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1. Article:
   An author's original work contributing new knowledge to the field in which research was conducted.

2. Review Article:
   A critical synthesis of the current literature in a particular field, or a synthesis of the literature in a particular field during an explicit period of time.

3. Brief Article:
   A short article (note) with the characteristics of an article.

4. Book Reviews

5. Forum:
   Letters to the editor, comments, responses, preliminary results or findings, and miscellany.

General Instructions

1. Submission of manuscripts:

   Original manuscripts should be typewritten (one side only), using an A4 size paper, double spaced along with 3 copies. All pages are to be numbered consecutively, including tables and graphs. Tables, other illustrations, and references should be presented on separate sheets with their proper text position indicated.

2. Abstracts:

   Manuscripts for articles, review articles, and brief articles require both Arabic and English abstracts, using no more than 200 words, in single column (13cm wide), for each version.

3. Tables and other illustrations:

   Tables, charts, figures, and plates should fit the journal's page size (12.5 cm x 18cm). All inner drawings must be presented on high quality. Tracing paper is necessary, using black Indian ink as well. Photographs may be submitted, but on glossy print paper in either black or color.

4. Abbreviations and Units:

   A4 sizes and quantities should be expressed according to international standards. Standardized abbreviation should only be used. The names of periodicals should be abbreviated in accordance with the words of scientific periodicals.

5. Title Page:

   Should contain the title, name of the authors, name and address of the institution, where the work was carried out. The title should be brief and use strong keywords. Scientific names of organism should be clearly stated and should be typed italic.

6. Text:

   The organization of the manuscript should be as follows: Introduction, materials, results, discussion, and references. Results and discussions can be combined in one section. Acknowledgement (if needed) should be brief and added before the reference sections.
1. References:
Citation of the references (within the text) should be indicated by author. Date, style, and references should be listed in an alphabetical order and conform to the following examples: Periodical citations in the text are to be enclosed in one line brackets, e.g. (6). Periodical references are to be presented in the following form:
References number in line brackets ( ), author’s name followed by a given name and/or initials, the title of an article or periodical (italicized), volume number, year of publication (in parentheses ) and pages e.g. Basahy, A.Y. (1992). Protein and Amino Acid contents in seeds of some soybean cultivate (Glycin Max 1) Arab Gulf J. Sci. Res. 11(2), 221-228.

Book Citation:
Book references should include the following: Reference number ( ), author’s surname followed by a given name and/or title of the book (italicized), place of publication, publisher, and year of publication.
Example:

2. Content Notes:
Content notes are to be presented on separate sheets. They will be printed below a solid line separating the content notes from the text.

9. The manuscripts and forum items submitted to the journal for publication contain the author’s conclusions and opinions, and if published they do no bear a conclusion or opinion of the Editorial Board.

10. Authors will be provided with 20 reprints free of charge, along with two issues of the journal. Additional copies could be purchased, if ordered when the proofs are returned. Price will be shown on the order form.

11. It is the responsibility of the researcher to make sure that the manuscript is free of linguistic, grammatical and typo errors.

12. The editors’ board has the right to set priorities of publishing the research.

13. The journal is not obligated to repeat the research it reaches, whether it was approved for publication or not.

14. All the received research is subject to primary examination by the editorial board in order to determine their eligibility for arbitration. The editorial board is entitled to excusing itself from accepting the research without giving reasons.

15. The journal is published twice a year.
IN THE NAME OF ALLAH, THE MOST GRACIOUS,
THE MOST MERCIFUL
Chrysomya Albiceps (Wiedemann, 1819) (Diptera: Calliphoridae) - Hanan Abo El-Kassem Bosly

Impact Behavior of Bridge RC Columns and Piers under Vehicular Collision - Shamsoon Fareed, Ali Almonbhi, Wadea Sindi, Ayed Alluqmani


The Applications of Control Charts in Higher Education: A Systematic Review - Abdulelah Ali

Ecological Adaptation in Some Sand Dune Grasses: Morpho-Anatomical Wafa Hamad Ahmed Maqbool
Effect of Fipronil Toxicity on the Larval Development of the Forensically Important Blowfly Chrysomya albiceps (Wiedemann, 1819) (Diptera: Calliphoridae)

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Abstract

Fipronil is a worldwide used phenylpyrazole pesticide for the control of insects. In forensic entomology, data about insects’ life cycles are used to give clues about a crime. The blowfly, Chrysomya albiceps (Wiedemann, 1819), family Calliphoridae, is important insect in forensic entomology. Because its larval development rate is important for forensic entomology estimates, the present study was designed to investigate the fipronil toxicity on the larval development of C. albiceps reared on muscle tissues from fipronil-treated rats (administered with a single oral dose 0.1 mg/kg of fipronil). Larvae were then subjected for the determination of the body weight and length every 12 hours for 144 hours. Results showed that the final larval weight and length were 44.30 ± 0.15 mg and 13.25 ± 0.14 mm after 132 h, respectively and pupal formation at 144 h in fipronil group. These measurements were significantly lower as compared to that of control group (reared on non-treated rat muscles) which showed larval weight and length of 77.50 ± 0.84 mg and 12.95 ± 0.12 mm, respectively, after 96 h; and pupal formation at 108 h. Moreover, larval developmental period and the time of finding fresh pupae in fipronil-treated group was 36 hours later than that of the control. The study demonstrates that fipronil affects the larval development of the forensically important C. albiceps which should be taken into account in forensic investigations and estimation of postmortem interval (PMI).

Keywords: Forensic entomology; Chrysomya albiceps; Fipronil; Larval development; PMI.

1. Introduction

Fipronil (5-amino-1-[2,6-dichloro-4-(trifluoromethyl)-phenyl]-4-(trifluoromethylsulfinyl)-1-H-pyrazole-3-carbonitrile) is a broad-spectrum phenylpyrazole insecticide which disrupts the central nervous system of insects via interference with the passage of chloride ions through the γ-aminobutyric acid (GABA) regulated chloride channel.
(Raymond-Delpech et al., 2005). Fipronil is used for crop protection in agriculture, animal health, horticulture, house protection and locust control (FAO, 2009). Fipronil is widely marketed due to its activity against a variety of insect pests like, fleas and ticks on pets, mole crickets in turf grass, and indoor pests such as ants and roaches (Kaakeh et al., 1997; Ree et al., 2006; Gunasekara et al., 2007; Insuasty et al., 2010; Poché et al., 2017; Gupta and Anadón, 2018). The U.S. Department of Housing and Urban Development in collaboration with the United States Environmental Protection Agency conducted a survey measuring insecticides in a randomly selected nationally representative sample of residential homes. The survey showed that most floors in occupied homes in the U.S. have measurable levels of insecticides and found that fipronil residues was recorded 40% of tested homes (Stout et al., 2009). The exposure to fipronil can pose a risk for mild, temporary health effects in various human body systems (Mohamed et al., 2004; Lee et al., 2010). Fipronil toxicity recorded not only by direct human dose but also through the food consumption of contaminated food with its residue (Gerletti et al., 2020; Đokić et al., 2020). Hence, the widespread of fipronil elevate its human exposure directly or indirectly.

In forensic entomology, collecting and analyzing insect evidence help in forensic examinations. Insects were used for the determination of the minimum time since death in cases of suspected death, which is either by determination of the age of the oldest necrophagous insects that developed on the corpse or by the analysis the insect species components on the corpse (Amendt et al., 2011). The Entemotoxicology is considered as an aspect of forensic entomology and examination of insects in corpses can indicate toxins or drugs in it and revealing an evidence about the cause of death (Introna et al., 1990; Goff et al., 1992; Hédouin et al., 1999; Hédouin et al., 2001). Moreover, the postmortem interval (PMI) estimates on larval development (Goff et al., 1992). *Chrysomya albiceps* (Wiedemann, 1819) (Diptera: Calliphoridae) is one of the most studied blowflies and is recognized as a pioneer species in the colonization of corpses and carcasses and is attracted by the odor produced during corpse decomposition (Kosmann et al., 2011; Vasconcelos et al., 2013; Mashaly et al., 2020). It is considered as one of the main species of forensic
importance due to not only its early presence on the corpse but also its high reproductive rate (Grassberger et al., 2003). *C. albiceps* was the dominant species recorded on indoor and outdoor carcasses in stages of bloating, decay and advanced decay in a recently published study in Saudi Arabia (Al-Khalifa et al., 2020; Mashaly et al., 2020). *C. albiceps* has been previously collected and identified in the area of interest of the present study (Jazan, Saudi Arabia) (Bosly, 2010; Setyaningrum and Al Dhafer, 2014; Dawah et al., 2019; Mashaly et al., 2020). *C. albiceps* is important in forensic entomology since it can be used to determine the PMI by calculating the age of the oldest larval stage feeding on a corpse (Gomes et al., 2006; Mendonça et al., 2010; Ramos-Pastrana and Wolff, 2017; Salazar-Souza et al., 2018).

Therefore, the present study aimed to explore the effects of fipronil on the larval development of *C. albiceps* that can provide a tool for forensic entomologists to estimate the PMI as information in judicial cases.

2. Materials and Methods

2.1. Experimental animals

The present study was carried on sixteen adult male albino Wister rats. Rats were supplied by the Animal Research Center of the Jazan University Medical Research Center (JUMRC) and weighing (200 ± 20 g) and 4 months aged. Animals were housed in environmentally controlled conditions (temperature of 22 ± 2°C) with a 12-h light/dark cycle and had free access to commercial rodent pellets and water *ad libitum*. All experimental procedures involving animals were reviewed and approved by the Standing Committee for Scientific Research Ethics-Jazan University. The ethical approval reference number (REC42/1/080).

2.2. Chemicals:

Fipronil commercial formulation (Fipronil 5% SC) was provided from Jazan Agricultural Research Center, LOT No: MI 190359, India.

2.3. Preliminary study:

The present study was started by pilot using different concentrations of fipronil orally administered to adult male albino Wister rats started from 25 mg/kg that induced mortality after 24 h, then the dose was reduced up to 1.5 mg/kg. The lower doses resulted in no animal mortality but showed *C. albiceps* larval mortality once or they did not complete their maturation for pupal formation.
2.4. **Preparation of fipronil treated rat muscles**

Animals were randomly divided into two groups, the control group (n=4) where rats were orally administered with single dose via oral gavage of 2ml of normal saline (control group) or fipronil-treated group (n=12) where each rat was orally administered a dose of 1mg/kg (in 2ml) fipronil (equivalent to 1/100 LD₅₀ of rats (Tingle et al., 2003). Control and fipronil-treated animals were sacrificed by sudden decapitation 24 h post oral administration and skeletal muscle tissue samples from each group was excised and were stored in freezer until used for feeding the experimental larvae.

2.5. **Origin of the *Chrysomya albiceps* Specimens colony**

The *C. albiceps* colony was established at the Biology Department, Faculty of Science, Jazan University, and were reared in the laboratory for four generations. Flies were placed in polypropylene breeding cages (45 × 30 × 20 cm), and adults were allowed access to diet (*ad libitum*); the diet consisted of skimmed powder milk and sugar 10g each in 100 ml of water in Petri dishes (Bosly, 2021). Larvae were placed in beakers within transparent boxes containing sand and sawdust to prevent the post-feeding larvae from escaping. Larva were provided fresh cattle liver tissue (purchased from governmental slaughter house in Abu Arish, Eastern Jazan) *ad libitum* as a rearing medium/substrate in the cages (Figure 1).

2.6. **Experimental procedures:**

The experimental procedures were performed in three replicates. In each replicate 40-50 first instar larvae/group were picked up under stereomicroscope with the aid of a brush (number 0) to plastic vials (15 × 12 × 11 cm³) containing 20 g of rat muscles from normal untreated rats muscle (control group) and from fipronil treated rats (fipronil group) as larval rearing substrates. The rearing muscles replaced every 24 h until pupation (Figure 2). The rearing vials were covered with muslin secured with a rubber band, and muscle tissue were replaced daily with sterilized muscle shavings. The vials were maintained in climatic chambers at 30±1°C, with 65±10% RH and a photoperiod of 12 h/12 d (light/dark). The experimental temperature at 30±1°C was chosen according to results of a previous study which recorded that rearing at 30°C was optimal for *C. albiceps* (Bosly, 2021).
Every 12 h until pupation, thirty randomly selected larvae from the replicates in each group were immersed in hot water (70–80°C) for 3–5 min to prevent shrinkage before preservation in 75% alcohol according to the method described by Adams and Hall (2003). They were used for the determination of the larval weights (mg) by using a sensitive electrical balance with a sensitivity of 0.001 g and larval lengths (mm) to the nearest 0.01 mm under a stereoscopic binocular microscope. The onset times of pupation in each group were recorded.

2.7. Statistical analysis

Data analysis was performed using one-way ANOVA (with a least significant difference (LSD) test), and significant differences were defined as those with P<0.05. Statistical analysis was performed using the Statistical Package for Social Science “SPSS” for Windows software, Release 22.0 (SPSS, Chicago, IL).

3. Results

Data in Table (1) show the means and standard errors of *C. albiceps* larval body weights (mg) every 12 h for 144 h of control and fipronil groups. The larval body weights of the control group were significantly increased after 24 h (7.50 ± 0.15 mg) from that at 12 h (2.30 ± 0.85 mg) of rearing up to 84 h (79.60 ± 0.78 mg) (P<0.05). On the other hand, body weight significantly decreased at 96 h (77.50 ± 0.84 mg) as compared to the last period of detection (84 h) (P<0.05). As in control group, but in a prolonged period, fipronil group showed significant increase in the larval body weight from 24 h (4.40 ± 0.09 mg) compared to that at 12 h (3.00 ± 0.12 mg) of rearing up to 120 h (45.10 ± 0.19 mg) (P<0.05). Then the weight significantly decreased at 132 h (44.30 ± 0.15 mg) as compared to the last period of detection (120 h). Data also presented a significant decrease in the larval body weight in the fipronil group as compared to the corresponding weights in larvae of control group at 12, 24, 48, 72 and 96 h (P<0.05). Moreover, larvae of control group initiated pupation at 108 h, which was earlier than the time of pupation in those reared on muscles of fipronil treated rats (144 h).

The effect of fipronil- treated muscles on larval body length represented in Table (2). Results clearly showed a significant increase in the body length (mm) of control larvae after 24 h (4.78 ± 0.08 mm), 36 h (5.90 ± 0.12 mm), 48 h (7.48 ± 0.08 mm), 60 h (8.89 ± 0.14 mm), 72 h
(13.30 ± 0.14 mm) and 84 h (14.00 ± 0.11 mm). Then the larval body length significantly decreased at 96 h (12.95 ± 0.12) as compared to that detected at 84 h. while, the larval body lengths in fipronil group significantly lower than their corresponding in control group from 12 h up to 96 h. Data showed body length at 12 h (2.00 ± 0.08 mm), 24 h (2.66 ± 0.08 mm), 36 h (4.38 ± 0.08 mm), 48 h (6.19 ± 0.09 mm), 60 h (7.92 ± 0.08 mm), 72 h (8.59 ± 0.05 mm), 84 h (9.55 ± 0.10 mm), 96 h (10.05 ± 0.13 mm), 108 h (11.90 ± 0.14 mm) and at 120 h (14.05 ± 0.11 mm). Then, the larval body length significantly decreased at 132 h (13.25 ± 0.14 mm) as compared to that detected at 120 h. Figure (3) represented the visualized difference in size between larvae in control (A) and fipronil group (B).

Table (1): Effect of fipronil on the average *Chrysomya albiceps* larval body weight (mg) (mean ± SE) at different durations and the onset time of pupa (h).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Control</th>
<th>Fipronil</th>
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<tbody>
<tr>
<td>Hours</td>
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<tr>
<td>12</td>
<td>3.00 ± 0.12a</td>
<td>2.30 ± 0.85a</td>
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<tr>
<td>24</td>
<td>7.50 ± 0.15b</td>
<td>4.40 ± 0.09b*</td>
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<td>36</td>
<td>12.90 ± 0.18c</td>
<td>6.40 ± 0.19c*</td>
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<td>48</td>
<td>39.40 ± 0.54d</td>
<td>10.10 ± 0.24d*</td>
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<td>60</td>
<td>49.00 ± 0.39e</td>
<td>14.50 ± 0.19e*</td>
</tr>
<tr>
<td>72</td>
<td>72.60 ± 1.53f</td>
<td>19.00 ± 0.45f</td>
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<tr>
<td>84</td>
<td>79.60 ± 0.78g</td>
<td>22.40 ± 0.19g*</td>
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<td>96</td>
<td>77.50 ± 0.84h</td>
<td>27.50 ± 0.24h*</td>
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<td>108</td>
<td>Pupation</td>
<td>32.50 ± 0.09i</td>
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<td>120</td>
<td>-</td>
<td>45.10 ± 0.19i</td>
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<td>132</td>
<td>-</td>
<td>44.30 ± 0.15i*</td>
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<td>Onset time of pupa (h)</td>
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Data represented as mean ± SE, n=30. Means sharing the same superscript are not significantly different from each other (P<0.05) within the same column and superscript (*) indicates significance between means within the same raw.

Table (2): Effect of fipronil on the average *Chrysomya albiceps* larval body length (mm) (mean ± SE) at different durations

<table>
<thead>
<tr>
<th>Groups</th>
<th>Hours</th>
<th>Control</th>
<th>Fipronil</th>
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<td>2.85 ± 0.06^a</td>
<td>2.00 ± 0.08^a*</td>
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<td></td>
<td>12</td>
<td>4.78 ± 0.08^b</td>
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<td>5.90 ± 0.12^c</td>
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<td>36</td>
<td>7.48 ± 0.08^d</td>
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<td>48</td>
<td>8.89 ± 0.14^e</td>
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Data represented as mean ± SE, n=30. Means sharing the same superscript are not significantly different from each other (P<0.05) within the same column and superscript (*) indicates significance between means within the same raw.
Figure (1): Rearing of *C. albiceps* colony on liver tissue.

Figure (2): Rearing of *C. albiceps* larvae on rat muscles, the first instar larvae (A) (arrow) and the pupae (B) (arrow).

Figure (3): A photograph represent the difference in *C. albiceps* larval size after 24 h (arrow) in control group (A) and in fipronil group (B).
4. Discussion

The present study started by preliminary investigation that showed *C. albiceps* larval mortality once or they did not complete their pupal formation when the first instars reared on muscle tissues from rats orally administered concentrations in a single dose from 25 mg/kg up to 1.5 mg/kg. The dead larvae could be used as evidence in case of suspicions deaths by their analysis to elucidate the effect of the insecticide on larvae as previously studied through the insect’s protein profile (Sawaby et al., 2009; Abd El-bar and Sawaby, 2011) or the insect’s pesticide level (Rashid et al., 2008). In the present study, unfortunately, the analysis was unavailable and the study continued with the single fipronil rat dose induced no mortality (1mg/kg).

The present study results demonstrated the effect of fipronil toxicity on the insect through the significant delayed development of the *C. albiceps* larvae and pupal formation. Where the larval development period and the time of finding fresh pupae in fipronil group was 36 hours later than that of the control. In addition to reduced larval body length and weight in the prepupal determined time. It was known that the *C. albiceps* life cycle constitutes three larval instars and a pupal stage, where the 1st stage feed on the decaying flesh while the 2nd and 3rd ones feed on other blow fly larvae (Faria et al. 1999). The 3rd larva continues to feed for a while then it stops feeding and inter a non-feeding wandering stage is called a prepupa (where larvae decreased in weight and length) to pupate (Dhang et al. 2008; Joseph et al., 2011).

Carrion flies feed on poisoned dead bodies previously ingested drugs or toxic substances and the investigation about how these substances interact with the insect following ingestion and the possibility to estimate the time of death is decisive to forensic entomotoxicology (Stojak, 2017). It was reported that the presence of drugs in decomposing tissues could alter the rate of development of insects colonized on carcass. Where insects could be alternative specimens when the body fluids and tissues are not valid for analysis and constitute an evidence to establish the estimation of PMI (Amendt et al., 2011; Harvey et al., 2016).

As regard to drugs, it is well known that addiction is a major public health problem worldwide and deaths through overdoses are common. The presence of drugs in carcass tissues can alter the rate of development and biomass of insects that
colonize them and affect the estimate of PMI (Mashaly et al., 2020). *Chrysomya albiceps* when was reared on rabbit tissues administered tramadol (opoid drud) caused a significant decrease in weight, length, width and showed abnormal fused small sized respiratory spiracles and deformed small posterior end with hypogenesis of the posterior respiratory spiracles of *C. albiceps* third instars larvae and the results collectively could affect PMI estimation (Elshehaby et al., 2019). In the same manner, cypermethrin (a pyrethroid pesticide) and tramadol hydrochloride retarded the mean total developmental period from egg to adult of *C. albiceps* (Ekrakene and Odo, 2017). In addition, higher concentrations of heroin or higher amounts of alcohol consumption as drug abuse or addiction may sometimes be a direct cause of death and that affect the succession patterns of insects that colonize a body (Tabor et al., 2005). Morphine sulphate when was previously administered to rabbits in recorded decreased *C. albiceps* larval development rate by an increase larval length and weight and accelerated the puparial development rate when they fed on rabbits tissues in a dose dependent manner (Salimi et al., 2018). The study concluded that the time taken for morphine-fed larvae to pupariate was longer and for puparial stage was shorter, than the time taken by control colonies (Salimi et al., 2018). The larvae of *C. albiceps* that fed on the cocaine-containing livers were developed faster than that fed on control liver tissue declaring the cocaine stimulation influence on the larval growth (de Carvalho et al., 2012).

Different studies were performed to assess the effect of insecticides on the on maggots and insects as a guide for establishment of the cause of death and could be aid in estimating postmortem interval. Previously, Malathion increased the period of larval development, the larval length and weight and delayed the pupal onset time in *C. megacephala* species and the pesticide accumulated in larvae (Yan-Wei et al., 2010). Dimethoate organophosphate showed delayed growth development effect on four species of blowflies (*Chrysomya megacephala, Chrysomya saffranea, Chrysomya rufifacies* and *Chrysomya Indiana*) that reared on sheep liver contaminated with dimethoate from the minimum dose concentration was used (1 ppm dose) up to 4 ppm in a concentration dependent manner (Abd Al Galil et al., 2021). In the same manner
Terbufos organophosphate (5 or 10 mg/kg) administered decomposed rats under environmental conditions affected the development of the forensic potential flies and implicated for the PMI estimation (Jales et al., 2021).

Fipronil as a pesticide worldwide used and actively marketed throughout a wide range of industrialized and developing countries. People are readily exposed to it in daily life, as it is effective against a variety of insect pests and control parasites in pets and possibly as a residual in feeding materials, so it offers hazards to human health. In humans, poisoning is mainly due to accident or suicide attempt (Chodorowski and Sein Anand, 2004; Lee et al., 2010; Gutta et al., 2019). A previous study (Pisa et al., 2015) concluded that the existing levels of pollution under authorized uses with fipronil probably to have large-scale and wide range negative biological and ecological impacts. Fipronil side effect on non-target invertebrates as honeybees when exposed to the nectar and pollen of treated plants showed evidenced effects on learning, memory, orientation and reduced their efficiency of foraging (El Hassani et al., 2009; Holder et al., 2018). Fipronil showed highly toxic to all tested bee species in addition to the effect on the predatory invertebrates of natural pest species (Pisa et al., 2015). The toxicity of fipronil and its degradates to non-target species, such as aquatic invertebrates, is well documented (Mize et al., 2008; Overmyer et al., 2007; Weston and Lydy, 2014).

Fipronil insecticidal activity exerts by binding GABA receptors and glutamate receptors leading to hyperexcitability (Gunasekara et al., 2007; Narahashi et al. 2010). The continuous neurons stimulation leads to death of the target invertebrates. While the binding of fipronil to insect GABA receptors is tighter than that observed for vertebrate receptors. In addition, the effect on the glutamate receptors is specified to insects and make the difference in efficiency on invertebrates over that on vertebrates (Grant et al. 1998; Hainzl et al. 1998; Ikeda et al., 2003; Mohamed et al., 2004; Narahashi et al. 2010). Fipronil metabolism in vitro and in vivo studies revealed that fipronil is converted to fipronil sulfone as a major metabolite that have oxidative and similar toxicity effects as the parent compound in insects and mammals (Scharf et al., 2000). Fipronil-desulfinyl, a photodegradation product of fipronil, on the basis that it could
be a significant residue, and its toxicity appeared to be greater than that of the parent molecule, fipronil. The sulfone was the major metabolite in rat fat and tissues (FAO fipronil). The presence of adipocytes associated with rat skeletal muscle can be important in addition to the skeletal muscles themselves in accumulation of the insecticide as previously detected because of fipronil oral administration in rats (Powles, 1992; Cravedi et al., 2013). Fipronil and its metabolites are widely distributed, particularly in adipose tissues, and have a high level of enterohepatic recirculation (Hainzl and Casida 1996; Mohamed et al. 2004). This in line with the predicted toxicity effects on larvae that fed on muscles from rats administered fipronil.

**Conclusion:** The present study demonstrates practically that fipronil affects the larval development of the forensically important *Chrysomya albiceps* and this practical implications may add for forensic investigations with suspected poisoning by fipronil to estimate the PMI as information in judicial cases.

**Acknowledgements:** The author wish to appreciate the Jazan Agricultural Research Center for providing the experimental animals.

**Conflict of interest:** The author declare that she has no competing interests

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تأثير سمية الفيبرونيل على تطور يرقات الذبابة ذات الأهمية الجنائية كرايزوميا البيسبس

Chrysomya Albiceps (Wiedemann, 1819)

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الفيبرونيل مبيد حشري يتبع المجموعة الكيميائية الفينيل بيرازول والمستخدم في جميع أنحاء العالم لمكافحة الحشرات. في علم الحشرات الجنائي تعد البيانات المتعلقة بدور حياة الحشرات إدراة لعدادات أدنى في القضايا الجنائية. معدل تطور اليرقات مهم في إنقاذ الحشرات الجنائي (Calliphoridae) فصيلة الذباب الأزرق (Chrysomya Albiceps (Wiedemann, 1819)) مهمة في علم الحشرات الجنائي والأن معدل تطور اليرقات مهم لتقديرات علم الحشرات الجنائي صممت الدراسة الحالية لتقدير سمية الفيبرونيل على نمو اليرقات، حيث تم تربية يرقات الطرول للذبابة الخضراء على نسيج عضلات جرذان ماء تم سحب الفيبرونيل بجرعة واحدة قيمتها 0.1 مجم/كجم (مجموعة الفيبرونيل) وهذه المجموعة استخدمت لتقييم وزن وطول اليرقات كل 12 ساعة لمدة 144 ساعة.

أظهرت النتائج أن وزن اليرقات كرايزوميا البيسبس وطولها النهائي سجل (44.30 ± 0.15 مجم) و (13.25 ± 0.14 مم) على التوالي بعد 132 ساعة وظهور العذارى عند (144 ساعة) في مجموعة الفيبرونيل، كانت القياسات المذكورة أعلاه أقل بكثير مقارنة بطبيعة المجموعة الضابطة (التي تم تربيتها على عضلات الفئران غير المعالجة) والتي سجلت (77.50 ± 0.84 (مجم) و (12.95 ± 0.12 (مم) على التوالي بعد 96 ساعة وظهور العذارى عند (108 ساعة). كانت فترة نمو اليرقات وقت ظهور العذارى الحديثة في مجموعة الفيبرونيل متاخرة 36 ساعة عن تلك في المجموعة الضابطة. أوضحنا الدراسة عمليًا أن الفيبرونيل يؤثر على ان تطور يرقات ذبابة كرايزوميا البيسبس المهمة من الناحية الجنائية وقد يضيف هذا المتضمن العملي إلى تحقيقات الطب الشرعي في حالة التسمم المشتبه به بواسطة الفيبرونيل لتقييم فترة ما بعد الوفاة.

الكلمات المفتاحية: علم الحشرات الجنائي; كرايزوميا البيسبس; الفيبرونيل; تطور اليرقات; فترة ما بعد الوفاة.
Impact Behavior of Bridge RC Columns and Piers under Vehicular Collision

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ABSTRACT

There has been a growing interest in the past few decades among the engineering community to understand the behaviour of reinforced concrete structures exposed to severe loads due to blast and impact. Although these severe transient dynamic loads are rare in occurrence for most structures, their effect can result in catastrophic and sudden structural failure. The structural elements of the bridges are most venerable to these accidental loadings. However, the piers are most critical and venerable to these kinds of loadings, therefore, in this investigation a detailed numerical investigation have been carried out which initially used the experimental data of published study of RC columns under impact to validate the Finite Element (FE) models, which is then extended to study the number of parameters (percentage of the longitudinal reinforcement, compressive strength of concrete ($f_c$), impact velocity and, stirrups spacing) which may influence the impact behaviour of the RC columns. Following this a typical RC pier full scale model has been used to investigate the vehicular collision. Based on the detailed numerical investigation, it was found that the percentage of steel significantly influence the impact force, however, compressive strength of concrete and stirrup spacing was found to have no significant influence on the impact force.

Keywords: Impact Loading, Vehicular Collision, Finite Element, Reinforced Concrete, Piers, Columns.
1. INTRODUCTION

As per 2017 statistics of Ministry of Transportation, Kingdom of Saudi Arabia (KSA) there are approximately 4989 Bridges. These bridges are typically designed for a live load of 600-kN (60-Ton) 3-Axle Truck Loading (133-K 3-Axle Truck Loading) and typically these bridges are made up of Reinforced concrete construction with concrete having compressive strength of approximately 35 MPa after 28-days moist curing and yield steel yield Strength of Grade-60 i.e 420 MPa. Furthermore, there are large number of these bridges having age of 45 and now under repair in order to use these bridges for there whole design life. The structural components of these bridges which are mostly under repair are Abutments, Girders, and Piers. There are several causes which requires maintenances of these bridges which may include higher traffic volume than the design loads, corrosion of reinforcement, natural disasters like floods, high speed winds, etc. These activities are not that frequent which results in the deterioration of the bridges on a daily basis, however, collision of vehicles with the structural elements significantly cause damage to the structure and require immediate action in order to avoid the closure of the route which may have significant influence on the economic.

Vehicular collision may cause damage to any structural element of the bridge, for e.g. recently a parapet was hit by a concrete mixer truck while passing on the bridge number: B02-0009 (B4929) located at the Eastern province, rout 615, King Abdul Aziz road. The superstructure of the bridge consists of prestressed concrete closed box girder. It was observed that the parapet bridge was hit by concrete mixer truck while passing on the bridge which resulted in severe damage of concrete and exposed bars of about 6-meter length and the height of 1.05 meter as shown in Figure 1.
Figure 1: Damage caused to the Parapet of Bridge B02-0009 (B4929) Located at the Eastern Province, Rout 615, King Abdul-Aziz Road.

Figure 2: Damage caused to the Bridge Number B3429 Located at the Western Province, Rout 15, Makkah – Madinah Road.

Similarly, another vehicular collision was reported on bridge number (B3429 located at the Almadina province, rout 15, Makkah – Almadina road in which bridge was hit by a trailer while passing under the bridge. The superstructure of the bridge consists of prestressed concrete Girder (4 Girder/ span). It was observed that the bridge was hit by a high vehicle while passing under the bridge in which the external girder-1 exhibited severe damage at 2 prestressing tendon and girder -3 showing lateral distortion and damaged concrete of about 3m length and exposed tendon as shown in Figure 2. Based on above two report vehicular collision on the bridges, it is important that the structural element should be able to withstand the dynamic forces generated during these impacts such that it should be able to operated through its design life. As mentioned above, any structural
member of the bridge i.e. girders, piers, deck can be subjected to the impact load produced due to the vehicular collision, however, the piers are most critical and venerable to these kinds of loadings. Therefore, investigating the behaviour of Piers under impact loading is very important in order to ensure smooth operation of the bridges. Number of studies have been carried out which studies the behaviour of RC columns under impact loadings.

The behaviour of reinforced concrete (RC) columns subjected to impact loading was studied by Cai et al. [1]. For this purpose, seven RC columns having identical cross-sections of 150mm x 150mm and having height of 1200mm were used. The specimen was tested using impact test setup which consist of drop weight and impacting hammer. In this investigation seven columns were impacted at the mid-height region with three different masses of (i) 1200 kg (ii) 1500 kg (iii) 1800 kg representing light, medium and heavy trucks respectively. The velocity of the impacting hammer used in this investigation was (i) 0.4 m/s (ii) 0.6 m/s (iii) 0.8 m/s (iv) 1.0 m/s (v) 1.2 m/s. In general, it was seen that for identical mass and with increasing velocity the maximum contact force and impact duration exhibited by the specimen increases. It was also observed that for identical velocity specimen impacted with smaller mass exhibits higher impact force. Similar to the observations of contact force time histories it was found that for identical mass and with increasing velocity the displacement exhibited by the specimen also increases.

The behaviour of a RC column subjected to multiple impact was studied by Zhang et al. [2]. A column having a square cross-section of 100mm x 100mm and a height of 800mm was used for this purpose. The impact load was applied using pendulum and for this purpose the pendulum was raised to desired height and released with velocities ranging from 230 m/s to 3580 m/s. It was observed that for the case when RC column was impacted multiple times the maximum contact force increases significantly with 1st, 2nd and 3rd impact. This may attribute to the fact that with each impact the local stiffness of RC column at the contact area decreases and as a result contact force increase. However, when a RC column is impacted fourth time a significant reduction in contact force was observed as due to last 3 impacts the column has lost its stiffness significantly.

The behaviour of Reinforced Concrete columns (RC) subjected to impact loading was studied by Demartino et al. [3]. For this purpose, four
cantilever circular RC columns having diameter of 300mm and a height of 1700mm were used. Two columns with a stirrup spacing (a) \( s = 330 \text{mm} \) and the remaining two columns with spacing (b) \( s = 100 \text{mm} \). The specimens were tested using impact test setup which comprises of drop weight and a test truck. The drop weight and the test truck was connected with the help of steel wires. The test truck was accelerated by the drop weight drive mechanism. In order to apply impact load, the drop weight was released which transferred the force to the test truck using steel wire. The separation system detached the test truck and steel wires (and the drop weight). After the separation the test truck strikes the specimen with the exhibited velocities. In this investigation four columns were impacted with two different velocities respectively. The adopted velocities were (i) 3.0 m/s (lower velocity) (ii) 4.5 m/s (higher velocity). In general, it was observed that large impact velocity leads to large damage. It was observed that when the columns were impacted with lower velocity the columns sustained their stiffness whereas when impacted with higher velocity the columns lost their stiffness resulting in failure of the column.

The behaviour of the columns under vehicular impact loads was also studied numerically; for e.g. Zhou & Li [4] proposed a model for assessing the damage caused to the bridges piers using non-linear finite element analysis. Chen et al. [5] carried out a detailed numerical investigation for studying the behaviour of bridge pier under the heavy-duty truck’s collisions. Based on the detailed numerical investigation it was found that during the collision the heavy-duty trucks shows two to three peaks in the impact force time histories. AuYeung & Alipour [6] studied numerically the influence of vehicle mass, velocity, diameter of the pier and transverse reinforcement on the bridge pier under vehicular collision and found that pier diameter is the main parameter in detecting the failure mode under vehicular collision. Brackin et al. using detailed numerical investigation found that 600 kips load is an appropriate design load for pier subjected to heavy vehicular impacts.

Based on above literature review and discussion, it is evident that most of the experimental studies focused on studying the scaled RC specimens, however, full scale RC piers under impact loading have not been studied extensively. Therefore, in this investigation a detailed numerical investigation have been carried out which initially used the experimental data of published study of RC columns under impact to validate the Finite
Element (FE) models, which is then extended to study the number of parameters which may influence the impact behaviour of the RC columns. Following this a typical RC pier full scale model has been used to investigate the vehicular collision.

2. NUMERICAL INVESTIGATION

The numerical investigation was conducted using non-linear finite element software ABAQUS-2016. Nonlinear FE analysis were carried out using implicit scheme. The same material properties were used as reported by Do et al. [7] for the validation of FE models. The concrete block and steel plates at the top of the column representing the super-structural loads were modeled as an elastic material with defined properties same as of concrete used in column and steel used in reinforcement. The other end of the column is made fixed by applying boundary condition such that translation and rotation in every direction is restricted. In order to ensure reinforcement is properly embedded in the column, a constraint of “embedded region” is used with reinforcement cage defined as embedded region and concrete column as host region. The steel impactor was also modeled as an elastic material and was given an initial velocity of 640m/s. The contact between the impactor and column is made by creating a surface-to-surface contact between the contacting surfaces with a friction co-efficient of 0.5.

3. VALIDATION OF THE FINITE ELEMENT ANALYSIS

In order to validate the prediction of the finite element analysis an experiment impact test results of a bridges column subjected to lateral impact load carried out by reported by Do et al. [7] were used. For this purpose, non-linear finite element analysis was conducted using ABAQUS [8]. The experiment test setup consists of a RC column having a cross-sectional area of 100 mm x 100 mm and a height of 800 mm subjected to lateral impact load. In order to represent the super-structure of the bridge a load was imposed on to the column with the help of a concrete block having a mass of 173 kg and steel plates with a mass of 115 kg prior to the application of the impact load. The impact load was applied with the help of the pendulum which consist of the impactor having a 300 kg which was used to impact the column at its mid height. Further details of the impact test setup can be found elsewhere [7].
A finite element model, similar to the impact test set up used [7] was developed as shown in Figure 1. The concrete block and steel plates at the top of the column which were used to represent the super-structural loads in the impact test setup was modeled assuming its elastic behaviour. Figure 2 shows the comparison of the impact force-time histories exhibited experimentally and predicted numerically. A good agreement between the experimental and numerical result is observed indicating the validation of the model. A slight deviation is observed in the time of the contact and the peak impact force established experimentally and numerically. The peak impact force from the experimental data is found to 21.49 kN while numerically it is 24.53 kN.
4. PARAMETRIC STUDIES

In order to study the influence of various parameters on the impact behaviour of the RC columns parametric studies were carried out using same FE validated model as described above. The parameters considered in this study are:

(a) Percentage of the longitudinal reinforcement

(b) Compressive strength of concrete ($f_c$)

(c) Impact velocity

(d) Stirrups spacing

4.1. Influence of Percentage of Longitudinal Reinforcement

As per ACI 318-14 [9] specifications, the minimum and maximum percentage of longitudinal reinforcement allowed for the design of RC columns is 1% and 8% respectively. Therefore, the study herein focuses on studying the influence of these longitudinal reinforcement on the impact behaviour of the RC columns. In the first case study, maximum percentage of steel i.e. 8% is considered (case(a)), whereas, in the second case study 4% of longitudinal steel was used (case(b)). The results of both these case studies are also compared with the column specimen having 1% longitudinal reinforcement as used.

Figure 4: Comparison between Impact-Force versus Time-Histories Established Experimentally [7], and Predicted Numerically.
in the case for the validation of the FE analysis (FE Model). Figures 3 and 4 show the comparison between impact force-time histories, and midspan deflection of RC columns having different percentages of longitudinal steel and subjected to same impact load as used above in the validation. As can be seen that increasing the percentage of steel results in increase in impact force hence a direct relation is established, whereas, the increase in percentage of steel results in decrease in the displacement at the point of impact.

**Figure 5:** Comparison between Impact-Force versus Time-Histories for RC Columns having 8% (Case (a)), 4% (Case (b)) and 1% (FE Model) Longitudinal Reinforcement.
4.2. Influence of Compressive Strength of Concrete

In order to study the influence of compressive strength of concrete ($f_c'$) on the impact behavior of the RC columns, three case studies were considered using different concrete compressive strengths:

(a) $f_c' = 20.6$ MPa
(b) $f_c' = 60$ MPa
(c) $f_c' = 80$ MPa

The reason for the consideration of compressive strength of 20.6 MPa is that it corresponds to 3 ksi which is common value of compressive strength considered for designing.

The results of these case studies are also compared with the column specimen made with concrete compressive strength of 42MPa as used in the case for the validation of the FE analysis (FE Model). Figures 5 and 6 indicate the effect of compressive strength of concrete on impact force and mid-span displacement. It was found that compressive strength of concrete does not have any significant influence on the impact force as similar magnitude of the impact force was observed for the case of RC columns made with different $f_c'$. It was also found that increasing $f_c'$ results...
in decrease in displacement but this decrease becomes insignificant at higher values of $f_{c'}$. 

**Figure 7**: Comparison between Impact-Force versus Time-Histories for RC Columns made with Concrete Compressive Strength of 20.6 MPa (Case (a)), 42MPa (FE Model), 60MPa (Case (c)) and 80MPa (Case (d)).

**Figure 8**: Mid-Span Deflection with respect to Time observed for RC Columns made with Concrete Compressive Strength of 20.6 MPa (Case (a)), 42MPa (FE Model), 60MPa (Case (c)) and 80MPa (Case(d)).
4.3. Influence of Velocity

In order to study the influence of the impacting velocity on the impact of the RC columns, two velocities as shown below were considered; (a) 320 mm/s and (b) 1280 mm/s. These velocities correspond to the half and double of the FE model velocity used above in the validation of the FE analysis. Figures 7 and 8 show the comparison of impact force time histories and mid-span displacement exhibited by RC columns subjected to different impact velocities. It can be seen that velocity of the impactor has significant influence on the impact force and the exhibited deflection. It was also observed that when considering the velocity as twice of the velocity used in the experimental setup [7] the magnitude of the impact force become twice, whereas, when velocity was considered half of that used in the experimental setup [7] approximately half of the impact force was observed when compared with the magnitude of the impacting force observed with the impact test velocity. Based on above, it can be concluded that direct linear relationship was observed between the impact velocity and the magnitude of the impact force. It was also observed that an inverse relation is observed between the velocity of the impactor and the deflection exhibited by the RC column at the point of impact.

Figure 9: Comparison between Impact-Force versus Time-Histories for RC Columns subjected to Impact Velocities of 320mm/s (Case (a)), 740mm/s (FE Model), and 1280MPa (Case (c)).
4.4. Influence of Stirrups Spacing

In order to investigate the influence of stirrup spacing on impact behaviour of the RC columns two case studies were carried out: (a) Increasing the stirrup spacing to double of that used in the experimental setup (i.e. 80 mm) (b) Decreasing the stirrup spacing to half of that used in the experimental setup (i.e. 20 mm)

The results of these case studies are also compared with the column specimen having stirrups spaced at 40 mm as used in the case for the validation of the FE analysis (FE Model). Figures 9 and 10 show the comparison between impact force and displacement-time histories respectively for RC columns having stirrup spacing at 80 mm (case (a)), 20 mm (case (b)) and 40 mm (FE model). It was observed the stirrup spacing does not significantly influence the impact force time histories, however, displacement time histories were found to be significantly influenced. It was also observed that with the decrease in the spacing of the stirrups the amount of the damage caused at the mid-span also decreased significantly.

Figure 10: Mid-Span Deflection with respect to Time for for RC columns subjected to impact Velocities of 320mm/s (Case (a)), 740mm/s (FE Model), and 1280MPa (Case (c)).
Figure 11: Comparison between Impact-Force versus Time-Histories for RC Columns having Stirrup Spacing at 80 mm (Case (a)), 20 mm (Case (b)) and 40 mm (FE Model).

Figure 12: Mid-Span Deflection with respect to Time observed for RC Columns subjected to Impact Velocities of 320mm/s (Case (a)), 740mm/s (FE Model), and 1280MPa (Case (c)).
5. VEHICULAR COLLISION ON A PIER OF RC BRIDGE

AASHTO-LRFD [10] recommends an equivalent static force (ESF) of 2668 kN acting at a height of 1.5m from the ground level to be considered while designing bridge piers in order to consider the vehicular collision, however, the behaviour of such elements significantly differ under dynamic conditions. Therefore, in this study in order to investigate the vehicular collision on a pier of RC bridge, a non-linear FE analysis was conducted using ABAQUS [8]. For this purpose, pier having height of 5.1m supporting girder loads which is considered as an axial load of 9227 kN acting on the pier is modelled. The Pier is reinforced with sixty-three 32mm-dia longitudinal bars till a height of 4 m from the bottom and forty-two bars for the remaining height. Figure 11 shows the pier cross section and reinforcement details. In the FE model, concrete compressive strength is assumed to be 27.5 MPa, whereas, the yield strength of reinforcing steel bar is assumed to be 410 MPa for both longitudinal bars and stirrups.

Figure 12 shows the FE model used for investigating the vehicular collision on pier. The vehicle model is taken from the sample models present in the ABAQUS [8]. Vehicle model consists of more than 200,000 elements and is designed especially for collision modeling. The vehicle falls in the category of passenger car having an approximate gross vehicle weight rating (GVWR) of 7000 lbs according to the federal highway authority (FHWA) [11] USA classification. In FE model, the vehicle is collided with pier at a height of 1.275m from the bottom with a vehicle velocity of 120 mph.

Figure 13 shows the displacement-time history of the pier at the collision point. It was observed that no significant deformation takes place in the as peak deformation 0.28 mm was exhibited. Figure 14 shows the FE model used for vehicular collision on pier and Figure 15 shows the displacement-time history of the pier at the point of collision. Figure 16 shows the profile of deformation of the FE Modelled collision of the car with the pier at the time of the collision, while Figure 17 shows the profile of deformation along the pier height. As can be seen that due to the collision of the vehicle the behaviour of the pier can be classified into two types; the local behaviour in which the deformation occur at the point of the contact of the collision and the global behaviour in which the deformation occur along its full height.
Figure 13: Peir’s Cross-Section and Reinforcement Details.

Figure 14: FE Model used for Vehicular Collision on Pier.
**Figure 15:** Displacement-Time History of the Pier at the Point of Collision.

**Figure 16:** Deformation Profile of the FE Model at the Time of the Collision.
6. CONCLUSIONS

A detailed numerical investigation have been carried out which initially used the experimental data of published study of RC columns under impact to validate the Finite Element (FE) models, which is then extended to study the number of parameters which may influence the impact behaviour of the RC columns. Following this a typical RC pier full scale model has been used to investigate the vehicular collision. Based on the scale RC column FE model and the parametric studies conducted, following conclusions were drawn.

- Impact force is mainly the function of velocity of the impacting object, as a direct relationship was observed.
- Percentage of steel significantly influence the impact force and compressive strength of concrete and stirrup spacing was found to have no significant influence on the impact force.

Based on the FE model investigating the full scale model of RC pier under high speed car collision, it was found that no significant damage was exhibited by pier. Due to the collision of the vehicle the behaviour of the pier can be classified into two types; the local behaviour in which the deformation occur at the point of the contact of the collision and the global behaviour in which the deformation occur along its full height.
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سلوك الصدمة لأعمدة وأرصفة الجسور الخرسانية المسلحة لتصادم المركبات

الملخص:

كان هناك اهتمام متزايد في العقود القليلة الماضية بين مجتمع الهندسة لفهم سلوك الهياكل الخرسانية المسلحة المكشوفة للأعمال الشديدة بسبب الانفجار والتأثير. على الرغم من أن هذه الأعمال الديناميكية الشديدة العابرة نادرة في حدوث معظم الهياكل، فإن تأثيرها يمكن أن يؤدي إلى فشل الهيكل الكارثي والفاجي. العناصر الهيكلية للجسور هي الأكثر توقيعا لهذه الأعمال العرضية. ومع ذلك، فإن أعمدة وأرصفة الجسور هي الأكثر أهمية وجوقة لهذه الأنواع من الحملات، وبالتالي، في هذا التحقيق تم إجراء تحقيق رقمي مفصل الذي استخدم في البداية البيانات التجريبية لدراسة المنشورة للأعمدة الخرسانية المسلحة بموجب التأثير على التحقق من صحة نماذج العناصر المحدودة، ومن ثم تم توسيعها بعد ذلك لدراسة عدد المعلمات (النسبة المئوية للتسلح الطولي، قوة الضغط للخرسانة، سرعة الإصطدام، وتباعد الركاب) والتي قد تؤثر على سلوك تأثير الأعمدة الخرسانية المسلحة. بعد ذلك تم استخدام نموذج رصيف نموذجي من أرصفة الخرسانة المسلحة للتحقيق في تصادم المركبات. بناء على التحقيق العددي التفصيلي، وجد أن النسبة المئوية للتسليح تؤثر بشكل كبير على قوة الإصطدام بشكل كبير، ومع ذلك، فقد وجد أن قوة ضغط الخرسانة وتباعد الكائنات ليس لها تأثير كبير على قوة الإصطدام.

الكلمات المفتاحية: حمل الإصطدام، تصادم المركبات، العناصر المحدودة، الخرسانة المسلحة، الأرصفة، الأعمدة.
Studying the Effect of Ambient noise, Font size and Character type on Typing Performance on computers

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ABSTRACT

Noise is considered one of the primary pollutions worldwide, which plays a key role in harming human physical and rational health. The current study was conducted to evaluate the effect of noise level, font size, and character type on the typing performance on computers. The data were obtained by measuring ambient noise at five levels of noise: 56, 63, 70, 76, and 82 dba during typing on computers by 20 participants. The noise was measured by a noise level meter device. We measured the average typing time and average typing accuracy at each level of noise at two different conditions. The first condition is by dividing the typing on computers into three types of characters (Times new roman, Arial, Andalus) and the second condition by dividing the font size into four types (10, 12, 14, 16). After that, we measured the average typing time with different font sizes at different characters type. The findings are discussed thoroughly in the paper, revealing that noise level, character type as well as font size are the remarkable conditions amid all controllable aspects that affect the average typing time and accuracy. In addition, the results show that the ideal conditions were, 70 dBa Noise level, Times New Romans and fourteen font sizes. In conclusion, working at noise level of 70 dba would greatly optimize the human performance represented by a low typing time and high typing accuracy.

KEYWORDS: Noise Level, Font Type, typing Time, computers, Font Size.

INTRODUCTION

Noise has been called one of the four primary pollutions worldwide, industriously alarming human physical and rational health and wellness. Noises such as make-up noise, passage sound, and workplace noises are arbitrarily circulating variables as well as the sound pressure scale modifications irregularly. The effect of noise has been well-elaborated from the sights of working accomplishment, [1, 2], diseased erection syndrome, [3], human health, [4] and feelings, [5]. A significant quantity of examination has been carried out on the feasible effects of sound on thermal sensation and communications in the middle of the understanding of noise and temperature.

For the time being, computer usage is predominant, while keyboard usage is a prominent characteristic of everyday life. Keyboard usage has been considered as a strong risk variable for carpal subway disorder as well as a diversity of various other musculoskeletal conditions, inclusive of epicondylitis [6]. According to the writing desk of Labor Data as well as several various other research studies, upper extremity MSD (Musculoskeletal Symptoms and Disorders) associating with computer keyboard usage is a
significant concern in work-related wellness [7, 8] as a result of its high propagation rate. Given that the computer’s keyboard usage can be explained by recurring finger motions, those conditions may expand from accumulative valuables of transitory loads on the tarpaulin out of recurring muscular tissue activations.

Word treatment jobs are a substantial part of everyday bureaucracy jobs, which need focus and concentration that might drive to cerebral stress and fatigue. Given that it is appealing mutual in workplaces to focus on the music while at the office [9, 10], music might have some comfy effect on people in reducing the work-related anxiety. Psychophysiological anxiety restriction has actually been recognized to increase muscle stress in repeated manual jobs [11], and if songs with its comfy impact can decrease muscular tissue stress it could possibly decrease Musculoskeletal Disorder (MSD) risk. Till now, there is no studies on the direct physical as well as psychological influence of music on computer word treatment jobs. This research study aims to analyze the impacts of music and intellectual tons induction on keying productivity, inputting force and also EMG (Electromyography) activity extensor digestome muscular tissues in word processing tasks.

Noise defilement in operating rooms negatively impacts both patient integrity and staff well-being prospectively predestined noise levels in the operating room and establishes a positive engagement amidst intraoperative noise levels and operative site infections, [12, 13]. Intraoperative noise confuses surgery, which may have unfavorable impacts on the focus of operating room staff, [14,16]. The poor focus caused by high levels of noise may affect operating room staff’s capability to implement aseptic techniques, growing the eventuality of developing operating site infections. Intraoperative noise affects operating room staff’s dialectics and their capability to execute their tasks, [13]. Anesthesiologists' clinical thinking execution was poorer in a noisy medium than in a peaceful environment, [17]. Moreover, intraoperative noise may damage efficient communication between operating room staff, [14,18,19] and unavailing communication is a leading factor contributing to inverse events, [20]. Unavailing communication not only negatively affects patient safety but also causes a raise in stress among operating room staff, [21].

Moreover, ambient noise in an artificial operating room generated a growth in the psychological and physiological stress of apprentice operators during laparoscopy, [22]. Besides the increase in stress, intraoperative noise growing the perception of workload and fatigue of operating room staff, [23].

Previous research has shown that vocals can have a negative influence on reproduction typing accomplishment, however high-volume music can have a positive effect on typing speed. The influence of accompanying music also seems to vary according to whether the entrant is a skillful typist or minimal experienced. The results from this work obviously shows that various parameters of music have different effects [24], and suggests that we intensity be able to achievement raucous, pragmatic music to improve execution when active at a computer. The study shows that the conditional reinforcing belongings of verbal feedback for accuracy or speed single increased accuracy or speed scores of typing achievement. Feedback for accuracy alone (quality of achievement) had the utmost, influence on overall performance raise. Therefore, feedback for accuracy appears to be the feedback of choice in this specific regulation, though utmost changes are anticipated if extra achievement administration tool are added [25]. Another study by Majaranta et al. [26] did not find different effects between superintendent and peer feedback, but this observation should further be scrupulous. Additional studies are
indispensable to further examine long-term effects of oral feedback unique as well as in group with other rendering enhancing tools. Such studies showed that the uninteresting task of eye typing is facilitated using appropriate feedback. The form of feedback impacts both employee performance and experience. By adding a short heard “click”, both the typing accuracy and speed is afflicted [26]. The period of the dwell time affects the suitability of different types of feedback: Short stay times demand short and pure feedback while long stay times can be showing extra information. Word forecast has been shown to be a potentially beneficial tool in supporting children with spelling distress to spell more carefully, despite the costs related to its use. However, the restraint of a person with spelling difficulties to word- forecast employment varies and is difficult to foresee, [27].

The main goals of this paper are to understand just how individuals are influenced by noise as an enhancement to mundane, tedious job-related computing jobs. By carrying out empirical studies in the field, it is hoped that this study will certainly cause a far better understanding of just how noise impacts individuals when functioning and also add to the advancement of theories describing why noise can transform people’s habits.

EXPERIMENTAL METHODS

1. Participants

Twenty male participants with average age 20-23 years old. The participants, who were in decent physical health and condition, have no history of hand nor forearm musculoskeletal signs. As well, they were able to read and write.

2. Design and Study

This descriptive, prospective, cross-sectional study was conducted and the data were obtained by measuring ambient noise at five levels of noise 56, 63, 70, 76 and 82 dBA during typing on computers by 20 participants. We measured the average typing time and average typing accuracy at each level of noise at two different conditions. The first condition was by dividing the typing on computers into three types of characters (Times new roman, Arial, Andalus) and the second condition was by dividing the font size into four types (10, 12, 14, 16). After that, we measured the average typing time and average typing accuracy with different font sizes at different characters types.

3. Research Instruments

The dimensions of the adjustable table to fit the study was (length 100 cm x breadth 70 cm x height 59 ~128 cm), as well as several 20-laptop computers, which were placed on the tables, were used. In addition, and to simulate the office workstation, adjustable office chairs with armrests were used. The participants adjusted the height of the chair’s seat according to their desire, following by the adjustment of the table height to relax and upright the upper body posture in order to feel comfortable when using the laptop keyboard. The noise was measured by a noise level meter device. Stopwatch with Countdown Timer was used to determine the typing time for each student.

4. Experimental procedure

This descriptive, prospective, cross-sectional study was conducted and the data were obtained by measuring ambient noise at five levels of noise during typing on computers by 20 participants. Participants were provided first with a student worksheet, and then performed a word processing task by typing a paragraph contain 70 words. Then, the time of typing full paragraphs was monitoring using a stopwatch for each participant. In the end, the average time of typing was computed from twenty participants.

5. Design of experiments

The experiences were designed to compute the following: 5 (level noise) * 3 (character type) * 4 (font size) within the subject design. The subsequent tables show the aggregate number of experiments considering the diverse conditions.
Table 1 Aggregate Number of Experiments with Diverse Conditions

<table>
<thead>
<tr>
<th>Noise,5 experiment</th>
<th>Characters type,15 experiment</th>
<th>Font size,20 experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>56 dBa</td>
<td>Times new roman</td>
<td>Arial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 12 14 16</td>
</tr>
<tr>
<td>63 dBa</td>
<td>Times new roman</td>
<td>Arial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 12 14 16</td>
</tr>
<tr>
<td>70 dBa</td>
<td>Times new roman</td>
<td>Arial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 12 14 16</td>
</tr>
<tr>
<td>76 dBa</td>
<td>Times new roman</td>
<td>Arial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 12 14 16</td>
</tr>
<tr>
<td>82 dBa</td>
<td>Times new roman</td>
<td>Arial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 12 14 16</td>
</tr>
</tbody>
</table>

Table 2 Number of Experiments of Characters Type and Font Size at Noise Level 1, 65 dBa.

<table>
<thead>
<tr>
<th>Noise, 56 dBa</th>
<th>Characters type</th>
<th>Font size,12 experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Times new roman</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td></td>
<td>Arial</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td></td>
<td>Andalus</td>
<td>10 12 14 16</td>
</tr>
</tbody>
</table>

Table 3 Number of Experiments of Characters Type and Font Size at Noise Level 2, 63 dBa.

<table>
<thead>
<tr>
<th>Noise, 63 dBa</th>
<th>Characters type</th>
<th>Font size,12 experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Times new roman</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td></td>
<td>Arial</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td></td>
<td>Andalus</td>
<td>10 12 14 16</td>
</tr>
</tbody>
</table>

Table 4 Number of Experiments of Characters Type and Font Size at Noise Level 3, 70 dBa.

<table>
<thead>
<tr>
<th>Noise, 70 dba</th>
<th>Characters type</th>
<th>Font size,12 experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Times new roman</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td></td>
<td>Arial</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td></td>
<td>Andalus</td>
<td>10 12 14 16</td>
</tr>
</tbody>
</table>

Table 5 Number of Experiments of Characters Type and Font Size at Noise Level 4, 76 dBa.

<table>
<thead>
<tr>
<th>Noise, 76 dba</th>
<th>Characters type</th>
<th>Font size,12 experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Times new roman</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td></td>
<td>Arial</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td></td>
<td>Andalus</td>
<td>10 12 14 16</td>
</tr>
</tbody>
</table>
Table 6 Number of Experiments of Characters Type and Font Size at Noise Level 5, 82 dBA.

<table>
<thead>
<tr>
<th>Characters type</th>
<th>Font size, 12 experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Times new roman</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td>Arial</td>
<td>10 12 14 16</td>
</tr>
<tr>
<td>Andalus</td>
<td>10 12 14 16</td>
</tr>
</tbody>
</table>

6. Test Conditions
Windows 7 was installed by students for typing on computers. After students finished typing the task, the data were recorded for the task time and typing accuracy. The task contains seventy words. Screen resolution was 720*1280 at the same zoom level of 100%. The tests were done at room temperature.

7. Data Analysis
The software used for data analysis is Minitab. The analysis of variance (ANOVA) and analysis of mean (ANOM) were applied to the collected data.

RESULTS AND DISCUSSIONS
Figures 1 and 2 show that the average typing time and average typing accuracy were affected by noise level under parameters of times new roman, character type and fourteen font size. In Fig. 1. The noise level shows remarkable effect on decreasing typing time, it can be investigated that, average typing time shows the minimum value at noise level 70 dba then increases. The lowest typing time was observed at 70 dba noise level. In Fig. 2. The highest accuracy was noticed at 70 dba noise level followed by 82 dba. These results matched the results of noise level with average typing time.

Fig. 1 Effect of noise level on average typing time
Fig. 2 Effect of noise level on average typing accuracy
Figure 3 and figure 4 display the main consequence of font size on average typing time and average typing accuracy under conditions of 70 dBA noise level and fourteen font sizes for times new roman character type. In Figure 3, it can be observed that the average typing time declines with rising font size up to fourteen font sizes, then slightly increases for sixteen font sizes. The lowest average time was observed at 14 font size. The average typing accuracy was shown in Figure 4. The highest accuracy is perceived at fourteen font size. These results may indicate that the recommended font size for such conditions is fourteen points.

Figures 5 and 6 display the consequence of character type on average typing time and average typing accuracy under conditions of 70 dBA noise level and fourteen font sizes. In Figure 5, it can be shown that the lowest average typing time at times new roman character type then at Arial followed by Andalus. The average typing accuracy was shown in Figure 4. The highest accuracy is noticed at times new roman font type.
Figures 7 and 8 show the effect of noise level as well as font type on average typing time and average typing accuracy at fourteen font sizes. In figure 7, it can be shown that the typing time declines until 70 dBA then increases for all character types and the lowest average typing time was at 70 dBA for times new roman font type. The average typing accuracy was shown in Figure 8, the highest accuracy observed for times new roman font type was at 70 dBA, the highest accuracy observed for Arial font type was at 56 dBA and the highest accuracy shown for Andalus font type was at 82 dBA.

Fig. 5 Effect of font type on average typing time at 70 dBA and 14 font size

Fig. 6 Effect of font type on average typing accuracy at 70 dBA and 14 font size

Fig. 7 Effect of noise level and font type on average typing time at 14 font size

Fig. 8 Effect of noise level and font type on average typing accuracy at 14 font size
Figures 9 and 10 show the main consequence of noise level as well as font size on average typing time and average typing accuracy for times new roman character type. In figure 9, it can be observed that the average typing time decreases until 70 dBA then increases for all font sizes and the lowest average typing time was at 70 dBA for fourteen font sizes. The average typing accuracy was shown in Fig. 10, the highest accuracy shown for times new roman font type was at 70 dBA and fourteen font sizes then at 56 dBA and sixteen font sizes.

Figures 11 and 12 show the effect of noise level and font size on average typing time and average typing accuracy for Arial font type. In figure 11, it can be observed that the average typing time declines gradually while noise level increases for all font sizes and the lowest typing time was at 82 dBA for twelve font sizes. The typing accuracy was shown in Figure 12, the highest accuracy investigated for Arial font type was at 56 dBA and font size sixteen then fourteen then, twelve and ten font sizes for the same noise level.
Figures 13 and 14 demonstrate the primary consequence of noise level and font size on average typing time and average typing accuracy for Andalus font type. In figure 13, it can be seen that the average typing time declines until 70 dBA then rises for all font sizes and the lowest average typing time was at 70 dBA for sixteen font size. The average typing accuracy was shown in Figure 14, the highest accuracy perceived for Andalus font type was at 70 dBA, and font size ten then at 56 dBA and font size twelve.

Fig. 11 Effect of noise level and font size on average typing time for Arial font type

Fig. 12 Effect of noise level and font size on average typing accuracy for Arial font type

Fig. 13 Effect of noise level and font size on average typing time for Andalus font type

Fig. 14 Effect of noise level and font size on average typing accuracy for Andalus font type
To estimate the significance of each control factor’s effect on the response factor, ANOVA was used. The conditions description were shown in Table 7.

Table 7 Conditions Description:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise Level</td>
<td>Character Type</td>
<td>Font Size</td>
</tr>
<tr>
<td>LEVEL 1</td>
<td>56 dBa</td>
<td>LEVEL 1 Times New Romans</td>
</tr>
<tr>
<td>LEVEL 2</td>
<td>63 dBa</td>
<td>LEVEL 2 Arial</td>
</tr>
<tr>
<td>LEVEL 3</td>
<td>70 dBa</td>
<td>LEVEL 3 Andalus</td>
</tr>
</tbody>
</table>

According to S/N Ratio, the ideal conditions observed at noise level 3, level 1 in character type and level 3 in font size, these parameters are 70 dBa Noise level and Times New Romans and 14 Font size. According to the standard deviation the ideal conditions shown at noise level 2, level 3 in character type and level 1 in font size, these parameters are 63 dBa Noise level, Andalus and 10 Font size. According to the means the ideal conditions were at noise level 2, level 2 in character type and level 2 in font size, these parameters are 63 dBa Noise level, Arial and 12 Font size.

Fig. 14 Main Effects Plot for SN Ratios

Fig. 15 Main Effects Plot for Standard Deviation
Response Table for S/N Ratios, Smaller is the best.
The response table displays the most affecting conditions’ effect on typing time. The response table for the S/N ratio investigated the noise level is the most affecting conditions then the character type followed by the font size. The response table for the means displays the same detected at the S/N ratio. The response table for standard deviation displayed that the font size is the most affecting condition followed by the character type and the noise level, tables 8 to 10.

Table 8 Response Table for S/N ratio.

<table>
<thead>
<tr>
<th>Level</th>
<th>Noise level</th>
<th>Character type</th>
<th>Font size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-44.19</td>
<td>-44.91</td>
<td>-44.03</td>
</tr>
<tr>
<td>2</td>
<td>-43.63</td>
<td>-43.8</td>
<td>-44.01</td>
</tr>
<tr>
<td>3</td>
<td>-45.11</td>
<td>-44.22</td>
<td>-44.88</td>
</tr>
<tr>
<td>Delta</td>
<td>1.47</td>
<td>1.11</td>
<td>0.87</td>
</tr>
<tr>
<td>Rank</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Fig. 16 Main Effects Plot for Means.
Table 9 Response Table for Means

<table>
<thead>
<tr>
<th>Level</th>
<th>Noise level</th>
<th>Character type</th>
<th>Font size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>154.9</td>
<td>170.5</td>
<td>154</td>
</tr>
<tr>
<td>2</td>
<td>146.7</td>
<td>149.5</td>
<td>153.3</td>
</tr>
<tr>
<td>3</td>
<td>175.6</td>
<td>157.3</td>
<td>169.9</td>
</tr>
<tr>
<td>Delta</td>
<td>28.9</td>
<td>21</td>
<td>16.7</td>
</tr>
<tr>
<td>Rank</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 10 Response Table for Standard Deviations

<table>
<thead>
<tr>
<th>Level</th>
<th>Noise level</th>
<th>Character type</th>
<th>Font size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53.03</td>
<td>59.19</td>
<td>44.52</td>
</tr>
<tr>
<td>2</td>
<td>44.33</td>
<td>46.04</td>
<td>45.51</td>
</tr>
<tr>
<td>3</td>
<td>53.25</td>
<td>45.37</td>
<td>60.58</td>
</tr>
<tr>
<td>Delta</td>
<td>8.92</td>
<td>13.82</td>
<td>16.06</td>
</tr>
<tr>
<td>Rank</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

The (ANOVA), (ANOM), the standard deviation of the investigated collected data, and S/N ratio were done. The minimum value that carried to identify the remarkable variables and to quantify their effects on the response characteristics was the best, show tables 11 to 13.

Table 11 Analysis of Variance S/N ratio (ANOVA)

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise level</td>
<td>2</td>
<td>3.313</td>
<td>1.6563</td>
<td>1.42</td>
<td>0.0414</td>
</tr>
<tr>
<td>Character type</td>
<td>2</td>
<td>1.888</td>
<td>0.9441</td>
<td>0.81</td>
<td>0.0553</td>
</tr>
<tr>
<td>Font size</td>
<td>2</td>
<td>1.483</td>
<td>0.7413</td>
<td>0.63</td>
<td>0.0612</td>
</tr>
<tr>
<td>Error</td>
<td>2</td>
<td>2.336</td>
<td>1.1682</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>9.02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 12 (ANOM)

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise level</td>
<td>2</td>
<td>155.3</td>
<td>77.66</td>
<td>1.00</td>
<td>0.05</td>
</tr>
<tr>
<td>Character type</td>
<td>2</td>
<td>364.4</td>
<td>182.22</td>
<td>8.34</td>
<td>0.0299</td>
</tr>
<tr>
<td>Font size</td>
<td>2</td>
<td>485.9</td>
<td>242.96</td>
<td>1.32</td>
<td>0.0242</td>
</tr>
<tr>
<td>Error</td>
<td>2</td>
<td>155.5</td>
<td>77.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>1161.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 13 (ANOVA)

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F-Value</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise level</td>
<td>2</td>
<td>1329.3</td>
<td>664.7</td>
<td>1.42</td>
<td>0.413</td>
</tr>
<tr>
<td>Character type</td>
<td>2</td>
<td>676.1</td>
<td>338</td>
<td>0.72</td>
<td>0.581</td>
</tr>
<tr>
<td>Font size</td>
<td>2</td>
<td>532.2</td>
<td>266.1</td>
<td>0.57</td>
<td>0.638</td>
</tr>
<tr>
<td>Error</td>
<td>2</td>
<td>936.3</td>
<td>468.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>3473.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Residual plots are mainly utilized for checking issues related to normality, variance randomization, and outliers.
CONCLUSION

Although previous studies have investigated the impact of noise on individuals’ typing performance, they have not considered various relevant conditions. Hence, this study evaluated human performance (typing time and accuracy) at different combinations of conditions. Several key points are summarized as follows:

- **Purpose:** The research was conducted to evaluate the effect of noise level, font size, and character type on the typing performance on computers.
- **Design:** Descriptive and cross-sectional study.
- **Methods:** The data were obtained by measuring ambient noise at five levels of noise: 56, 63, 70, 76, and 82 dBA during typing on computers by 20 participants. The noise was measured by a noise level meter device. We measured the average typing time and average typing accuracy at each level of noise at two different conditions. The first condition is by dividing the typing on computers into three types of characters (Times new roman, Arial, Andalus) and the second condition by dividing the font size into four types (10, 12, 14, 16). After that, we measured the average typing time with different font sizes at different characters type.
- **Findings:** Noise level, character type as well as font size are the remarkable conditions amid all controllable aspects that affect the average typing time. In addition, the results show that the ideal conditions were, 70 dBA Noise level, Times New Romans and fourteen font sizes.
- **Conclusions:** Working at noise level of 70 dBA would greatly optimize the human performance represented by a low typing time and high typing accuracy.

REFERENCES


تأثير مستوى الضوضاء و حجم الخط و نوع الخط على مستوى أداء الكتابة على أجهزة الكمبيوتر

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قسم هندسة الإنتاج والتصميم الميكانيكي، كلية الهندسة، جامعة المنيا، جمهورية مصر العربية

الملخص

الضوضاء تعتبر من المصادر الرئيسية للتلوث حول العالم، حيث أنها تلعب دوراً بارزاً في الأذية الجسدية للبشر. تم إجراء هذا البحث من أجل تقييم مستوى الضوضاء، حجم الخط، نوع الخط على الأداء أثناء الكتابة على أجهزة الكمبيوتر. تم الحصول على البيانات من خلال قياس مستوى الضوضاء عند 5 مستويات: 56، 63، 70، 76، 82 و ذلك من خلال أداء 20 مشارك لمهمة الكتابة على أجهزة الكمبيوتر. تم قياس مستوى الضوضاء من خلال جهاز خاص بقياس مستوى الضوضاء. لقد قمنا بقياس متوسط وقت الكتابة و متوسط دقة الكتابة عند كل من المستويات الخمسة في سياقين مختلفين. النتائج تناقل بعمق في هذه الورقة العلمية، موضحة مستوى الضوضاء المقبول و حجم و نوع الخط المناسبين في أفضل الأماكن، و الخصائص التي تؤثر على زيادة أو نقصان دقة و وقت الكتابة على أجهزة الكمبيوتر. النتائج أوضح أيضا أن مستوى 70 (الضوضاء عند مستوى 70، نوع الخط: تايمز نيو رومان، و حجم الخط: 14) هي أفضل ظروف مجتمعة لأفضل دقة و أقل وقت كتابة. بشكل ملخص، عند التعرض للضوضاء أثناء العمل، فإن مستوى ضوضاء يقدر ب 70 يعتبر أفضل مستوى لأداء الكتابة على أجهزة الكمبيوتر.
The Applications of Control Charts in Higher Education: A Systematic Review

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ABSTRACT

The aim of present review is to investigate the impact of quality control charts on enlightening the quality of higher education and the effectiveness of education and learning. A systematized literature search was accomplished from numerous sources viz., PubMed, MEDLINE, CINAHL, and EMBASE to identify relevant studies published from 1998 to 2019. Based on the search methodology it was tried to reveal the factors that influence the quality control chart's enlightenment on the quality of higher education. In addition, it tries to emphasize how statistical control charts can help teachers improve the quality of education and the effectiveness of supervision in practice. Therefore, all quality control challenges have been addressed so that appropriate actions and adjustments can be coordinated. Thus, quality control enhances thorough quality oversight in higher education and stimulates the professional growth and development of teachers and students. It can be concluded that, if researchers use control charts as SPC methods to improve Saudi Arabian higher education institutions (educational outcomes, non-curriculum skills, success/failure rates, mental stress, etc.), it will be beneficial. Therefore, statistical control charts are a tool for moving problems in right direction. This is a recognized and consistent way to find its place, particularly in quality control of higher education systems.

Key Words: Control Charts, Higher Education, Statistical Quality Control, Academic Progress.

1 INTRODUCTION

Higher education (HE), also referred to tertiary education, comprising private and public institutions that help promote growth, reduce poverty and promote shared prosperity. A skilled workforce with a concrete knowledge is essential for invention and development. Well-educated workforces are more likely to be hired, receive better salaries, and cope better with financial shocks. Higher education graduates behave better and make higher levels of public contribution. In short, HE institutions not only provide the right and proper work skills, but also prepare individuals to become active members of the community and society. Reforms of existing higher education institutions can be facilitated through deliberate collaboration by governments, the corporate sector, civil society and academia. This could help reinvent the HE
system for quality delivery in research, education and community services. Higher education institutions need to set up internal quality assurance and quality control techniques to enhance quality delivery.

Traditionally, a variety of quality "quantitative" tools (such as control charts) have been applied primarily in industrial products. In addition, the use of control charts for quality evaluation has been gradually introduced into the service sector since the last few decades. However, quality of service has been associated with increased profitability, creating a significant competitive benefit for service businesses by creating repetitive sales and greater market share, confirming consumer retention and positive reviews [1]. Therefore, service suppliers should always stick to quality measurements so that they can establish ways to improve quality. Among the many types of existing services, present study focuses on education, more precisely higher education (HE).

However, in some situations, it has been found that due to educational system policies and strict regulations, it also plays a role that can lead to increased levels of stress by students. Some sources include overcrowded lecture rooms, semester grade evaluation systems, insufficient resources and equipment [2], huge syllabuses [3] lengthy hours, and expectations for memorization [4]. In addition, parents and institutes are relentlessly instilling fear of failure that affects their self-esteem and self-confidence.

Therefore, the purpose of this review is to investigate the impact of quality control charts on improving the quality of higher education and the effectiveness of education and learning. It was also attempted to emphasize how teachers improved internships in the quality of education and the effectiveness of supervision.

1.1 STATISTICAL PROCESS CONTROL

Walter Shewhart introduced the concept of statistical process control (SPC) to improve industrial production. SPC is an online quality control system that can be defined as a philosophy, policy, and method for improving systems, results, and processes. SPC is based on the theory of variability, the general and special causes of variability. This includes the theory of process thinking, data learning, analytical research, experiments, measurement, and methods of data gathering reported by Ning et al. [5]. The most widely used charts in SPC are run charts, average charts, range charts, histograms, Pareto charts, and so on. It should be noted that while SPC and statistical quality control are frequently used reciprocally, the latter is used to define a broader management approach towards quality management.

1.2 DESIGN OF A CONTROL CHART

Control charts are mainly graphs derived from the normal distribution curve. There are two categories of control charts, variable charts and attribute charts, depending on the nature of data. The data is placed in subgroups to establish a set of interpretations that indicate stable and controlled behavior for the process. For example, you can select interpretations of group reaction times that can involve subgroups on a regular basis throughout the day and plot them as a single point on the control chart. The attribute chart is used to predict the number of defective products. One defective unit can have several defects. Control charts can be categorized into X & S charts, X & R charts, p
charts, np charts, and more. For more information on creating and using control charts, see Kaminsky et al. [6] and Amin [7]. Thor et al. [8] discussed variables used in medical observations, their benefits, and the obstacles related with the use of control charts. Laney [9] and Mohammed & Laney [10] have proposed used of control charts for attributes with very large sample sizes (thousands or millions). Prajapati [11] have proposed a modified X-chart for autocorrelation observations. Depending on the suitability of the chart; it can be used in certain situations.

In addition to the charts above, there are additional charts used for the quality control such as CUSUM (Cumulative Sum Chart) and EWMA (Exponentially Weighted Moving Average Chart). However, these charts fall into the category of variable control charts. These control charts are highlighted because the above control charts are not sufficiently sensitive to process measurements. For more information on creating and using CUSUM and EWMA charts, see Woodall [12]. Pillet et al. [13] states that multivariate charts are used when monitoring multiple variables.

2 METHODOLOGY

Extensive research is done to find articles related to the use of control charts in various service departments. A systematized literature search was accomplished from numerous sources viz., PubMed, MEDLINE, CINAHL, and EMBASE to identify relevant studies published from 1998 to 2019. Based on the search methodology it was tried to reveal the factors that influence the quality control chart's enlightenment on the quality of higher education. The search keywords are "SPC", "control chart", "application", "and control chart application in higher education", and "SPC to promote student progress". The search excluded unpublished work from the master's and doctoral dissertations because these studies are likely to appear.

3 RESULTS AND DISCUSSION

Many countries have embarked on a major reformation of their higher education systems, increasing their scope and effectiveness. However, the progress is uneven. Many countries around the globe need to confirm that national policies prioritize fair access, better-quality learning, competent retention, and augmented assurance of success for all the students, regardless of background. Both the policy and the degree programs need to be better tailored to the needs of the local economy. Only then can the government achieve improved achievement in high education, turning its success into increasing and sustaining economic and social development. Thus, quality control enhances thorough quality oversight in higher education and stimulates the professional growth and development of teachers and students.

In one study Braimah and Abdulsalam [14] monitored the training / learning process at a college in Kwara, Nigeria, and to confirm that whether teacher services to students meet the university's academic standards. This goal is achieved by monitoring student failure rates after the end of an academic session. They used the P-chart to observe the rate of failure (process average shift). Based on their findings, they encouraged management to take action on the part of teachers and students to stay in control of the process (reduce failure rates). In addition, Taiwo and Olufemi [15], investigated the
performance process in higher education in Nigeria using Ibadan's polytechnic as a case study to see if institutions, students and teachers meet the academic standards set. The P-chart reveals that the failure rate is out of statistical control. However, they found that some of the content of these courses was a school certificate syllabus that students must have done in secondary school, but nevertheless the failure rate of some courses is high. This indicates that student performance is not encouraged in some of the courses offered, which can be caused by a range of reasons. In another study, Okwonu and Ogini [16] investigated student performance based on two semester exam scores. They reported that student performance fluctuated due to common or assignable causes. Positive fluctuations improve the student's overall performance, and negative fluctuations adversely affect the overall performance.

In another study, Braimah and Abdulsalam [14] use the P-Charts in the Quality Control of Students Performance in Tertiary Educational Since P-chart detected shift in the process (teaching/learning), it can be used to monitor failure rate in schools (Colleges and Tertiary Institutions). Conclusively, the teaching/learning process is said to be out of statistical control since some of the plotted points fall outside the upper control limit (UCL), meaning that the failure rate of courses corresponding to these points above the UCL are not conforming to the failure level of conformance by the college.

In another study, Braimah and Abdulsalam [1] used P-graphs in the quality control of student performance in higher education. Since P-graphs detect changes in the process (teaching/learning), it can be used to monitor school failure rates. (College and colleges and universities). Finally, the teaching/learning process is considered to be out of statistical control because some of the plotted points exceed the upper control limit (UCL), which means that the failure rate of the courses corresponding to these points is higher than the UCL non-conformity level of the college.

Hanna et al. [17] present a different approach to identify educational issues in retention, progression, and graduation. They use the SPC to analyze changes related to a student's academic performance and enable the supervisor to perform root cause analysis and take corrective action. In addition, they emphasize that in the current academic environment, the evaluation process guarantees learning, and that the SPC also provides a means of monitoring the relationship between quality of education (i.e., learning outcomes) and academic progress. Therefore, the main goal of SPC is to discover the occurrence of special causes in time, so as to investigate the process and take corrective measures. Focusing on higher education teaching issues, control chart can be used to monitor the performance of different faculty members over time. It is certainly feasible to compare the performance of several faculty members at a specific moment (such as a semester) at the same time [18].

In addition, Sivena and Nikolaidis [18] elaborate on statistical frameworks based on SPC technology and tools, such as those extensively used in some application control charts. In addition, by scientifically determining the limits of the suggested control chart, decision makers can not only identify
unproductive faculty members, but also decrease the adverse reactions evoked by the recognized members. In addition, for HE institutions around the world that have not been evaluated by questionnaires, they actually improve monitoring and, as a result, improve the quality of university courses, as well as educational ability and performance.

The academic stress due to academics has become an unescapable problem worldwide in different cultures and ethnicities. The academic stress prevalence cannot be a stream-specific condition, and high-stress levels have been reported among engineering and medical students, which emphasizes necessary medical intervention [19]. In a study Reddy et al. [20] showed that academic stress remains a catastrophic problem affecting students' mental health and well-being. In addition, techniques such as biofeedback, yoga, life skills training, mindfulness, meditation, and psychotherapy have been found to be effective in reducing student stress. Therefore, the basic knowledge provided by learning and development science, coupled with decades of educational research insights, provide a framework to support the welfare of children in various environments [21]. Some sources include overcrowded lecture rooms, semester grade evaluation systems, insufficient resources and equipment [2], huge syllabuses [3] lengthy hours, and expectations for memorization [4]. If students do not take appropriate exams according to the standards, their teachers may be lazy, corrupt and incompetent, and the exams set are far below the standards [22]. Therefore, external examinations are a way to ensure that all written examinations meet the standards. For example, if the failing rate of a course in an academic institution is too high, the management of the institution can take action. In another study, Cervetti et al. [23] recommended that the PCC should be clearly displayed on the wall of the classroom so that students and teachers can easily see it. Teachers should encourage students to master class progress and point out the goals of each exam. This should encourage teamwork and cooperation with teachers in the class, thereby creating a more conducive classroom environment. Therefore, the use of statistical control tools can help management meet the standards of educational quality.

4 RECOMMENDATIONS

Based on our review results, the following suggestions can be made. Control charts can often be used to identify courses that students seem to have a problem with them. Instead of complaining about high failure rates and uncontrollable problems, university administrators and teachers should focus on what they can control. In addition, reforms of existing higher education institutions can be facilitated through deliberate collaboration by governments, the corporate sector, civil society and academia. This could help reinvent the HE system in Saudi Arabia for quality delivery in research, education and community services. Staff must be available through the provision of improved service, basic infrastructure, virtual libraries, communication technology, and internet connectivity. Higher education institutions need to set up internal quality assurance and lecture unit monitoring to enhance quality delivery. To improve quality, teachers and non-teachers should be motivated to make them more devoted and effective in their work. Therefore, if researchers use control charts as SPC methods in order to improve Saudi Arabian higher education institutions (educational
outcomes, non-curriculum skills, success/failure rates, mental stress, etc.), it would be beneficial.

5 Conclusion

Higher education principally aims at developing the mental capacity and the character of the individual to lead a productive life in society. It is worth mentioning here that the future of countries greatly relies on quality education. Among many useful techniques, statistical control charts are seen as a practical tool for efficient problem-solving. This method is widely known, and, at the same time, reliable to be applied in the social sciences field, particularly in the educational systems’ quality control.

6 References


تطبيقات مخططات التحكم في التعليم العالي - مراجعة الأدبيات

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الملخص
في هذه البحث، تم إجراء مراجعة للأدبيات لفحص تأثير مخططات التحكم الإحصائية على تطوير جودة التعليم العالي، بالإضافة إلى تعزيز فاعلية التعليم والتعلم. تهدف هذه الدراسة أيضاً إلى التأكيد على كيفية قيام المعلمين بتقسيم التدريب الداخلي في جودة التعليم وفعالية الإشراف لتنمية وتحسين العلاقات بين المشرف والمعلم لتحقيق تعليم وتعلم أكثر كفاءة. تحقيقاً لهذه الغاية، تمت معالجة جميع تحديات مراقبة الجودة بحيث يمكن تنسيق الإجراءات والتعديلات المناسبة. يمكن تعزيز مراقبة الجودة من خلال مراقبة التحقق في التعليم العالي لتحسين النمو المهني وتقوية المعلمين، وكذلك الطلاب على حد سواء. لتحسين جودة التعليم في مؤسسات التعليم العالي، يمكن للمشرفين المعدين توفير التحسينات المناسبة للمعلمين. يمكن أيضًا النظر في مواقف المعلمين تجاه التعليم والتحرير الإحصائي المناسب. لذلك، ينظر إلى مخططات التحكم الإحصائي على أنها أداة مفيدة لحل المشكلات بكفاءة. هذه الطريقة معروفة على نطاق واسع. كما أنها موثوقة عند تطبيقها في مجال العلوم الاجتماعية، وخاصة في مراقبة جودة الأنظمة التعليمية.

الكلمات المفتاحية: مخططات التحكم، التعليم العالي، مراقبة الجودة الإحصائية، التقدم الأكاديمي.
التكيف البيئي في بعض حشائش الكثبان الرملية: دراسة مورفولوجية – تشريحية

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الملخص

تعتبر ربيئة رركيبان بررملي باضلسة رركيبايررموسةكيبرر ي ي ررب ي باممسنرركيباعبئةرركيبايررع اكيلررتيبابة ررم ي ب ي
بلإ هم ب يبابة ةكيباعدادةيبامتم سكيب يشدةيبلإشعمعيباشمي يوباحببرةيباعماةكيوباجفمفيوباتتعبضيباميتمب
اسبارم ي وباغمبيئمابلمل.يباقسةليلتيبلأن بعيبا بمتةكيلرتيايرتعمبيهراليبابة رم ي ونظربب ياقسركيبادربترم يباتر يت موار يتنة
ةر في وتأقسم يئة ركيبان برملي باضلسة ركيلرتيبا ر بو يبام رب ا ةرك ي وباتشرباحةكيبادقةقركيىسرليباميرت عيباعرمام يىملرك يوبر ي
ئهرردف يإاقررمءيباءرر ءيىسررليئعرر يباج بنربايبام رب ا ةرركيباتبكةبةرركيباتنةفةرركي وباتشررباحةكيبادقةقرركي
ا بمتررم يبان بررملي بابلسةكيبامختمرة؛يولتيأئبزي هالي بلأن بعيبا ل ك يوهمابيادليىسليوجمي بخس يأكببياتخ اتيباممءيلقمرنكيئيطحيخمر  يأقلياسب مءيباء ئ .يباشر كمي
وبا مم ي وييتمكيأقليلتيبايرعديلمرمياع ر يليرموكيأكبربياسب رمءيباءر ئ يلقمرنركيئحجرمي بخس يأقرلياحفر يبامرمء
وهرر يكررليلررتيبا مررم ي يرلياهررمياستنررم بي وبلانتشررمر يوامقمولرركيواررأةيباظرربوفيبايررمئدةيبرر يئة تهررم
؛ي وهرر يكررليلررتيبا مررم ي يرلياهررمياستنررم بي وبلانتشررمر يوامقمولرركيواررأةيباظرربوفيبايررمئدةيبرر يئة تهررم
Panicum turgidum يوباش كمي Odyssea mucronata يوبايّعدي Cyperus conglomeratus .ي أظهب ينتمئجيهاليبادربتكي
تبما م يوبضحم ي ب يبا خمئايبامظهباك.يبلتسكيبايعديأكببيتمكيالأوربايئرةتي
بلأنر بعيبا ل ركيتن ا رم يوبضرحم ي الأ سفكيبابلسةكي Rhizosheath اُظهبيباتبكةايباتشباح يالأوربايب يبلأن بعيبا ل ركيأنممارسةيلتشرمئهك يوةرثيتتبكرايبلأوربايلرتيابقركي
لفب ةيلتيباخلاميتؤافيكل يلتيبايطحيباعس ييوبايفس يتحابيبةمميئة هميبا يةجيبا تط يباايياءميخلامي مدي
باح لكيبامحةطكيئماح  يبا ىمئةك.يئع يخل اميبايرطحيباعسر ييتتءرخّميلن نركيخلارميوبكةركي bulliform cells ي دريرقةقكيىم ةيوقدرةيىماةكيىسليبلاننممشيوباتمرد يلمرميايربايبنطبرماي رمنب يترطحيبا رقركيباعسر ييى ردي
باجفمفيوتمد ليى ديبلالتلء.ي خلامي مديباح لكي(بات يتتأافيلتيابقتةتيلرتيباخلارميباتم ةسةركي chlorenchyma تحاةطيئنليو لكيوىمئةك)يت ديب يأوربايبلأنر بعيبا ل رك.يهراليباخلارميتؤاّرفينمرطيباتبكةرايبداتشربائىربايّرعديتبكةبرم يلمةر ب يئ ر يخلارمي مرديباح لركي(تشرباحي كببنرر ي kranz anatomy يوهرر يصررفكيتشررباحةكي ةرربيلأا برركياسيررما يواعسهررميخمصررةكيتعرر زيلررتيبعماةرركي
باء ئ يايمايبايعد.يئااكياتءحيبلي باخامئايباتبكةبةكيوباتنةفةكيبامتشمئهكيى رديتشرمئهيباظربوفي
بااييتن ليبةهيباح  يبا ىمئةكيلبع بةيضمتيبا يةجيبلأتمت يوب ي اكيتع ا يا قليبامرمءيباممرتايىبربيباجراوري
ئفعماةك.يوئخلفيبا ىةتي(باش كميوبا م )يأظهبيتمايبايّرعديتبكةبرم يلمةر ب يئ  ر يخلارمي مرديباح لركي(تشرباحي
باتبكةررايباتشررباح ياسجرراوريكررمليلتشررمئهمي باخلارميتؤاّرفينمرطيباتبكةرايبداتشربائىربايّرعديتبكةبرم يلمةر ب يئ ر يخلارمي مرديباح لركي(تشرباحي
كببنرر ي kranz anatomy يوهرابيإشرمرةيإارليباخارمئايباتبكةبةركيوباتنةفةركيبامتشرمئهكيىرديةتشرمئهيباظربوفي
باتبكةررايباتشررباح ياسجرراوريكررمليلتشررمئهمي
بنتشريح كرايز Odyssea mucronata ، والشوكوم turgidum و Panicum turgidum و Odyssea mucronata و Cyperus conglomeratus
أظهرت نتائج هذه الدراسة تبايناً واضحاً في ما يتعلق بالمorphology. امتلك السعر أكبر سمك للأوراق بين الأنواع الثلاثة، وهذا يدل على حجم داخلي أكبر لتخزين الماء مقارنة بحجم الأوراق الصغيرة، والثمام نو سمك أقل من السعر مما يعني مساحة أكبر للبناء الضوئي مقارنة بحجم داخلي أقل لحفظ الماء، والأنواع ذات النتفاء زداد في أوقات النجف؛ مما يقلل من مساحة الأسطح المعرضة للنلحي. فيما يخص سمك الطبقة الحديقة في سوق الأنواع الثلاثة أظهر تبايناً بين الأنواع، حيث كانت الطبقة الحديقة أصغر في سوق الشوكوم ، وثانيها السعوم ثم الثام. زيادة سمك الطبقة الحديقة تقلل من النجف وقدر الماء. وتظهر الأنواع الثلاثة تكويناً واضحاً للغلافة الرميلية

يظهر التكيف التشريحي للشوكوم في الأنواع الثلاثة أنماطاً متشابهة، حيث تتركب الأوراق من طبقة مفردة من خلايا تولف كلاً من السطوح العلوي والسفلي، تحصر فيما بينها التسيج الوسطي الذي يضم خلايا غرم bulliform cells الحزمة المحيطة بالحمر الوحانية. بعض خلايا السطح العلوي تتضخم كخلايا حركية ذات رنجة رعدية عادة عالية على الانكماش والتفاحد، مما يسبب انطلاقة جانبي سطح الرغوة العلوي عند الكونية، وتمدد عند الشريحة. خلايا غرم الحزمة (التي تتولف من طبقة من خلايا التشريحة) تحيط بكل حزمة وعانية) توجد في واقع الأوراق الثلاثة. هذه الخلايا تولف نمط التشريحي المسمى kranz anatomy، وهو دالة على امتلاك هذه الانتانات لمارس C4 بتشريح كرايز Rhizosheath

نيكفيما للبناد الضوئي مع ظروف نقص الماء والحارة. السبط والإرجوزات في كل من الشوكوم تظهر نمط تشتت مشابه عبر النطاق المعروف في سوق المشاش، Panicum turgidum والثام ومملايقraic и Odyssea mucronata، الذي تكون فيه الحزم الوحانية مبسطة ضمن النسيج الأساسي، وفي ذلك تنتمي نقل الماء المتمتص عبر الجذور بفهالة. ويخالف النوعين (الثام والثام) أظهراً الواقع OTW ينتمي يوجد خلايا عك抱 الحزمة (تشريحي) (kranz anatomy) وهي صفة تشريحية غير مألوفة للسماق، ولعلها خاصية تعزز من فعالية البناء،
البيئية في نفس الموقع، وهذا النطع (توزيع جسمة الوعانة حول نخاع مركزي) يعزز من انتصاب الماء ونقله للأجزاء الحضرمية بالغالية.

الخصائص المظهرية والتشريحية لهذه النباتات تساهم بشكل أساسي وجوهري في استعمالها لبيئات الكثبان الرملية المنخفضة، وتعزز من انتشارها وتكرارها في تلك البيئات التي تقل فيها الأنواع الأخرى من النباتات، والتي تساهم في جهود المحافظة على هذه الأنواع وغيرها من مكونات الحياة النباتية الفطرية، والاستغلال الأمثل لمواردها.

**الكميات المفتوحة:** حشاش، الكثبان الرملية، النمام، والشوك، *Odyssea mucronata*, *Panicum turgidum*, و*Cyperus conglomeratus*.

### 1.1 مقدمة

بشكل عام، تعرف الصحاري بالمناطق القاحلة التي تتميز بنقص المياه والجفاف، وقلة النباتات. إن معظم دول الشرق الأوسط تقع داخل النطاق الصحاري شبة القاحل والجاف (اليونسكي، 1994). وتتميز هذه المناطق بمؤشر الجفاف (الذي يمثل النسبة بين هطول الأمطار السنوي ومتوسط التبخر) الذي يتراوح بين ≥0.20 و≤0.50. (Yossef & Mearz 2013).

توجد الكثبان الصحارية في وسط سلسلة الأردن وشمال الشام وجنوب العراق. وoriented على مناطق الطبيعية، يمكن تعريف الصحاري على أنها مناطق ذات نباتات مترفقة، هذه النباتات تشكل جماليات تتكيف معها من البيئات القاسية، ومقاومة ظروفها أو تحملها. تغطي الصحاري حوالي 50% من مساحة الأرض في العالم، ويتم حوالي 40% من سكان العالم في هذا النطاق الجغرافي. إن موقع هذه المنطقة القاحلة هو في المقام الأول نتيجة للضغط العالي شبه الدائم المحموم على هذه المنطقة إضافة إلى جوانب أخرى مثل تأثيرات ظل المطر، النbuquerque، بعد نبع مصادر الرطوبة، (Tchakerian, 2015).


إن معظم هذه التغيرات تنشأ بالعمليات الطبيعية في حين أن التغيرات الأخرى هي نتاج الأنشطة البشرية. بالنظر إلى أن الكثبان الرملية في
المملكة والتي تشكل مساحات شاسعة ضمن ظروف بيئة شديدة الوطأة من إجهاد الجفاف والحرارة، ومثل هذه البيئات الجافة تمثل الحد الأقصى للظروف البيئية وضخامة على الكائن الحي، ومع ذلك تضم هذه البيئات بعض الأنواع التي تكيفت على المعيشة والبقاء ضمن بيئات تكيف غرف بعضها ولا يزال الكثير بالدراسة والبحث.

يتحلل البيئات الفحلية كبيئة الكتان الرملية، في العديد من التكيفات التي حياة الله عز وجل بها، مع أن العديد من الظروف (كالرياح العاتية) (Bradley, et al., 2019) تتحدى استمرار النباتات في هذه البيئات، وتتكاثف الكتان الرملية تأقلمت للمعية في أراضي قدراتها الكبيرة على النمو ضمن روابط الرمال بالإضافة إلى الواجهة الضيقة المماثلة للموارد الرملية الضيقة. إضافة إلى آثارها العالمية على الإنتاج ضمن فترات قصيرة من توفر الماء؛ مما يمثل جزء هام في تكيفها مع بيئتها (Danin, 2012).

في منطقة جازان يوجد نطاق الكتان الرملية بشكل شريط متنقل على امتداد موارد الشريط الساحلي. وصنف هذا النطاق من بيئة الكتان المميزة لهذه البيئة، أهمها: Odyssea والتمام (mucronata)، Panicum Poaceae، ك الذين يتبعون الفصيلة النجيلية (Cyperus conglomeratus) والسعد Cyperaceae، (صريح 2012،) وفي هذا النطاق تلعب عمليات نقل الرمال دورًا هامًا في بيئة الكتان الرملية، بالإضافة إلى الاستغلال غير المنتظم للموارد الطبيعية من قبل الإنسان الذي يعتبر من الأسباب الرئيسية لتدوهر العديد من أنواع النبات البيئية.

ونظراً لقلة الدراسات التي تناولت تكيفات وتشكل بيئية الكتان الرملية من النواحي Morphology والتشريحية الدقيقة (and Anatomy) في بيئات المملكة العربية السعودية خاصة، كانت فكرة وهدف هذه الدراسة.

1. "沸腾 الرمليات المئات من إجهاد الجفاف والحرارة، ومثل هذه البيئات الجافة تمثل الحد الأقصى للظروف البيئية وضخامة على الكائن الحي، ومع ذلك تضم هذه البيئات بعض الأنواع التي تكيفت على المعيشة والبقاء ضمن بيئات تكيف غرف بعضها ولا يزال الكثير بالدراسة والبحث.

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1. سهول ساحلية واسعة يملأ 40 كم في الأرض يتكون في معظمها من الإرسابات الرملية الطبية.
الكثبان الرملية الساحلية (مسرحي، 2012)، ويوضح الشكل (2-1) مظاهر السطح الجيولوجي الفراغية الثلاثة للمناطق.

2. وقائمة الساحل يمثل شريط من السماح يتالف من تربة الناعم الطين والطين مع محتوى عال من الأملاح الناتجة عن ارتفاع مسرب الماء الأرضي والمعدل التبخر.  
3. ومحاذاة الجزء الشرقي من السياح توجد في بعض المواقع مساحات متنافعة من النزف السوداء (صورة الأقمار الصناعية Nasa Landsat - بكروم من هيئة المساحة الجيولوجية)

شكل (2-1): جزء من جزء جازان يوضح مظاهر السطح الجيولوجي الفراغية الثلاثة للمناطق (تقوم بيتة بينها - بتكرم من هيئة المساحة الجيولوجية).

تقع منطقة الدراسة على امتداد طريق جازان المدينة الصناعية وتم اختيار الموقع بالإحصائيات التالية: (N:47°03’07.5”- 30°33’30”). وضمن هذا النطاق من الكثبان الرملية تنمو بعض النباتات الجفافيات في تربة قليلة الاشتياق بالماء.

2. الغطاء النباتي السائد لمنطقة الدراسة: 
منطقة الدراسة تمثل جزء من الكثبان الرملية الساحلية، وتتكون من الناحية الجغرافية النباتية إلى الأراضي السودانية التي تضم نباتات جفافية (xerophytes) el-demerdash, et al., (1994).
(شكل 2-3): يوضح منطقة الدراسة (علامة النجمة) في نطاق الكثبان الرملية الساحلية.

في حين تم تقدير الطبقة الحدية (Boundary layer) للأوراق وعرض الورقة (بالمتر المكعب/ثانية) لـ (نوبيل,2005) بواسطة السماك (الملم) (Caliper) للمادة السطحية الساقية (S/V) والسوق (S/V ratio) في الأوراق وسوق الأوراق:

\[
S/V \text{ ratio of clado}d\text{es and flat leaves } = \frac{2}{T} \\
S/V \text{ ratio of cylindrical stems is } = \frac{2}{r}
\]

حيث: 
- T = سمك الورقة (الملم) 
- r = نصف قطر الساق (الملم)

في حين تم تقدير سرعة الرياح السائدة (بالمتر/ثانية) في حالة الساق الإسطوانية (Nobel,2005) بواسطة السماك (الملم) (Caliper) للمادة السطحية الساقية (S/V) والسوق (S/V ratio) في الأوراق:

\[
\frac{d}{v} = 5.8 \text{ (mm)}
\]

حيث: 
- d = سماك الساق الإسطوانية (الملم) 
- v = سرعة الرياح السائدة (م/ث) 

وقد تم اعتبار سرعة الرياح السائدة ضمن البيئة الموضعية للمواضع المكشوفة للنباتات في البيئات الجافة في الأحوال العادية = 1 m/ث (Masrahi,2020a).

(شكل 2-3)
قياس بعض الأبعاد في الأجزاء الخضرية للنباتات المدروسة

2.4 دراسة سطح الورقة بالمجهر الإلكتروني (SEM) للمورفولوجيا الدقيقة لسطح الورقة (surfaces).

وضعت أجزاء من الورقة لكل من السطحين (العلوي والسفلي) بعد تجفيفها، في القاعدة الخاصة بفحص العينات، وتتم التعليل ببطاقة رفقة من الذهب، وفحصت بالمجهر الإلكتروني الماسح ضمن JSM-6380 LA-JEOL، (Japan).

استخدم المجهر الإلكتروني الماسح لدراسة سطحي الورقة في نوع واحد فقط، وهو الشوكم Odyssea mucronata، وذلك لأنه النوع الوحيد الذي أظهر خصائصًا بارزة في سطحي الورقة ضمن ثلاثة الأنواع.

2.5 قطاعات المجهر الضوئي:

جُعلت قطاعات بدائية لكل أجزاء النباتات المدروسة (أوراق - سوق - ريزومات - جذور) وذلك من عينات خفظت في ۷۰% كحول إثيلي.
شكل (3.1) الغطاء النباتي في منطقة الدراسة تسود فيها النباتات التالية: A- الاراك B- ام تويح تاكوي C- حصار D- إروآ E- علقة F- عَلْقَا عُشر

الغطاء النباتي في منطقة الدراسة تسود فيها النباتات التالية:

A- الاراك
B- ام تويح تاكوي
C- حصار
D- إروآ
E- علقة
F- عَلْقَا عُشر

3.1 الوصف المظهرى للنباتات المدروسة:

3.1.1 الشوكم

جنسالشوكم هو أحد الأجناس الكبيرة في العائلة النجيلية. وهي نباتات ممتازة تستفيد بالسبخة بالصرف. تحتوي النباتات على أوراق متفرقة ونباتات مشهورة في العالم. وقد تم العثور على العديد من الأنواع المختلفة في المنطقة المدروسة. وتشتت النباتات بأشكال عديدة تختلف من م.getElementsByTagName('text').forEach((text) => {text.remove();}) خضرة إلى صفراء. وتتنوع الأوراق من ألوان عديدة تتنوع من الأزرق إلى الأبيض. وتتنوع النباتات على امتداد الكثبان الرملية الساحلية للبحر الأحمر في إريتريا والصومال والساحل الجنوبي الغربي للبحر الأحمر من شبة الجزيرة العربية. (Masrahi, et al., 2012)
يساعد. 

Cyperus L هو أحد أبرز وأكبر أجناس الفصيلة السعفية Cyperaceae، يضم أنواعاً شبيهة بالحشائش تكون غالباً بسيقان ذات مقطع مثلث وأوراق شرطية مع قواعد عديدة أو أوراق غير ظاهرة، تميز بوجود سباق تحت الأرضية، التي تنتج درنات، سباق هذه النباتات قريبة، النباتات الطفيفة عادة ما تكون شكل النبات شبه الخملي، تتكون من عد كبير من الساقين، وعادة ما تكون مضغوفة طرفية بليغة، قد تصل في عدها إلى 50 شهرة. يضم جنس السعد نحو 150 نوعاً. تنتشر حول العالم (Cyperus et al., 1997).

نباتات السعد

السعة: للنباتات المعمرة

النباتات المعمرة congolomerasus

الحشائش: النباتات المعمرة Cyprus

النوبات في صورة رؤوس طفيفة تتكون من مجموعة من الساقين تصل عدها من 3 إلى 5 ساقين، والأوراق شرطية، 5 - 25 سم وعرض نحو 2 مل، عديدة ويعشاد من قاعدة النبات. قد تصل سقته لارتفاع 5 م (عدها 30 – 50 سم)، وبسح من 0.1 إلى 0.2 سم. يتميز السعد بالبوريئات البيضي القصرية، والجذور متفرعة يصب سمكة إلى 5 مل وعادة ما تتغلف بغلاف سمك رمادي اللون. يوجد السعد في النوبة الرملية ونادر ما يوجد في التربة الطينية أو الطينية.

(Edwards et al., 1997)
(جدول 3.1) قياس كل من سمك وعرض الأوراق، وسمك السوق الحاملة للأوراق وتقدير نسبة مساحة السطح إلى الحجم (مم)

<table>
<thead>
<tr>
<th></th>
<th>الفضاء (المم)</th>
<th>السمك</th>
<th>الساق</th>
<th>نسبة مساحة السطح للحجم</th>
<th>سمك السوق الحاملة للأوراق</th>
</tr>
</thead>
<tbody>
<tr>
<td>الثمام</td>
<td>0.22 ± 0.01</td>
<td>0.42 ± 0.06</td>
<td>0.27 ± 0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>السعد</td>
<td>1.42 ± 0.21</td>
<td>1.68 ± 0.32</td>
<td>2.92 ± 0.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>الشوكم</td>
<td>3.6 ± 0.38</td>
<td>1.73 ± 0.15</td>
<td>2.36 ± 0.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9.23 ± 0.55</td>
<td>7.44 ± 0.61</td>
<td>4.76 ± 0.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.81 ± 0.10</td>
<td>1.36 ± 0.27</td>
<td>2.38 ± 2.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.24</td>
<td>0.16</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.22</td>
<td>0.23</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(شكل 3-3) الأغلاف الرملية: أ- الثمام ب- السعد ج- الشوكم

(شكل 3-4) الأغلاف الرملية: أ- السعد ب- الشوكم ج- الثمام
5.3 المورفولوجيا الدقيقة لسطح الورقة في *Odyssea mucronata*

الشوكم

يُظهر سطح الورقة العلوي نمطًا متميزًا من الأضلاع البارزة ridges تحصر فيما بينها أشواكًا غائرة grooves. ترتيب على امتداد جوانب الأضلاع شعرات شوكية prickle hairs في حين تكون الأجزاء العلوية البارزة من الأضلاع

الخصائص التشريحية للأنواع المدروسة (قطاعات المجهر الضوئي)

وجدت الدراسة في القطاعات التشريحية المأخوذة بالمجهر الضوئي لأوراق الشوكم شكل (6-3 أ)، البذرة (العلوية أو السفلية) تتألف من طبقة واحدة من الخلايا، تليها مجموعة من حزم ليفية كثيفة إلى الداخل ضمن كلا السطحين. هذه الحزم من الألياف توجد أعلى وأسفل تشريح كراتز الذي يمثل غلاف من الخلايا الكلوئينيية تحيط بالحزم الوعائية (خلايا غمد الحزمة). خلايا غمد الحزمة هنا تتألف من طبقتين من الخلايا الكلوئينيية، وهي تتمثل النسيج الأساسي للبناء الضوئي في أوراق النبات النباتات بين مجموعات أعداد الحزم الوعائية لمثل الأشواك ضمن المنظور السطحي، بينما أعلى grooves
البشرة هنا تتألف من طبقة واحدة من خلايا صغيرة سميكة الجدر، تليها مجموعة من حزم الألياف توجد بشكل متقطع (وليس متصلة). ثم طبقة متصلة تقريباً من الخزوم الوعائية التي تحيط بها الخلايا التمثيلية لعدم الحزمة (تشريحة كرانتز). في حين أن التركيب الداخلي (anatomy) للسائل (الجزء الأكبر) هو خلايا براتشيومية تتشارك بها حزمة وعائية قليلة. وجود خلايا غمد الخزوم المميزة لتشريحة كرانتز في الساق صغيرة تشريحي فريدة في ساق السعد (3-7). 

تظهر الجذور لنبات الشوكوم والثمام التركيب التشريحية النمطي لجرذان الحشائش، حيث توجد طبقة واحدة من اليرقة (تبرز من بعض خلايا الأكياس الوعائية)، ثم طبقة تتشكل غمد الألياف، وحلول العمود الوعائي في المناشف توجد طبقة اليرقة الداخليّة. إلى الداخل من اليرقة الداخليّة توجد أوعية الخشب التي تُحاط خلايا متصلة من الألياف، وفي مركز القطاع للجذر يوجد النخاع متماثلًا بجزء صغير من الخلايا البراتشيومية (3-8). بينما يظهر الجذور في الساق نفسها نمط التركيب التشريحي لجرذان الحشائش بعوائم وجود طبقات من الألياف إلى الخارج من طبقة اليرقة الداخلية، حيث تكون هذه الخلايا ممتقة من الخلايا الأنسانية للماء الداخلي يعطلت جدراً وأصبحت خلايا DME (دي في ج.3) Derivatives of the meristematic endodermis في القطاعات التشريحيّة المأخوذة بالمجهز الضوئي لساق الشوكوم. والتي أظهرت فيه الصور أن اليرقة تتألف من طبقة سميكة ملدننة، تحتها 3-2 طبقات من الألياف. ثم عدة طبقات من خلايا براتشيومية كبيرة، تليها طبقة اليرقة السفلية للساق (3-7). ويظهر الساق، والثمام نفس النمط الشائع لتشريحة سوق الحشائش، حيث يتألف داخلياً من الخلايا البراتشيومية التي تكون النسيج الأساسي، وتوجد الخزوم الوعائية مبعثرة في النسيج الأساسي، وتحيط بكل حزمة خلايا ليفية. إضافة إلى ذلك يظهر في الساق تركيب مميز يتمثل في وجود طبقات من النسيج التمثيلي تحت اليرقة مباشرة (Chlorenchyma) (2-6 طبقات، الأولى منها عمادية خلايا اليرقة طويلة في مظهرها ذات جدر ممكّنة، توجد تحتها بنظام متقطع (وأوسم حلقة متصلة) حزم من الألياف (فوق الطبقة التمثيلية المتصلة)، وLEEP في الداخل من الطبقة التمثيلية توجد طبقة من الألياف بنمط متصل غير متقطع. ويعكس إيجز التركيب التشريحي المتميز للساق الشوكوم وجود طبقات من النسيج التمثيلي تحت اليرقة، يُحيط بها نسيج اسكارتشيمي داعم من الألياف (الخارج بنظام متقطع ومن الداخل بشكل متصل)، في حين يشكل النسيج الأساسي من الخلايا البراتشيومية والحرام الوعائي المعززة فيه معظم الجزء الداخلي للساق (3-7). يُظهر التركيب التشريحي للساق في السعد نمطاً مميزاً يختلف عما سبق من نواع الفصيلة التشريحية.
شكل (3-6) - ق. ع ورقة الشوكم ب- الثمام ج- السعد عند تكبير 100 X

شكل (3-7) - ق. ع ساق الشوكم ب- الثمام ج- السعد

شكل (3-8) - ق. ع جذر الشوكم ب- الثمام ج- السعد
الأوراق تعكس قيم سبك الأوراق والحيز الداخلي المخصص للتخزين، والخليج المخصص للبناء الضويني (Masrahi, 2020a). كان النمط أكبر S/V الأنواع الثلاثة في نسبة سماكة النحل للحم في كل من الأوراق والسوق، وهذا دليلً على ما سبق من أن النمط بنى مساحات أصغر للبناء الضويني (تقابل امتدادات أكبر للجراثيم كما لوحظ في بيئة استشراء في موقع الدراسة). وعلى الرغم من أن مساحة النحل الأكبر لمساحة البناء الضويني

4. المناقشة:

يؤدي التبليين الناجم عن البيئة في السمات المورفولوجية والفيزيولوجية إلى تحسين اكتساب الموارد. وتشير النباتات المخبرية والدقيقة المحدودة المشتركة إلى أن الشجاعات الصياح مُن طورت خصائص تفسيولوجية ومورفولوجية خاصة في عملية التكيف مع البيئة النباتية. وتبدو تحمل أكبر بكثير للنفاذ مقارنة بالنباتات الأخرى (Liu, et al., 2020) بشكل ملحوظ من خلال عدد خصائص متمايز النباتات الجافة، وهذه الخصائص تتباين بتأبين بريق بيئة اكتسابها. يشير الكثبان الطبيعة سمات ذات إجادات تقلل من نمو النباتات بما، وتتبط في إجادات الرياح والشدة ورشة الرياح والغمر بالبرم بالشكل مستمر، وقلة الاحتفاظ بالماء الناتج عن نسبة التربة الرطبة الخشنة غالبًا والتي ينفد فيها الماء إلى العام سريعاً وبالتالي تقبل Batanouny, (2001; 2002). ومن وسائل التكيف هذه الإجادات لبيئة الكثبان الرملية ما يلاحظ تأثير الأجزاء الخضرية (المعرضة للإجادات بشكل أكبر) من خصائص مظاهرية، تتبدى بشكل أكبر في أشكال الأجزاء الهوائية للنباتات من سوق وأوراق ونسب بعدها عرضة وسماكة

تظهر الأنواع الثلاثة تكويناً واضحاً للغلافية الرئيسية (Rhizosheath) في الجذور. يتكون الغلاف الرملي من تجمع حبيبات الرمال حول الجذر والتصاقها به عند نمو ونمو شرائح الجذور وأفرزات النبتة. هذا الغلاف الرملي وجانب عدم عدد الكائنات الدقيقة التي تسهم في تثبيت النبتات للنبات (Batanouny, et al., 2009; Danin, 1996; Batanouny, 2001).

الخصائص المورفولوجية الدقيقة للأوراق تعكس العديد من الطفائف والتكتيفات مع ظروف البيئة المحيطة. (Masrahi, 2020a, b) أظهرت نتائج الدراسة أن الخصائص المورفولوجية الدقيقة للأوراق الشوك المأخوذ من الأطراف والأخليد تتغذى نمذجة من الأراضي الأخليد. (grooves) تكون أكثر وضوحاً في السطح الظاهري. للورقة منها في السطح السفلي الأراضي (الإضاءة أرفع أو أرفع عن الأخرى) وaxy på أرضية مقارنة بالسلفية. تمثل هذه الأراضي كما تؤثر النسبة من قدرة الزجاجة من leaf conductance طريق التقليل من معدل الرياح لتبادل الغازات (2009). تنتشر على السطح بطرق وشوكية دقيقة. وهى من التراكيب التي وجدت أنها تتزوج من سمك الطبيقية الحدية، وبالتالي تقلل من فقد الماء. الأجسام السبيكة تنتشر ضمن كلا الطبقتين البحر ويؤثر بشكل كبير على الأوراق الشوكية. تتغير هذه الشكل ضمن السطح في أوراق الشوك. حالة أن هذه الطبقية الحدية تقلل من فقد الماء، والأعمال البيئية تتغذى من النباتات. (Maricle, et al., 2009) وتوزع الأوراق الشوكية على السطح بشكل متساوي في النباتات (Batanouny, 2001).

هناك طبقة من الأرتفاع في النباتات التي تكوين تراكيب ملمسة كعوامل تدعي توزعون على المواد وتوفرها لأنشطة أبدية أخرى للنبات.

يتضح الترتيب التشريحي للأوراق في الأنواع الثلاثة أنماطًا متشابهة، حيث تتحرك ومع فعالية الأجزاء الخضرية بإ斯塔جحا ذاث المساحات الأكبر للنوب السويين؛ فهذ يفسر ذلك التفاعل المستمر للكائنات الرملية والانتالي النمو في تلك البجور ذات الظروف القاسية. وهذا تستمر الأكماة الرملية حول النبات بالنمو (Batanouny, 2001).

الطبقة الحدبية هي طبقة الهواء الساكنة تقرب إلى الملاحة السطحية، (Nobel, 2005; Masrahi, 2020a) سماً هذه الطبقة من مغشى طبقة الهواء الساكنة حول سطح النبتة الجذور للنبية الخارجية (سطح النبتة السويين). كما أنها هذه الطبقة أسفل كل قدر نبتة.(Nobel, 2005).

السمك الكامل في طبقة الهواء الساكنة في أوراق النبتة يتميز الشوك الذي يتزوج من فقد الماء، (Batanouny, 2001). حيث كانت طبقة السويين أسفل في أوراق الشوك، باليه السوي ثم النبات. سوق الشوك متفرقة وكثيرة مثل النبات، (دال) فهي معرضة لمساحات أسطح كبيرة، (مقابلة بالسفل)، حيث كانت طبقة السويين أسفل في أوراق الشوك كبرى. يتزوج من فقد الماء من أسطحها سوق السوي ذات أكبر تكزية للماء والمغشيات، ولا إذا سماك البطاقة الحديقة بها يمتلك التكزية بقلل نelem الماء. إطلاق أنبات سوق الشوك، (الشور) ATL, adolescente غازياً أكبر، وتحظى أكثر من ضوء وحرارة، ووه هذ السوي أكبر طبقة الحديقة بتعبير الماء، (Bartenhouny, 2001) يتزوج من فقد الماء من سوق الشوك، (Bartenhouny, 1983). هذه الجهود من ضوء وحرارة، ووه هذ السوي أكبر طبقة الحديقة بقلل نelem الماء. إطلاق أنبات سوق الشوك، (الشور) ATL, adolescente غازياً أكبر، وتحظى أكثر من ضوء وحرارة، ووه هذ السوي أكبر طبقة الحديقة بتعبير الماء، (Bartenhouny, 1983).
الأوراق من طبقة مفردة من الخلايا تتوفر كلاً من السطح العلوي والسفلي، تحرص فيما بينه النسيج الوظيفي الذي يضم خلايا غطاء الحزمة المحيطة بالحزم الوعائية. بعض خلايا السطح العلوي تتشكل مكونة خليا حركية ذات جدر nulliform cells رقيقة. اعتماداً وانتقال هذه الخلايا بال Sequelize, Panicum turgidum, Poaceae من الفصيلة النجيلية (البانياو كثرة)، انتشر هذه النباتات بشكل واسع ضمن بيئة الكثبان الرملية يمكن تأقلمها العالي مع ظروف إجهاد بيئتها. هذا التأقلم يتم بالاعتماد على الخلايا المظهرية (المورفولوجية) والتشريحيّة والوظيفية. وتمثل التكيفات المظهرية والتشريحيّة خصائص مميزة تفسر العديد من جوانب التكيف لهذه النباتات مع بيئتها القاسية، بما فيها ارتباط الوعي بالتكيفات الوظيفية.

النتائج والبحثات السطحية surface to volume ratio للأجزاء الخضرية التي تقوم بالبناء الضوئي عبر زيادة أو التقليل من سمل الأجزاء الخضرية، لوحظ بأنماط مختلفة في الأجزاء الخضرية للنباتات المدرجة (السق الحضرية والأوراق). هذه الأنماط لزيادة نسبة السطح (زيادة سطح البناء الضوئي) أو اختزالها (الدولح المخصوص للتخزين الماء)، أو التقليل منه على سمل الأسطح المخصصة لبناء الضوئي، كانت ظاهرة مميزة لكل من السوق والأوراق في كل نوع بحيث يمكن لكل أجزاء الخضرية تفسر فعلاً مع اثر إجهاد الفجاف (التقليل من النحاب). وقد كان لكل من النشاط، والشوك، و (high S/V ratio, و على الرغم من أن ذلك – إجمالاً، يمكن على حساب المخصص من الحجم (الحلزون الداخلي للتخزين) إلا أن هذه النوعين يمكن تكيف تقلل من المساحات المعرضة للإجهاد عند استعداد وطأة الظروف، وتقلل من فقد الماء (الخلايا الحركية التي تسبب انحلال طرف الوعاء السطحي للورقة، ووجود سوق استودائية خضراء تقوم بعملية البناء الضوئي جنبًا إلى جنب مع الأوراق، سمك الطبقة الحدية (الحدودية) كائن لها الأثر

5. الاستنتاج

وجدت الدراسة الحالية أن القليل من النباتات (المعمرة بالذات) يتكيف للنمو والبقاء في تلك

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الكبيرة (تُبَدِّلُ الْخَالِقُ عَزَّ وَجِلَّ الَّذِي أَبَدَعَهَا) في انتشارها الواسع في بيئة الكثبان الرملية، وتتكاثر تكاثرًا هبشوسي وتكوينها للأكمات (التي تحتاج نشاط وفعالية لاسحل البناء الضوئي) بمراعاتها نظام جذري فعال ويتمتع بمسافات طويلة ضمن الطبقات السطحية من الترد (لاستفادته من أقل قدر من الماء المتاح). وبدافع التقدم والنمو، فإن البناء لا يُنْبَأ ولا يُضْعِف، وأفراده متاثرة لا تكون أكمات رملية كبيرة وواضحة، وهذا يدل على أن أسطح البناء الضوئي بها أقل فعالية ونشاطًا من التوسيع الآخرين. ومع ذلك فإن منساح (S/V ratio) طبقية الحدة تعزز بشكل كبير مساحات البناء وحفظ الماء، وهذا قد يكون أحد أسباب مكانها غضة حتى في ظروف التlehج أعلى.

6. التوصيات

توصي هذه الدراسة بإجراء المزيد من الدراسات حول النباتات الموجودة في موقع الدراسة وتعريفها باستخدام التشخيص الجزيئي أو الدراسات الجزيئية من أجل توفير أساس لفهم أفضل للتاريخ التطوري لأنواع السعودية من أنجاس الشوك والمثمر والهاد وعلاقتها بالنباتات الأخرى الموجودة وكذلك توضيح علاقات النشوء والتطور باستخدام DNA النووي.

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Ecological Adaptation in Some Sand Dune Grasses: 
Morpho-Anatomical Study 
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ABSTRACT 

Coastal sand dunes habitats in southwestern Saudi Arabia are one of the stressed 
habitats with high intensity of solar radiation, high temperature, drought and 
permanently exposure to winds and sand accretion. Few plant species colonize these 
habitats. In view of the lack of studies that dealt with the adaptation of the sand dune 
environment of the morphological and anatomical aspects at the global generally, and 
the environments of the Kingdom of Saudi Arabia particularly, the idea of this study, 
which was conducted during the years 2020-2021, was aimed at shedding light on some 
aspects of the adaptive morphological and anatomical compositional aspects of plants 
selected sand dunes, the most prominent and widespread species in them are three 
perennial grasses: Panicum turgidum, Odyssea mucronata, and Cyperus conglomeratus. 
These plants possess many morphological, anatomical and physiological characteristics 
that God Almighty has created for them to reproduction, spread and resistance of 
prevailing conditions in their habitats. The results of this study showed that the leaves of 
the three species differ in their morphological characteristics. Cyperus conglomeratus 
had the largest leaf thickness of the three species, medium value in the thickness of the 
stem, and the lowest in leaf width. This indicates a greater internal volume of water 
storage compared to a lower outer surface for photosynthesis. Odyssea mucronata and 
Panicum turgidum are of less thickness in vegetative parts, which means more space for 
photosynthesis compared to a smaller internal volume to water storage. On the other 
hand, the leaves have more curl in times of drought, reduces the surface area exposed to 
transpiration. For the thickness of the boundary layer, Cyperus conglomeratus was the 
lowest of the three species, whereas Panicum turgidum was the largest. The three 
species show prominent formation of Rhizosheath on their roots. The anatomical 
structure of the leaves in the three species shows similar patterns including the structure 
of the leaves, these plants have the C4 pathway, the stems and rhizomes. The stems and 
rhizomes in both Odyssea mucronata and Panicum turgidum show a similar pattern that 
characterizes the well-known pattern in the grasses. In contrast, Cyperus conglomeratus 
stem exhibited a distinct structure with the presence of bundle sheath cells (Kranz 
anatomy), an uncommon anatomical feature of the stem, and perhaps a feature that 
enhances the photosynthetic activity of Cyperus conglomeratus stem. The anatomical 
structure of the roots was similar in all three species, an indication of the similar 
structural and adaptive characteristics when the environmental conditions are similar in 
the same habitat, and this pattern (by distributing its vascular bundles around a central 
pith) enhances the absorption of water and its transfer to the vegetative parts effectively. 

Keywords: Weeds, Sand Dunes, Panicum Turgidum, Odyssea Mucronata, 
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جميع حقوق النشر محفوظة. لا يسمح بإعادة طبع أي جزء من المجلة أو نسخه بأي شكل ولياً وسيلة سواء كانت
electronique أو أوتأثير. أما في ذلك التصوير والتسجيل أو الإدخال في أي نظام حفظ معلومات أو استعادتها بدون الحصول
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تعليمات النشر في المجلة

1. تقسيم المواد: يتم قسم البحث من خلال تقسيم المقال إلى مقالات ذات صلة، حيث يتم تقسيم المقالات إلى جزأين.

2. الأقزام: يتم استخدام الأقزام في النص المكتوب، حيث يتم استخدام الأقزام في النص المكتوب.

3. التصغير: يتم استخدام التصغير في النص المكتوب، حيث يتم استخدام التصغير في النص المكتوب.

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5. المراجع: يتم استخدام المراجع في النص المكتوب، حيث يتم استخدام المراجع في النص المكتوب.

6. الصور: يتم استخدام الصور في النص المكتوب، حيث يتم استخدام الصور في النص المكتوب.

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