Investigation note

Chromatography of Pfaiffer in the analysis of soils of productive systems

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Abstract

The Pfaiffer chromatography is a qualitative analysis technique that can be used in soils, composts and biofertilizers, being able to quickly observe the relationship between microorganisms, organic matter and minerals, as elements that compose them. For the agricultural producer, it is important to know the conditions of the soil or supplies that he uses to obtain better results in his crops. The objective of the work was to perform Pfaiffer chromatography to analyze the soils of productive systems and compare some qualitative characteristics. The soil samples were taken at random from different plots, the first one with conventional agronomic management, the next one from a land with temporary production and the last one from an organic production system, were analyzed by Pfaiffer chromatography separately. The chromatograms were interpreted, being able to observe that the three types of soil provide the characteristics of the farming system to which they belong.

Keywords: chromatograms, conventional, organic, temporal.

Reception date: April 2018
Acceptance date: May 2018

With the so-called biodynamic agriculture of Rodolf Staineren in 1924, his student of biochemistry Ehrenfried Pfeiffer, found that a solution of 1% sodium hydroxide, in a sample of living soil was sufficient to solubilize the nitrogenous substances of the metabolism of the microorganisms present in she and they reacted on a special filter paper impregnated with silver nitrate and then revealed a series of specific colors, shapes and distances, which is now known as complex substance separation and analysis techniques to identify soil and compost behavior patterns in its two phases, one mobile and the other stationary (Restrepo and Piñeiro, 2011).

Agricultural production systems represent a set of inputs, techniques, labor, land tenure and organization, to obtain agricultural products, in a sustainable environment must conserve productive resources while taking care of the environment and socially justified (Martellotto *et al*., 2001). In conventional production systems, it is common for the process to happen, the degradation of organic matter to its mineral constituents, favoring carbon oxidation and CO_2 release (Gallardo, 2001). On the contrary, organic or conservation agriculture favors humification of the organic matter leaving the bioelements trapped and released slowly, the action of the edaphon solubilizes and releases the nutrients to be absorbed by the plants (Kolmans and Vásquez, 1999).

Soils are living entities affected by anthropogenic activities and erosion is the main cause of their destruction, with inadequate work can be lost by the effect of rains and wind around 200 t ha^{-1} $year^{-1}$ and with it about 200 kg of nitrogen, 300 kg of phosphorus, 2 000 kg of potassium, 2 000 kg of organic matter (Kolmans and Vásquez, 1999).

According to Primavesi (1984) to improve soil structure and prevent erosion of the topsoil, the incorporation of crop residues must be in the first 15 cm and maintain an adequate vegetal cover, thus ensuring an aerobic decomposition, however conventional agriculture with its mechanized tillage practices, bury the plant material at 40 cm and hardens the soil because it loses structure, the porosity decreases the same as the bacteria fixed nitrogen, for Restrepo (2012) another cause of the imbalance is the use of synthetic fertilizers and agrochemicals.

In search of improving the soils and taking care of the environment, the farmers find an alternative in the organic fertilizers fermented in aerobic conditions, using local resources of low cost in their elaboration (Shintani *et al.*, 2000).

The objective of the work was to perform Pfaiffer chromatography to analyze the soils of productive systems and compare some qualitative characteristics.

Preparation of filter paper

The Whatman No. 1 filter paper was impregnated in a 0.5% silver nitrate solution, initiated from the center to the first 3.5 cm, covered with an absorbent paper and reserved in the dark.

Sampling of three soils

Soil samples were collected from three production systems, were taken at random from 15 different points following the zigzag technique and three depths: at 0 cm, 10 cm and 20 cm, obtaining a total of 45 subsamples per plot of 500 g each one, they were mixed to obtain a representative 500 g of each plot.

Floor sample of conventional system

The first plot sampled was in the community of Puerta of Monte in the municipality of Salvatierra, Guanajuato, was selected for its conditions to produce throughout the year intensively, with irrigation system, mechanized tillage, fertilization with synthetic products and control of pests, diseases and weeds based on agrochemicals.

Sample of temporary system soil

The second was taken from a rainfed crop in the hill of Culiacán in the municipality of Salvatierra, Guanajuato, chosen for the situations in which poor farmers work regularly, combining synthetic fertilizers with manure and control of pests and diseases with agrochemicals. the control of weeds is carried out manually, during the rest of the dry season the soil is fallow and left without vegetal cover, the tillage is carried out 50% mechanized and 50% with yoke of draft animals.

Organic system soil sample

The third sample was obtained from the property called Santa Cruz of Ojo of Agua of the municipality of Epitacio Huerta, Michoacán, of a soil with 5 years of organic cultivation with use of compost, biofertilizers and beneficial microorganisms, its tillage is carried out in 80% with draft animals and 20% mechanized. It is important to know the behavior of the soil in a regenerative situation.

Preparation of soil samples

The sun-dried samples are ground in a porcelain mortar until they are well pulverized, after sieving, 5 g are weighed, 50 ml of a 1% sodium hydroxide solution are added in a beaker, shaken gently with water, and then stirred. Repeats of 7 on the right and on the left repeating the series at 15, 30 and 60 min to let it rest for at least 6 hours.

Run of the samples on the filter paper

From the diluted soil sample, take 10 ml and add it in a petri dish where the filter paper is already impregnated with silver nitrate, run up to two centimeters from the edge and then let it dry.

Results analysis

It was taken into account for the interpretation of the chromatograms the zones that compose the chromatogram (central zone, inner zone, intermediate zone, external zone and management area), their size, shape, revealed colors and the harmony and integration of their revealed parts (Figure 1), according to the criteria of Restrepo and Piñeiro (2011).

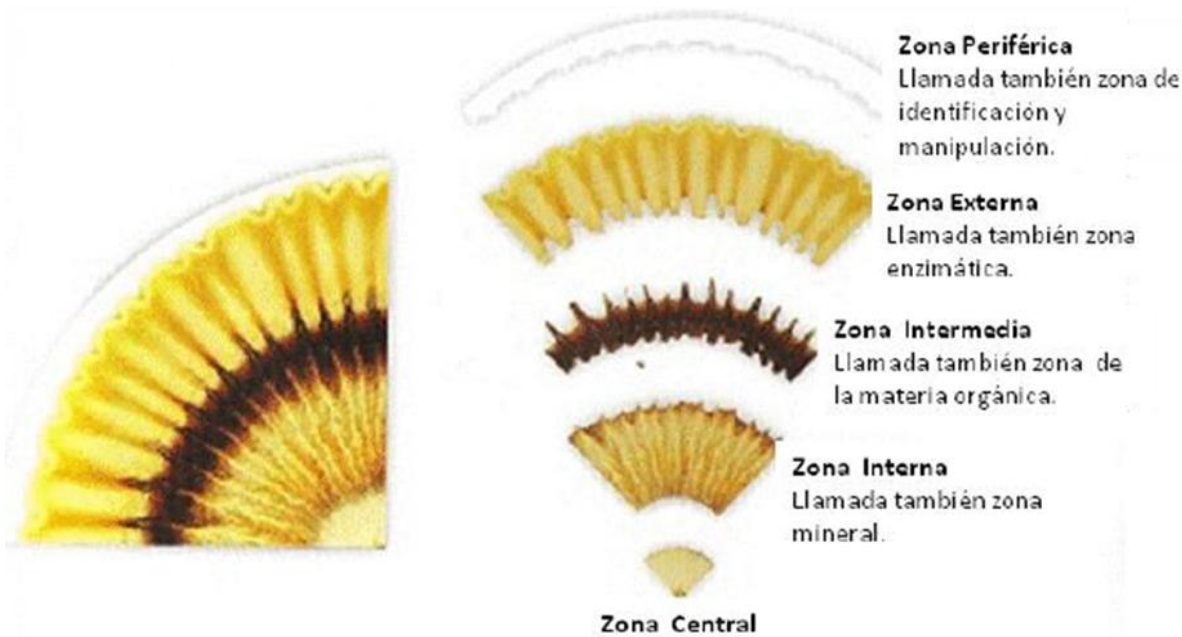

Figure 1. Areas of a Pfaiffer chromatogram (Restrepo and Piñeiro 2011).

In the Figure 2 shows the result of the preparation of the filter paper with the silver nitrate that was reserved in the dark for use with the soil samples.

Figure 2. Number 1 Whatman filter paper impregnated with 0.5% silver nitrate.

After 6 h of rest and being run on the filter paper prepared with the silver nitrate, the results of the three soils sampled were obtained (Figure 3).

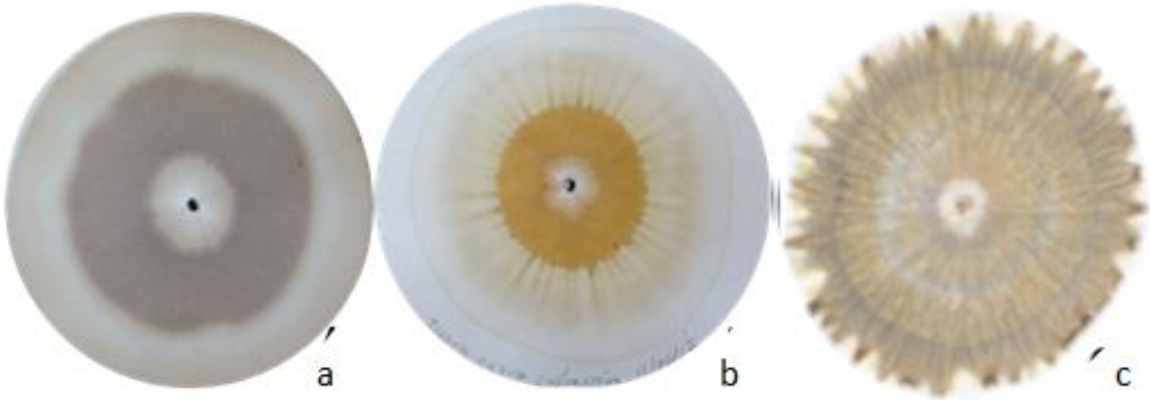

Figure 3. Soil chromatograms of systems: conventional (a); of temporary (b); and organic (c).

The Figure 4 shows the result of the conventional system soil, where it is observed that in zone 1 (Z1) or internal is wide and clear, well delimited result of the use of nitrogen fertilizers, zone 2 (Z2) or mineral strip is of blackish brown color indicative of a compacted, mineralized soil, destroyed organic matter and absence of biological activity therefore the enzyme zone has no presence.

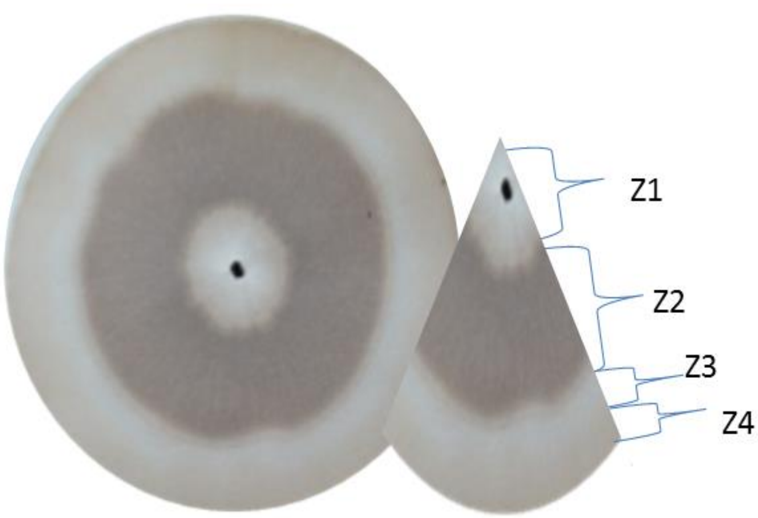

Figure 4. Conventional system chromatogram in Puerta of Monte.

In the Figure 5 of the temporary crop the internal zone shows a white coloration of irregular shape by the use of fertilizers and manure, the golden color of zone 2 or internal (Z2) with a well-defined strip, indicates that the minerals are isolated of little organic matter, microbiology and enzymatic activity as a result of a bare and eroded soil.

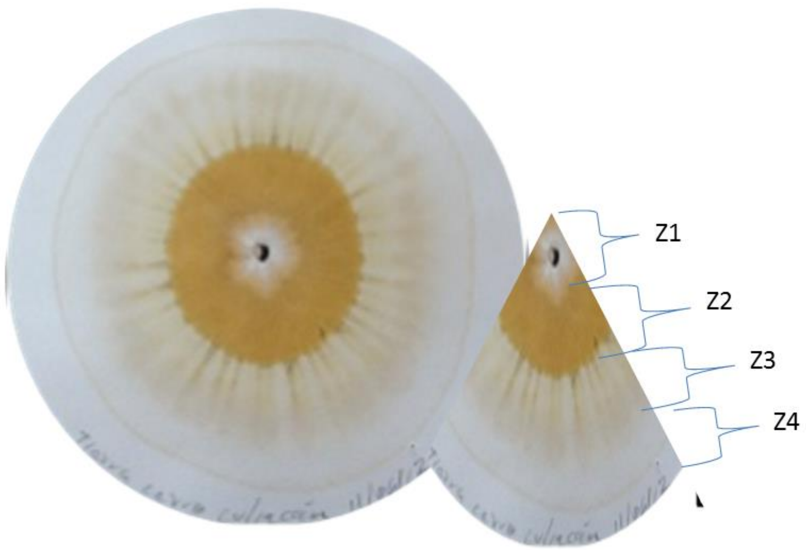

Figure 5. Chromatogram of storm system in the Hill of Culiacán.

In the Figure 6 shows the result of the organic soil where it indicates the integration of all its zones (Z1, Z2, Z3, Z4), abundant enzymatic activity, with good presence of organic matter and minerals integrated by the microbiological activity as a consequence of 5 years of ecological tillage.

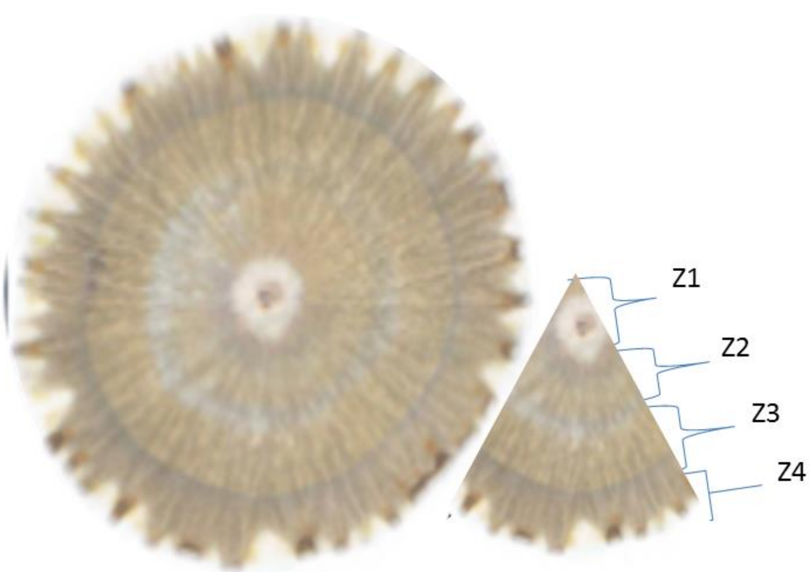

Figure 6. Chromatogram of organic production system in Santa Cruz of Ojo of Agua.

After the chromatograms of the different production systems were revealed and analyzed, a comparison of them was made (Table 1).

Table 1. Comparison of chromatograms of production systems.

Production system	Characteristics of the different zones of the chromatograms			
	Central zone	Internal zone	Intermediate zone	Peripheral zone
Conventional system (Puerta of Monte)	Brownish white color due to excess nitrogenous fertilizers	Black color indicative of a compacted soil	Absent	Absent
Temporary system (Hill of Culiacán)	White and irregular coloration due to fertilizer and manure nitrogen	Golden coloration isolated from the others, are isolated minerals	Light radiations indicative of low organic matter	Absent
Organic system (Santa Cruz of Ojo of Agua)	Creamy color, fades to integrate to the next area	Light brown collation integrated to the following zones, minerals available for the plant	Light brown coloration and radiations reveal organic matter integrated by microbiology	Dark brown coloration and ripples says of good enzymatic and protein activity

In the zone 1, called central zone (Z1) in the conventional agriculture floor of Puerta of Monte (Figure 4), found a slightly brown, broad and well-defined white color without integrating into the next zone (Z2), it is an indicative of excess of nitrogen fertilizers, something similar happens in the storm system of the Hill of Culiacan (Figure 5) with white collation although in smaller amount because the fertilization is based on chemical fertilizers combined with manure, on the contrary the case of the same one organic soil of Santa Cruz of Ojo of Agua (Figure 6) its coloration is creamy white and related to zone 2 (Z2), indicates the good structure of the soil, without compaction and presence of organic matter.

In zone 2 (Z2) of the analyzed chromatograms they showed the mineral strip and in the case of the Puerta of Monte soil (Figure 4) it is blackish brown and is mineralized, organic matter destroyed and without biological activity, in it But the soil of the Hill of Culiacán (Figure 5) is golden in color with a well-defined fringe indicating little relation to the little organic matter, so they are isolated minerals, the Santa Cruz of Ojo of Agua chromatogram (Figure 6) is of creamy colorations, light and dark coffee, with integration with the other zones indicating the good structure, efficient biological activity and good amount of organic matter.

In relation to zone 3 (Z3) of the chromatograms, called intermediate zone, zone of organic matter or protein, in the chromatogram of conventional soil (Figure 4) is absent indicative of the scarce organic matter; for the temporary soil (Figure 5) its chromatogram indicates a slight amount of organic matter but no microbiology that integrates the minerals; you found the organic terrain (Figure 6) because of its light brown shapes and colors, it shows harmony between organic matter, minerals and microbiology, a sign of good health of the system.

The Zone 4 (Z4) or external zone also called enzymatic and nutritional zone, for the case of the chromatogram of the conventional system (Figure 4) is absent without manifesting any reaction, in the chromatogram of the temporal soil (Figure 5) it is practically absent and the organic soil in its chromatogram shows the presence of humus, with the undulations and soft spots are indicative of the relationship of organic matter with minerals and microbiology.

According to Restrepo and Piñeiro (2011), the soil of the conventional production system (Figure 4) is an exhausted soil, affected by the intensity of its production, deep mechanization and the intensive use of fertilizers and agrochemicals, affecting the humification of the soil. organic matter with a rapid mineralization of its elements (Primavesi 1984; Gallardo, 2001), the corresponding chromatogram (Figure 4) indicates the excess of nitrogen in its central zone (Z1), element with serious problems of erosion, in addition to its dark color of its internal zone (Z2) without organic matter or enzymatic activity as a consequence of the absence of biological activity (Kolmans and Vásquez, 1999).

In a rainfed cropping system it is customary to finish the crop to fallow the land and if there are no more rains the soil remains uncovered, according to Primavesi (1984) and Restrepo (2012) it affects the soil structure and its incorporation of organic matter affecting microbiology, the image of the chromatogram of this soil (Figure 5) indicates its golden coloration of the internal zone (Z2) with minerals that are not integrated by the low organic matter and active microbiology, with serious problems of erosion.

A soil worked with compost, biofertilizers and efficient microorganisms improves in its structure, organic matter and minerals available in a constant way due to the presence of biological activity (Kolmans and Vásquez, 1999; Gallardo, 2001), in a chromatogram such as that of the Santa Cruz of Ojo of Agua (Figure 6) with an organic production system shows the good health of its soil by the shapes, colors and harmony that its different zones keep (Restrepo and Piñeiro, 2011).

Conclusions

The Pfaiffer chromatography is a simple and useful technique for quickly discovering the qualities and conditions of a soil. The three production systems expressed the particular characteristics of their way of working, being the Pfaiffer technique a useful tool that reveals the characteristics of the tillage systems.

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