Annual Methodological Archive Research Review
http://amresearchreview.com/index.php/Journal/about
Volume 4, Issue 3 (2026)

Online ISSN 3007-3197
Print ISSN 3007-3189

http://amresearchreview.com/index.php/Journal/about

Evaluation of *Raphanus Sativus* Yield Under Different Soil Types Across Sargodha Regions

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ABSTRACT

The growing reliance on untreated sewage water for irrigation along with the industrial activities and over agricultural practices is creating an environmental and public health crisis due to soil pollution. Contaminated soils and their impact on radishes (*Raphanus sativus*) with a focus on heavy metals and pesticide residues were studied. Also enhanced were the contributions of phytoremediation and the earthworms, especially *E. fetida* and *P. posthuma*, in the radishes. Earthworms, through bioturbation, are soil engineers and increase contaminant availability and microbial activity, and also improve soil structure. In comparison to other crops, the hyperaccumulator radish was more able than the rest to extract and accumulate in the shoots and roots the metals, pesticides, and metamines such as Cd, Pb, Cr, and As. More than *P. posthuma, E. fetida* is supportive to phytoremediation in radishes as it was able to enhance more highly than the other the roots and shoots pesticide and metal concentrations.

A parallel study was conducted in Pakistan to determine the level of heavy metals in radish crops irrigated with canal water, tube well water, and sewage. Contaminated soils of sewage irrigated crops according to the soil quality indices of CF, EF, BCF, EDI, HQ were observed to be significantly more deteriorated. Moreover, research assessed the sustainable fertilization alternatives and determined that food compost and vermicompost led to considerable improvements in the growth of radishes when measured against chemical fertilization. All things considered, the results of the research support the importance of sustainable soil management practices and point to radish as well as the utilization of earthworms as a viable means to counteract soil pollution.

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Introduction:

The consequences of soil pollution may be dire, and not only the agricultural performance but also the well-being of the environment and society. The cities, especially, are experiencing the problems connected with soil pollution since industrial processes emit pollutants into the land [1]. The problem is usually compounded by the absence of control and management of the situation where dangerous chemicals are allowed to linger longer in the soil. To solve the issue of soil pollution, a multifactorial strategy involving the implementation of improved methods of waste handling, awareness of the population, and the tightening of the environmental policy should be used [2]. There is also the destabilization of the ecological functions that pinpoints at the fine balance of the soil microorganisms and the nutrient cycle [3]. With the erosion of soil fertility, agricultural productivity is hit and food insecurity becomes a cyclical phenomenon and particularly in areas of the world where agriculture is the main source of livelihood. This degradation has not only agricultural, but biodiversity and the health of a general ecosystem. This may result in the reduction of useful microorganisms that are needed in nutrient cycling and soil structure in polluted soils. Such a decrease may also increase the problems of soil erosion and degradation to the point of losing arable land with time [4]. As a result, it is necessary to conduct an extensive examination of the polluted agricultural environment so as to eradicate the potential risks of soil and crop contamination [5].

Finally, the knowledge obtained in these studies may help to improve the food safety criteria and enhance the health results of the population [6]. Accordingly, organic amendments of contaminated soils do not merely justify their use but can be instrumental in enhancing the health of crops and minimizing the harmful impact of soil contaminants [7].

Possible bioaccumulation of toxic substances in the food chain creates the concern of long-term health consequences especially in the very susceptible groups of children and the pregnant women. Besides, the socio-economic consequences of eating contaminated food may be significant, which makes the healthcare expenditures higher and causes a drop in productivity [10]. Communities need to be informed of such risks and should prioritize food safety laws by policymakers.

The role of the public health campaign in terms of providing education to consumers regarding the risks of consumption of contaminated produce and safe agricultural practices cannot be underestimated. Through awareness creation, communities can work to promote health and clean soil and food systems [11]. Moreover, partnership between scientists, policymakers, and farmers may result in creation of sustainable agricultural practices that are based on soil health and reduce pollution. It is, finally, important to consider that human health is to be safeguarded against the threats of soil pollution through a complex strategy involving education, regulation and community involvement [12].

Not only that, soil contamination is hazardous to human health, but it has a negative impact on plant physiology.

This may bring about dependency on the chemical inputs which further enhances the cycle of pollution. The disturbed biochemical pathways can also result in the changed nutritional value of crops and this will influence food security and health of people [14]. Scientists are also more interested in working out the processes concerning the

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impact of pollutants on plant physiology to devise specific remediation policies.

The phytoremediation method of soil management is one of the prospective solutions to rehabilitate polluted soils, making them be more resilient to crops. We can take a step towards more sustainable agricultural practices that are appropriate to the environment and human health by enhancing a greater understanding of how soil health is connected to plant physiology. Finally, the problem of soil contamination is one that needs to be addressed with the purpose of making the long-term sustainability of agriculture and the well-being of ecosystems [15].

To evaluate the state of the polluted soils with regard to the risk on the population health and how the agricultural practices affect the growth of radishes and the retention of the contaminants, there is a need to examine the mechanisms that control the crop growth and the overall quality. The knowledge of these mechanisms is essential in trying to come up with practices that guarantee the health of the population [16]. The most important of them are the nature and level of contaminants existing in the soil, the nature of the farming activities being practiced, and how crops react to the stressors [17].

With the pressure on agricultural lands to become more and more contaminated, the use of radishes [18] as the research tool could assist in developing efficient strategies that will allow improving crop resistance and fostering safe agricultural practices [19]. Finally, the knowledge obtained in these studies may help to improve the food safety criteria and enhance the health results of the population [20]. It is possible to test the efficiency of different remediation methods faster due to their rapid.

The eco-friendly and more powerful remediation techniques can be achieved through the synergistic effects of earthworms and radishes on the contaminated soil systems [21]. Through such interrelated methods, scientists will be able to find long-term solutions to the problem of soil pollution and enhancement of agricultural output.

Accordingly, organic amendments of contaminated soils do not merely justify their use but can be instrumental in enhancing the health of crops and minimizing the harmful impact of soil contaminants [22]. Ther'e are numerous disturbance indices that should be included in a scientific evaluation of the impacts of soil pollution such as the contamination factors, enrichment factors, bioconcentration factors, estimated daily intake and hazard quotients [23]. The indices aid in the assessment of the extent of contamination and the risks that might be faced by human health by giving a comparative analysis of pollution in various regions and sources of irrigation.

The methodologies have to be used to determine the risks that are presented to the public health and the sustainability of crops cultivated in polluted farm soils [24]. Moreover, knowing how pollutants are stored in plant tissues is very important in the provision of food safety and the health of the human being in the coming of growing challenges of soil pollution [25].

LITERATURE REVIEW:

The safety of vegetables and the health of the consumers had at stake as pollution in the soil and waterways increase, especially on the issues of heavy metals, pesticides, and wastewater. Since these pollutants enter agricultural land, they were extremely dangerous to the environment as well as the health of the human being. There is absorption of the toxic substances by vegetables planted in contaminated soils and

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consequently to build up in the edible portions of the plants [26]. Such stockpile is a cause of serious concern about food safety because consumers do not realize that they are consuming contaminated foods, and this may lead to several health complications in the long run.

Heavy metals like lead, cadmium and arsenic may have toxic influences on the human organ system and the pesticide residues may distort hormonal levels to cause chronic health disorders. These dangers indicate a pressing necessity of the effective monitoring and management strategies that are to guarantee the safety of the food supply and prevent the threat to the population [27]. Radish in specific has been an extreme point of focus in the research that evaluates the risk of soil and water contamination. Radish has a short life cycle and can therefore quickly show the effects of environmental contaminants and therefore it is a good research subject in risk assessment and phytoremediation [28]. Its root to shoot ratio is high enabling researchers to estimate the level of contamination in the soil and determine the success of the remediation exercises in a limited period of time. Due to the current development of research in this field, there is a strong need to consider health and safety of agricultural produce to provide the future generation with a safe food supply. The importance of solving the issue of soil and water pollution by new farming approaches will be essential in preserving consumer health and ensuring the adoption of sustainable food systems.

Root vegetable like radish is very susceptible to absorption of contaminants in the soil that therefore make it very susceptible to soil pollutants that are found in the soil particularly the heavy metals like cadmium, lead, nickel and other trace elements that can be even found in moderate amounts in the soil. The scientific studies have revealed that radish is highly prone to accumulation of these pollutants in its edible tissue implying that even soils that seem safe when viewed through the normal standards are capable of producing radish crops that are contaminated. This build-up presents a grave food safety problem since it may lead to prolonged health complications by the fact that these metals may be absorbed into the human body by way of food and lead to long term health problems such as kidney damage, nerve disorders and the weakening of the immune system.

In addition, these pollutants are not easily degraded in the environment and have a tendency of staying long in the agricultural soils therefore the problem is cumulative in nature. Because radish is usually eaten uncooked as salads and as garnishes, the risk of these pollutants is even severe. Radish is also a possible bioindicator plant since it is able to absorb heavy metals and therefore its contamination level can determine the general level of pollution of farm land. Nonetheless, although the given property can be applied to environmental monitoring, there are critical issues concerning food safety and health of the population when radish has been grown on contaminated Soil [32].

The toxicity of heavy metal build-up in radish is not restricted to food safety hazards only but also in the actual physiological health of the plant itself, a process known as phytotoxicity. Studies have shown that pollutants like cadmium, lead and nickel prevent the germination of seeds i.e., few radish seeds germinate in contaminated soil. Also, the development of radish plants is adversely influenced, leading to the decrease of biomass, roots, and weak leaves, which directly reduces the yield and

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quality of crops. The cellular mechanisms of these toxic metals cause oxidative stress in the tissues of radish by causing the production of too much reactive oxygen species, which destroys cell membranes, proteins, and DNA [33].

The gains were credited to the enhancement of soil structure and microbial activity and metal binding and complexation although the inconsistency of compost source was acknowledged. This observation is an indication that the mixture of compost and fast accumulating metal plants can increase the prospects of the bio extraction of metals in the soil [43].

Radish experiments have shown an enhanced rate of removal of Cd and Pb under controlled conditions, although there must be a compromise between efficiency in the remediation exercise and food safety in the short term since radish edible roots can have high levels of contaminants at any time of day during the treatment period. Better radish chromatographic and mass spectrometric methods and sample preparation methods provide a more efficient way to estimate exposures since 2021 by reducing the limit of detection of trace metals and pesticide residues in radish tissues [44]. The literature includes the major risk of exposures not being properly estimated; the measures against that should include the use of validated methods and quality control.

These studies do not recommend frequent monitoring and radish intake of these locations. The abundance of root vegetables composition shows the regionalization of patterning, where in areas with arid environment, using treated wastewater in farming with high contamination of root vegetables whereas in the humid area with less population and more runoff of wastewater; the roots vegetable contamination is less. In this regard, local evaluations and location-specific reduction strategies are justified and are better than generalized guidelines [45].

Although most of the recent literature is restricted to researching the individual aspects of contamination and/or remediation, a very limited number of them use truly integrated designs, which include the multi-contaminant exposures, earthworm dynamics, compost chemistry, and consumer risk evaluations together. Still, too, there exist limited long-term field scale experiments and much of the published work is based on pot studies which generally simplify the complex processes that occur in the field [46]. In this way, the literature has demanded multi-year field research of multidisciplinary nature and application of uniform methodologies and frameworks in the context of analysis and reporting.

A literature review of the literature published after 2021 supports what has been mentioned earlier, i.e. that radish is not only a feasible short-term bioindicator to be used in phytoremediator investigations, but also a delicate indicator of soil pollution. The utilization of earthworms, composts or other mobilizing agents though can cause the required timing and management quite a complex task due to the dual purpose of the plant. To address the risk management, we suggest the use of soil and plant tissue analyses and calculation of the estimated risks in diet when there is wastewater irrigation to confirm the field practices.

PROBLEM STATEMENT

Soil pollution due to heavy metals, pesticides, and wastewater impedes the growth of *Raphanus sativus* while also contaminating the edible portions of the plant.

The combined impacts of the multiple soil contaminants on radish have been the

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subject of limited research, leading to a knowledge gap regarding the unencumbered terrestrial cultivation of radish and the subsequent risk mitigation strategies needed to manage such contaminants.

OBJECTIVES

Evaluation of soil pollution with heavy metals, pesticides, and wastewater irrigation on the growth, physiological performance, and accumulation of contaminants of radish (*Raphanus sativus*), and attempt to devise a sustainable approach to mitigate the risks through the evaluation of sustainable methods, and the determination of effective ways to reduce the risks through sustainability.

The objectives of the research are to:

To determine the impact of soil pollution with heavy metals, pesticides, and wastewater irrigation on the growth, physiological responses, and accumulation of contaminants in radish (*Raphanus sativus*).

To investigate the potential of organic soil amendments, namely vermicompost and earthworms, to reduce contamination and enhance the growth of radish within agroecosystems.

METHODOLOGY

Place of Work

The current experimental research was carried out in Superior University Sargodha Campus, Punjab Pakistan.

Experimental sites

The experiment was done in Sargodha where *radish* is a common invasive species that is posing a threat to the agricultural and the native biodiversity of the region. Experimental sites were chosen according to consumer, land use, and ecological factors. The sites were the varying environment conditions to test the effects of *radish* and its prospective application.

Procurement of Soil

Samples of soil collected from Makkah Town Faisalabad Road, Lahore Road near Superior university, and Silan Wali road.

Figure 1: Procurement of Soil

3.1 Processing of Soil Sample

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Figure 2: Fumigation of soil



Figure 3: Preparation of pots for experiment

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Soil health analysis

An in-depth analysis of soil quality was done in order to determine the impact of soil and water on Radish yield. Physical and chemical indices were also studied, such as soil texture, electrical conductivity (EC), pH, percentage of saturation, organic matter and nutrient content (potassium, phosphorus, and nitrogen).

Determination of soil texture

After adding 50g of the air-dried soil to 100mL of sodium hexametaphosphate (a dispersing agent) and distilled water in a measuring cylinder, the soil is mixed. The mixture is mixed and left to sediment in a given time periods. Measurements of a soilhydrometer are taken at 40 seconds (sand fraction) and 2 hours (silt and clay fraction). The composition of the sand, silt and clay percentages is determined and categorized on the USDA Soil Texture Triangle. Sandy soils (>70% sandy soils) are highly draining yet have low nutrient holding capacity whereas clay soils (>40% clay soils) retain water but do not have good aeration. Loamy soils that have an ideal combination of sand, silt, and clay are what are considered to be good in agriculture. Mineral and soil analysis of the soil aids in evaluating the suitability of the soil to crop, irrigation and soil enhancement requirements.

Determination of electrical conductivity of soil (EC)

Electrical conductivity (EC) is a change of the capability of soil to carry an electrical current that is directly proportional to the amount of dissolved salts in the soil solution. The excessive amounts of salt at high EC levels may cause the development of osmotic stress, failed plant growth, and imbalances of nutrients [47]. EC of soil is calculated by the method of 1:5 soil/water ratio where a known mass of air-dried soil (20g mass) is poured into 100mL distilled water and the mixture stirred by the 30 minutes period and left to settle before measurement with a digital conductivity meter calibrated using 0.01 M KCl solution.[48].

Determination of soil pH

The pH of the soil depicts whether it is acidic or alkaline which influences nutrient availability and plant development. It is quantified by trying 10g of soil with 25mL of distilled water, stirred and settling it. A calibrated pH meter records the supernatant's pH [49]. Soils are classified as acidic (<6.5), neutral (6.5–7.5), or alkaline (>7.5). The nutrient deficiencies in soils can be caused by acidic soils, whereas alkaline soils can restrict the availability of micronutrients. pH monitoring can be helpful in managing the fertility of soils and the choice of crops[50].

Determination of soil organic matter

The soil organic matter (SOM) is very essential to the soil fertility, structure, and the activity of the microorganisms. It is calculated by the Walkley-Black method, which oxidizes organic carbon by the use of potassium dichromate ($K_2Cr_2O_7$) and sulfuric acid. The contents of ferrous sulfate are installed to titrate the unreacted dichromate and the content of organic carbon is calculated.

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SOM is estimated using the formula:
SOM (\%) = Organic Carbon} (\%)} * 1.724
Soil with >3% SOM are fertile, while those with <1% SOM percent signifies low fertility. This analysis assists in quantifying the productivity of soil and cycling of nutrients.

Collection of germplasm

Wild type of radish has been collected from agriculture centers (Fodder Research Institute, Sargodha and Citropak Limited, Sargodha). According to the recent research, radish had been identified as a valuable bioindicator species that can be used to measure soil contamination as a result of high ability of absorption and physiological responses to heavy metals including cadmium, lead, chromium, and nickel.

Sowing of seeds

Wild type seeds were sown in pots filled with soil. seeds were planted at appropriate depth and spacing to ensure uniform germination and seedling establishment.



Figure 4: Sowing of seeds

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Online ISSN 3007-3197
Print ISSN 3007-3189

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Figure 5: Sowing of seeds





Figure 6: Watering of Pots for seed germination

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Determination of Soil texture and Microbial Analysis

Percentage content of sands, silt, and clay of a sample of the soil. Fifty grams of a soil sample is suspended in 100mL of sodium hexametaphosphate solution and mixed and left to settle. Measurements of hydrometer are done at 40 seconds (sand fraction) and 2hours (silt and clay fractions). On the basis of soil texture microbial existence examination were made along with checking their biological activities.

Determination of Heavy metal in soil & waste water

Soil and water samples were analyzed for the determination of Cd, Pb, Cr and as concentrations using standard laboratory techniques [51]. Extracted samples were quantified using appropriate analytical techniques to assesses the level of heavy metal contamination in soil [52].

Figure 7: Laboratory Analysis for Soil samples



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Figure 8: Weighing of soil samples



Figure 9: Soil Sample EC Measurement

Evaluation of soil contamination on plant growth and Seed germination

To determine the plant growth rate by microbial and organic content and heavy metal activities were observed during all the experiment duration, by using Microscope and lab activities in Agriculture college.

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Online ISSN 3007-3197
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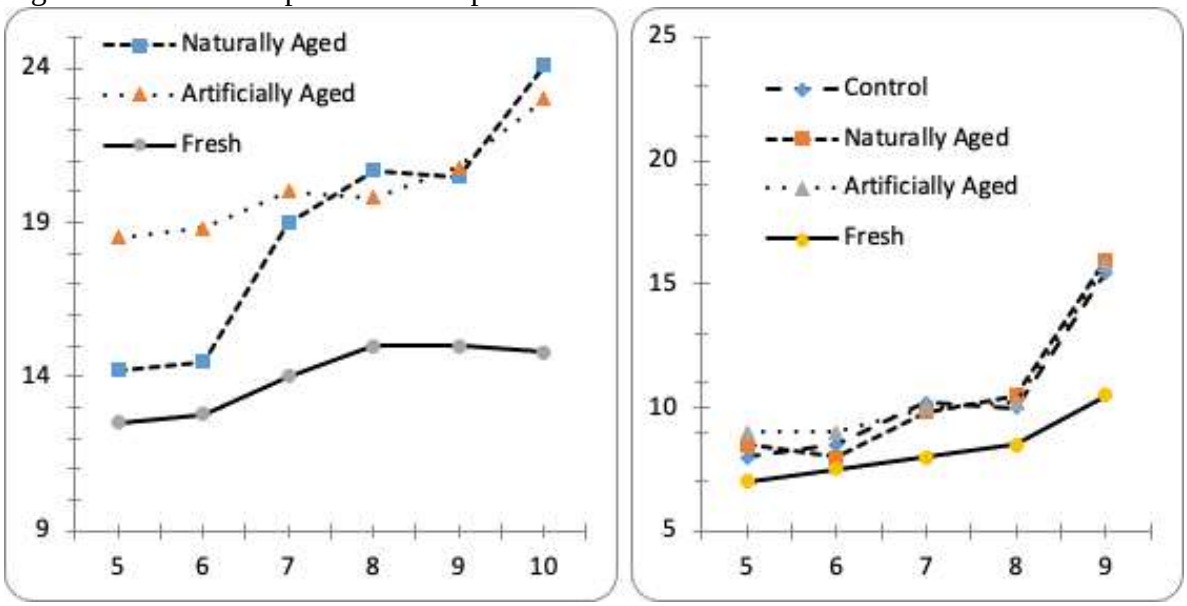
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For the Analysis of seed germination at equal interval of time (10 days) observations were made regularly.
Readings were made by using following formula

$$\textbf{percentage germination} = \frac{\textbf{number of seedlings emerged/pot x 100\%}}{\textbf{number of seed planted/plot}}$$

RESULTS

The statistical analysis demonstrated that there was a strongly significant time fertiliser interaction on the soil pH ($P < 0.001$) and EC ($P < 0.05$), which ascertained that the impact of fertiliser on the two soil qualities fluctuated throughout the experiment. Conversely, the effects between biochar ageing and fertiliser, biochar ageing and time, were only significant on soil pH ($P < 0.01$). This implies that biochar ageing has minimal influence on salinity based properties like EC as compared to acidity. On day 0, distinct differences in the soil pH were evident in the treatments. The fresh biochar-amended soils showed the greatest pH value (7.37) that was considerably higher than control soil (6.89) and soils that received naturally aged biochar.
The application of fertilisers was majorly acidifying to the soil pH in the majority of the experiment stages. PH decreasing after fertilisation can be explained by the action of nitrification, the release of hydrogen ions and by the enhanced activity of microbes. An exception was however noted in week 4 where fertiliser was not significant to lower soil pH. This short-term excursion can indicate a counterbalance of acidification caused by fertilisers and the buffering power of biochar or the soil organic matter at that point of the experiment.



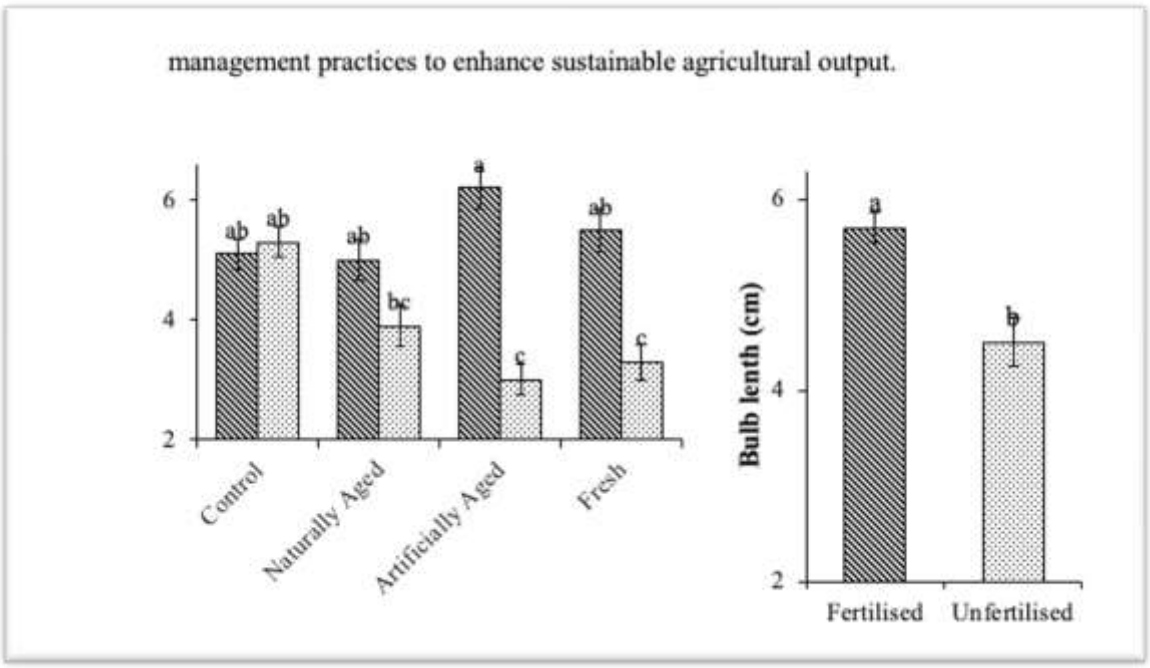
Graph 1: Interaction of time x biochar ageing

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http://amresearchreview.com/index.php/Journal/about
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These results also highlight the need to manage fertilisers carefully in order to ensure that soils are kept in an optimum position to allow plants to grow without adverse effects like over acidification or salinity. The findings also reveal that even though biochar can be useful in enhancing the health of the soil, its effects can be minimal in an environment where intense chemical inputs like fertilisers prevail in the soil. Such interactions and their changes with time allow agronomists and farmers to take more knowledgeable action about the use of fertiliser, soil supplements, and long-term soil management practices to enhance sustainable agricultural output.



Graph 2: Interaction of (a) fertilisation x biochar ageing on bulb diameter and (b) effects of fertilisation

In saturated hydraulic conductivity, the ageing of biochar and time was again also found to be the same in the two-way interaction; however, P-value was more than 0.05 hence the effect was not significant. This implies that there might have been trends or minor variations in the saturated hydraulic conductivity with the interaction of biochar ageing and time, but they might have been by chance and were not sufficiently high to be statistically significant. Saturated hydraulic conductivity is a value that determines how easily water can be transported through soil when it is saturated, and, although biochar is capable of changing the extent of soil structure and porosity, the present research results did not have any significant effect in the long run.

Graph 3: Effect of biochar ageing and fertilization on leaf area of radish grown in Haplic Cambisol soil

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There was an increment in the fresh shoot biomass of 77% and in the dry shoot biomass of 72.4 percent compared to the no fertiliser treatments. Such massive growths demonstrate that fertiliser promotes a lot of above ground vegetation growth upon the application of aged biochar. The fresh biomass gives reflections of water content and immediate growth response and the dry biomass gives the actual accumulation of plant material. These gains in the two measures indicate that the plants did not only grow larger but also their structural biomass grew, which implies a healthier and productive growth.

Plants of fertilised modified were found to give more total biomass, root mass, bulb mass and shoot mass when compared to untreated controls. That is, fertiliser was dominant in enhancing the overall growth of plants despite the biochar being subject to various ageing treatments. Ageing of biochar alone did not suppress the positive influence of fertiliser and this indicates that the nutrient availability due to fertiliser was more significant to plant growth as compared to variability that biochar ageing produced. These results reveal the significance of proper supply of nutrients in order to have increased crop productivity.

These changes can be changes in porosity, surface area or interactions with the soil particles that can have an impact on the routes in which the water travels. This interaction is significant in the management of biochar used in soils with extreme water infiltration and retention because the timing and the ageing process of biochar should also be taken into account to maximise its effect.

The effects of the various types of biochar and application of fertiliser were presented in the table on the plant biomass in terms of total biomass, root mass, bulb mass and shoot biomass in both fresh weight and dry weight. The treatments are artificially aged biochar (AB), naturally aged biochar (NB), fresh biochar (FB) and control (C) tested in fertilised

(F) and non-fertilised (NF) environments. The numbers beside the values (a, b, c, d) signify that there are statistical differences among treatments, i.e. two different values will have different letters on them. This enables the comparison of the effects of each treatment on the growth and production of biomass of the plant. In general, the results of the table indicate that the fertiliser and its type and biochar type have a strong impact on the performance of plant growth.

DISCUSSION

Biochar improves the soil properties [81] and the process of ageing influences the magnitude of improvement of the soil properties. Soil pH is a critical parameter of the soil that determines the availability of nutrients, biological, and chemical processes in the soil and crop development. The application of all the biochar types led to higher pH of the soil than the control without biochar. The observation is consistent with numerous other past researches, which showed that biochar application led to an increase in soil pH. In this case, I should mention that both NB and FB amended soil obtained their similar pH at the conclusion of the investigation. This is an indication that the natural ageing process applied in the research might have a minor effect on pH of biochar.

Alternatively, the pH difference in NB and AB amended soils validates who opined that biochar ageing activities have varied effects on biochar characteristics. The pH

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difference between AB and NB treatment could also be due to the fact that the artificial ageing process decreases the biochar pH as compared to natural ageing. In general, the pH of fresh biochar was higher during the entire study compared to aged biochar This could be since, under the ageing process, the number of carboxyl and hydroxyl functional groups on the surface of biochar is high, and this predisposes to lower biochar pH.

CONCLUSION

The research was aimed at gaining knowledge of the effects of two primary variables on the soil characteristics and the growth and productivity of radish plants as biochar ageing and fertilizer use. Biochar ageing is the way biochar alters with age in the soil, either naturally or artificially, and this can be used to influence the way in which the biochar reacts to nutrients and water. The researchers were interested in the chosen chemical characteristics of soils, including electrical conductivity and pH, and hydraulic characteristics associated with water movement and retention in soil. They also monitored responses of plants such as germination, growth and final yield. The study was intended to give useful recommendations on how to enhance soil management and crop production by taking into consideration the measures of soil and crop performance.

The findings revealed that the use of fertilisers affected the chemical conditions of the soil a lot. The conductivity of the soil rose as fertiliser was added meaning that there weremore concentrations of dissolved salts and nutrients in the solution. Simultaneously, the pH level of the soil declined, i.e. the soil became a bit more acidic with the usage of fertilisers. Such changes are typical to occur when mineral fertilisers are used, they tend to be full of salts and compounds that are formed acidically. These changes could be useful in enhancing availability of nutrients to the plants, however, they must be controlled to prevent degradation of the soil in the long run. This is where the balanced utilisation of fertiliser comes in, to stabilise the chemical content of the soils and to enable the growth of crops.

When it comes to parameters of growth and yield, treatments which were fertilised always gave the highest values. This indicates that fertiliser is a key factor in providing the necessary nutrients which are needed in the growth and biomass of plants. Combination of fertiliser with biochar that had been aged, particularly the artificially aged biochar and natural aged biochar, improved plant growth and yield more. Older biochar was likely beneficial in terms of water-holding capacity and nutrient retention in the soil, and thus the nutrients contained by the fertiliser were made more accessible to the roots of plants. This interaction improved the growing conditions and the plants became healthier with an increase in the yield of radishes. These findings show that there is a synergistic effect of fertiliser and aged biochar to enhance soil quality and crop performance.

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http://amresearchreview.com/index.php/Journal/about
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