Inspecting the Potency of Pumice as an Insecticide[1]

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ABSTRACT

Background: Nowadays, we are tackling various issues related to the overuse of synthetic insecticides. Bio-pesticides have attracted attention in pest management in recent decades, and have long been promoted as prospective alternatives to synthetic pesticides. Compared to conventional synthetic chemical pesticides, biopesticides are usually less toxic and generally affect only the target pest and closely related organisms. Biopesticides are often effective in relatively small quantities, and decompose faster, resulting in lower exposure. Pushing agriculture toward a more sustainable approach, and research is moving in this direction, looking for environmentally friendly alternatives to be adopted in Integrated Pest Management (IPM) protocols.

Result: Evaluation of single and integrated effects of pumice and *Azadirachta indica* leaf extract, against one to three-day-old instar of whitefly. Three replications were performed by contact toxicity, and the mortality was measured on day 1, day 3, and day 11th later. After 48 hours intervals, the formulation of Pumice with *Azadirachta indica* against white fly was less than 24 hours intervals. In the case of other species, this amount decreased over time, from 24 to 48 hours intervals on *Solanum melongena.*

Conclusion: According to the first aspect, a method for killing arthropods may include providing the mineral composition to a substrate that arthropods will contact, wherein the mineral composition is not a carrier for a chemical toxin. The mineral composition may include a silicate particulate. Herein contact between the mineral composition and the arthropod results in death.

Keywords: *Pest management; integrated pest management; pumice; integrated effects*

INTRODUCTION

Bio rational substances offer a great source of insecticides that are effective against a wide range of insect pests and have relatively low environmental impacts. They include naturally derived active ingredients that are biodegradable, readily available, and economically suitable for resource-limited farmers in Africa [1,2,3]. Botanical extracts of various plant species, especially neem (*Azadirachta indica*), have also been reported to show insecticidal properties against FAW (fall armyworm) [4]. Different insecticides are applied to repel, destroy, or decrease pest infestations to save crops from insect pests and increase yield [5]. When insecticides are applied to crops, the foliage is the first contact part and the insecticide is then transferred to other plant parts [6]. Previously, it was reported that less than 10% of insecticides are utilized by the crop leaf, while the rest runs off into the nearby surroundings, and about 0.1% of an applied insecticide reaches the target insect [7,8]. Therefore, it is very important to reduce losses by increasing the adhesion and deposition of insecticides into the plant foliage. An insecticide formulation with strong deposition and adhesion to the plant foliar could be required for increasing utilization on the plant surface and producing a successful application rate [9, 10]. The Role of Nanotechnology for Crop Protection Nano-based insecticides have attracted agriculture scientists for significant control and management of devastating polyphagous insects in agriculture [11]. In current years, Nano technological systems have been developed for agricultural applications, operating intensive research and development practices at both industrial and academic levels. [12, 13] Innovations in nanotechnology can help to alleviate the complications related to the applied technologies of classical insecticide formulations. [12].Moreover, insecticide-loaded nanoparticles decrease the dose of insecticides, reduce nutrient losses, identify plant-damaging insects and pathogens, detect insecticide residue, and increase plant yields without harming the environment and non-target beneficial organisms [11]. Due to their small size and large surface area to volume ratio, Nano insecticides display exceptional characteristics compared to their bulk counterparts [14, 15]. Fortunately, recent studies have been working on nanotechnology to produce residue-free Nano-formulations of insecticides with minimum environmental persistence, better insecticidal activity, and the least negative effect on the

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environment and human health [16, 17].In addition, the application of Nano-based insecticides can delay the development of resistance against the insecticides [18]. According to some embodiments, the silicate particulate may include natural glass material derived from natural glass. For example, the silicate particulate may be selected from the group pumice, volcanic ash, calcined kaolin, smectite, mica, and rice hull ash to yet another aspect, a composition for killing arthropods may include a mineral composition for associating with a substrate. The mineral composition may include at least one silicate particulate. Wherein the mineral composition may have a median particle size d_{50} of 10μm or less. The mineral composition may have a low crystalline silica content (e.g., quartz, cristobalite, etc.), such as less than 2% crystalline silica [24]. The mineral compositions herein may serve as an insecticide that kills arthropods while avoiding insecticide resistance, e.g. thus avoiding chemical resistance typical of chemical insecticides. Without wishing to be bound by theory, it is believed that the hard sharp edges of the mineral composition may be effective in killing arthropods, including but not limited to, what is thought that the sharp edges can scratch the waxy or oily outer layer of the insects(such as soft-bodied insects), which then results in death by dehydration. Mineral particulates with a smaller (including, e.g., ultrafine) particle size distribution may have relatively sharper edges than mineral particulates with a relatively larger particle size distribution. Smaller particles may also be more easily transferred and attached to the body of insects to scratch their outer layer with hard sharp edges. Thus, mineral particulates having a relatively smaller particle size distribution may be more effective at killing arthropods via a mechanical insecticide effect, for example, without the presence of chemical insecticides or toxins. [25]

COMBINATION WITH BOTANICAL

Plant extracts, essential oils, and other plant-based products are all ingredients with the potential to control stored-product insects [19, 20]. Combining them with silicate may enhance their properties, pursuing better insecticidal performances at lower doses and under a wide range of conditions. Several studies have been conducted in this direction, using compounds from several sources [26].

MATERIAL AND METHOD

Using an aerosol delivery system, a method for killing arthropods may include applying silicate particulate and *Azadirachta indica* powder combined conjugate to an area or crops. For example, the aerosol delivery system can include a spray can suitable for spraying powder, and unmatured anhydrous alcohol can be intermixed with the silicate particulate. According to the method for protection, the agricultural commodity may include plants, and the method may further include forming a slurry including the mineral composition, and applying the mineral composition including spraying the slurry onto the plants. The method for protecting, slurry may include water. The slurry may further include at least one of soap, and a composition including at least one of pyrethrins and azadirachtin mixed with water. The soap may be comprised of fatty acids that dissolved in water, the fatty acids may be long-chain fatty acids having 10 to 18 carbon atoms. For example, the binder may include a polymer, such as acrylic polymer or other similar polymers. Other binders are contemplated. The slurry may include the mineral composition, water, and one or more additional additives. For example, the slurry may include one or more dispersants, wetting agents, deformer agents, thickeners, antifreeze, and anti-microbial agent. A method for killing arthropods may include applying a silicate particulate to an area or item as a wettable powder in a dilute suspension-through liquid spraying equipment. The preparation of Pumice powders were assessed for their toxicity to white fly under laboratory conditions. Pumice powder and *Azadirachta indica* powder #100 mesh sieve (150 μm) to ensure homogenous fine powder for testing. Several concentrations of these powders were prepared for the bioassay by weighing the specific mass of powders. These powders' lower concentrations were tested, including Indian lilac [21]. For practical application where control is taken as a pest-attacked crop and different dosages as treatment were given to 106 white fly-attacked 25 eggplant crops in control with no silicate and *Azadirachta indica* powder conjugate was sprayed. The current investigation includes 25 crops whit heavy white flies attach. Consecutive reduction in whitefly population was observed from 106 to 2 as the effect of treatment with different concentrations of conjugate range from 25% to 100%, to be more precise Control, 25%, 65%, 75%, and 100% treatment results in form of whitefly population reduction as 106,96,53,24 to 2 respectively. [Table 6] [FIGURE 1 (a, b, c)]

TABLE 1: DESCRIBES INSECTICIDE FORMULATION (IF1)

Silicate	65 %
Indian Lilac	25 %
Soap base	4 to 9 %

TABLE 2: DOSAGE DIRECTION FOR APPLICATION

DOSAGE DIRECTION				
IF1	25 %	50 %	75 %	100 %
water	75	50	25	0

MATERIAL COLLECTION AND AUTHENTICATION

Azadirachta indica trees are easily found near the surroundings in Vadodara.
Extraction, Cleaning and Drying of Plant Materials Prior extraction, leaves were cleaned 2 to 3 times with running water, once with sterilized distilled water, The materials were dried under shade at room temperature (30±5°C) for 10 days.

Preparation of Crude Powder

After about 10 days of shade drying, well dried plants parts were powdered by using electric mixture .Then product was subjected to mass sieving to obtain fine powder. Powder was kept in a plastic jar with air tight lid and store for required period.

Preparation of Stock Solution

100 gm crude powder of collected part was soaked in 1000 ml of distilled water separately and left overnight in an airtight plastic bottle for maceration. The mixture was filtered in Whatman filter paper No. 42 boiled for 5 min in a heating mantle and allowed for cooling by keeping it in desiccators. The stock solution was kept in the refrigerator at 4°C for future use.

Phytochemical screening:

Test for Alkaloids:
Mayer’s reagent was used to test alkaloids. 2 ml of
Mayer’s reagent was used to test alkaloids. 2 ml of botanical extract was taken in a test tube and 2-3 drops of Mayer’s reagent were added to it. The presence of alkaloids was indicated by the appearance of a green colour precipitate in the solution. Wagner’s test was done by using Wagner’s reagent. When a few drops of Wagner’s reagent were added to a test tube containing 2 ml of extract, the appearance of brick colour precipitate indicated the presence of alkaloids.

Test for Flavonoids:

Alkaline reagent test: 2 ml of botanical extract was taken in a test tube and 2 ml of sodium hydroxide (2% w/v) solution was also added to it. An intense yellow colour appeared in the test tube. In addition to a few drops of dilute hydrochloric acid, it was colourless, indicating the presence of flavonoids. For Shinoda Test, 2 ml of botanical extract was taken in a test tube. 5 drops of Hydrochloric acid and 0.5 gm of magnesium pieces were added to it. The pink colour was observed in the solution containing flavonoids.

Test for Saponins Foam test:

The extract solution was diluted with distilled water and taken in a test tube. There was a suspension formed for minutes. A two centimeter layer of foam indicated the presence of saponins.

Test for Terpenoids:

The crude extract was dissolved in 2ml of chloroform and was evaporated to dryness. To this, 2ml of concentrated H_2SO_4 was added; a reddish-brown coloration at the interface indicates the presence of terpenoids.

Test for Glycosides Salkowski's test:

The crude extract was mixed with 2ml of chloroform. Then 2ml of concentrated H_2SO_4 was added carefully and shaken gently. A reddish-brown color indicates the presence of a steroidal ring, i.e., the glycone portion of the glycoside. Keller-Kilani test: Crude extract was mixed with 2 ml of glacial acetic acid containing 1-2 drops of 2% solution of $FeCl_3$. The mixture was poured into another test tube containing 2 ml of concentrated H_2SO_4. A brown ring at the interface indicates the presence of cardiac glycosides.

Test for Polyphenols and Tannins:

The crude extract was mixed with 2 ml of 2% solution of $FeCl_3$. A blue-green or blue-black coloration indicated the presence of polyphenols and tannins.

Test for Steroids:

The crude extract was mixed with 2 ml of chloroform and concentrated H_2SO_4 was added sidewise. A red color produced in the lower chloroform layer indicates the presence of steroids. Another test was performed by mixing crude extract with 2 ml of chloroform. Then 2 ml of each of concentrated H_2SO_4 and acetic acid was poured into the mixture. The development of a greenish coloration indicates the presence of steroids.

Test for Coumarins:

Extract solution is concentrated to yield a residue. Dissolve residue in hot water. After cooling divide the solution in two test tubes. To one test tube add 10% (w/v) Ammonium Hydroxide. Other test tube was used as control. Fluorescence color was indicating the presence of coumarins.

Table 3: Phytochemical components of Indian Lilac leaf aqueous extract.

Components	Test Method	Scoring
Alkaloids	Dragendorff's	+
Saponins	Frothing	+++
Tannins	Ferric chloride	++
Glycosides	Salkowski's	++
Combined anthraquinones	Borntrager's+Sulphuric acid	-
Anthraquinone derivatives	Borntrager's	-
Terpenes	Lieberman-Buchard	+
Flavonoids	Pew's	+
Reducing sugars	Fehling's	+
Ketones	Standard	-
Pentoses	Standard	+
Monosaccharides	Barford's	-
General Carbohydrates	Molisch's	+

Key:-

-: not detected.

+: low concentration

++: moderate concentration

+++: high concentration

The result of the phytochemical screening for active substances is shown in Table 1. Saponins showed high scoring in the extract while tannins and glycosides indicated moderate scores. Alkaloids, terpenes, flavonoids reducing sugars, pentoses, and whole carbohydrates showed low scores. Anthraquinones, ketones and monosaccharides were not detected from the extract.

High slurry concentration is referred to produce high mechanical insecticide loading/coverage on the applied surface to apply the ultrafine pumice mechanical insecticide. High-concentration particles with high bulk/ wet density and low water/oil absorption can be loaded into the slurry without increasing the slurry viscosity over the limit for spraying.

Table 4: Physical properties of the ultrafine pumice mechanical insecticide.

Loose bulk density(gm/ltr.)	416.48
Wet density(gm/ltr.)	961.108
325 mesh retaining (%)	1
Water absorption (gm/100gm)	33
Oil absorption (gm/100gm)	39
Moisture (%)	0.2

Table 5: Slurry Concentration and Viscosity

Sample	Slurry Concentration (%)	Viscosity(Cp)
DI water	0	1
Milled Ultrafine Pumice Mechanical Insecticide (present disclosure)	5	6.29

Table 6. Application of the formulation.

Treatment	Application Dose Powder (gm)	Number of Crops	White Fly Population
Control	0	25	106
Treated 1	25	25	96
Treated 2	50	25	53
Treated 3	75	25	24
Treated 4	100	25	2

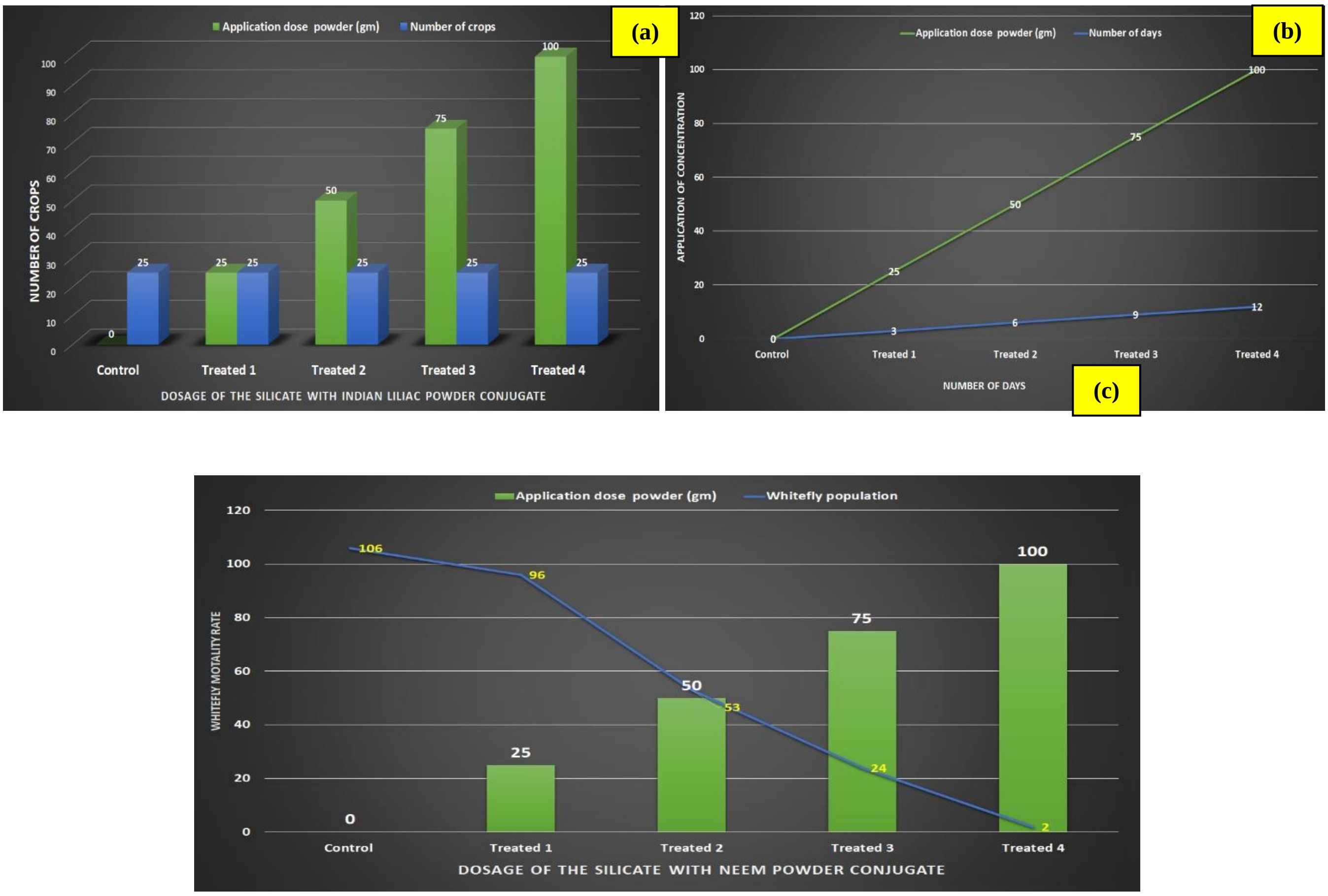

Figure 1. (a), Graphical representation of silicate with Indian lilac powder with several crops, Figure (b), Graphical representation of treated dosages vs days, Figure (c), Graphical representation of silicate with Indian lilac powder vs whitefly population mortality rate.

RESULTS

A method for killing arthropods provides a mineral composition to a substrate that arthropods will contact, wherein the mineral composition is not a carrier for chemical toxins, the mineral composition comprises a silicate particulate, and contact between the mineral composition and an arthropod results in the arthropod's death. Silica nanoparticles' potential controlled release characteristics have received considerable attention because of their application in smart delivery systems [22, 23]. When incorporated with *Azadirachta indica* powder and applied to the *Solanum melongena* crop with a white fly on 1st day a significant drop in the population was seen on 3rd day Fig 2. (a) the population declined by 50% on the 7th-day Fig (b) white fly can be seen on the 11th-day Fig (c) the crop started recovering from the damage Fig (d).

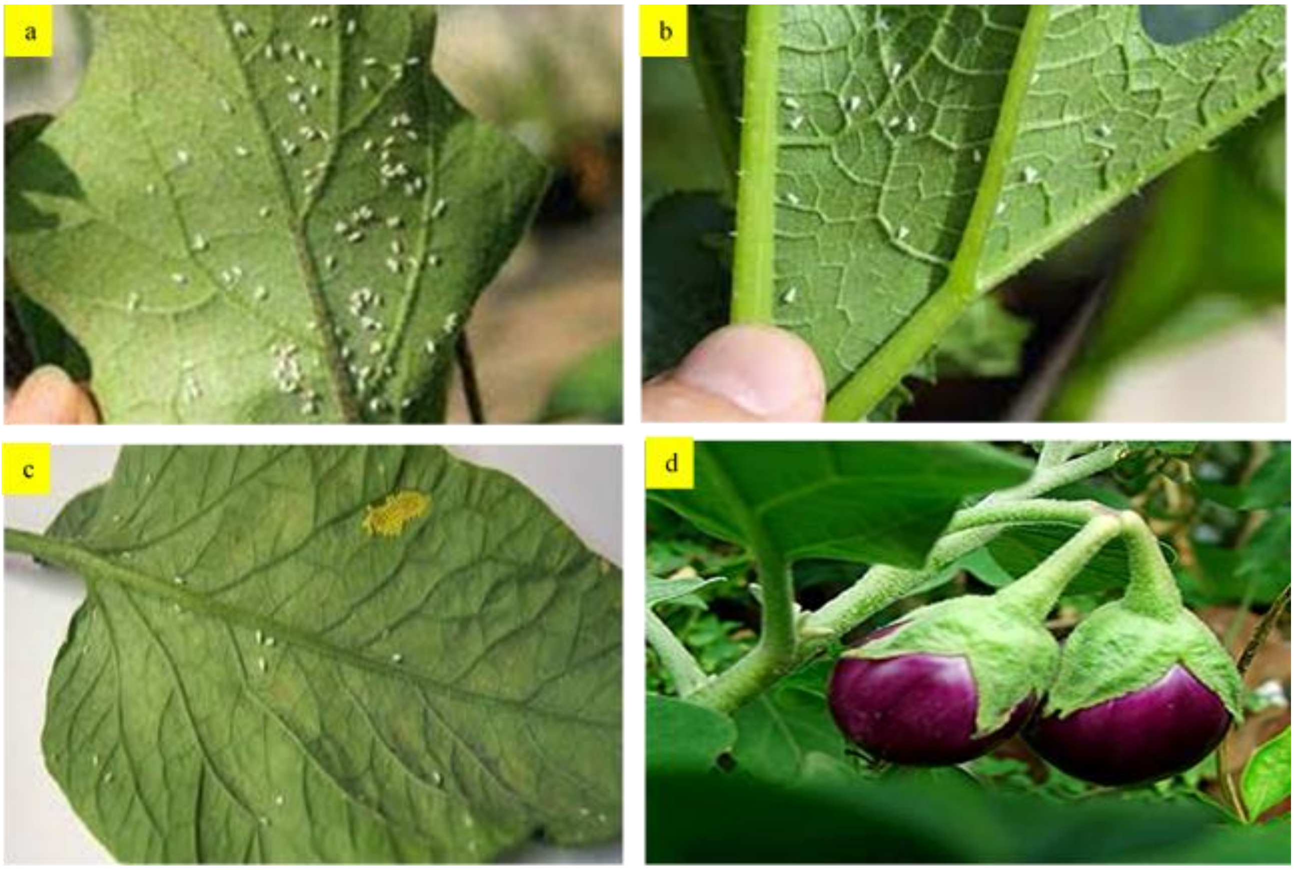

Fig 2. (a) Heavy whitefly attack, (b) reduction in whitefly attack after 3 days, (c) on 7th-day whitefly attack visually eliminated, (d) plant retain healthy growth.

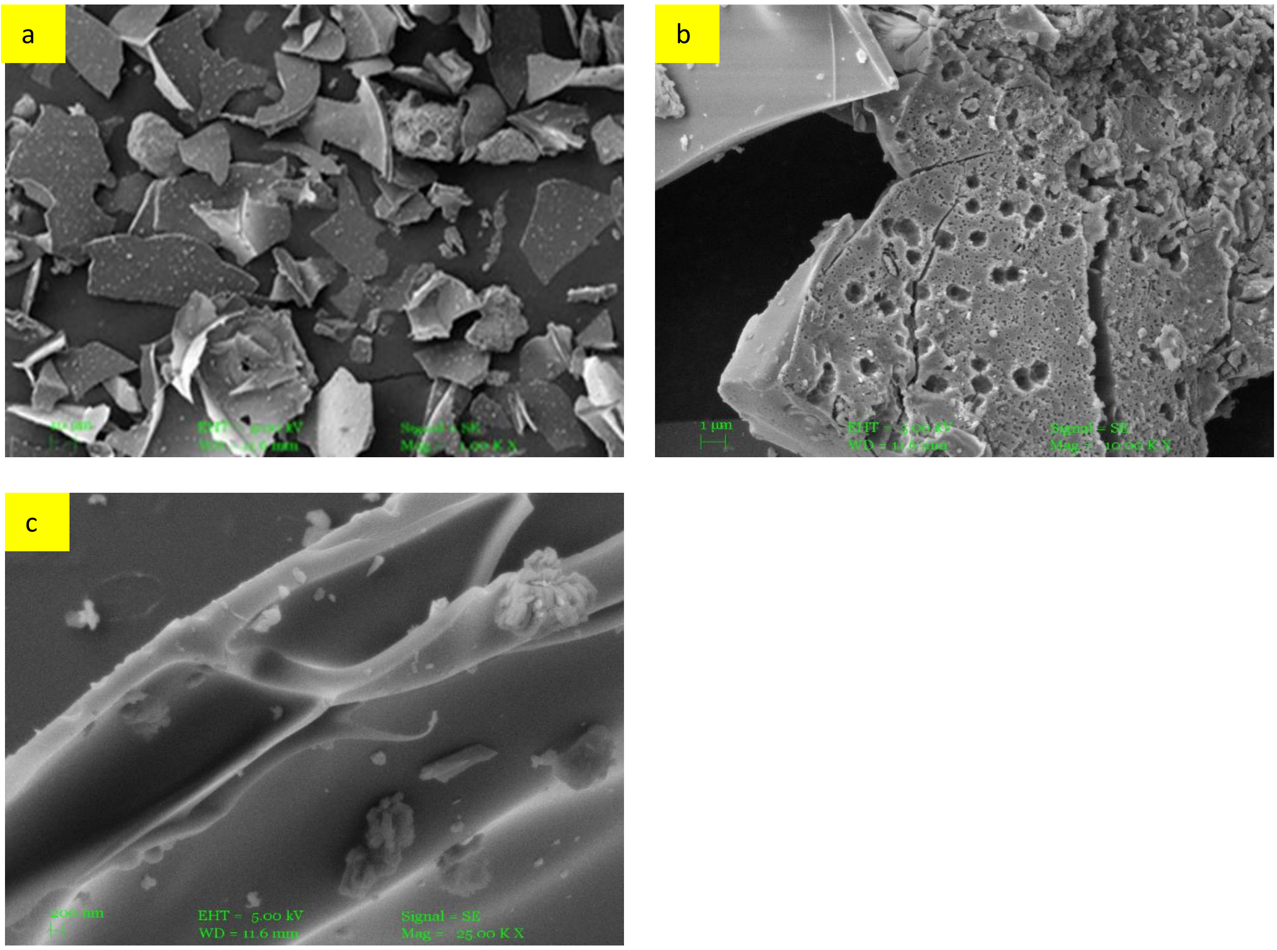

Fig 3. SEM analysed structural morphology of silicate (a) Platy structure, (b) Porous Structure, (c) Magnified view of a platy structure

DISCUSSION

The method for protecting agricultural commodities from arthropods comprises: mineral composition a silicate particulate is used as a potential composition for eradicating arthropods.

As seen in Fig (3) indicates the scanning electron microscope (SEM) data of ultrafine pumice from Fig 3 (a) indicates the uneven platy structure with rough sharp edges. While Fig 3 (b) indicates some micropores with rough defects. Fig 3 (c) indicates the sharp portion of the pumice. It is mostly responsible for the killing of whitefly. This sharp portion may damage the exoskeleton of whitefly by scratching the waxy or oily out layer of soft-bodied insects, which die eventually from dehydration. Ultrafine pumice sample Studies on the effects of Indian lilac active compound azadirachtin based products and pumice often use as an insect repellent. The current investigation highlights specific formulations including mineral composition and azadirachtin as a principal component with effective insecticidal activity.

CONCLUSION:

This recent study has proved that the potential of silicate with botanical extract has a negative effect on larval health and ultimately causes death. They exert a range of detrimental impacts on defense mechanisms and insect physiology. The reduction in the activity of enzymes related to oxidative stress and defense is a symptom of cytotoxicity executed and can completely disrupt the enzymatic activities of larvae. Moreover, the insecticides released from silica nanoparticles have already been proven to be safe in controlling any insect models. Therefore, the current study highlights the toxicity. Further studies should focus on evaluating the specificity of toxicity to other important agricultural insect pests. It should also aim to understand the mode of action of insect toxicity. These studies will showcase the as a low-cost competent material for use in integrated pest management practices. It was previously believed that desiccation by absorbing wax (lipids) molecules from the epicuticle of insects was the mode of action for natural powder insecticide.

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