Quest Journals
Journal of Research in Agriculture and Animal Science
Volume 10 ~ Issue 4 (2023) pp: 01-05
ISSN(Online) : 2321-9459
www.questjournals.org

Research Paper

Effects of Printer Toner Waste on the Growth of Okra (*Abelmochus esculentus L.*)

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ABSTRACT: *A research work to investigate the effect of printer toner waste on Abelmochus esculentus L. was carried out at the Ecological Research Center of the University of Port Harcourt. In this study, the effect of different concentrations of printer toner waste on the growth of okra plants were investigated. The printer toner waste and the soil were analyzed to determine the substances present in them, the toner waste was high in potassium(K) 823 mg/kg, sodium (Na) 780.25 mg/kg and iron (Fe) 639 mg/kg. The okra seeds were sown in planting bags containing soil mixed with different concentrations of toner waste (0%, 2%, 4%, 6%, and 8%). The plants were monitored for growth and development over a period of 6 weeks. The plant height, number of leaves, leaf length and leaf width were recorded on a weekly basis. Results showed that the growth and yield of okra plants were significantly (P=0.05} affected by the concentrations of toner waste in the soil. The highest concentration of toner waste (8%) resulted in a significant (P=0.05} decrease in plant height (21cm), number of leaves (2) and leaf area compared to the control (28cm, 5 and 42cm^2 respectively). These findings indicated that exposure to printer toner waste at high concentrations can have adverse effects on the growth, making it important to properly manage and dispose toner waste to prevent contamination of the environment.*

KEYWORDS: *Printer toner waste, Germination, Contamination, Okra, concentrations*

R*eceived 22 Mar., 2023;* ***R****evised 03 Apr., 2023;* ***A****ccepted 05 Apr., 2023 © The author(s) 2023.*
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I. INTRODUCTION

Okra is a traditional vegetable crop commercially cultivated in west Africa, India. The growth and performance of okra can be negatively affected by many factors like temperature, moisture, pollution, bad soil etc.

The soil is a very crucial factor in food production. Negative impacts on the soil can result in food crisis. The most important problem of tropical agriculture is the inability of the land to sustain annual food crops for more than a year. All agricultural activities directly or indirectly depends on the soil. The fertility of the soil is important in making decisions on planting of crops.

Printer toner waste refers to the leftover toner particles that remain after printing and that can have negative impacts on the environment. The components of printer toner waste vary depending on the type of toner used, but in general, they contain a combination of plastic particles, carbon black, iron oxide, and various other metals and chemicals.

According to [9] the primary components of laser toner waste include polymers such as polyester, polyethylene, and polypropylene, as well as carbon black, iron oxide, and other metals such as aluminum, copper, and zinc. and some laser toners contain small amounts of toxic substances, such as antimony and beryllium, that can have harmful effects on the environment and human health.

Printer toner waste is a pollutant and contains some harmful components which might be harmful to okra plant. when printing with a laser printer, although most of the ink lands on your paper, small particles of toner powder collects and surrounds your drum unit. This is called waste toner.

Toner is a powder mixture used in laser printers and photocopiers to form the printed text and images on paper through a toner cartridge. early mixtures added only carbon powder and iron oxide, however, mixtures

have since been developed containing polypropylene, fumed silica, and various minerals for tribo-electrification. Such a combination of organic and inorganic materials makes the toner powder stable and steadily fixes it to papers. Nevertheless, these ingredients render the toner nearly non-degradable and eco-unfriendly, posing serious environmental threats.

Since germination and seedling development are the pioneer steps for crop growth, development and yield, study of germination indices and seedling quality has been shown to be highly indicative of subsequent performance of seed throughout the growing period [4].

In recent years, there has been an increasing ecological and global public health concern associated with environmental contamination by heavy metals. [7].

This research work was undertaken to investigate the effects of different concentrations of printer toner waste on growth performance of Okra (*Abelmochus esculentus L*.)

ll. Materials and Methods

The viable seeds of *Albemechus esculentus* were sourced from the Agricultural Development Programme (ADP), Rumudomanya, Portharcourt, Rivers State.

The soil samples were obtained from the agricultural farm in the Department of Agriculture in Abuja campus of the University of Port Harcourt.

The printer toner waste was obtained from a cyber café at Choba campus of the university of Port Harcourt, Rivers State, Nigeria.

The field experiment was carried out at the Centre for ecological research and studies, University of Port Harcourt, Rivers State

Viability test was carried out to know if the seeds were viable. This is done by placing the seeds in a basin of water and left for five minutes, the ones that floated were considered not viable while the ones that sank were considered to be viable.

The different percentages of printer toner waste were prepared using a weighing balance which is calibrated in kilogram. Generally, for each treatment, a measured kilogram of printer toner waste was thoroughly mixed with a standard weight of soil(7kg) to make up different treatments ranging from 0% which is control, 2%, 4%, 6%, 8%.

Four seeds of *Albemechus esculentus* were planted in each of the planting bags having the treatments and kept in a conducive environment where they were all exposed to the same environmental conditions necessary for growth such as sunlight and rainfall in an open field. The plants were watered as required after perforating the planting bags to allow drainage of water.

The following parameters were analyzed: The plant height, number of leaves, leaf length, leaf width and leaf area.

Data collected for each parameter were subjected to analysis of variance (ANOVA) using Microsoft Excel 2010 version. Means were compared using the least significant Difference (LSD) [Steel and Torrie,1960].

III. Results

ANALYSIS OF PRINTER TONER WASTE

Table 1.0 shows the result of the printer toner waste analysis, from the analysis it is observed that the printer toner waste contains a large amount of Potassium (823.85mg/kg), Sodium (780.25mg/kg), Iron (639mg/kg) and other components like sulphate ion, phosphate ion, lead, zinc, magnesium, manganese, ash, chromium.

Table 1.0 The Nutrient content of Printer toner waste

S/N	COMPONENTS	QUANTITY (MG/KG)
1	SO4: SULPHATE ION	213
2	PO4: PHOSPHATE ION	11.54
3	Fe: IRON	639
4	Cr: CHROMIUM	1.450
5	Mn: MANGANESE	187.825

6	Pb: LEAD	1.825
7	Ca: CALCIUM	2.975
8	Zn: ZINC	7.625
9	Mg: MAGNESIUM	370.15
10	K: POTASSIUM	823.85
11	Na: SODIUM	780.25
12	ASH	16.65

PLANT HEIGHT

Figure 1.0 showed the effect on plant height of *Abelmochus esculentus L*. treated with different concentrations of printer toner waste.

The result indicated that 0% printer toner waste treatment gave the highest plant height value (28.3cm) after 6weeks of growth. There was a corresponding decrease in the plant height from 8% to 2% treatments. All treatments gave a poor plant height when compared to control after 6weeks of growth.

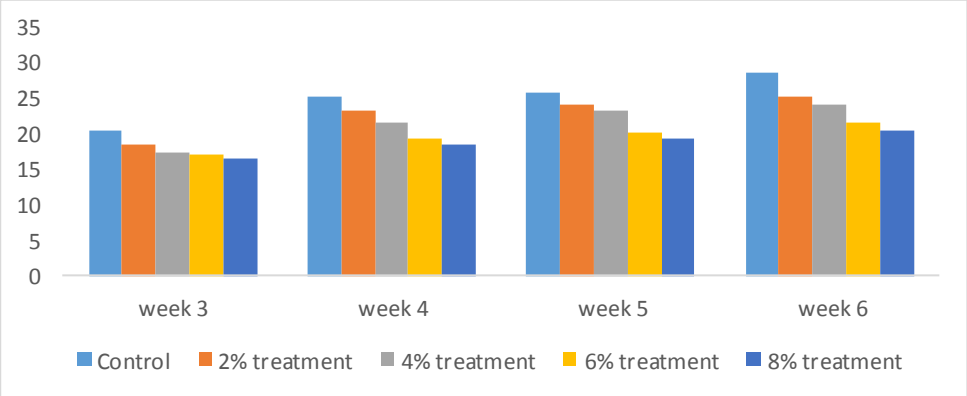

Fig1.0 The Effects of different concentrations of the printer toner waste on the plant height of okra.

NUMBER OF LEAVES

The number of leaves were observed and recorded for each week and the result obtained showed the effect on number of leaves of *Abelmochus esculentus L.* treated with different concentrations of printer toner waste.

The result showed that control had the highest number of leaves while 2% and 4% treatment had the same number of leaves (5 leaves and 4 leaves respectively). There was a gradual decrease in the leaves number from 6% to 8% treatments. Just like in plant height all the treatments had lower number of leaves when compared to the control.

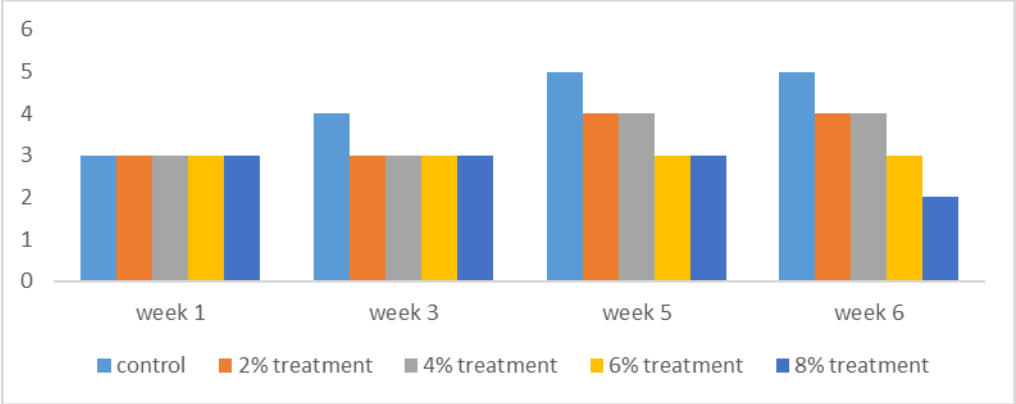

Fig. 2.0 The effects of different concentrations of printer toner waste on the number of leaves of okra.

LEAF AREA

Figure 3.0 below showed the effect on leaf area of *Abelmochus esculentus L.* treated with different concentrations of printer toner waste and it indicated that 0% treatment gave the highest value for the leaf area (44cm^2), while the 8% treatment gave the lowest value for leaf area (18.7 cm^2).

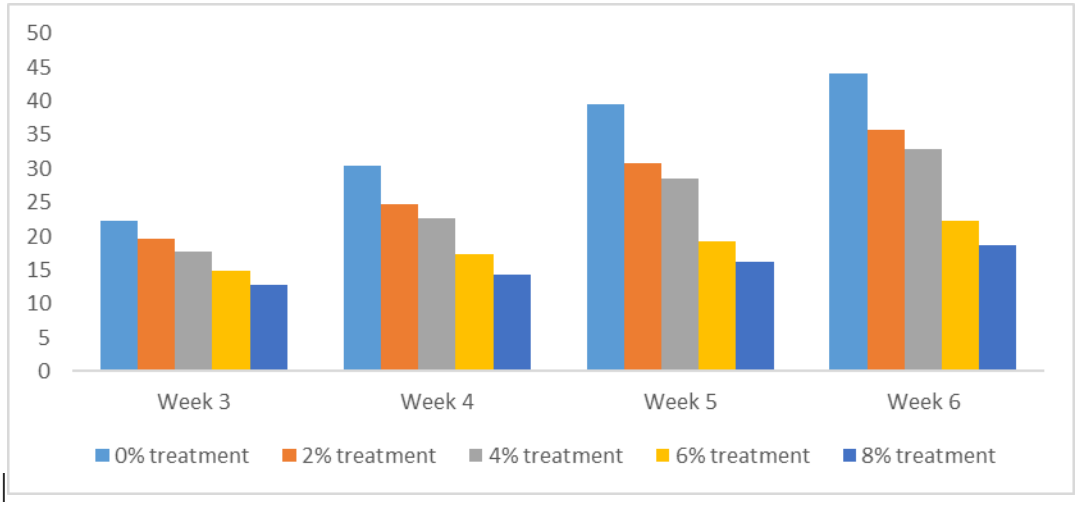

Fig. 3.0 The effects of the different concentrations of printer toner waste on the leaf area.

IV. DISCUSSION

The result of the research work showed that the 0% treatment gave the highest values for the various growth parameters such as plant height, number of leaves, leaf area when compared to other treatment values. the 2% treatment was the closest to the control or 0% treatment in terms of plant height, number of leaves and leaf area. Generally, the treatments performed poorly in terms of the various growth parameters when compared to the control. Therefore, increasing concentrations of printer toner waste especially from 4% reduces the plant height, number of leaves and leaf area of *Abelmochus esculentus L.*

The reduction in plant height, number of leaves and leaf area can be attributed to the presence of a lot of metals in the printer toner waste. According to the result obtained from the printer toner analysis it was discovered that the printer waste used in the research work contained a high level of iron (Fe) 639mg/kg, potassium (K) 823mg/kg, and sodium (Na) 790mg/kg

Heavy metals have high density and mostly toxic in nature for human, plants and animals regardless of their concentrations due to their accumulation in food chain and persisted in nature [1, 5].

This research work supports the statement above that heavy metals are toxic to plants.

Toner waste contains various chemicals, including pigments, resins, and toner particles. When these chemicals are disposed of improperly and leach into the soil, they can have a negative impact on plant growth and health. The chemicals can change the soil chemistry, making it less hospitable for plants, and also potentially contaminate water sources that plants rely on for survival. [2].

the poor performance of the treatments from 2% to 8% can also be attributed to the presence of various chemicals in the printer toner waste.

The toner used in printers is made up of fine particles of carbon black, polymers, and various other chemicals. When toner waste is disposed of improperly, it can have a negative impact on the environment, including plants. Toner waste can contain heavy metals, such as lead and cadmium, which can be toxic to plants. [3].

V. CONCLUSION

From the research work carried out, it can be concluded that printer toner waste has a negative effect on the measured growth parameters of *Abelmochus esculentus L* when compared to the control. The 8% treatment which contains the highest concentration of printer toner waste had more effect on the growth parameters of okra. Therefore, printer toner waste can be said to have a negative effect on the growth parameters of okra, the higher the concentration the more impact the toner waste has on the plant. Printer toner waste should be disposed of properly or recycled if possible to help reduce the concentrations that leach into the soil due to improper disposal.

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