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## EFFECT OF 4-TERT OCTYLPHENOL ON POTTED SEEDLINGS OF JUTE MALLOW

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**ABSTRACT:** In recent years, the presence of emerging pollutants, especially in the aquatic environments, has drawn the attention of environmental experts. Many of the priority pollutants are from Endocrine disrupting chemicals (EDCs). Alkylphenols (APs) fall in the EDCs group and have estrogenic effects. 4-tert Octylphenol (4-t-OP) is one of the most important and widely used Alkylphenolic compounds. This study therefore evaluated the effect of different concentrations of 4-tert Octylphenol on seedling performance of Jute Mallow (*Corchorus olitorius*). The experiment was carried out at the screen house of Ladoko Akintola University of Technology (LAUTECH), Ogbomosho, Oyo State, Nigeria. Six treatment combinations ( $V_{4-t-OP}kg/V_{sand}kg$ ),  $1 \times 10^{-4}$ ,  $5 \times 10^{-5}$ ,  $4 \times 10^{-5}$ ,  $3 \times 10^{-5}$ ,  $2 \times 10^{-5}$  and control were used, each replicated three times. These combinations were fitted in a Completely Randomized Design and means separated through the use of Duncan Multiple Range Test. Parameters such as plant height, germination rate, plant girth, number of leaves and leaf area were measured to determine the effect of 4-tert Octylphenol on Jute Mallow (*Corchorus olitorius*). Results showed that higher concentration of 4-tert Octylphenol (at  $1 \times 10^{-4}$  kg) has a negative effect on germination rate by suppressing the germinability of Jute Mallow seeds for the first day thereby having no germination (0.00). Also, negative effect was observed with higher concentrations of 4-tert Octylphenol (at  $1 \times 10^{-4}$  kg and  $5 \times 10^{-5}$  kg) on the height at week 9 and 11 having (29.91 and 40.31) respectively, on number of leaves at week 9 having (21.44) and on leaf area at week 5, 7 and 9 having (9.19, 20.12 and 25.74) respectively. The result of the negative effect was found to be retardation in growth of Jute Mallow vegetatively while no significant effect was observed on the girth. Conclusively, 4-tert Octylphenol could be said to encourage environmental pollution as the product is used in the manufacture of toothpaste, some personal care products and detergents. It is therefore recommended that while in use, 4-tert Octylphenol should be consciously handled and its effluent thereof should be disposed off carefully.

**Keywords:** Pollutants, 4-tert Octylphenol, Endocrine Disrupting Chemicals, Jute Mallow, Vegetative Performance.

### 1. INTRODUCTION

*Corchorus olitorius* are tall, usually annual herbs, reaching a height of 2.4 m. The plant could be unbranched, or with only a few side branches. The leaves are alternate, simple, lanceolate, finely serrated or lobed

margin (Nuwangburuka and Denton 2012; Smith 2000). It has diverse common names; bush okra, nalta jute, jute mallow and Jew's mallow, ewedu, melokhia and monoheiya (Bijlmakers and Verhoek 1995; Deton 1997; Fontem *et al.* 2003; IRD 2004; DAFF 2012; Faith *et al.* 2012).

The plant prefers light (sandy), medium (loamy), and heavy (clay soils). It is propagated by seed (Akoroda 1985; Hossain and Sasmal 2006; Kumar *et al.* 2006; Begum and Eukaryotes 2011; Banerjee *et al.* 2012; Benor *et al.* 2012; Ghosh *et al.* 2012). *Corchorus olitorius* is an important green leafy vegetable in many areas including Egypt, Southern Asia, Japan, India, China and Nigeria.

4-tert-Octylphenol, an alkylphenol, is used to manufacture alkylphenolethoxylates, which are anionic surfactants used in detergents, industrial cleaners, and emulsifiers. The alkylphenolethoxylates enter the environment through human use of products containing them, through sewage, and through manufacturing waste streams (Warhurst, 1995; Ying *et al.*, 2002).

Human exposure to alkylphenols and alkylphenolethoxylates may occur through ingestion of contaminated foods (e.g., fish) and drinking water, and from contact with some personal care products and detergents. Indoor and to a lesser extent, outdoor air may contain detectable levels of 4-tert-octylphenol and 4-tert-octylphenol monoethoxylates, leading to inhalation as another potential exposure route (Rudel *et al.*, 2003; Saito *et al.*, 2004).

Several alkylphenols, including 4-tert-octylphenol, have demonstrated estrogenic effects particularly when injected at high doses in animals. These high dose parenteral effects of 4-tert-octylphenol have included altered sex hormone levels and hypothalamic-pituitary suppression, impaired steroidogenesis, altered estrus cycles and reproductive outcomes, altered neonatal sexual development, testicular atrophy, and impaired spermatogenesis (Bian *et al.*, 2006; Blake and Boockfor, 1997; Katsuda *et al.*, 2000; Laws *et al.*, 2000; Myllymaki *et al.*, 2005; Nagao *et al.*, 2001; Sweeney *et al.*, 2000; Yoshida *et al.*, 2001).

4-tert Octylphenol (4-t-OP) is one of the most important and widely used Alkylphenolic compounds. As mentioned above, one of the most important ways to transfer 4-tert Octylphenol (4-t-OP) to the environment is through wastewater. 4-t-OP due to high Kow<sup>1</sup> (4-t-OP lgKow =5.3), have a high tendency to be adsorbed to surfaces such as sludge, sediments and soils. This study therefore evaluated the effect of different concentration of 4-tert Octylphenol in soil on seedling performance of Jute Mallow, so as to conclude the would be effect on man, the end user.

## 2. MATERIALS AND METHODS

### 2.1. Study Area

The study was carried out at the Screen house, Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. The coordinate is Latitude 8.17, Longitude 4.2E, Altitude 420.2

### 2.2. Materials Used

4-tert-Octylphenol, Jute mallow seeds, Clean water, Polythene bags, Tags for identification, Top Soil, Sensitive Weighing scale, Manual weighing scale, Meter rule, Pestle and Mortar, Spatula, Vernier Calliper, sieve.

### 2.3. Procedure

Top soil was collected at the back of Olusegun Oke's library, under Gmelina woodlot, LAUTECH. Soil analysis was carried out and percentage of parameters pointed out include; Available P= 124.48, % O.C= 6.80, N=0.75, E. A= 0.30, PH= 6.9, Ca= 5.51, Mg= 3.77, K= 1.25, Na= 1.61, Mn= 188.00, Fe= 126.00, Cu= 0.24, Zn= 5.21, %Sand= 77.0, Silt= 10.0, Clay= 13.0. The soil was sieved and weighed into 5kg per pot. A 4-tert Octylphenol (white solid) was taken to the laboratory, ground with the use of mortar and pestle and weighed through the use of sensitive scale into 5 different concentrations (1x10<sup>-4</sup>kg, 5x10<sup>-5</sup>kg, 4x10<sup>-5</sup>kg, 3x10<sup>-5</sup>kg, 2x10<sup>-5</sup>kg). The weighed out concentrations of 4-tert Octylphenol was later incorporated individually into each of the pots of soil earlier weighed and left for 48hrs so the chemical could be absorbed by the soil.

**Seed Procurement and Pretreatment** The corchorus seed was obtained from NACGRAB (National Center for Genetics Resources and Biotechnology), seed dormancy was broken using hot water with the seed soaked in it for 5mins and after which sowing was done. Ten (10) seeds were sown per pot which was later thinned to 3 seedlings after germination. Clean water was being supplied to the plants at every two-day interval.

#### 2.3.1. Treatment combination and experimental design

Six (6) treatment combinations were used and each was replicated three (3) times to make Eighteen (18) experimental units in total.

The treatment combinations were as set below:

T<sub>1</sub> ----- 0.10g of 4-tert Octylphenol  
T<sub>2</sub> ----- 0.05g 4-tert Octylphenol  
T<sub>3</sub> ----- 0.04g 4-tert Octylphenol  
T<sub>4</sub> ----- 0.03g 4-tert Octylphenol  
T<sub>5</sub> ----- 0.02g 4-tert Octylphenol  
T<sub>6</sub> ----- Control.

The treatment combinations were arranged using a Completely Randomized Design.

#### 2.4. Data Collection

The following parameters were measured:

**Germination rate:** Germination rate was determined quantitatively by counting.

**Plant height:** Plant height was measured using a meter ruler from the soil level to the terminal bud.

**Number of leaves:** Number of leaves was determined quantitatively by counting.

**Leaf area:** The leaf area was determined using the formula

Leaf Area =  $0.919 + 0.682LW$  (Peksen 2007), where L is the leaf length, W is the leaf width and 0.919 and 0.682 are the conversion factors.

**Stem girth:** The stem girth was determined by using Vernier caliper.

#### 2.5. Statistical analysis

Data were collected for 12 weeks and were analyzed using Analysis of Variance (ANOVA) and means were

separated with the use of Duncan Multiple Range Test at 5% level of probability.

### 3. RESULTS

#### 3.1. Effect of 4-tert Octylphenol on Germination Rate of Jute Mallow

Result from Table 1 revealed that at day1, highest germination rate (4.33) was recorded in treatment 3 ( $4 \times 10^{-5}$  Conc of 4-t-OP), followed by (3.33) in treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP) and least in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP) which has no germination. At day3, highest germination rate (3.33) was recorded in treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP), followed by (2.33) in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP) and least (1.00) in treatment 3 ( $4 \times 10^{-5}$  Conc of 4-t-OP) and 6 (Control). At day 5, highest germination rate (2.67) was recorded in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP), followed by (1.67) treatment 3 ( $4 \times 10^{-5}$  Conc of 4-t-OP) and least (0.67) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). At day 7, highest germination rate (0.67) was recorded in treatment 4, 5 and 6 ( $3 \times 10^{-5}$ ,  $2 \times 10^{-5}$  Conc of 4-t-OP and Control) respectively, followed by (0.33) treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP) and no germination was recorded in treatment 2 and 3 ( $5 \times 10^{-5}$  and  $4 \times 10^{-5}$  Conc of 4-t-OP respectively). At day 9, highest germination rate (0.67) was recorded in treatment 6 (Control), followed by (0.33<sup>a</sup>) in treatment 3 and 4 ( $4 \times 10^{-5}$  and  $3 \times 10^{-5}$  Conc of 4-t-OP respectively) and no germination was recorded in treatment 1, 2 and 5 ( $1 \times 10^{-4}$ ,  $5 \times 10^{-5}$  and  $2 \times 10^{-5}$  Conc of 4-t-OP) respectively. Significant difference exists at Day 1 in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP) having no germination at all.

**Table 1: Effect of 4-Tert Octylphenol on Germination Rate of Jute Mallow**

| Treatment | Day               |                   |                   |                   |                   |
|-----------|-------------------|-------------------|-------------------|-------------------|-------------------|
|           | 1                 | 3                 | 5                 | 7                 | 9                 |
| 1         | 0.00 <sup>b</sup> | 2.33 <sup>a</sup> | 2.67 <sup>a</sup> | 0.33 <sup>a</sup> | 0.00 <sup>a</sup> |
| 2         | 3.00 <sup>a</sup> | 2.00 <sup>a</sup> | 0.67 <sup>a</sup> | 0.00 <sup>a</sup> | 0.00 <sup>a</sup> |
| 3         | 4.33 <sup>a</sup> | 1.00 <sup>a</sup> | 1.67 <sup>a</sup> | 0.00 <sup>a</sup> | 0.33 <sup>a</sup> |
| 4         | 2.67 <sup>a</sup> | 1.33 <sup>a</sup> | 1.00 <sup>a</sup> | 0.67 <sup>a</sup> | 0.33              |
| 5         | 3.33 <sup>a</sup> | 3.33 <sup>a</sup> | 1.00 <sup>a</sup> | 0.67 <sup>a</sup> | 0.00 <sup>a</sup> |
| 6         | 3.00 <sup>a</sup> | 1.00 <sup>a</sup> | 1.33 <sup>a</sup> | 0.67 <sup>a</sup> | 0.67 <sup>a</sup> |

#### 3.2. Effect of 4-tert Octylphenol on Girth of Jute Mallow

Results from Table 2 showed the effect of 4-tert Octylphenol on girth of Jute Mallow. No significant differences were observed however, highest girth value (0.94) at week 1 was recorded in treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP), followed by (0.93) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP) and least (0.90) in treatment 1 ( $1 \times 10^{-4}$

Conc of 4-t-OP). At week 3, highest girth value (1.30) was recorded in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP), followed by (1.29) in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP) and least (1.16) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). At week 5, highest girth value (1.64) was recorded in treatment 5&6 ( $2 \times 10^{-5}$  Conc of 4-t-OP and Control) respectively, followed by (1.61) treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP) and least (1.40) in treatment 2 ( $5 \times 10^{-5}$  Conc of

4-t-OP). No significant difference exists within the mean at all levels of treatment for all the weeks.

Table 2: Effect of 4-Tert Octylphenol on Girth of Jute Mallow (cm)

| Treatment | Week              |                   |                   |
|-----------|-------------------|-------------------|-------------------|
|           | 1                 | 3                 | 5                 |
| 1         | 0.90 <sup>a</sup> | 1.30 <sup>a</sup> | 1.51 <sup>a</sup> |
| 2         | 0.93 <sup>a</sup> | 1.16 <sup>a</sup> | 1.40 <sup>a</sup> |
| 3         | 0.91 <sup>a</sup> | 1.27 <sup>a</sup> | 1.47 <sup>a</sup> |
| 4         | 0.92 <sup>a</sup> | 1.29 <sup>a</sup> | 1.61 <sup>a</sup> |
| 5         | 0.94 <sup>a</sup> | 1.27 <sup>a</sup> | 1.64 <sup>a</sup> |
| 6         | 0.91 <sup>a</sup> | 1.27 <sup>a</sup> | 1.64 <sup>a</sup> |

Means followed by the same letter within the same column are not significantly different at  $P < 0.05$  using DMRT.

### 3.3. Effect of 4-tert Octylphenol on Height of Jute Mallow (cm)

Week 1 in Table 3 shown below, highest plant height (1.09) was recorded in treatment 6 (Control), followed by (1.08) in treatment 3 ( $4 \times 10^{-5}$  Conc of 4-t-OP) and least (0.53) in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP). At week 3,

highest plant height (3.27) was recorded in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP), followed by (3.13) in treatment 6 (Control) and least (2.57) in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP). Highest plant height (8.38) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), followed by (7.48) in treatment 3 ( $4 \times 10^{-5}$  Conc of 4-t-OP) and least (6.01) in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP) at week 5. At week 7, highest plant height (20.60) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), followed by (19.41) in treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP) and least (15.41) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). Result revealed at week 9 that highest plant height (36.07) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), follow by (31.97) in treatment 6 (Control) and least (29.91) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP), while at week 11, highest plant height (52.86) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), follow by (45.08) treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP) and least (40.31) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). Significant difference exist at week 9 with treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP) having the least plant height (29.91) and treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP) having the highest plant height (36.07) and at week 11 with treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP) having the least plant height (40.31) and treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP) having the highest plant heights (52.86).

Table 3: Effect of 4-Tert Octylphenol on Height of Jute Mallow (cm)

| Treatment | Week              |                   |                   |                    |                     |                     |
|-----------|-------------------|-------------------|-------------------|--------------------|---------------------|---------------------|
|           | 1                 | 3                 | 5                 | 7                  | 9                   | 11                  |
| 1         | 0.53 <sup>a</sup> | 2.57 <sup>a</sup> | 6.01 <sup>a</sup> | 15.46 <sup>a</sup> | 30.99 <sup>ab</sup> | 43.54 <sup>ab</sup> |
| 2         | 0.76 <sup>a</sup> | 3.27 <sup>a</sup> | 7.00 <sup>a</sup> | 15.41 <sup>a</sup> | 29.91 <sup>b</sup>  | 40.31 <sup>b</sup>  |
| 3         | 1.08 <sup>a</sup> | 3.01 <sup>a</sup> | 7.48 <sup>a</sup> | 18.08 <sup>a</sup> | 31.53 <sup>ab</sup> | 41.96 <sup>ab</sup> |
| 4         | 0.74 <sup>a</sup> | 2.70 <sup>a</sup> | 8.38 <sup>a</sup> | 20.60 <sup>a</sup> | 36.07 <sup>a</sup>  | 52.86 <sup>a</sup>  |
| 5         | 0.92 <sup>a</sup> | 2.84 <sup>a</sup> | 6.53 <sup>a</sup> | 19.41 <sup>a</sup> | 30.07 <sup>ab</sup> | 45.08 <sup>ab</sup> |
| 6         | 1.09 <sup>a</sup> | 3.13 <sup>a</sup> | 6.50 <sup>a</sup> | 16.36 <sup>a</sup> | 31.97 <sup>ab</sup> | 43.39 <sup>ab</sup> |

Means followed by the same letter within the same column are not significantly different at  $P \leq 0.05$  using DMRT

Fig 1: Effect of 4-tert Octylphenol on height of Jute Mallow

### 3.4. Effect of 4-tert Octylphenol on Number of Leaves of Jute Mallow

Result presented in Table 4 showed the highest number of leaves (4.11) in treatment 3 and 6 ( $4 \times 10^{-5}$  Conc of 4-t-OP and at Control) respectively, follow by (4.00) in treatment 4 and 5 ( $3 \times 10^{-5}$  and  $2 \times 10^{-5}$  Conc of 4-t-OP) respectively and least (3.78) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). At week 3, highest number of leaves (7.22) was recorded in treatment 3 ( $4 \times 10^{-5}$  Conc of 4-t-OP), followed by (7.11) in treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP) and least (6.33) in treatment 6 (Control). At week 5, highest number of leaves (10.44) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), followed by (10.33)

in treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP) and least (8.67) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). At week 7, highest number of leaves (16.67) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), followed by (16.44) treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP) and least (14.11) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). At week 9, highest number of leaves (32.22) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), followed by (31.56) in treatment 6 (Control) and least (21.44) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). Significant difference exists at week 9 with treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP) having the least number of leaves (21.44) and treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP) having the highest number of leaves (32.22) followed by (31.56) in treatment 6 (control).

**Table 4: Effect of 4-Tert Octylphenol on Number of Leaves of Jute Mallow**

| Treatment | Week              |                   |                    |                    |                      |
|-----------|-------------------|-------------------|--------------------|--------------------|----------------------|
|           | 1                 | 3                 | 5                  | 7                  | 9                    |
| 1         | 3.89 <sup>a</sup> | 6.67 <sup>a</sup> | 9.56 <sup>a</sup>  | 15.56 <sup>a</sup> | 25.56 <sup>abc</sup> |
| 2         | 3.78 <sup>a</sup> | 6.44 <sup>a</sup> | 8.67 <sup>a</sup>  | 14.11 <sup>a</sup> | 21.44 <sup>c</sup>   |
| 3         | 4.11 <sup>a</sup> | 7.22 <sup>a</sup> | 10.11 <sup>a</sup> | 15.33 <sup>a</sup> | 21.89 <sup>bc</sup>  |
| 4         | 4.00 <sup>a</sup> | 7.00 <sup>a</sup> | 10.44 <sup>a</sup> | 16.67 <sup>a</sup> | 32.22 <sup>a</sup>   |
| 5         | 4.00 <sup>a</sup> | 7.11 <sup>a</sup> | 10.33 <sup>a</sup> | 16.44 <sup>a</sup> | 26.00 <sup>abc</sup> |
| 6         | 4.11 <sup>a</sup> | 6.33 <sup>a</sup> | 10.00 <sup>a</sup> | 15.78 <sup>a</sup> | 31.56 <sup>ab</sup>  |

Means followed by the same letter within the same column are not significantly different at  $P < 0.05$  using DMRT

### 3.5. Effect of 4-tert Octylphenol on Leaf Area of Jute Mallow

Result in Table 5 showed that at week 1, highest leaf area value (3.09) was recorded in treatment 6 (Control), followed by (3.00) treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP) and least (2.58) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). At week 3, higher leaf area value (6.10) was recorded in treatment 5 ( $2 \times 10^{-5}$  Conc of 4-t-OP), followed by (6.00<sup>a</sup>) treatment 6 (Control) and least (4.20) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). At week 5, highest leaf area value (14.73) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), followed by (14.37) treatment 6 (Control) and least (9.19) in treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP). At week 7, highest leaf area value (24.77) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), followed by

treatment 6 (Control) and least (20.12) in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP). At week 9, highest leaf area value (38.39) was recorded in treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP), followed by (31.38) treatment 6 (Control) and least (25.74) in treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP). Significant difference exist at week 5 with treatment 2 ( $5 \times 10^{-5}$  Conc of 4-t-OP) having the least leaf area value (9.19) and treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP) having the highest leaf area value (14.73), at week 7 with treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP) having the highest leaf area value (24.77) and treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP) having the least leaf area value (20.12) and at week 9 with treatment 4 ( $3 \times 10^{-5}$  Conc of 4-t-OP) having the highest leaf area value (38.39) and treatment 1 ( $1 \times 10^{-4}$  Conc of 4-t-OP). Having the least leaf area value ((25.74).

**Table 5: Effect of 4-Tert Octylphenol on Leaf Area of Jute Mallow**

| Treatment | Week              |                   |                     |                     |                     |
|-----------|-------------------|-------------------|---------------------|---------------------|---------------------|
|           | 1                 | 3                 | 5                   | 7                   | 9                   |
| 1         | 2.63 <sup>a</sup> | 4.99 <sup>a</sup> | 11.90 <sup>ab</sup> | 20.12 <sup>b</sup>  | 25.74 <sup>b</sup>  |
| 2         | 2.58 <sup>a</sup> | 4.20 <sup>a</sup> | 9.19 <sup>b</sup>   | 23.83 <sup>ab</sup> | 29.22 <sup>b</sup>  |
| 3         | 2.74 <sup>a</sup> | 5.78 <sup>a</sup> | 13.46 <sup>ab</sup> | 24.13 <sup>ab</sup> | 28.52 <sup>b</sup>  |
| 4         | 2.92 <sup>a</sup> | 5.84 <sup>a</sup> | 14.73 <sup>a</sup>  | 29.92 <sup>a</sup>  | 38.39 <sup>a</sup>  |
| 5         | 3.00 <sup>a</sup> | 6.10 <sup>a</sup> | 13.18 <sup>ab</sup> | 20.31 <sup>b</sup>  | 27.30 <sup>b</sup>  |
| 6         | 3.09 <sup>a</sup> | 6.00 <sup>a</sup> | 14.37 <sup>a</sup>  | 24.77 <sup>ab</sup> | 31.38 <sup>ab</sup> |

Means followed by the same letter with the same column are not significantly different at  $P \leq 0.05$  using DMRT

## 4. DISCUSSION

Result on germination rate shows that no significant difference exists between the plants for all the weeks in which the data were taken except for week one, where treatment 1 has no germination at all. Higher concentration of 4-tert Octylphenol at ( $1 \times 10^{-4}$  Conc of 4-t-OP) was observed to suppress the germinability of Jute Mallow seed. This is in line with the work of (Morteza saberi et al., 2011) who found out that seed germination, germination speed and seedling vigor were significantly

decreased by increasing extract concentrations of *Thymus kotschyianus* allelopathic compounds in seeds.

Result on girth shows that no significant difference exists between the plants. Plant girth which is the thickness of stem is a function of secondary growth in plants (Lumen, biology for major II). Secondary growth which is the division of cells in the lateral meristem brought about the formation of secondary xylem tissues which aid in the transportation and storage of water and water-soluble contents and secondary phloem which aid in the transportation of sugar and nutrients produced by the

shoot in plants. Secondary growth is known to occur in some dicot plants (Lumen, biology for major II), in which Jute Mallow is one.

Results on height, number of leaves and leaf area revealed that higher concentrations of 4-tert Octylphenol at latter weeks has a negative effect on the vegetative growth of Jute Mallow by retarding its growth. This is in line with the work of (Sumeet et al., 2016) who found out that increase in concentration of soap water has a negative effect on Moong plants (a dicot) vegetative growth.

## 5. CONCLUSION

It can be concluded that;

1. 4-tert Octylphenol has no effect on the girth of Jute Mallow.
2. Higher concentration of 4-tert Octylphenol has a negative effect on the germination rate of Jute Mallow by suppressing the germinability / germination energy of Jute Mallow seeds
3. The vegetative growth of Jute Mallow (in terms of plant height, leaf area and number of leaves) were also retarded by higher concentrations of 4-tert Octylphenol.

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