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Effects of Different Weed Management System Practices on Some Chemical Properties of Soils in University Teaching and Research Farms

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ABSTRACT

The study on the effect of different weed management techniques on some chemical properties of soil was carried out on the university teaching and research farm in Girei Local Government Area of Adamawa State. This project was aimed at determining whether there will be a difference between soil chemical properties in areas treated with herbicide and those without herbicide treatment in the study area. The soil was examined in the field during the survey period after which eight profile pits were dug. Four of the pits were treated with herbicide, while four was not treated with herbicide. The soil samples were taken to the laboratory for analysis. The pH of the soil was found to range from moderately acidic to moderate alkaline with a mean pH values of 6.52 and 6.64 in herbicide and non herbicide use respectively. The electrical conductivity was found to be very low with mean values of herbicide and non-herbicides use of 0.02 and 0.25 respectively. Organic carbon of the soil was found to be moderate. And only organic compound was found to correlation with a significant difference. The exchangeable cations were generally found to be low and the total nitrogen was also found to be low. Generally, soils with chemical weed management practices were found to differ from those managed without chemicals. The major limitation of this project is that, other factor which may cause changes in the soul chemical properties were not considered in this study. I will recommend that further research be done to eliminate all other factors that can cause a change in soil chemical properties in other to determine more accurately the effect of herbicide on soils.

Introduction

The global drive for sustainable agricultural system involves optimizing agricultural resources to satisfy human needs at the same time maintain the quality of the environment and sustain natural resources (FAO, 1989). In other to achieve this optimization, herbicide use is significant. Herbicides are substances or cultured biological organisms used to kill or suppress the growth of unwanted plant vegetation (Cork and Krugar, 1992). During the past four decades, a large number of herbicides has been introduced as pre- or post-emergence weed killers in many of the world. In Nigeria, Herbicide has been effectively used to control weed in the agricultural system (Adenikinju and Folarin, 1976). The first widely used herbicide was 2,4-dichloromephenoxyacetic acid, often abbreviated 24-D. It was first commercialized by the Sherwin- Williams Paint Company and was in use in the late 1940s. It is easy and inexpensive to manufacture and kills many broadleafs while leaving grasses mostly unaffected (although high doses of 2,4-D at a crucial growth period can harm grass crops such as maize and cereals). The low cost of 2,4-D has led to continued usage today, and it remained one of the most commonly used herbicides in the world. Like other acid herbicide, current formulation utilizes either an amine salt (usually trimethylamine) or one of many esters of the parent compound. This is easier to handle than the acid. The 1950s saw the introduction of triazine family of herbicide, which includes atrazine, which has the current distinction of being the herbicide family of most significant concern regarding groundwater contamination. Atrazine does not break down readily (within few weeks) after being applied to soil of above natural pH (Hamide et al, 2011).

Modern agriculture relies on herbicides for the control of weeds in crops and pastures to maximize yield, and improve economic benefit to sustain an increasing world population.The introduction of herbicide-resistant traits in several crops, such as glyphosphate resistant traits in several crops (GR), such as soybean, maize, and canola, has further

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increase herbicide consumption worldwide (Cerdeira and Duke, 2006). The environmental faith of herbicide is a matter of recent concern given that only a small fraction of the chemical reaches the target organisms (Pimentel, 1995) leading to the potential impact of residual herbicides in soils and water on human, animal and crop health. While herbicides are very important to agriculture, under certain circumstances, they may act as a pollutant that can deteriorate both groundwater and surface glasses of water. Herbicides do affect not only target organism but also the microbial community in the soil. These nontarget organisms may reduce the performance of soil functions. (Altimirsky and Karev,1994; Perucci and Sarponi,1994 and Hutsh, 2001) and poses a risk to the entire ecological system.

Rhizobium-legume symbioses are the primary source of fixed nitrogen in land-based systems and can provide well over half of the biological source of fixed nitrogen (Tate, 1995).Atmospheric nitrogen fixed symbiotically by the association between *Rhizobium* species and legumes represents a renewable source of nitrogen for agriculture (Peoples *et al*,1995). Members of the genus Rhizobium, upon infection of the appropriate legume, can cause the formation of nodules and participate in the symbiotic acquisition of nitrogen (Alexander, 1983). Use of herbicides for weed control in legume fields has contributed to increased yield and improved quality (Knott, 1985). Frequently, herbicides not only affect plant growth but have a detrimental effect on soil microorganisms, growth, and metabolism (*Sawicka et al, 1996*). The outcome depends on the herbicide, its concentration, and different weather conditions. Applied research methodology also may rely on the *Rhizobium* or *Bradyrhizobium* species and even the strain used (*Sprout et al*, 1992). Damin et al. (2008; 2010a) observed losses of around 10 to 20% of applied N fertilizer after the application of glyphosate and glufosinate ammonium in *Brachiaria decumbens* and *Pennicetum glaucum* In those same studies, a reduction of around 40% of the total- N in the plant was observed after the application of herbicides. From a practical point of view, the effect of herbicides on the total N of plants used for soil covering is essential because it can affect the mineralization rate due to a rise in the C:N ratio, and it can affect the immobilization of N by soil microorganisms, a process that reduces the nutrient's availability to plants. Acinelli et al. (2002) observed that the application of the recommended doses of glyphosate and glufosinate ammonium did not interfere in the activity or in the soil microbial carbon biomass. The application of higher doses than recommended resulted in greater microbial activity, which can be connected to the death of lithotrophic micro-organisms, ensuring a competitive advantage to heterotrophs. Similar results were found for glyphosate by Haney et al. (2000), Ratcliffe et al. (2006) and Zabaloy & Gómez (2008). Argenta et al. (2001) observed an increase in the C: N ratio on the aerial parts of black oats 16 days after the application of glyphosate, glufosinate, and paraquat. Because of the increased demand of inorganic fertilizers to produce crops optimally, it is evident that there is a marked decrease in crop yield per hectare. Several factors including herbicides applications may be responsible for this. Despite the importance of herbicide in agriculture, there is an indirect effect of reduction in rhizosphere exudates and organic materials due to reduction in vegetation after repeated application of herbicides.

Sustainable agriculture, to a large extent, relies on the use of herbicide for optimal production. However, the indiscriminate use of these chemicals, have raised lots of curiosity on researchers from soil science and other fields. Continues use of herbicide gradually causes a decline in organic matter content which plays a vital role in soil fertility and productivity. It is important to study the effect of herbicide on soil chemical properties, for proper management and longtime productivity.

2 Methodologies

2.1 Location and Extent of the Study Area

The study was carried out in Girei Local Government area of Adamawa state Nigeria. The area has a total population of 129,995 (NPC2006), and it is located on latitude 9° 11° and 9°39°north and longitude 12°,21° and 12°,49°east. (Adabayo1999). The area has a total land mass of about 2,186km², and it lies on the Benue River, the dominant tribe in the area are the Fulani. However, a substantial number of Bwatiya also dwells in the villages like Greng, Ntabo, and Labondo. Within the Girei Local study Government, the primary occupation of the people in the areas is farming and cattle rearing. The dominant soil type of the Local Government area are; sandy and sandy loam. Agricultural practices in the area are mainly arable crops such as maize, millet, sorghum, rice, groundnut, and beans etc.

2.2 Field Work/ Sampling

Eight (8) sites, of the total land area of 49.55 hectares was selected from a university research farm, of which four of the site has been treated with herbicide while the other four have not. Profile pits was dug on the selected sites, of university farm of Girei Local Government Area of Adamawa State. Permission was taken to dig a profile pit, and all safety precautions required was obeyed after which the profile was carefully observed to determine properties and differences between horizons. A marker was placed at the top and bottom of each horizon to identify it clearly. Four (4) samples was collected from each horizon and was properly labeled in leather bags and taken to the laboratory for analysis.

2.3 Laboratory Analysis

The samples collected were taken to the laboratory for air drying after which the samples were crushed using a wooden mortar and pestle and sieved using a 2mm sieve. Analysis was conducted for the following chemical parameters.

2.4 Soil Reaction (pH)

The pH was determined in distilled water using a glass electrode pH meter of 1:1 soil-water suspension ratio, as described by (E. J Edo et al, 2009).

2.5 Organic Carbon

The organic carbon was determined using the Walkey Black (1934) method.

2.6 Exchangeable Acidity (EA)

Exchangeable acidity was determined using titration method.

2.7 Exchangeable bases (EB)

Exchangeable bases were determined using EDTA titration method for Mg and Ca and using flame photometer for K and Na will be determined.

2.8 Effective Cation Exchange Capacity (ECEC)

The effective cation exchange capacity was determined by summing up the exchange cations and exchangeable acidity (blank 1965).

2.9 Available Nitrogen

The available nitrogen was determined using the normal Kjeldahl digestion methods as determined by Jaiswal (2003).

3.0 Statistical Analysis

In this study, results were presented in there means and illustrated with tables and the statistical analysis used for this analysis is a correlation

3 Results and Discussion

3.1 Soil Reaction (pH)

The soil without herbicide treatment has meant in the first pedon as 6.67. While those in the second third and fourth pedons have values of 6.39, 6.63, and 6.26 respectively. In soils that have been treated with herbicide, the mean pH value of the first pedon is 6.67, while the mean pH value of the second third and fourth 6.56,6.67, and 6.62 respectively. The pH of non-herbicide use ranges from 6.32 to 7.72 in pedon one, from 6.31 to 6.59 in pedon two, from 5.9 to 7.46, in pedon three, from 6.06 to 6.50 in pedon four. Non-herbicide use soils have mean values of 6.65. In the herbicide use, pedon one range from 6.41 to 7.40, pedon two from 6.37 to 6.80, pedon three from 6.20 to 7.62, and pedon four from 6.31 to 6.99. The herbicide used soils have a mean value of 6.63. Generally, the pH values of soils of this area ranges from 5.90 to 7.70. This implies that the soil ranges from moderate acidic to alkaline. Similarly, ph value was also reported by (Ugban Joice, 2010) in Amau Memorial Farm in Girei Local Government Area, Yola Adamawa State.

3.2 Electrical Conductivity (EC)

E. C of non -herbicide use for first pedon has a mean value of 0.03d/Sm. Non-herbicide use for second, third and fourth pedons have mean values of 0.03, 0.04, 0.02, and 0.02dSm-1 respectively. The E.C of non-herbicide use for pedon one range from 0.02 to 0.03dsm-1 in pedon two, from 0.01 to 0.03dSm-¹ in pedon three and from 0.02 t0 0.04dSm-1 in pedon for. The mean value of non-herbicide use is 0.03dSm-1. While that of the herbicide pit 1, pit 2, pit 3, and pit 4 have E.C value ranging from 0.01 to 0.04, 0.02 to 0.05, 0.01 to 0.03 and 0.02 to 0.03dSm-1 respectively with a mean value of 0.03. generally, the EC value falls below 0.4dSm-1 which implies that the soil is not saline.

3.3 Organic Carbon (OC)

The Organic Carbon content of the study areas ranges from 0.59 to 1.71%. the mean values of soils without herbicide treatment in pedon one, two, three, and four ranges from are 1.03, 1.01, 1.19, and 1.06% respectively. The mean value of non-herbicide use is 1.07%. In the herbicide use, the mean organic carbon of the first, second third and fourth pedons are 1.01, 0.82, 0.99, and 1.05 respectively. The mean value of organic carbon in the pits of herbicide use is 1.03. The organic carbon content of the soil range from low to high but most of the samples falls within the moderate range (Aduayi etal, 2002). The mean values of non-herbicide use indicates that the area generally have moderate organic carbon content.

3.4 Total Nitrogen

The total nitrogen which is shown in table 1 indicates that it ranges from 5.00 to 12.14mg, the mean value of first second third and fourth pedons are 7.33, 7.15, 9.11, and 8.08 respectively for non-herbicide use soil, and the mean value of the non-herbicide use soils is 7.95 mg/kg. while the mean values of herbicide use for first, second third and fourth pedons are 7.50, 6.97, 7.14 and 7.86/kg respectively. The mean value of the herbicide use pits is 7.38mg/kg; this shows that the total nitrogen in the soil is low. This may be as result of nitrogen consuming crops cultivation, like maize and most cereals.

3.5 Available Nitrogen (AVN)

The available nitrogen of the soils in the study area of non-herbicide use has mean values of the first, second third and fourth pedons of 0.25, 0.23, 0.37, and 0.22mg/kg n respective1y. The mean value of non-herbicide use is 0.27mg/kg. In herbicide use, the mean value of first, second, third and fourth pedons are 0.30, 0.24, 0.14 and 0.89mg/kg respectively. The mean value of herbicide use soils is 0.53mg/kg. The soil in the study has values ranging from 0.05 to 0.60 mg/kg in herbicide use areas soils of all pedons, while those of non-herbicide use for all horizon ranges from 0.05 to 0.70mg/kg.

3.6 Total Exchangeable Acidity (TEA)

The total exchangeable acidity is shown in table 1 and table2. The mean values in the first, second, third and fourth pedons are 1.10, 1.20, 1.30 and l.25Cmo1kg' in non-herbicide use soils. The mean value of the soils is 1.21. The mean values of herbicide use z first, second, third and fourth pedons are 1.30, 0.70, *0.95* and 2.25Cmo1kg respectively. The mean value of the pits is 1.38.

3.7 Exchangeable Bases (EB)

The results for exchangeable bases are presented in tables below. The of bases were found to be low throughout the pedons of the eight pits.

3.7.1 Exchangeable Calcium (Exch. Ca^{+}).

In the first, second third *and* fourth horizon, the exchangeable calcium (Ca^{2+}) ranges from 1.20 to 3. 80Cmol/kg in non-herbicide use soils, while those in the herbicide use soils for all pedons ranges from 1.20 to 3.80Cmol/kg. This implies that the soil in the area has low calcium (Usman, 2005).

3.7.2 Exchangeable Magnesium (Exch. Mg^{2+}).

The exchangeable magnesium in soils treated with non-herbicide ranges from 0.20 to 2.80 in all pedons and from 0.2 to 2.8 herbicide use soils. Therefore the magnesium level ranges from low to moderate in all samples (Usman, 2005).

3.7.3 Exchangeable Potassium. (Exch. K^{+}).

The exchangeable potassium of the soil ranges from 0.23 to 2.56Cmol/kg in non- herbicide use soils in all pedons and ranges from 0.26 to l.74Cmol/kg in herbicide use soils in all horizons. Therefore the exchangeable potassium ranges from low to high in the soils (Usman, 2005).

3.7.4 Exchangeable Sodium (Exch. Na^{+}).

Exchangeable sodium of non-herbicide used soils in all pedons ranges from 0.09 to 0.26Cmol/kg while that of herbicide use for all pedons ranges from 0.09 to 0.22Cmol/kg. This is an indication that the exchangeable sodium is low (Usman, 2005).

3.7.5 Total Exchangeable Bases (TEB)

The mean values of the total exchangeable bases for first, second, third, and fourth peons are 3.87, 4.87, 3.43, and 4.23Cmol/kg respectively for non-herbicide use soils, while the mean value of non-herbicide use soils is 4.10Cmol/kg. The mean values of herbicide use soils in the first; second, third and fourth pedons are *3.56*, *3.75*, 4.48, and 4.54Cmol/kg respectively. The value of herbicide use soils is 4.08Cmol/kg. The value of the soil of non-herbicide use of all pedons ranges from 2.41 to 6.49 while that of herbicide use for all pedons ranges from 2.69 to 6.61. This shows that the total exchangeable bases are low (Kparmwang *et al.* 2000).

3.8 Effective Cation Exchange Capacity (ECEC).

The mean values of the effective cation exchange capacity of first, second, third and fourth pedons are 4.97, 6.07, 4.73 and 5.63Cmol/kg respectively in non-herbicide use soils. The mean value of non-herbicide use soils is 5.35Cmol/kg. The mean values of first, second, third, and fourth pedons are 4.83, 4.68, *5.43* and 7.09Cmol/kg respectively for herbicide use soils. The mean value of herbicide use soils is 5.5l Cmol/kg. The values in the non-herbicide use in all pedons ranges from 3.44 to 7.69Cmol/kg while that of herbicide use ranges from 3.49 to 9.25Cmol/kg in all pedons.

Table 1. Chemical Properties of the Study Area.

Sample	*pH*	*EC dS/m*	*OC %*	*Exch. Ca^{2+} Cmol/kg*	*Exch. Mg^{2+} Cmol/kg*	*Exch. K^{+} Cmol/kg*	*Exch. Na^{2+} Cmol/kg*	*TEB Cmol/kg*	*TEA Cmol/kg*	*ECEC Cmol/kg*	*AVN Cmol/kg*	*TN Cmol/kg*
HU PT1 (0-30)	7.40	0.01	1.06	1.80	0.20	0.56	0.17	2.73	1.00	3.73	0.14	7.86
(30-60)	6.43	0.04	0.99	1.60	0.60	0.66	0.17	3.03	1.60	4.63	0.24	7.14
(60-90)	6.41	0.03	0.98	1.40	0.40	0.17	0.17	3.71	2.00	5.71	0.10	7.14
(90-130)	6.42	0.02	1.07	1.20	3.00	0.26	0.22	4.63	0.60	5.23	0.70	7.86
HU PT2 (0-40)	6.64	0.04	1.14	1.60	1.80	0.33	0.13	3.95	0.20	4.15	0.12	6.43
(40-60)	6.37	0.05	0.19	3.20	0.60	0.74	0.09	4.67	1.20	5.87	0.08	7.14
(60-85)	6.44	0.02	1.08	2.00	1.00	0.61	0.13	3.70	0.60	4.30	0.05	7.86
(85-120)	6.80	0.03	0.86	0.80	1.40	0.36	0.13	2.69	0.80	3.49	0.70	6.43
HU PT3 (0-30)	6.63	0.01	0.99	3.80	2.40	0.28	0.13	6.61	0.80	7.41	0.24	7.14
(30-80)	7.62	0.03	1.10	3.00	0.60	0.36	0.13	4.09	0.60	4.69	0.18	7.86
(80-120)	6.20	0.03	0.87	2.80	1.00	0.31	0.22	4.33	1.80	6.13	0.08	6.43
(120-150)	6.22	0.02	0.99	1.80	0.60	0.36	0.13	2.89	0.60	3.49	0.05	7.14
HU PT4 (0-40)	6.66	0.03	1.19	1.80	2.40	0.28	0.13	4.61	0.80	5.41	0.34	8.57
(40-90)	6.70	0.02	1.33	2.80	1.80	1.17	0.13	5.90	2.40	8.30	0.26	9.29
(90-130)	6.13	0.02	1.16	2.20	1.40	0.28	0.13	4.01	1.40	5.41	0.14	8.57
(130-150)	6.99	0.02	0.73	1.40	1.80	0.28	0.17	3.65	5.60	9.25	0.15	5.00

Table 2. Chemical Properties of the Study Area.

Sample	*P^{H}*	*EC dS/m*	*OC %*	*Exch. Ca^{2+} Cmol/kg*	*Exch. Mg^{2+} Cmol/kg*	*Exch. K^{+} Cmol/kg*	*Exch. Na^{2+} Cmol/kg*	*TEB Cmol/kg*	*TEA Cmol/kg*	*ECEC Cmol/kg*	*AVN Cmol/kg*	*TN Cmol/kg*
NHU PT1 (0-30)	6.60	0.03	1.14	1.20	0.80	0.28	0.13	2.41	1.80	4.21	0.13	7.86
(30-90)	6.39	0.03	0.88	3.20	0.60	0.36	0.22	4.38	0.20	4.58	0.15	6.45
(90-110)	7.72	0.02	1.12	3.80	1.00	0.23	0.22	5.25	1.20	4.45	0.10	7.86
(110-150)	6.32	0.04	0.98	2.60	0.40	0.26	0.17	3.43	1.20	4.63	0.60	7.14
NHU PT2 (0-50)	6.13	0.02	1.28	2.20	0.40	0.31	0.13	3.04	0.40	3.44	0.39	9.29
(50-90)	6.33	0.02	1.14	2.60	1.20	2.56	0.13	6.49	1.20	7.69	0.35	7.86
(90-110)	6.59	0.02	0.93	1.40	2.80	0.28	0.13	4.61	1.60	6.21	0.05	6.43
(110-150)	6.50	0.02	0.67	2.60	2.20	0.13	0.22	5.33	1.60	6.93	0.14	5.00
NHU PT3 (0-40)	5.90	0.03	1.71	2.00.	0.40	0.23	0.13	2.76	1.20	3.96	0.43	12.14
(40-80)	6.67	0.02	1.30	1.20.	1.40	0.26	0.09	2.95	1.60	4.55	0.42	9.29
(80-120)	6.50	0.01	1.15	2.00	1.00	2.44	0.13	5.57	0.60	6.16	0.24.	10.71
(120-150)	7.46	0.02	0.59	1.20	0.80	0.31	0.13	2.44.	1.80	4.24	0.38	4.29
NHU PT4 (0-50)	6.04	0.03	0.78	1.40	1.00	2.56	0.22	5.18	1.80	6.98	0.24	5.71
(50-80)	6.50	0.02	1.15	1.40	2.40	0.31	0.26	4.36	0.80	5.16	0.15	10.71
(90-120)	6.20	0.02	1.26	1.60.	1.40	0.26	0.17	3.43	1.60	5.63	0.33	9.29
(120-150)	6.30	0.04	1.05	2.40	1.00	0.36	0.17	3.93	0.80	4.73	0.16	7.14

These values indicate that the soil is low in Effective Cation Exchange Capacity (Kparmwang *et al.* 2000). This may be due to the parent material of the soil, nutrient depletion as a result of its continuous cultivation, erosion and poor soil management in general.

3.9 Correlation Studies

Herbicide use soils were correlated with non-herbicide use for all parameters. Soil reaction (pH). electrical conductivity (EC), total exchangeable bases (TEB) and total exchangeable acidity (TEA) all showed a negative correlation with no significant difference between them. Organic carbon (OC), total nitrogen, available nitrogen (TN), and effective cation exchange capacity (ECEC) all showed a positive correlation, with only organic carbon having a significant difference.

The correlation was also carried out between parameters of herbicide use soils.

Correlation of pH with electrical conductivity, organic carbon, total nitrogen, available nitrogen, and total exchangeable acidity all had negative correlations with no significant difference.

Only total exchangeable bases and effective cations exchange capacity had a positive correlation with no significant difference. EC was correlated with all other parameters, of which pH, effective cation exchange capacity, and organic matter had a negative correlation with no significant difference, total exchangeable bases had a negative correlation with significant deference, total exchangeable acidity and available nitrogen are positively correlated with no significant difference. Correlation of organic carbon with other parameters showed a negative correlation with only total nitrogen having a significant difference for all other parameters except for total exchangeable bases which shows a positive correlation with no significant difference. Correlation of aa1 nitrogen with pH, electrical conductivity, available nitrogen, and total exchangeable acidity all had negative correlations, with only organic carbon having a significant difference.

4. Conclusions

This study was carried out on the soils of the university research farm of the Modibbo Adama University of Technology,

Table 3. paired sampled correlations.

Pairs		Number	Correlation	Significance
Pair 1	H. USE pH and N.H USE pH	4	-0.890	0.110**
Pair 2	H. USE EC and N.H USE EC	4	-0.707	0.293**
Pair 3	H. USE OC and N.H USE OC	4	0.958	0.042*
Pair 4	H. USE TN and N.H USE TN	4	0.936	0.064**
Pair 4	H. USE AVN and N.H USE AVN	4	0.624	0.376**
Pair 6	H. USE TEB and N.H USE TEB	4	-0.042	0.958**
Pair 4	H. USE TEA and N.H USE TEA	4	0.390	0.610**
Pair 8	H. USE ECEC and N.H USE ECEC	4	0.605	0.586**

*Correlation is significant at 0.05 level (2 tailed)
**correlation is not significant at 0.05 level (2 tailed).

Girei Local Government Area, Yola, Adamawa State.The aim of this study is to determine whether there will be a change in some chemical properties as a result of herbicide application on the field. Literatures were review. The work was categorized in two phases, the field and the laboratory work. The field work involved field survey, the sinking of profile pits, and sample collection while the laboratory work involved sample analysis. The result shows that organic carbon is lower in the area used with herbicide. The result also indicates that, only organic carbon shows a positive correlation with a significant difference between herbicide use and non herbicide use.The result obtained shows that the soil in the study area is moderately acidic to slightly alkaline, pH ranges from *5.9* to 7.72. The electrical conductivity of the soil is low, with EC ranging from 0.01 to 0.05d5/m. The low electrical conductivity of the soil indicates that the soil has low nutrient and is not saline. The soil has low cation exchange capacity with values ranging from 3.49 to 9.25*Cmol/kg.* The soil organic carbon is moderate with values ranging from 0.59 to 1.71%, and mean values of 1.07 and 0.97 for 20n-herbicide and herbicide use respectively. There is no significant difference in corre1ation between the soils cultivated with herbicide application and those without herbicide application for most parameters, except for organic carbon which has a significant difference.

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