (T3) and above recommended rate (T4). The highest mean % Phosphorus was recorded in T1 (16.13%) followed by T4 (13.37%) while the least mean was recorded in T3 (12.02%). There was no significant difference (P>0.05) in the level of % Phosphorus of the various soil treatments.

Table 6 shows the mean exchangeable acidity (Cmol/kg) of the control soil (T1), soil treated with pendimenthalin below recommended rate of 0.5 kg/L (T2), recommended rate level of 1.5 kg/L (T3) and above recommended rate (T4). The highest mean exchange-able acidity (Cmol/kg) was recorded in T1 (0.42 Cmol/kg) followed by T2 (0.4 Cmol/kg) while the least was recorded in T3 (0.36 Cmol/kg). There was no significant difference (P>0.05) in the level of exchangeable acidity of the various soil treatments.

DISCUSSION

The effect of herbicide treatment showed that herbicide treatment at recommended and above recommended

Table 5. Phosphorus content (ppm) of control soil and pendimenthaline treated soil.

Soil treatment	Weeks				
	2	4	6	8	Mean
T_1	14.43	17.10	16.0	16.0	16.13**
T_2	14.60	13.23	11.40	11.40	12.65*
T_3	14.63	11.20	11.13	11.13	12.02*
T_4	14.60	13.47	11.30	11.30	13.37*

* Significant; ** Insignificant.

Table 6. Exchangeable acidity (cmol/kg) of control soil and *pendimenthaline* treated soil.

Soil treatment	Weeks				
	2	4	6	8	Mean
T_1	0.41	0.45	0.40	0.42	0.42*
T_2	0.41	0.39	0.42	0.42	0.40*
T_3	0.41	0.39	0.32	0.37	0.36**
T_4	0.40	0.41	0.39	0.32	0.37**

* Significant; ** Insignificant.

rate (T3 and T4) resulted in significant changes in soil pH ($P<0.05$). Soil treatment at below recommended rate (T2) did not result in any significant difference in pH when compared to the control soil. These results agree with the work of Ayansina and Oso (2006) who observed significant changes in soil pH at herbicides treatment at recommended and above recommended rates in soil treated with atriazine and metolachlor. The study also revealed changes in the physicochemical properties of the treated soils. A significant increase in the nitrogen content of the soil on the site T2 and T3 was observed. Site T3 showed no significant difference to the control site.

There was a slight reduction in the organic matter in all the herbicide treated soils. The exchangeable acidity showed a significant reduction in site T3 and T4 that is 0.36 and 0.37 Cmol/kg compared to T2 and T1 at 0.40 and 0.42 Cmol/kg respectively. Phosphorus showed a decrease in the treated soils with treated soil T2, T3 and T4 showing a significant difference to the control soil. The decrease in all these essential elements suggests that they have been utilized for growth by microorganisms. The same decrease applied in the study of Kaufman and Kearney (1970) who researched on Microbial Degradation of S – Triazines herbicides. The study reveals that pendimenthaline has significant effects of the physicochemical properties of soil examined.

REFERENCES

Akobundu IO (1987). Weed science in the Tropics- Principles and practice, Wiley Interscience public, pp. 112-153.

Ayansina ADV, Oso BA (2006). Effect of Two Commonly Used Herbicides on Soil Microflora at Two Different Concentrations. Afr. J. Biotechnol., 5(2): 129-132.

Cork DJ Krueger JP (1992). Pesticide Biodegradation *in Encyclopedia of Microbiology* (Lederberg, J-ed), 3: 357-36.

Extoxnet (1993). *Pendimethalin*\available in http://pmep.cce.cornell.edu/profiles/extoxnet/ metiram-propoxur/pendimethalin-ext.html#6.

Kaufman DD, Kearney PC (1970). Microbial Degradation of S-triazines herbicides. Residue Rev., 32: 235-265.

Murphy J, Riley IP (1962). A modified single solution method for the determination of phosphate in natural waters. Anal. Chim. Acta, 27: 31-36.

Swarcewicz MK,Gregorczyk A (2011). The effects of pesticide mixtures on degradation of pendimethalin in soils, Environ. Monit. Assess. Available in http://www.ncbi.nlm.nih. gov /pubmed/21713483.

Van Reeuwjkl LM (2002). Procedure for soil analysis (6th ed.). Technical report of International soil Reference and Information Center (ISRIC). Food and Agriculture Organization of the United Nation, p. 53.