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EFFECT OF SPENT ENGINE OIL ON THE MORPHOLOGICAL GROWTH INDICES OF GROUNDNUT *(ARACHIS HYPOGEA* L.) IN KEFFI LOCAL GOVERNMENT AREA OF NASARAWA STATE.

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Abstract
This study investigates the impact of spent engine oil (SEO) contamination on the morphological growth indices of Arachis hypogaea (groundnut) in Keffi, Nigeria. Groundnut, a vital crop for nutrition and economic sustainability, often faces challenges from soil pollutants, including hydrocarbons from used engine oil. The experiment involved cultivating groundnuts in soil treated with varying concentrations of SEO (0%, 3%, 6%, and 9%) to evaluate its effects on plant height, leaf dimensions, branch number, and yield. Results demonstrated a concentration-dependent decline in growth and yield, with the control group consistently outperforming polluted treatments. Interestingly, the 3% SEO treatment resulted in increased leaf length compared with the control, suggesting complex interactions at lower pollution levels. The findings underscore the harmful effects of SEO on crop productivity, emphasizing the need for proper waste management practices to protect agricultural resources. This research provides valuable insights into mitigating pollution's impact on food security and sustainable farming.

INTRODUCTION

Arachis hypogaea, commonly known as peanuts or groundnuts, is an important crop worldwide. As a member of the Fabaceae family, it is an important legume crop cultivated worldwide, as well as in Nigeria, because of its high nutritional value and economic importance (Varshney *et al.,* 2013). It is rich in protein, oil, vitamins, and minerals, making it an essential component of human diets and a valuable source of income for farmers (Janila *et al.*, 2019).

Groundnut farming is a significant contributor to rural livelihoods in Nigeria. Small-scale farmers cultivate groundnuts as cash crops, selling their harvest in local markets or to larger processing companies. The income generated from groundnut cultivation plays a vital role in poverty reduction and rural communities' economic empowerment (Okoye and Orji, 2020). Notwithstanding this, they are an essential crop for ensuring food

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security in Nigeria because they are a rich source of protein, healthy fats, fiber, and several essential vitamins and minerals, making them a valuable addition to the diet. They can be consumed in various forms, including roasting, boiling, ground into paste (peanut butter), or used as an ingredient in traditional dishes. They are a reliable dietary protein source, particularly for individuals with limited access to animal protein sources (Ogunsola and Aina, 2012). Haulms are used for animal feed production because they are rich in protein and provide essential nutrients for animal growth and development, contributing to improved productivity in the livestock sector (Ugwuona, *et al.,* 2015). In addition, groundnut oil, derived from *Arachis hypogaea*, plays a crucial role in Nigerian cooking. Oil is widely used for frying and cooking because of its high smoke content and distinctive flavor. It is also a crucial ingredient in the production of various food products such as margarine, confectionery, and snacks.

The groundnut oil extraction and processing industries create employment opportunities and contribute to the growth of the agro-processing sector in Nigeria (Eje, and Isangedighi, 2019), also contributing to Nigeria's export capacity. Nigeria holds significant export potential for groundnut products. The country exports groundnut kernels, oil, and processed groundnut products to international markets, including Europe, Asia, and neighboring African countries. Groundnut exports contribute to foreign exchange earnings and enhance Nigeria's position in global agricultural trade.

The growth and yield of *Arachis hypogaea* can be severely affected by soil pollution, including oil contamination (Chigbo *et al.*, 2014). The roots and shoots of plants are in direct contact with the soil, making them highly susceptible to the toxic effects of pollutants such as spent engine oil. The agricultural region of Keffi, which is known for its cultivation activities, may face the risk of soil contamination with spent engine oil due to various anthropogenic activities in the area (Iwegbue *et al.*, 2019).

In today's rapidly changing environment, especially in Nigeria, plants, including *Arachis hypogaea*, are increasingly exposed to various stresses, such as pollution. Pollution from industrial emissions, vehicular exhaust, agricultural practices, spent engine oil from automobile disposal, and crude oil spills. These factors have detrimental effects on plant growth, development, and overall plant productivity. These pollutants contain toxic compounds such as PAHs, which have been shown to hinder seed germination, reduce plant growth, and negatively impact the physiological processes of plants (Li *et al.,* 2019; Singh *et al.,* 2017). They can also persist in the environment for extended periods and accumulate in plant tissues, posing potential risks to human health through the food chain (Chigbo *et al.,* 2014). Furthermore, oil-contaminated soils can alter the physiological processes of plants, leading to nutrient deficiencies, decreased photosynthetic activity, and impaired water uptake (Li *et al.,* 2019; Singh *et al.,* 2017). Therefore, it is essential to assess the impact of spent engine oil on the morphological growth indices of *Arachis hypogaea* in Keffi. This understanding of the morphological responses of *Arachis hypogaea* to spent engine oil contamination is crucial for assessing the potential risks and limitations associated with cultivating this crop in oil-contaminated environments.

MATERIALS AND METHOD

Materials

Some of the materials that were used for the study include: Matured seeds of *A. hypogea*, Poly bags, measuring cylinder, masking tape, water, water cans, weighing balance, spent engine oil, and test tubes.

Experimental Site

The potted experiment was conducted at the Botanic Gardens of Nasarawa State University, Keffi, in the Keffi Local Government Area of Nasarawa State. It is situated in the North Central part of Nigeria. The climate of the area is characterized by a tropical monsoon climate with a mean annual temperature of 23.55°C to 35.11°C and annual rainfall of over 160.03 mm. The annual mean relative humidity was 59.9%, and the soil was usually sandy or sandy loam underlain by a layer of impervious pan.

Treatments

The following treatments were adopted for the study:

i. Control: soil without pollution (C)

ii. Soil + 3% Spent Engine Oil (3%SEO)

iii. Soil + 6% Spent Engine Oil (6%SEO)

iv. Soil + 9% Spent Engine Oil (9%SEO)

Soil Contamination with Spent Engine Oil (SEO)

The pollution treatment was carried out by adding 3%, 6%, and 9% SEO to a measured quantity of sandy-loam soil. These was thoroughly mixed before it is transferred into perforated poly bags, this is to however allow aeration and drainage of air and water, respectively, in the polybags. The soil samples were allowed to be preconditioned for one week to allow the oil to react and soil to acclimatize before planting.

Cultivation of *A. hypogea*

Three (3) seeds of the plant (*A. hypogea*) were planted in a planting bag filled with loam soil (control) and soil polluted with different concentrations of spent engine oil (3%, 6% and 9%). The plants were allowed to grow normally for approximately 12 weeks with intermittent measurement of the requisite parameters bi-weekly. There were three plants per planting bag and three bags per treatment, thus resulting in nine (9) replicates for each treatment and thirty-six (36) across all treatments.

Experimental Design

A completely randomized design (CRD) was adopted in the experiment with four (4) levels of treatment and three (3) replicates in a 4 X 3 matrix system which were; C, 3%SEO, 6%SEO, and 9%SEO.

Duration of study

The study lasted for 12 (twelve) weeks, with 1 week for germination-type viability testing of the seeds and soil pollution, and 11 weeks for growth of the plants with intermittent measurement of the requisite parameters bi-weekly.

Parameters Studied

Some of the parameters investigated include: plant height, leaf length, leaf width, number of fruits, number of leaves, plant girth, number of flowers, and number of branches. These parameters were observed bi-weekly for 12 weeks.

Measurement of Number of Leaves and Number of Flowers:

The number of leaves and flowers were determined by visually counting the number of leaves and flowers on each plant.

Plant Height Measurement:

The plant height was obtained by measuring the height of the shoot of the plantlets (from soil level to the topmost leaf) using a meter.

Determining the Leaf width:

The leaf width was determined by measuring the width of the longest part of the leaf using a meter rule.

Determining the Leaf Length:

The leaf length was determined by measuring the length of the leaf using a meter.

Number of fruits**:**

The number of fruits was determined destructively by visually counting the number of mature fruits in each plant at 12 WAP.

Measurement for Plant Girth:

The stem plant girth was determined by measuring the stem immediately above the soil level using a Venier caliper.

Table 1: Analysis of Variance of all evaluated parameters.

Source of variation	Df	Mean Squares							
		PH	NL	LL	LW	PG	NFR	NFL	NB
Between Groups	3	224.82*	73.89***	16.41***	3.72**	1.42**	46.67***	43.00*	1132.42**
Within Groups	8	23.83	1.50	0.62	0.31	0.16	0.58	7.08	96.39
Total	11								

*P < 0.05, **P < 0.01, ***P < 0.001

Df = degree of freedom; PH = height; NL = number of leaves; LL = leaf length; LW = leaf width; PG = plant girth; NFR = number of fruits; NFL = number of leaves; NB = number of branches

Statistical Analysis

Data collected were analyzed with the Analysis of Variance tool in Microsoft Excel, and the means were separated using the LSD at a 5% level of probability.

RESULTS

Plant Height (cm)

The effect of spent engine oil on the growth of *A. hypogea* showed that treatment C had the highest height, with a mean height of 23.30 ± 0.66 at the end of the 12WAP, followed by 3%SEO (10.33 ± 0.17) while 6%SEO recorded 6.7 ± 0.33. The 6%SEO value was higher than the 9%SEO value (3.66 ± 0.15), (Fig. 1). The results indicated that treatment C resulted in the highest plant height. Thus, the results showed significant differences (P < 0.05) among the treatments.

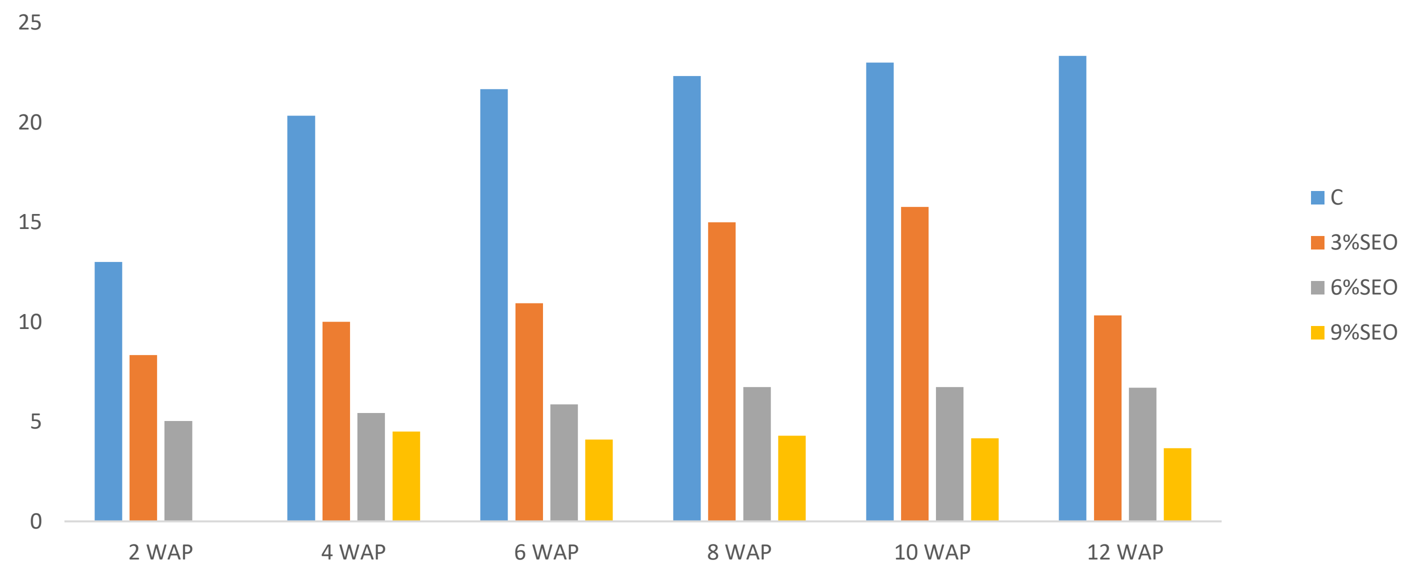

Fig. 1: Height of A. hypogea plants raised in the control (C), 3%SEO, 6%SEO, and 9%SEO groups.

Number Of Branches

The effect of spent engine oil on the growth of *A. hypogea* showed that treatment C had the highest number of branches, with a mean value of 8.66 ± 0.06 at 12WAP, followed by 3%SEO (2.66 ± 0.17). 6%SEO and 9%SEO recorded 0.66 ± 1.23 and 0.66 ± 0.23 (Fig. 2). The results indicated that treatment C had the highest value.

Thus, the results showed that there were significant differences among the treatments, but 6%SEO and 9%SEO were not significantly different (P < 0.05).

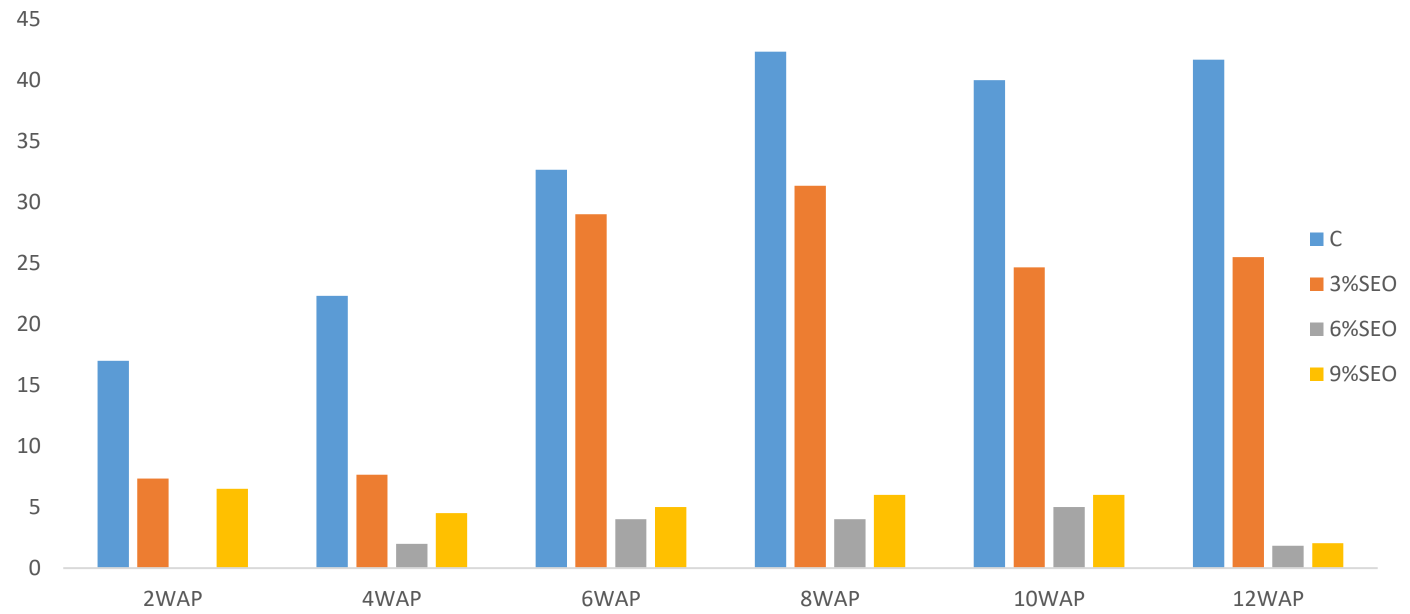

Fig. 2: Number of A. hypogea branches raised in control (C), 3% SEO, 6% SEO, and 9% SEO groups.

Plant Girth (cm)

The effect of spent engine oil on the growth of *A. hypogea* showed that in Plant girth, treatment C had the highest number of branches, with a mean value of 1.7 ± 0.61 at the 12WAP, followed by 3%SEO (0.5 ± 1.17). 6%SEO and 9%SEO recorded 0.23 ± 1.08 and 0.3 ± 1.03 (Fig. 3). The results indicated that treatment C had the highest value. Thus, the results showed that there were significant differences (P < 0.05) among the treatments but 6%SEO and 9%SEO were not significantly different (P > 0.05).

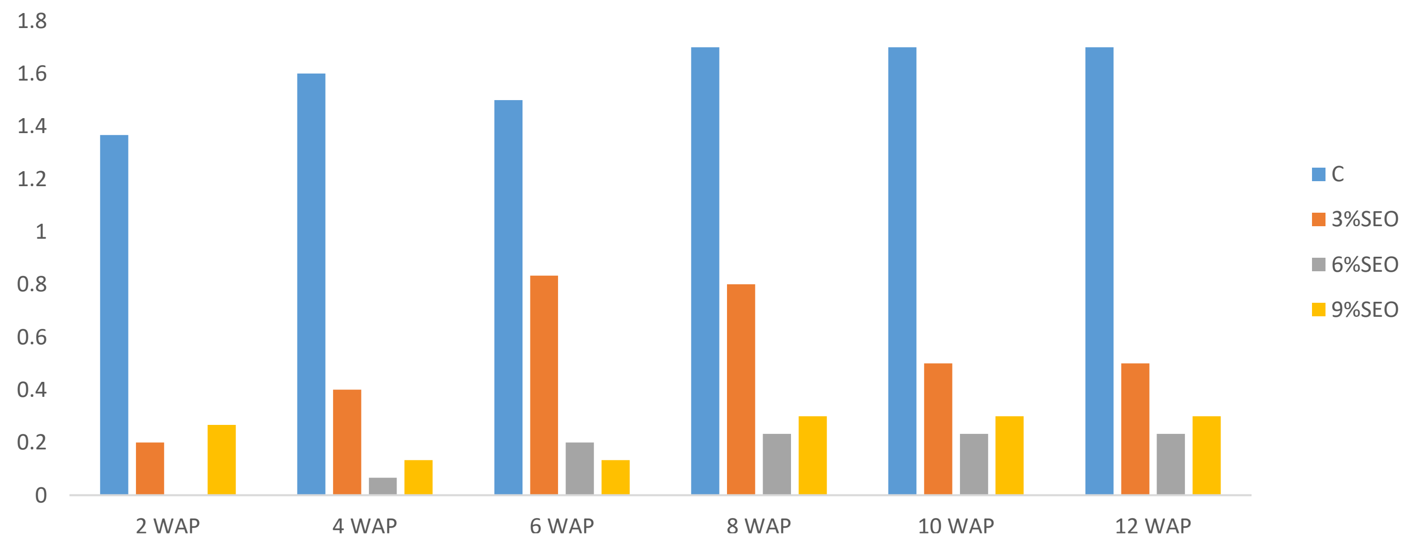

Fig. 3: The plant girth of *A. hypogea* was raised in control (C), 3%SEO, 6%SEO, and 9%SEO groups.

Leaf Length (cm)

The effect of spent engine oil on the growth of *A. hypogea* showed that treatment with 3%SEO had the highest mean leaf length, with a mean value of 4.75 ± 0.20 at 12WAP, followed by C (4.5 ± 5.40). 9%SEO and 6%SEO recorded 0.73 ± 0.285 and 0.643 ± 0.08 respectively (Fig. 4). The results indicate that 3%SEO had the highest value. Thus, the results showed that there were significant differences among the treatments; however, 3%SEO was not significantly different ($P < 0.05$) from C. also, 9%SEO and 6%SEO were not significantly different ($P > 0.05$).

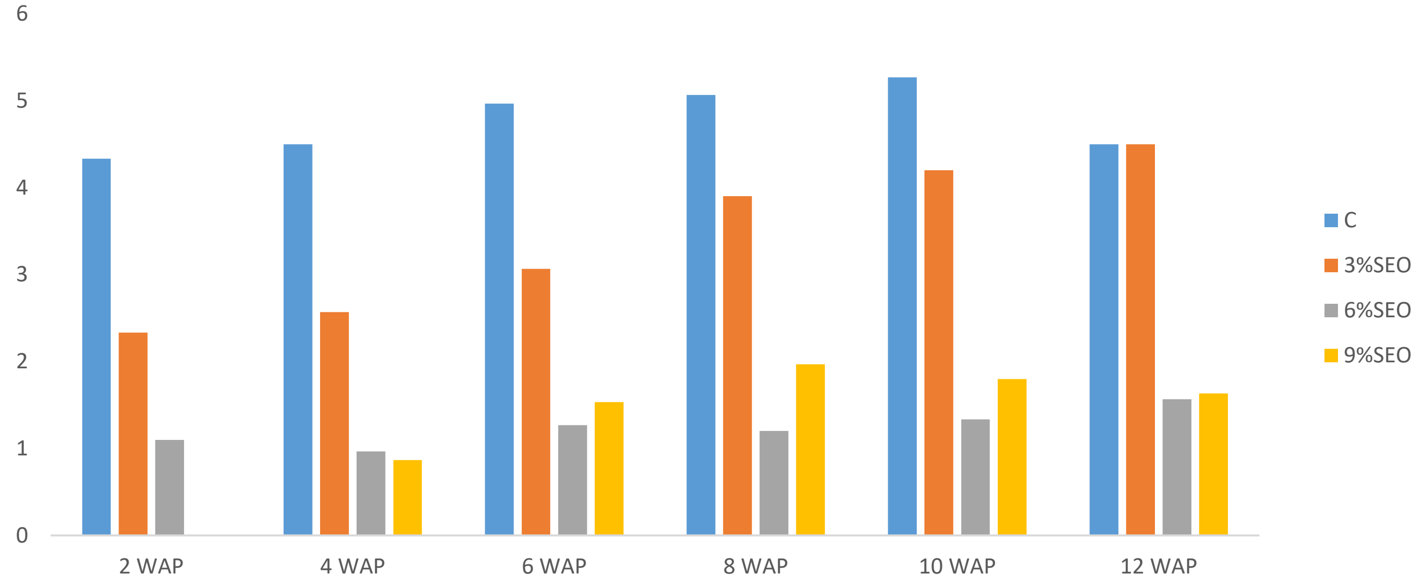

Fig. 4: Leaf Length of *A. hypogea* in control (C), 3% SEO, 6% SEO, and 9% SEO groups.

Number of Leaves

Fig. 5 Mean values of A. *hypogea* seeds raised under different soil treatments. Treatment C gave the highest number of leaves, with a mean value of 11.0 ± 1.15 at the end of the 12-week growth period. This result was followed by 3%SEO (3.33 ± 0.66). The mean numbers of leaves of 6%SEO and 9%SEO indicated least mean values of 0.66 ± 0.33 and 0.33 ± 0.33 respectively. The results for the number of leaves generally indicate that treatment C achieved the highest mean value. The statistical analysis showed that C and 3%SEO were significantly different ($P < 0.05$) from all treatments. However, 6%SEO and 9%SEO were not significantly different ($P > 0.05$).

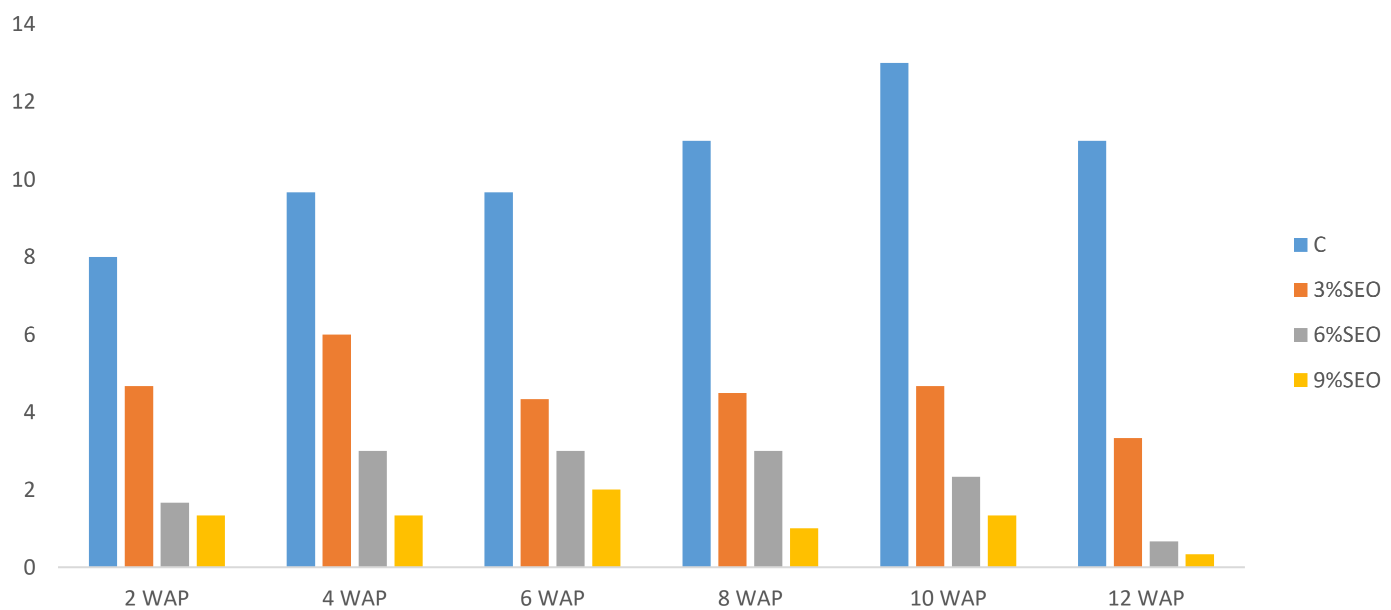

Fig. 5: Number of Leaves of *A. hypogea* raised in control (C), 3% SEO, 6% SEO, and 9% SEO groups.

Number of Flowers

Fig. 6 Mean values of A. *hypogea* seeds raised under different soil treatments. Treatment C gave the highest number of flowers, with a mean value of 8.66 ± 1.18 at the end of the twelve weeks of growth. This result was followed by 3%SEO (2.66 ± 0.16). The mean numbers of flowers in 6%SEO and 9%SEO indicated least mean values of 0.66 ± 0.43 and 0.66 ± 0.43 respectively. The results for the number of leaves generally indicate that treatment C achieved the highest mean value. The statistical analysis showed that C and 3%SEO were significantly different ($P < 0.05$) compared with the other treatments. However, 6%SEO and 9%SEO were not significantly different ($P > 0.05$).

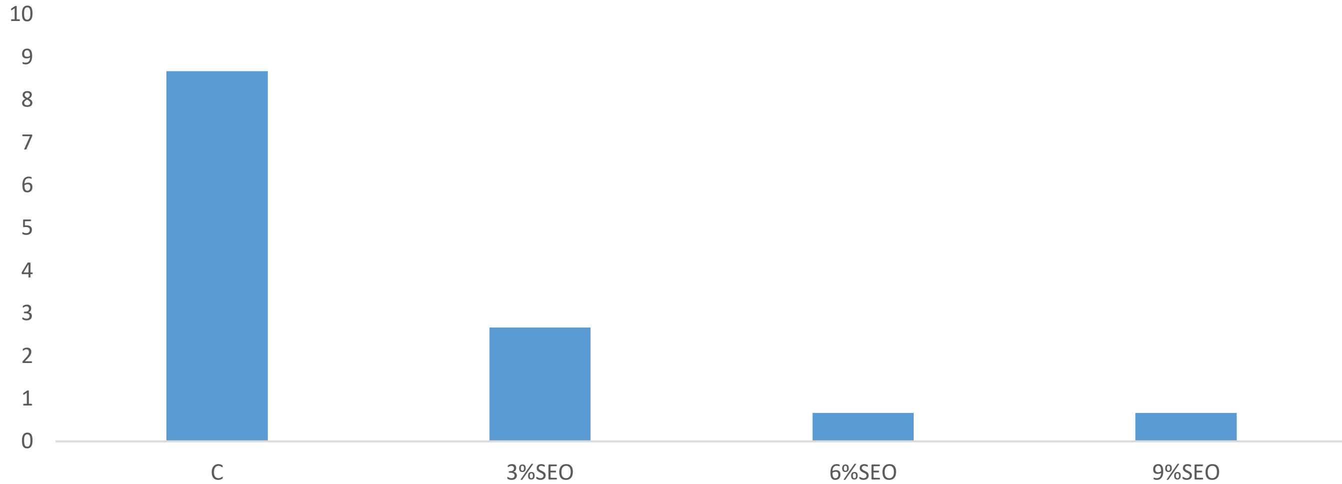

Fig. 6: Number of Flowers of *A. hypogea* raised in control (C), 3% SEO, 6% SEO, and 9% SEO groups.

Number of Fruits

Fig. 7 Mean values of A. *hypogea* seeds raised under different soil treatments. Treatment C gave the highest number of flowers with a mean value of 9.0 ± 0.18 at the end of the twelve weeks of growth. This result was followed by 3%SEO (3.66 ± 0.16). The mean numbers of flowers in 6%SEO and 9%SEO indicated least mean values of 1.66 ± 0.73 and 1.0 ± 0.33 respectively. The results for the number of leaves generally indicate that treatment C achieved the highest mean value. The statistical analysis showed that C and 3%SEO were significantly different ($P < 0.05$) compared with the other treatments. However, 6%SEO and 9%SEO were not significantly different ($P > 0.05$).

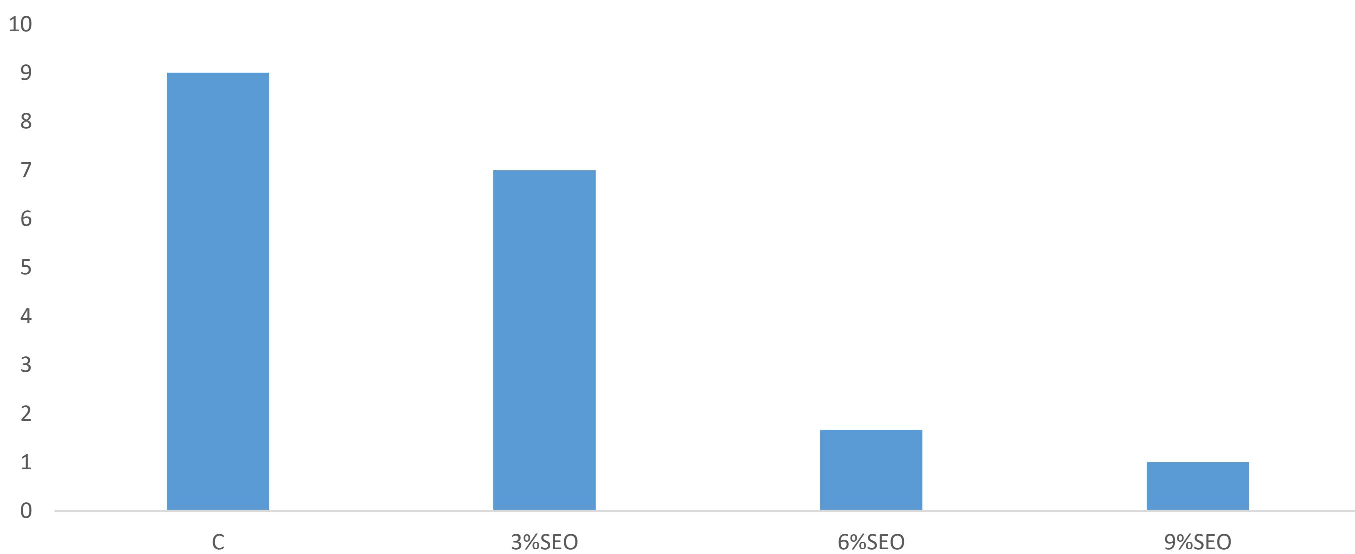

Fig. 7: Number of Fruits of *A. hypogea* raised in control (C), 3% SEO, 6% SEO, and 9% SEO groups.

Leaf Width

Figure 8 shows the mean values of A. *hypogea* seeds raised under different soil treatments. Treatment C gave the highest leaf width, with a mean value of 2.6 ± 1.18 at the end of the 12-week growth period. This result was followed by 3%SEO (1.63 ± 0.11). The mean leaf widths of 6%SEO and 9%SEO indicated least mean values of 0.23 ± 0.23 and 0.4 ± 0.63 respectively. The results for leave width generally indicate that treatment C achieved the highest mean value. The statistical analysis showed that C and 3%SEO were significantly different ($P < 0.05$) compared with the other treatments. However, 6%SEO and 9%SEO were not significantly different ($P > 0.05$).

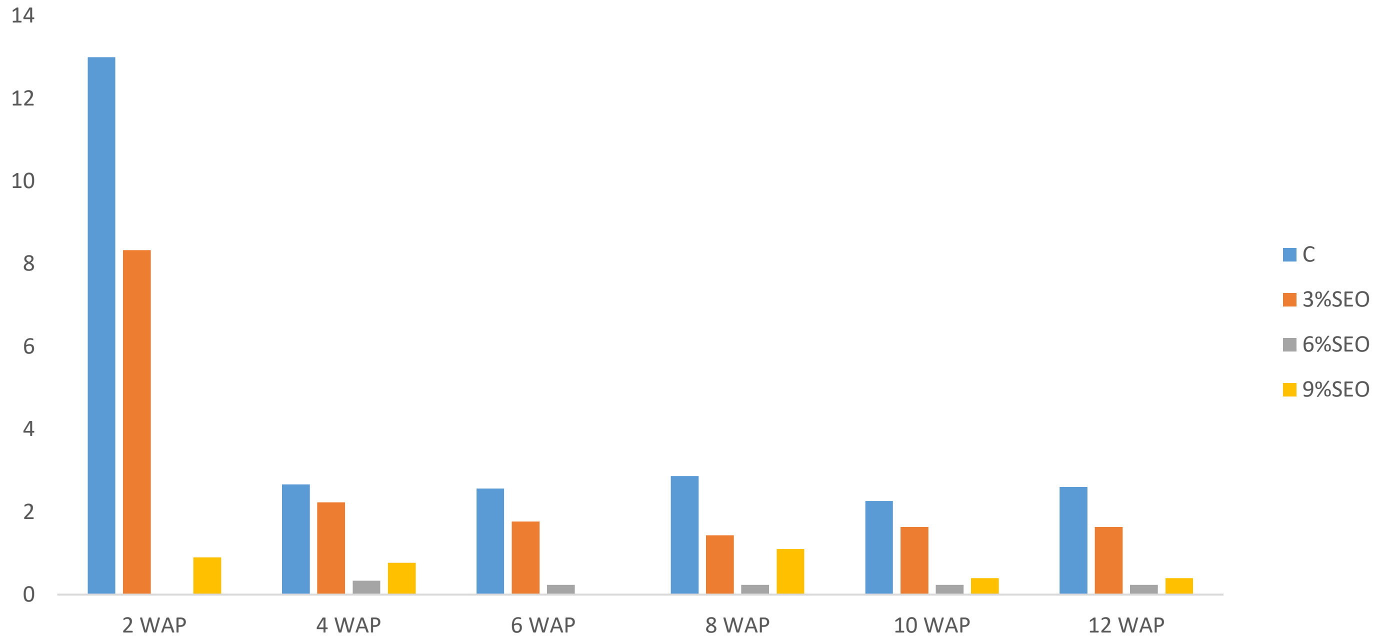

Fig. 8: Leave Width of *A. hypogea* increased in control (C), 3% SEO, 6% SEO, and 9% SEO groups.

DISCUSSION

The result from the research showed the intricate dynamics between spent engine oil (SEO) and the morphological growth indices of Groundnut (*Arachis hypogea* L.). The results revealed the responses of groundnut plants to varying concentrations of SEO, showing branching, fruits, plant girth, leaf dimensions, and flowering patterns. From the result, there was a decline in the number of branches in the SEO-treated groups compared with the control (C). This is in line with existing literature on the phytotoxic effects of hydrocarbons, particularly those present in spent engine oil (Singh *et al.*, 2017). This reduction in the number of branches may result from the oil's capacity to modify nutrient availability and disrupt crucial physiological processes in plants (Pandey *et al.*, 2020). The intricate balance between nutrient assimilation and hormonal regulation disrupted by SEO could be a key contributor to this observed decline. The number of fruits, which was also observed to have a significantly decreased in SEO-treated groups as the concentration increased, supports prior studies highlighting the adverse impact of oil contaminants on plant reproductive structures (Adesodun *et al.*, 2010). The interference of SEO in flower development and subsequent fruit formation, as suggested by Kumar *et al.* (2018), implies a reduction in overall yield. This underscores the vulnerability of plant reproductive processes to the harmful effects of SEO.

In examining plant girth, the decline in SEO-treated plants aligns with research positing that hydrocarbons in engine oil can interfere with cell division and elongation, thereby influencing overall plant development (Atagana, 2009). The reduction in girth is a potential indicator of compromised cell expansion and differentiation processes. This suggests that SEO-containing treatments may disrupt the fundamental cellular mechanisms responsible for plant growth and development. Contrary to typical responses to oil contamination, the increased leaf length in the 3%SEO treatment compared to the control group introduces a layer of complexity to the narrative. This variance may be attributed to the intricate interactions between oil concentration, plant species, and soil conditions, as suggested by Maestri *et al.,* (2017). The atypical response calls for further investigation into the specific mechanisms influencing leaf elongation under the influence of SEO. In addition, the observed decline in the number of leaves in the SEO-treated groups corresponds with studies highlighting the inhibitory effects of oil pollutants on leaf initiation and growth (Ogboghodo *et al.*, 2012). This reduction implies that SEO interferes with the physiological processes governing leaf development. The complex balance of hormonal regulation and metabolic pathways may be disrupted, leading to the observed reduction in leaf numbers.

Furthermore, the plant height, which showed a significant reduction in the SEO-treated groups aligns with (Akan *et al*., 2011) that oil contaminants have a negative impact on plant stature. The hindrance of root development and nutrient uptake by SEO may contribute to the observed stunted growth (Adenipekun and Lawal, 2002). This indicates a broader systemic impact of SEO on plant structural development across different SEO treatments. The reduction in leaf width in the SEO-treated groups is in line with the findings of a study assessing the impact of oil pollutants on leaf morphology (Akinyemi *et al.*, 2012). SEO-induced stress may disrupt normal leaf expansion processes, thereby affecting the overall photosynthetic capacity of the plant. Alterations to leaf morphology could impact the plant's ability to harness sunlight for energy through photosynthesis. Lastly, the decreased number of flowers in SEO-treated plants aligns with previous research indicating that hydrocarbons in engine oil can negatively affect floral development and reproductive success (Osuji *et al.*, 2018). The decrease in flower production suggests disruption of pollination processes and alterations of floral structure induced by SEO. This highlights the complicated impact of SEO on the reproductive aspects of the plant's life cycle.

CONCLUSION

In conclusion, these findings underscore the adverse effects of spent engine oil on the morphological growth indices of Arachis hypogea. The varied responses observed for different parameters emphasize the complexity of plant-oil interactions, which are influenced by factors such as oil concentration, exposure duration, and plant species. These results have implications for agricultural practices, emphasizing the importance of proper engine oil disposal to prevent soil contamination and potential harm to crops.

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