Effect of Some Ecological Factors on Earthworms (*Lumbercus terrestris*) in Wasit Governorate

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KEYWORDS

Ecological factors, Distribution, Earthworms, Wasit.

ABSTRACT

Monthly earthworm samples were collected from two locations in Suwairah City of Wasit Governorate. where the first location was northwest of the district and is characterized by an abundance of citrus trees such as orange, lemon and Punica granatum as well as many palm trees of different types, the second area is characterized by an abundance of vegetable plants like Cauliflower, Allium cepa, and Brassica oleracea. Soil temperature, moisture, pH, texture and organic matter levels were measured at all sample sites. Soil temperature ranged between 11C° to 50C° as recorded during February and August respectively. The values of PH have ranged between 6.8 to 8.0. Soil moisture and Organic matter content were highest in Region (B) samples, 40% and 6.6% respectively. However, lowest organic matter and soil moisture percentage were 17% and 3.13% recorded at in Region (A) samples respectively. All sites were characterized by loamy acidic reactive soils.

1. Introduction

Earthworms are invertebrate animals, play a major role in the proper functioning of the soil ecosystem, belong to the class Clatellata and subclass Oligochaeta under the phylum Annelida and can be categorised into several ecological groups basing on their physiology along with feeding and burrowing behavior (Acharya and Mishra, 2020). Earthworms are major decomposed in the soil ecosystem they increase of the nutrient turnover by breakdown of dead roots, the burrowing increase of porosity and aeration in the soil (Massey University, 2015). The presence of earthworms in the soil is an important and necessary component of the soil system, mainly due to their positive effects on soil structure and function. Earthworms also help increase soil fertility, so they referred to a farmer friend and considered them a source of protein. (Mathur *et al.,* 2010; Chachain and Jamil,2017).

Earthworms are great important in the environmental which is well known since antiquity as mentioned by Aristotle and surnamed intestine of earth for its role in the decomposition of plant leaves into organic compounds and inorganic simple (Veeramani,2010). Earthworms constitute the highest biological component of soil among all animal biomass contents in soil and are commonly referred as ecosystem engineers (Blouin *et al.*, 2013). they are known to constitute more than 80% of the soil invertebrate biomass and have profound effects on ecosystem (Nainawat and Nagendra, 2001; Acharya *et. al.*, 2020). Earthworms are natural burrowers, they devour organic matter in the soil and release feces or castings along with the decomposing manure. Castings are small, round pads or balls that create porosity in the soil, which helps the soil retain water., aeration, and microbial growth in the soil. Soil.

In rapid biofertilizer formation, earthworms are found to change organic matter into compost or vermicompost within a short period. In the natural process, one ton of decomposed organic fertilizer is produced in six months while the same amount of fertilizer can be obtained by using a thousand earthworms in one month, thus earthworms emerge as a unique biofertilizer agent and are referred to as mini fertilizer plant, also in agriculture. The availability of resources necessary for the survival of earthworms is directly and indirectly affected by the physical and chemical properties of the soil (Bhaskar Mahanayak *et.al.*, 2017). Soil structure and pore size also play a major role in the distribution of earthworms within the soil and subtle changes therein can negatively impact earthworm community structure. The distribution of earthworms depends on their proximity to human habitat, as moist soil rich in organic matter is the preferred habitat. (Dorsey *et.al.*, 2006; Schon *et.al.*, 2017; Singh *et. al.*, 2020) . There are many factors affecting the distribution of earthworm like temperature, pH, organic matter, moisture and soil texture (Moreno and Mischis, 2004). Soil moisture play good role on movement and breathing oxygen of earthworms while any change in temperature affect the activity of earthworm (Holmstrup, 2004). PH important for earthworms because increased or decreased in PH value lead to kill earthworm (Chan *et.al.*,2003). There is a relationship between earthworms and type of soil, some of species preferred chalky soil or loam while others like mud soil more than sand and graves (Hernandez *et.al.*,2003; Al-Khafagi *et.al.*, 2013).

Several research works have been recorded that have been conducted all over the world that investigate the relationship between soil properties, earthworm activity and environmental factors, and the increasing importance of earthworms has been noted. Various ecological studies have reported the close relationship between the availability of different earthworm species and different land use patterns. (Nunes, Pasini, Benito, & Brown, 2006; Tao *et al.*, 2013; Sankar and Patnaik, 2018), as well as Al-Khafagi *et.al.*,2013) study Effect of ecological factors on the distribution of earthworms in Baghdad.

Temperature has an effect on distribution of earthworms, It affects the incubation period of cocoons. Where high temperature decreased incubated of epigeic worms instance of *E. eugeniae* ((Emmerling and strunk ,2012; Vasanthie *et al.*, 2013). Positive relationship between temperature and juvenile growth when food availability the species *A. tuberculate* , *L. terrestris* and *Eudrilus eugeniae* the range of temperature to survival the species 7-35 ºC(Ogbonna and Berebon,2013). The surface covered with straw or stubble reduces fluctuations in soil temperature and affect the earthworms, at high temperature earthworms move towards the depths of the soil to avoid high temperature (Holmstrup,2004).

Physico- chemical soil properties that effect on earthworm distribution (Emmerling & Strunk.2012). Soil properties including: pH, electrical conductivity K ,Mn, Cu ,S and Ca concentrations has an effect on native , total or juvenile earthworms densities in different treatment combinations. Here it can be utilized to a biological treatment soil (ALKhafagi *et al*.,2010).Earthworms have an effect on the environmental factors (AL-Khafaji, 2011) Explained earthworms effect on change pH 6.5 , moisture rate 66.8- 74.6 and temperature 30 and 35ºC during studies that mean earthworms effect on physical properties and effect on microbial properties that they reduced of the numbers of total bacteria , colon bacteria and fungi . also effect on chemical properties such as organ matter increases rate to 3.51% , increase of Potassium 97%, Phosphate 47% and Nitrogen 0.089%. Earthworms improve soil stability , the physical structure of soil , more pH stable , moisture and porosity and improve root growth by Creating channels with nutrient for plant (Nature's way Resources ,2012) .

Influence of earthworms on soil organ matter remains in conclusive, several studies shown earthworms have been acted to stabilize soil carbon by rapidly in corpora ting organic residue into micro aggregates within macro aggregates (Fonte et al.,2009) . Which is considered as one of the key indicators of soil quality. Most of features of soil affected by soil organ matter such as friability, moisture retention and stability (ALKhafaji,2006 ;Riley *et al.*,2008). As well as come from the decomposition of leaves, dead roots and crop residues, nitration of earthworms are feed on dead plant parts .At night they scrabble on the algae on soil surface during the day and pull dead plant parts into their burrowing (pre- digestion) they lack teeth and cannot feed on roots accumulates in the upper part of the soil by microorganisms release Nutrients (FiBL,2014). Earthworms do not live in dry soil either by entering hibernation or migrate to lower layer of soils. They circumvent about the same and secret coelomic fluid . Some species emigrate to surface of the soil instance of *Lumbricus terrestris* in the night (Gajakshmi and Abbasi,2004 ; AL-Khafgi ,2006 ;Emmerling and Strunk, 2012). Moisture increase the movement of worms and supports them to absorb oxygen and increases the activity of members of species *L. rubellus* . But decrease of members of species *A. caliginosa* and biomass percentage will be 55% if high moisture and the presence of straw layer above the surface of the soil and watering process increases of moisture .(Reynolds,2004;Ogbonna and Berebon, 2013).Soil moisture content range from 21.4% to 69.3% (Idowu *et al.,* 2006). AL-Khafaji (2006) appeared the average soil moisture reach to 44% the percentage suitable for *Lumbercus terrestris* .
Clay, sand and loam contents determine the texture of the soil, which indicates the percentage of fine and coarse particles. A loamy – clayey soil mainly loam and clay, a sandy soil contain more sand. Water distillation rates (vertical flow) in sandy soils are so faster than in clayey soils. Earthworms are not favorable heavy clay and dry sandy soils. But prefer medium- heavy loam to loamy sand soil. Sandy soil cannot save much water but can absorb water easily and quickly migrate to the lower parts of soil. (Guide to Texture feel,2011). The clayey soils is fertile because it can be save more water than sandy because the spaces between clay is smaller. (Dunca *et al.*, 2006; Oliveira *et al.*,2012).

Materials and Methods

Sampling method

Monthly samples were collected during the period from the beginning of September 2022 until the end of August 2023 from two orchards located in Al-Suwaira region north of Wasit governorate figure (1), The soil was dug in the shape of a square with aside length of (40) cm with as hovel, and sample worms were isolated from the soil using sieve. The large worms were collected tweezers, then an amount of soil taken from the collection site was placed in glass bottle and transferred to Mustansiriyah University laboratories to conduct the necessary tests (Rodney, 1995).

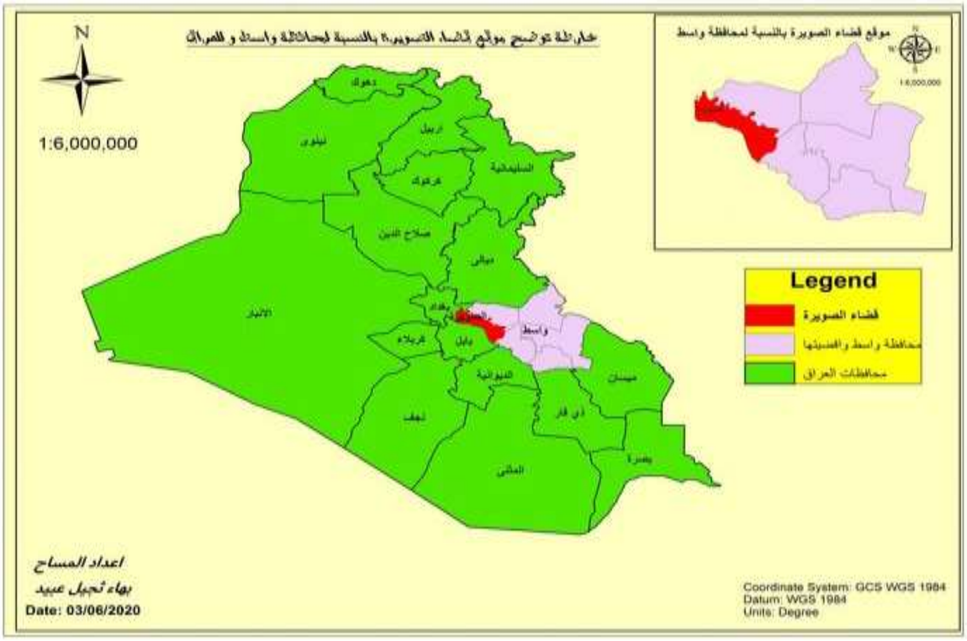

Figure (1): map of studied regions

Identification of Earthworms

Morphological identification of earthworms species confirmed by prof. Dr. Nebrass Faleh in biology department /college of science/ Mustansiriyah University, depending on the external characteristics by relying on the taxonomic key (Csuzdi *et al*, 2006).

Regions of study and there characterizes

Worms samples were collected in two different areas in Al-Suwayra district in Wasit Governorate, where the first area was northwest of the district and is characterized by an abundance of citrus trees such as orange, lemon and *Punica granatum* as well as many palm trees of different types, the second area is characterized by an abundance of vegetable plants like *Cauliflower*, *Allium cepa*, and *Brassica oleracea*

Ecological measurements

Temperature

The temperature was measured of the soil by using a digital thermometer ranging between 0 - 250ºC Where the digital thermometer is placed at a depth of 10 cm^3 and for 15 min (Black,1965; Page and Kenney ,1982).

pH

Soil pH was measured by the BP3001 professional bench top, which was calibrated before using by standard solutions with values 5-7-10 (Richards, 1954 and Kenney,1982).

Electric Conductivity

Soil was measured by EC3020 professional bench top conductivity Meter, the device was calibrated with standard solutions of 1430 micro Siemens MS. Electrical conductivity value was then converted to salinity by formula (APHA, 1998).

Salinity (%) = EC (Msemin/ cm) * 0.00064

Organic Matter

The method of burning the soil was used where the soil dried in an oven 100-1-5 C^0 for 12 hours, then weighted and placed in an oven to burn at a temperature of 500 C^O for 24 hours then weighted again (page *et al*,1982).

Dry weight – post – burn weight * 100

Organic matter percentage = ____

Dry weight

Estimation of Soil Moisture

A sample of soil transferred from each of the study location to the laboratory in a plastic sealed bag tightly. Then took the amount of the soil, placed in basin, was weighting accuracy (first weight) sample was then placed in an oven temperature 65-70ºC for 48hours, then weighting one more time (second time) after to conclude percentage for moisture according to the Law. (Allison *et al.*,1954; Black, 1965; Page and Kenney, 1982).

Wet weight – dry weight * 100

Moisture rate = ———————————————

Wet weight

Soil Texture

The method Hydrometer described by Black (1965); Page and Kenney (1982), were used. From the dry soil, the weight was 50g, added HCL 30 ml to the soil and added distilled water to 1000ml in the cylinder, then shake by Belanger and leaved for one day for the purpose of washing the soil.

In second day empty the water with carefully, added 30 ml H_2O_2, for 15 minutes then added 30 ml Calgon $(NaPO_3)_6$ 30% concentration, for 15minutes and then mixed by Belanger and added distilled water to sign. Calculate the first weight after shake the soil by shaker 15 once. And calculate after 40 second takes reading during hydrometer waiting after two hours for two reading without shake. Taking into an account the temperature taken in the first and second times by thermometer.

Calculation of Population Density

The total number of earthworms account for all the studied areas for a period of 12 months from September of 2022 to August 2023 have been isolated monthly for mature and immature worms sexually at all the study location(ALKhafaji,2006).

Results and Discussion

The study was conducted in two regions of Suwairah City in Wasit Governorate, table (1) showed ecological factors that studied in region A, high temperature was 50 C̊ in August, low temp. 11 C̊ in February, pH value recorded 7.4 in May, June and August and 6.8 in July. Percentage of moisture 22% in May and October while in January 17%. High percentage of organic matter record in December 4.41% while low percentage 3.13% recorded in March while percentage of mud, silt and sand were slightly differed through studied months and recorded high percentage of mud 40% in August and September while lower percentage 40 % in December while silt higher percentage in June and October 47% and lower 29% in December, sand percentage in December recorded high percentage was 50% and low percentage 20% in June and October.

Table (2) showed ecological factors that studied in region B, high temperature was 32 C̊ in July, low temp. 11 C̊ in December, pH value recorded 8.0 in August. Percentage of moisture 40% in August while in January and February 20%. High percentage of organic matter record in September 6.6% while low percentage 4.0% recorded in January while percentage of mud, silt and sand were slightly differed through studied months and recorded high percentage of mud 34% in August and May while lower percentage 23 % in December while silt higher percentage in July 51% and lower 32% in September, sand percentage in September recorded high percentage was 39% and low percentage 19% in May.

The distribution of earthworms depends on temperatures in all study regions, which were **11-50** C̊ and This is a very good value for earthworms when temperatures become high or low, earthworms moved to the lowest layer of soil and rotate around itself in the end of channel that made it and its bioactive decreased until Temperature be good (Al-Khafagi *et.al.*, 2013). Temperature is considered one of the most important climate change factors that determine the activity of soil organisms and decomposition processes. As a result, the effects of temperature on the activities of soil invertebrates and microorganisms in the soil were studied. Earthworms tend to gather in areas where conditions are ideal for metabolism. Moisture and temperature interactions are also observed the maximum growth rate of *Eisenia fetida* at high moistures and moderate temperatures, but after reproductive maturity, the maximal growth and survivorship occurred in low temperatures and moderate/high moistures (Singh *et al.*2019). Lima *et al.* (2015) also found that *Eisenia andrei* lost part of their weight at temperature at 26°C compared to 20°C, stressing the context-dependency of temperature effects. It has also been observed that earthworms when stay close to the surface at higher temperature, they may be more susceptible to detrimental conditions like heat produced by UV radiation (Singh *et al*.2019).

In addition, several studies have reported seasonal variations in the growth and activity of earthworms in relation to changes in soil moisture and temperature (Eisenhauer *et al.* 2009). As a result, climatic conditions are major determinants of the distribution and diversity of earthworms (Fisichelli *et al*. 2013, Phillips *et al.* 2019). Warmer and drier climates in the future are expected to reduce the prevalence of earthworm invasions, because earthworm activity is limited by rising temperatures under drought stress. (Eggleton *et al.* 2009), While the opposite may be true if warming coincides with sufficiently high soil moisture levels. For example, the ability of Aminthas species to respond quickly to warming winters has been shown to have positive consequences for invasion and range expansion. (Görres *et al.* 2018).

Earthworms has been observed that show very clear seasonal dynamics in their occurrence and activity patterns, especially in cold and dry climates. In the parched or very cold season, It was found that the abundance of earthworms begins to decrease gradually and reaches a high level of biomass when suitable climatic conditions are available, for example, the conditions that typically occur in spring and autumn in temperate regions when temperature is modest and soil water content is high. (Walsh & Johnson-Maynard 2016; Singh *et al*.2019). These changes in earthworm diversity and abundance are likely to have important impacts on long-term soil organic matter dynamics. (Blouin *et al*. 2013) and to be expected other soil organisms (Eisenhauer, 2010).

Also, pH is an important factor in a particular site for the distribution of earthworms as earthworms can survive not only in neutral soil conditions but also in slightly acidic to slightly alkaline soil conditions. The effect of soil pH on the abundance of earthworms is not directly at a particular site, but soil pH indirectly stimulates other chemical processes in earthworms, which affects nutrient availability (Cesaez *et al.* 2016; Singh *et al.* 2020). Most studies have reported that earthworms can tolerate a pH range from 5.0 to 8.0 and that earthworm abundance increases as the pH shifts from acidic or basic to neutral. De Wandler et al. 2016 also observed that earthworm abundance and diversity in soil increased as pH increased from acidic to neutral and maximum earthworm abundance was found near pH 7.

The Moisture is a critical factor in the distribution of earthworms due to their cutaneous mode of respiration (Sharma and Bharadwaj, 2014). Walsh and Johnson-Maynard, 2016, reported that earthworms are disappearing from drier sites and that their high densities and biomass depend on local conditions such as soil properties and management. Talavera et al. 2020 reported that both Organic Carbon and Moisture are the main factors for predicting earthworm communities at a given site.. Soil moisture is an important factor that is a key variable controlling the exchange of water and thermal energy between the atmosphere and the Earth's surface through evapotranspiration and plant transpiration, and is therefore critical for the survival, growth and reproduction of earthworms (Zorn *et al.* 2008).Low soil moisture, in contrast, causes decreased aerobic metabolism and growth, and aerobic metabolism differs in earthworm species exposed to air versus water. Besulitsyna (2012) studied the influence of soil moisture and different soil types in the landscape of southern Central Siberia and observed that the abundance and distribution of earthworms is mainly affected by soil moisture. It has been reported that forest and meadow ecosystems with moderate temperature and high soil moisture in the upper soil layer and litter are most suitable for earthworm communities, but wet soils can also be unfavorable for earthworm survival, for example, in the case of anaerobic conditions. Earthworms can survive under harsh conditions for a certain period of time, especially if the oxygen content of the water is high enough, although most species will die when exposed to conditions of overexposure to water. Similar to context-dependent effects of temperature, the effects of precipitation and soil moisture on earthworms vary and depend on temperature (Table 1).Hence, a significant correlation was observed between earthworm density and soil moisture, biomass and temperature (Fournier *et al.* 2012). Furthermore, positive interaction effects between soil moisture and temperature were found to lead to higher population densities of earthworms at sites with low rainfall due to higher reproductive rates. Soil moisture content has generally been observed to decrease with increasing temperature due to increased evaporation, but it has been shown to decrease faster in the presence of earthworms (*Lumbricus terrestris*) after heavy rainfall (Ernst *et al.* 2009, Eisenhauer *et al*. 2014; Andriuzzi *et al.* 2015, González-Alcaraz and van Gestel 2016). Many studies have recorded that the growth and activity of earthworms changes according to changes in soil moisture (Eriksen-Hamel & Whalen 2006, Perreault & Whalen 2006, Eggleton *et al.* 2009, Fisichelli *et al.* 2013). The abundance of earthworms was observed to increase proportionally with the increase in organic matter content in the soil.

Earthworms play an substantial and major role in accumulating and transforming organic matter, while ingesting plant remains and soil rich in organic litter (Valchovski, 2010). In general, the organic matter content of pasture soils, which is affected by field management and plant species, increases with pasture use time. Increased soil organic matter (SOM) factors appear to support earthworm abundance (Van Vliet *et al.*, 2007).

Soil that contains different amounts of mud, silt and sand its very good to earthworm lived and all regions of study contain from these materials so they good for earthworm life (Al-Khafagi *et.al.*, 2013). During his study, Yvan *et al.* 2013 noticed that soil texture affects the vital activity and growth of earthworms. The high clay content plays an important role in enhancing the growth and abundance of earthworms species (Singh *et al.*, 2020), Which applies to our study.

Table (1): Ecological factors in Region (A) of Suwairah City in all studied months:

Total numbers of earthworm		Soil temperature	I values	Percentage of organic matter	Percentage of moisture	Percentage of mud	percentage of silt	Percentage of sand
78		18	7	3.55	17	30	37	33
72		11	7	3.51	18	28	40	32
70		22	.1	3.13	20	28	38	32
78		30	.3	3.22	20	34	40	25
82		32	.4	3.60	22	33	40	25
80		37	.4	3.78	20	35	47	20
73		48	.8	3.52	19	33	46	22
60		50	.4	3.41	21	40	45	37
68		42	.3	3.80	20	40	43	27
75		30	.2	3.95	22	34	47	20
84		25	.2	4.02	19	28	34	28
90		20	7	4.41	18	20	29	50

Table (2): Ecological factors in Region (B) of Suwairah City in all studied months:

Total numbers of earthworm	Months	Soil temperature	PH values	Percentage of organic matter	Percentage of moisture	Percentage of mud	percentage of silt	Percentage of sand
70	1	15	7.1	4.0	20	28	36	36
72	2	12	7.1	4.8	20	25	43	32
78	3	17	7.2	4.9	25	29	46	25
78	4	25	7.4	5.8	28	33	41	26
82	5	28	7.8	5.3	30	34	46	19
80	6	30	7.8	5.3	30	31	40	29
73	7	32	7.9	5.4	37	30	51	22
60	8	25	8.0	6.0	40	34	50	25
68	9	22	7.5	6.6	38	29	32	39
75	10	20	7.3	6.2	38	30	38	33
84	11	16	7.2	5.7	29	29	37	34
90	12	11	7.0	5.3	25	23	48	30

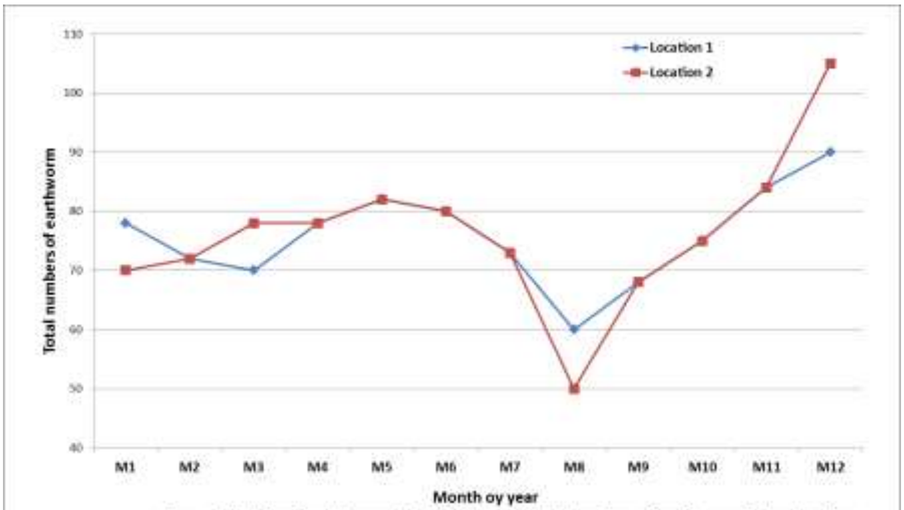

Figure 1: Relationshiop between Month of year and Total numbers of earthworm in two Locations

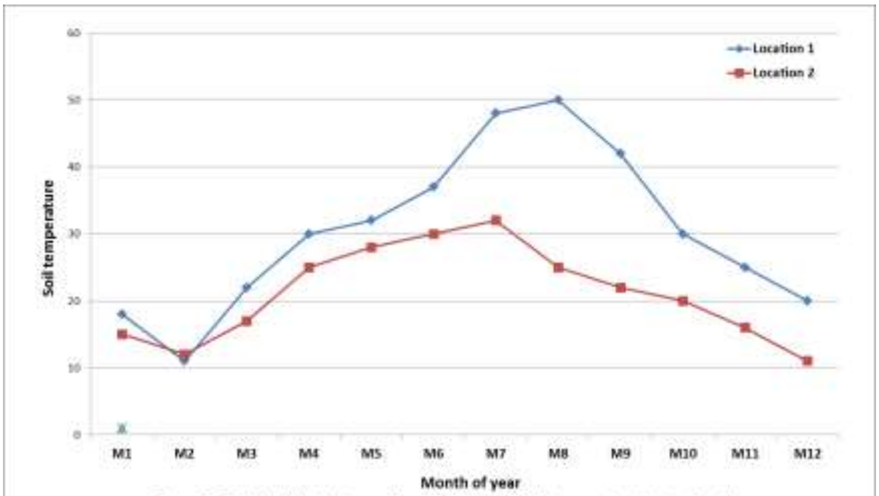

Figure 2: Relationshiop between Month of year and Soil temperature in two Locations

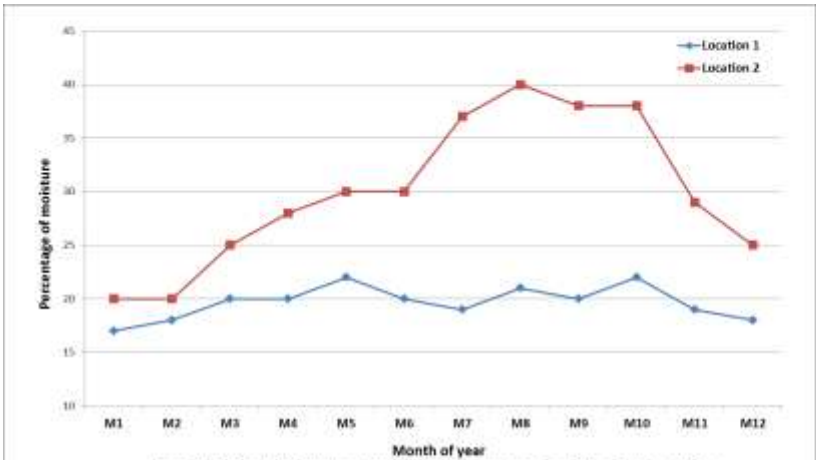

Figure 3: Relationshiop between Month of year Percentage of moisture in two Locations

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