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Eucalyptus Oil as One of the Best Mortality and Repellency Oil against Maize Weevil: A Review

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A B S T R A C T
Maize being as unique of the imperative staple cereal crops contribute as the major source of income throughout the world. Due to infestation of disease and pest production of maize is being decreasing day by day among which maize weevil is considered as the determining pest for yield reduction. Maize weevil (*Sitophiluszeamais*) is a cosmopolitan insect which shows the massive yield loss and is problematic for farmer as well. Plants like Citronella (*Cymbopogonwinterianus*), Eucalyptus (*Eucalyptus globule*), French Basil (*Ocimumbasillicum*), Juniper berry (Juniperus recurve), Lemon grass (*Cympogoncitratus*), Mint (*Menthaarvensis*) and Palmarosa (*Cymbopogon martini*) shows insecticidal property among which Eucalyptus act as a best source.However Advance study is still to be carried out and acclaimed on the bioactivity of specific chemical components of essential oils that can be used for the alleviation of maize weevil and other insect pest during the storage condition.

Keywords*: Eucalyptus, Maize weevil, Mortality, Repellency, Sitophiluszeamais, Sustainability*

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INTRODUCTION
Maize is considered as one of the most significant cereal crops throughout the world. Almost all parts of the world cultivate maize as the primary crops. Maize can be widely used as a source of dietary supplement and is popular not only among the rich society but also people living below the poverty line. However, in recent years most of the farmer are facing the harsh environmental condition and high disease and pest infestation. It not only arise the invasion of new insect pest but also arise the food deficit throughout the world. On the estimated scale of 10 -40% of total damage occurring in stored grains is primarily caused by insect and pests [1]. It is necessary to study about the disease affecting the yield of maize so that the preventive measures can be carried out for the sustainability of the global world. Among the number of disease that cause damage on the maize, maize weevil is the primary insect that causes damages on the maize. Maize is the cosmopolitan pest that basically attack the maize grain during the storage condition. Its infestation reduces the quality of the maize and reduce the post-harvest shelf life of the grain. Its infestation is highly seen in the warm and tropical parts of the world. If serious circumstances is visualized the yield loss might range from 20 to 100%. That is the main reason why serious measures should be taken so as to alleviate the problem arising from the infestation of maize weevil. Number of researches and study are carried out to reduce its harmful impact. In due course many chemical pesticides are recommended such as Malathion powder, Aluminium phosphide i.e celphos. But these chemical pesticides so both health and environment hazards which drag the eye of numbers of researcher and in due course they began to study the eco-friendly plants. From the multiple researches conducted oil of eucalyptus shows the insecticidal properties resulting in the safe eradication of the insect pest.

ECONOMIC LOSSES CAUSE BY INSECT AND PEST
In the hilly region of Nepal post-harvest losses are causing problematic situation for farmers as stated by Ransom. K.C. in 1992 stated that the losses are around 15-20%. The most devastating insect pest of maize is weevil and cause the losses of around 20-90% world widely as per Giga and Mazarura[2]. In the eastern parts of Nepal, Boxal and Gillet in 1989identified that 5.5% on an average weight reduction is caused due to attack of weevil and almost all losses of grain occur in stored condition[3]. The determining criteria for yield loss are harvesting time of maize, storage duration and its circumstances which results in of about 1-5% losses in maize[4], [5]. The most serious insect pest that causes severe economic damage is maize weevil (*Sitophiluszeamais*)Solely maize weevil accounts up to 5-30% weight loss of total stored grain. Regardless of their major damage too it seems to be very difficult for the farmers to alleviate the problem. Synthetic fertilizers are expensive and they cannot afford the highly priced the synthetic fertilizer.

NEGATIVE IMPACTS OF SYNTHETIC FERTILIZER

Despite having many benefits of fertilizers as increasing production rate, providing proper supplements to plants, there are some negative impacts too. Synthetic fertilizer shows both environmental and health hazards. Therefore, [6] demonstrated that if fertilizer is over saturated in the soil, they might cause many hazard to soil and environment. Similarly, these are never free of risk as it might cause different types of diseases. Food adulteration is a somber hazard with chemical pesticides that poses prodigious intimidation to farmers, retailers, grain wholesalers and public health universal. Its noxiousness effect can be both acute or chronic, the effect might range from minor discomfort like headache, nausea, vomiting, nerve pain and joint pain to major health hazards like cancer, organ failure, endocrine, commotion, depression, organic syndrome and other consequence which embraces: Neurological effects such as unresponsiveness or weakness of hands, legs, reduction of immunity problem, memory loss and loss of concentration. Excessive use of these chemicals also shows reproductive vigor hazards such as amendment in sexual performance fecundity and pregnancy. Organic syndrome include disruption and failure of organs and body parts such as e.g. kidney, lungs, heart, liver blood or digestive tract and circulatory disorder and poses precise risk to children. Accumulation of those pesticides goes on increasing over and over as they are remained penetrated in the seeds and grains. As per the study conducted by Desmareheher, Holland and Uyguntal during the storage condition pesticidial residue is also able to penetrate and accumulate with time on the grain[7,8].

MAJOR INSECT PEST OF MAIZE

Infestation of various disease and pest reduces the yield. Infestation might occur in field and storage house. Pests include rodents, birds, insect, microorganism and sometimes ruminants as well. Some rodents like squirrel and the grass cutter are also noticed that attack maize. There are number of insects that are soil dwellers as well as plant destructor directly. Among all of these reason insect pests are the primary reason for yield loss. In 1981 Alam analyzed of approximately 20 species of arthropods attacking the maize[9]. In 1987 Rahman put forward the list of about 24 arthopodsas a pest of maize[10]. Similarly, in 2011 Udo identified 20 different species of insects that attack maize grains at storage condition [11]. As per the recorded data of Parkash and his coworker's insect from family: pyralididae "chilopartelus", a noctuidae: "*sesamiainferens*" and the anthomyidae: "Atherigonasp" of maize crop are the major insect identified in maize[12]. Researcher like Karimullah in 1992 and Mashwani in 1989 observed that white grub, cutworm (Agrotisipsilon), black field earwig true wireworms, fall army worm (*Mythimna separate*) aphids, spotted stem borer and grasshopper appeared during initial and mid-seasonpest while corn earworm (*Helicoverpaarmigera*) earworm and the corn aphid Rhopalosiphum maids, shoot fly, maize jassid, appeared during late season pest of maize crop[13],[14]. These insects cause huge losses in maize crops. Others pestsinclude maize leafhoppers, the stem borers, maize thrips, cutworms, green vegetable bugs, grasshoppers, white fringed weevil, and termites[15].The most conjoint insects that invade grain of maize in storage ailment embrace Sitophiluszeamais, Rice weevil, Sitophilusoryzae, Khapra beetle, Prostephanustruncatus (Horn) (larger grain Borer), (L.), flour moth, Grain and Granary weevil, Sitophilusgranarius(L.), red rust flour beetle and the lesser grain borer, Rhyzoperthadominica(F.). Among all these enlisted insects and pest, the maize weevil is assumed principal insect pest that shows devastating effect in maize[16]. Since the edaphic, climatic, and topographical scenario is warm humid and favorable for growth, development, and multiplication of maize weevil, its infestation is increasing day by day[17]. Therefore, many of the insect pest are enough for creating hazardous damage to the plant and sometimes this will be hard to prevent. However, proper management, strategies to control pest and insect can work well[18], demonstrate that using proper insecticides, monitoring and combating their impacts with proper strategies can minimize its maximum effects and help in increase their production.

The weevil of is the crucial insect pest of maize as it is adept of destroying an entire grain[19]. The negative impact of weevil can be visualized not only in untreated maize but also on the treated grains. The research conducted by Abebe and his fellow members analyzed that the insect causes losses of around 80% and 20% in untreated and treated maize grain respectively[20]. As the plant is attaining the progressive growth and development, the larva can devour of about 50% gain weight in total[21]. Both adult and larva are gregarious feeders that strongly feeds upon the maize grain and can cause several physical and morphological damages in the maize grains not only at the field condition but also at the storage condition[22]. The economic damages can be visualized in most part of the world like Asia, Africa, Europe and America where the climate is warm and humid and specially the damages is more in storage condition and at that condition the metabolic activity of insect is also high.

IMPACT OF WEEVIL ON GRAIN

The female weevil burrow holes in the grain and continue its feeding process on the grain via which there is a gradual reduction in weight of the grains and support the food for offspring once the egg get hatched inside the grain. Along with the reduction of weight it also results in other consequences like purity percentage reduction, low germination rate, nutritional value reduction, artistic and aesthetic value reduction which ultimately reduce the market value of the commodity along with its economic value as well[20]. A similar report by[23] shows that insects pests are the key factors for reducing crop production, quality and quantity. Being as an internal feeder's maize weevils primarily feed on the endosperm which result in the formation of cavity. Along in the formation of cavities its activities include secretion in the grain, sloughing and molting. The pest died inside, and the dead bodies infect the grains and reduces the

quality of the grain which ultimately reduces its market and commercial value as well [24]. The damage is also caused due to the heat produced by insect thus lowering the quality of grain to the extent to lower its price. Infestation of maize weevil lowered the germination percentage of the seed and reduce the quality criteria of the healthy seed including physiological, physical, and pathological quality as well. As a result, the infested grain became weak and are susceptible to other rodents, insect and pest such as mice, floor beetle, grain beetle and mites.

HEALTH HAZARDS OF WEEVIL

Since the larva feed on the interior portion of maize, early detection of infestation is quite difficult. However, after feeding weevil left the hull portion. After the infestation it can be detected by placing those in the water as infested own float on the surface. The destruction caused by weevil not only shows impact of grain but also to the consumer as well. The consumer noticed health hazards in both human and cattle feeding it. Even though capability of fungus to produce my co toxin that is associated with maize is unknown, it is generally identified to be developed on the grain at preeminent relative moistness[25]. Contamination of aflatoxin in maize is the present day's major concern. The aflatoxins occurrence in the diet can lead to lethal effect to the consumer. If the content is consumed in small quantities, it shows disorder and illness while if it is ingested in large amount, it can be lethal as well leading toward death of individual[26].

PREVENTION AGAINST WEEVIL

Prevention against weevil is the superlative approach. Alleviation of the other possible causes like topographical, climatic, and edaphic condition can be the first initial steps if in case resistance is assumed. Analyzing the different aspects of its hazards, organic amendment can be used for the prevention, where organic fertilizer application that is balanced enhances fertilizer performance while also improving the physical, chemical, and biological environment of the soil[27], resulting in higher crop yields which simultaneously prevent the insects and pest. The eco-friendly locally available repelling plant material like Azadirachta indica, Meliaazadirach and Acorus calamus possess positive result to cure against weevil[28]. Plant growth and development, therefore, depends on prevention of insects-pest, their controlling strategy, water level, i.e. biomass enhancement modifications, organic amendments [29]. Therefore, having these strategies and techniques can help plant for the prevention of the insects as weevil. The plants like sweet flag, Zanthoxylumalatum, and Artemisia vulgaris and their plant parts and extraction of oil powder are intensively used to manage the insect pest at storage condition[30]. Along with numbers of plants eucalyptus is also considered as a best control measure for weevil. Furthermore, different sequence of crop rotation as wheat-turnip rape-barely-pea can reduce the insect-pest and their infestation [31]. Therefore[32], also demonstrate that insect reproduction their life cycle are disrupted by the crop rotation.

EUCALYPTUS AND ITS CHEMICAL CONSTITUENTS

Being a fast growing ever green tree it is widely spread throughout the world and possess the chemical that reduce cough, cold and disinfect wounds. Over 700 species of Eucalyptus are identified. It consists of Renantherin, a phenolic compound that allows chemotaxonomic discernment. Therefore, phenolic compounds (flavonoids and phenolic acids) are very functional compounds that improves the major constituent of the plant and helps in maintaining its antioxidant functionality [33]. Similarly, it also consists of components like leucoanthocyanins. Moreover leaves of Eucalyptus consist of essential oil and compounds such as 1,8-cineol(49.07 to 83.59%) and α-pinene (1.27 to 26.35%), p-cymene, and aromadendrene, linalool, citronellal, eucamalol, alloocimene, citronellyl acetate, g-terpinene, citronellollimonene, a-terpineol [34],[35], [36], [37]. The ingredients Eucalyptol isolated from the plant Eucalyptus, exhibits insecticidal and insect repellent properties. The eucalyptus oil extracted from eucalyptus plant is a intricate assortment of a variety of monoterpenes and sesquiterpenes, and scented phenols i.e. Renantherin, oxides group, ethers and ester compounds, alcoholic groups, aldehydes compound and ketones group.

INSECTICIDAL PROPERTIES OF EUCALYPTUS

Number of research conducted by researcher indicated that Eucalyptus oil is the best and efficient way to alleviate Sitophiluszeamaisin storage condition of maize grain. The Eucalyptus have carminative, anti- fungal, anti-bacterial, and insecticidal and anti- pathological properties. Because of these curative characteristics of Eucalyptus it is also considered as grain protect ant. The oil form the protective layer and prevent ovi-position thereby killing the insect and pest. Eucalyptus oils also act as the repellent nature for insect pest and possess pesticidial and insecticidal properties that may cause stomach poisoning.

Eucalyptus oil has a hideous effect on the olfactory, auditory system and gustatory perception of Sitophiluszeamais[1]. Number of researches conducted shows that repellency effect of the oils was persistent throughout the entire study period as the oil directly affect the auditory senstation and olfactory functioning of the insect used for testing [38]. The punget and unpleasant smell arising from the Eucalyptus oil create the restless and discomfort situation in insect [39]. Insect repellents such as alcohols, flavonoids, phenolic alkaloids and terpenes are considered as a secondary metabolites[40].
Several researches have been carried out to protect stored seeds against insects by the use of essential oils[41,42,43,34]. Essential oils present in Eucalyptus display a broad range of biological action against the microorganism like MLOs,

bacteria, nematodes, fungi and sometimes virus as well. It also shows the similar mode of action for other living creatures like mites, termites, insects in the soil microbes [44] and weeds, making them convenient, low-cost, and ecologically acceptable pest control mechanism which do not pollute the environment and does not show toxicity effect [45]. The haze forms arising from the eucalyptus oils shows strong noxious effect to variety of microorganisms. The oils can be widely used for both stored products and packaging as a fumigant which act as a best preventive measure against the infestation of disease and pest. Eucalyptus oils are also utilized for their curative, scented, flavoring, antimicrobial, and bio pesticides characteristics, and are harmless for humans and other mammals [46]. According to Batish et al.[34], the chemical constituents present in the plant function as a pesticidal activity. One of the major constituents extracted from the oil namely: is 1, 8-cineole, are responsible for its pesticidal properties.

REPELLENT PROPERTIES OF ESSENTIAL OIL

Essential oils can be extracted from different species of Eucalyptus such as Eucalyptus benthamii Maid. & Camb., E. globulus, Eucalyptus dunnii Maiden, Eucalyptus saligna Smith and Eucalyptus viminalis Labill. are repellent to S. zeamais [45]. The essential oil extracted from the 24 species of Eucalyptus had the strongest repellent effect at 24 hours with the highest concentrations [43]. According to [47], E. radiata oil showed strong inhibition activity (>70%) at 1 hour after the release of the maize weevils which diminished over time, conceivably either due to the evaporation of the oils through the inaugural of the test chamber or the due to the loss of concentration gradient in the air of test tubes. The study done by [48] proves that leaf powder of Eucalyptus globules Labill was effective up to 3 months. The protective effect indicated by the plant is non-persistent and for the longer storage duration its repeated application is recommended.
According to the study done by [42] it was observed that the mortality percentage rate of maize weevil S. zeamaisrised goes on increasing with the increased quantity of oil of E. globulus and the exposure time of insects. The median lethal concentration of the oil is lowest of about LC50: 184.3 L/L of air which makes it the most poisonous oil for the insect pest upon application. The concentration of the oil is lowered than that of the other essential oils that are based upon the non-overlapping criterion of LC50 confidence at interval of 95% probability[43]. The oils of two species of the eucalyptus namely: E. globulus and E viminalis was confirmed to present zeinith level of toxicity. Through the regression analysis of the both compounds LD50 of 0.08, at a concentration of 0.10 µL cm−2 E. dunni direct to a LD50 of 0.16 µL cm−2 and E. saligna direct to LD50 of 0.25 µL cm−2,depicting the toxicity level of these indispensable oils. The essential oil of E. benthamii is less harmful with a LD50 of 0.79 µL cm−2 [45].

CONCLUSION

Maize is the most famous staple cereal crops distributed throughout the world. It is used as a major source dietary supplement in the world. However, in the present days the production of the plant is reduced due to the high infestation of disease and pest. Among the numbers of insect pest maize weevil is the common and most predominantly damaging insect in maize which reduce of about 30 -50 % of the entire production. The research conducted by number of researchers analyzed the constituents like p-cymene, and aromadendrene, linalool, citronellal, eucamalol, alloocimene, citronellyl acetate, g-terpinene, citronellollimonene, a-terpineol to be effective to control maize weevil extracted from eucalyptus plant. The essential oil present in eucalyptus oil function as an anti- insecticidal property which avoid the closure of the insect pest. The plant also shows lethal effect to the insect pest if it is utilized in higher concentration. Eucalyptus oils are also utilized for their curative, scented, flavoring, antimicrobial, and bio-pesticidal characteristics, and are harmless for humans and other mammal so can be the best remedy to eradicate the weevil problem in the storage condition.

CONFLICT OF INTEREST

The author affirmed no conflict of interest.

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