MiteXstream – a new, safe, environmentally friendly and the most effective biopesticide for controlling pests in Cannabis

Peter Wojcik, B.A. Adv. and Fawzia Afreen, Ph. D. Botany

Abstract

Pest infestation plays a major role in Cannabis crops, as well as other crops by decreasing crop yield, reducing the quality and the market value of the plant and causing substantial financial damages. To control the outbreak of pests, an alternative to chemical pesticides called biopesticide has been recently gaining attention of the farmers and producers due to its various beneficial reasons. The principal objective of the current study was to evaluate the effectiveness of MiteXstream Concentrate (Distributed by: Black Bird Botanicals Inc. a Wyoming corporation; Flower Mound, Texas), a newly developed, liquid biopesticide, for controlling mild to heavy infestation of spider mites and powdery mildew at different stages of the vegetative growth cycle of different strains of Cannabis. MiteXstream was used to control spider mites and powdery mildew in heavily infected plants; plants which were infected for experimental purposes and also as a preventative measure in healthy plants. When MiteXstream was applied in full strength as foliar spray to the heavily infected plants the migration of spider mites to the uninfected parts of the plants stopped immediately and by the end of two weeks it was completely eradicated, and no reoccurrence was observed. However, when MiteXsteam was diluted to half strength and was used in combination with a wetting agent, SM-90 by Nutralife (Richmod Hill, Ontario) as a preventative measure, the plants did not respond well. Although no infestation with spider mites or powdery mildew was noticed but after the first week of application, deformation of leaves, leaf curling, and eventually overall stunted growth of the plants were recorded by the end of the experiment compared to the untreated counterparts. The results also indicate that application of MiteXstream as a preventative measure at a very young stage (one to two weeks old clones) had no positive effect. Rather it adversely affected the growth. However, in the case of more mature stages like the four-week-old field grown, healthy plants of CBD Dana (a hemp variety) when MiteXstream was applied as a preventative measure, the response was very satisfactory. The plants not only

remained uninfected by any kind of pests but exhibited very healthy growth compared to the untreated ones. On the contrary, the rows of untreated plants were infected with slugs which resulted in slower growth than that of the treated ones. In a separate experiment, MiteXstream was applied to control mild to severe infestation of powdery mildew and spider mites at different stages of Kush, Sativa and Hemp plant varieties. The results confirm the effectiveness of MiteXstream in controlling powdery mildew (100%) within 6-7 days and spider mites within 14-21 days. As an after effect of treatment, no recurrence of pests was noted and the formation of new leaves from the tip portion of the branches indicated a good sign of recovery.

Introduction

Cannabis, which has been legalized in total 37 states, (latest one being Mississippi) and four territories and is currently the fastest growing industry in the United States, often suffers tremendous financial damages due to the infestation of pests. Among others, infestation with spider mites, powdery mildew and fungus gnats are the most common ones experienced by many growers especially when cultivating Cannabis, indoor or in the greenhouse environment. Once the outbreak is noticed, the best and most effective way to control it is the use of pesticides - generally chemical pesticides. However, the increased awareness about environmental integrity, workers safety, human health safety, the indiscriminate use of chemical pesticides has necessitated for the use of alternatives. Which are biopesticides. Biopesticides (or in other words biological pesticides) are based on pathogenic microorganisms specific to a target pest and offer an environmentally friendly and effective solution to pest problems. Unlike chemical pesticides they do not contain harmful toxic chemicals that are released into the environment and cause damage to the ecosystems. They are mostly biodegradable, and pests never develop resistance to biological controls. All of these made biopesticides a preferred choice to control pests. Several reports have documented the successful application of biopesticides as a part of the Integrated Pest Management (IPM) in controlling the foliar disease, powdery mildews and spider mites affecting various horticultural and agricultural crops. For instance, extract of neem oil is used to control powdery mildew in cucurbits. Sporatec AG. (18% rosemary oil, 10% clove oil, and 10% thyme oil) is used to control powdery mildew in squashes, melons, and cucumbers etc. Other biopesticides such as Mildew

Cure (30% cottonseed oil, 30% corn oil, 23% garlic extract), Kaligreen, 82% potassium bicarbonate, etc. are also used to control powdery mildew. Suffoil (97% v/v safflower and cottonseed oils and 3% v/v emulsifier) is quite often used to control spider mites for its excellent ovicidal activity which kills the eggs of two-spotted spider mites and is less harmful to *Neoseiulus californicus*, an important natural enemy of spider mites.

MiteXstream Concentrate (Distributed by: Black Bird Botanicals Inc. a Wyoming corporation; Flower Mound, Texas), a newly developed liquid biopesticide that specifically targets plant mites, mold and mildew in agricultural crops and ornamental plants was selected for our current study. The aim was to document its efficacy in eradicating spider mites and powdery mildew at various vegetative stages of different strains of a growing Cannabis plant.

Materials and Methods

Plant material

Indoor Experiment: The experimental materials used for the current study were, several randomly selected mature plants of Kush Strain, one was labelled as "Plant #10", the other Kush strains were Rockstar, Island Pink, Bruce Banner and Godfather OG. In addition to mature plants, four plants in the juvenile stage (1.5- 2.0 ft tall) and clones (4-5 inch long) in multicelled trays (total 45 clones/tray) of Death Bubba, a Kush strain were also used for this study.

Outdoor Experiment: Total 120 mature field grown plants of one Hemp Strain variety, CBD Dana, were used as experimental materials.

Experiment 1. ***Effects of MiteXstream, a biopesticide on controlling spider mites of a randomly selected mother plant of Kush Strain***

One unhealthy mother plant of Kush strain growing in a grow room was randomly selected, labelled as "Plant #10", and was used for this study. The plant was moderately infected with Spider Mites at the beginning of the study (Fig: 1c). This infected plant was then thoroughly sprayed with MiteXstream Concentrate (Distributed by: Black Bird Potentials Inc. a Wyoming corporation; Flower Mound, Texas) a liquid biopesticide having a concentration of 1 fl.oz/ 1 Gal water (full

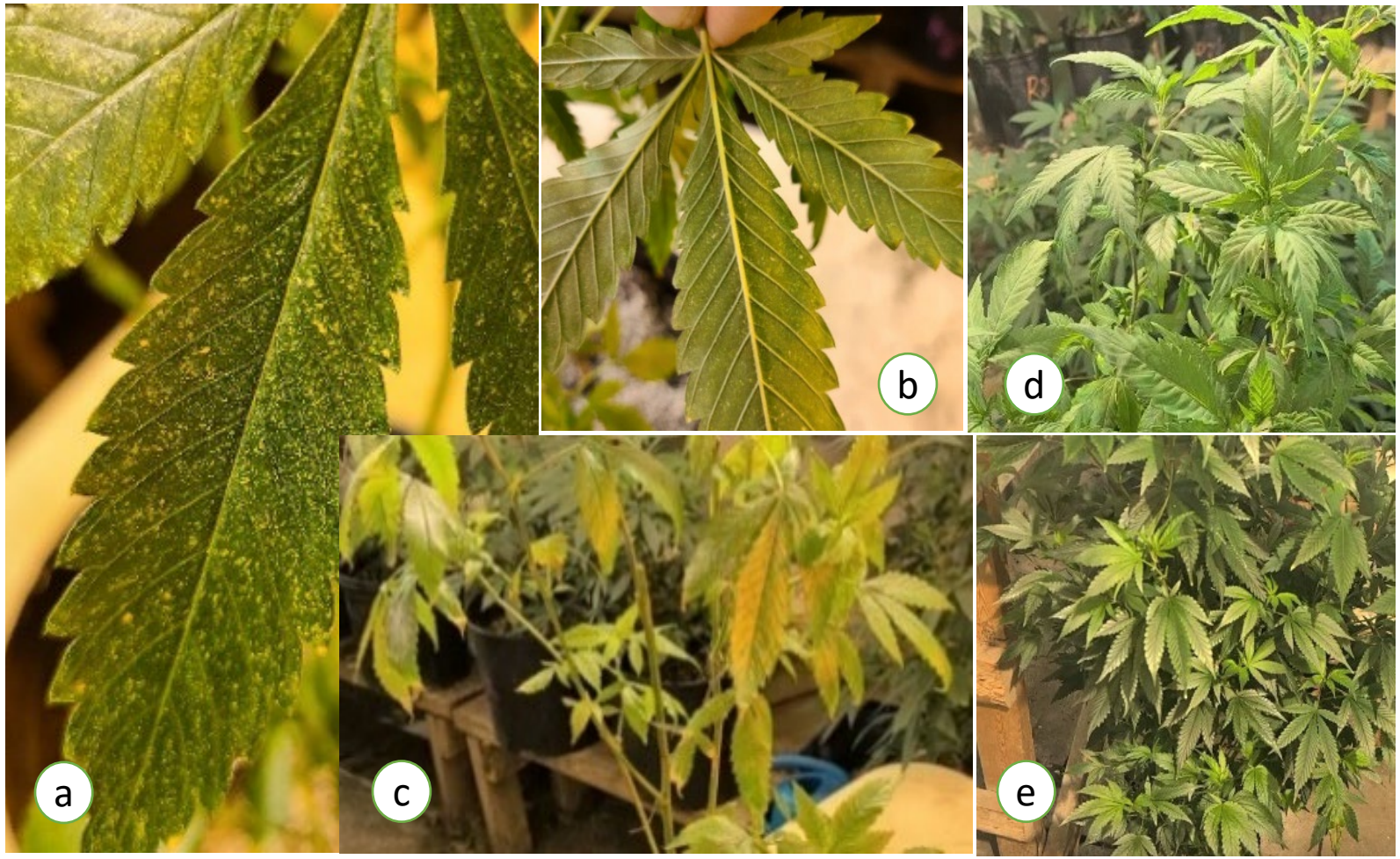

Figure 1. Plant #10 (Kush strain) exhibiting moderate infestation of Spider mite will be treated with MiteXstream (full strength). a) Fan leaves – Showing Spider Mites, adults and eggs covering the entire leaf area. b) Lower side of fan leaves showing eggs of Spider mite. c) Plant #10 on Day 0 before application of MiteXstream. d) Plant #10 on Day 14 after application of MiteXstream. Note almost 50% of Spider mites are eradicated. e) Plant #10 after one month of application with MiteXstream exhibiting normal, healthy growth and no sign of infection with spider mites.

strength) using an electric pump foliar sprayer. Total number of applications was two. The experiment started on May 29, 2021 and continued until July 21, 2021.

The concentration of MiteXstream used was same (full strength) in all of the following experiments, except in Experiment 2. MiteXstream was used in accordance with the product label instructions and agricultural use requirements which includes the use of Personal protective equipment (PPE), restricted-entry interval (REI) of 12 hours for indoor and 72 hours for outdoor condition. In addition, all other safety and precautionary measures were taken during the application. The effects of MiteXstream on controlling the infestation of spider mites or powdery mildew were recorded by taking images at different time of the experiments.

Experiment 2. ***Effects of MiteXstream, a biopesticide added with surfactants/wetting agent on controlling spider mites of four Kush strains, Rockstar, Island Pink, Bruce Banner and Godfather OG.***

For control, rooted healthy clones grown from seed of four Kush strains, Bruce Banner (Fig: 2a), Godfather OG (Fig: 2.1a), Island Pink (Fig: 2.2a) and Rockstar (Fig: 2.3a) were transferred to one gallon pots containing HP PRO Mix bales with perlite supplemented with General Hydropnics Grow and Micro as standard nutrients (used for feed schedule). The clones were grown indoor for one week in case of Island Pink and two weeks, for the rest three strains under the same environmental conditions. After that, ten healthy Rockstar plants, six healthy plants each from Island Pink, Bruce Banner and Godfather OG were selected as experimental materials. Half of the plants were sprayed with half strength (0.5 oz/ 1 Gal water) of MiteXstream added with surfactants, a wetting agent called SM-90 by Nutralife (Richmod Hill, Ontario) for six consecutive applications at two days interval. This was done as a preventative measure. Another half of the plants remained untreated. The experiment started on May 29, 2021 and continued for a month until June 25, 2021.

Experiment 3. ***Effects of MiteXstream, a biopesticide on controlling spider mites of clones of Death Bubba, a Kush strain***

Four multicelled trays, each containing 45 rooted healthy clones of Death Bubba grown indoor were used for the current experiment (Fig: 3a). The trays were sprayed with MiteXstream using

Figure 2. Bruce Banner, a Kush strain treated with MiteXstream (half strength) added with surfactant called SM-90 by Nutralife. a) Untreated plants after two weeks of the start of the experiment exhibiting normal, healthy growth. b) Treated plants showing deformation of the leaves after two weeks of treatment. c) Treated plants showing slow growth of the plant after three weeks of the treatment. d) Untreated plants exhibiting normal growth until the end of the experimental period. e) Treated plants showing signs of recovery after the treatment was discontinued by the end of the experimental period.

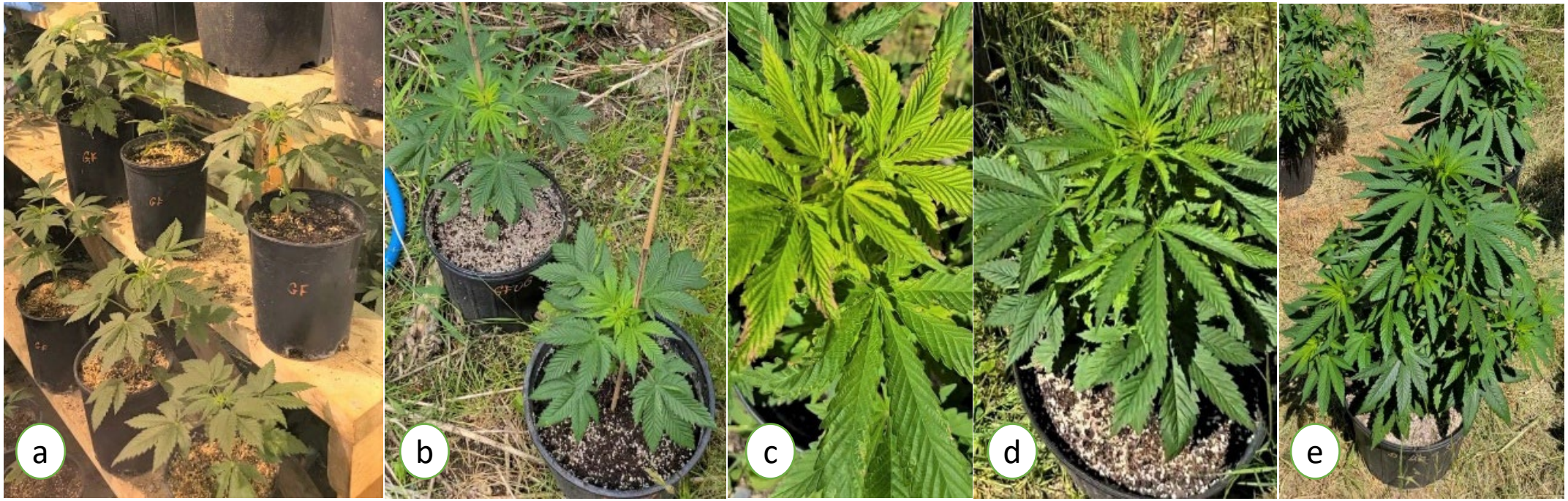

Figure 2.1 GodFather OG, a Kush strain. a) Experimental set up showing top row three plants will be treated with MiteXstream (half strength) added with surfactant called SM-90 by Nutralife; bottom row three plants will remain untreated.

b) Control or untreated plants on Day 10 of the experiment showing normal, healthy growth (outdoor).

c) Treated plants exhibiting deformation and discolouration of the leaves after two weeks of the treatment.

d) Control or untreated plants after two weeks of the start of the experiment exhibiting normal growth.

e) Treated plants showing signs of recovery after the treatment was discontinued by the end of the experimental period.

Figure 2.2. Island Pink, a Kush strain.

a) Experimental set up of Island Pink, a Kush strain Top row three plants were treated with MiteXstream (half strength) added with surfactant called SM-90 by Nutralife; bottom row three plants are untreated.

b) Treated plants exhibiting leaf curling and discolouration of the leaves after 5 days of the treatment.

c) Control or untreated plants after 5 days of the start of the experiment exhibiting normal, healthy growth.

Figure 2.3 Rock Star, a Kush strain. a) Experimental set up – A set of five of Rock Star on Day 0. Top row five plants will be treated with MiteXstream (half strength) added with surfactant called SM-90 by Nutralife; bottom row plants will remain untreated. b) Comparison of growth between treated plants (top row) and control or untreated (bottom row) after 14 days of the start of the experiment. Note the stunted growth of treated plants compared to the untreated ones. c) Close up view of treated plants showing stunted growth, leaf curling and leaf discolouration after 14 days of the start of the experimental period. d) Close up view of control plants showing normal growth and lime green leaves after 14 days of the start of the experiment.

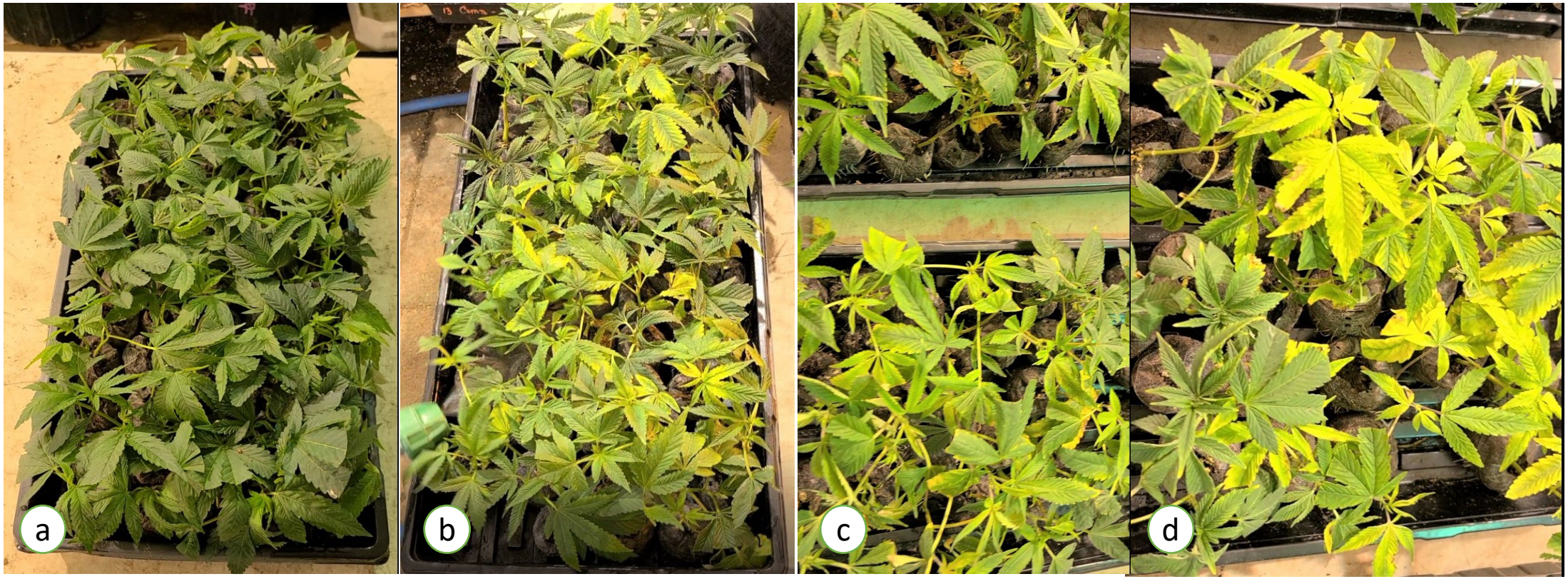

Figure 3. Two weeks old clones of Death Bubba, a Kush strain. The clones will be treated with MiteXstream (full strength) as a preventative measure.

a) Day 0 before the start of the treatment. b) Treated clones exhibiting slow growth after ten days of treatment. c) & d) Treated clones showing severe deterioration of the overall health after two weeks of the treatment. No Spider mite or powdery mildew infestation were recorded throughout the experimental period.

Figure 4. CBD Dana, a Hemp variety - four weeks old, outdoor plants will be treated with MiteXstream (full strength) as a preventative measure. a) Two rows of CBD Dana on Day 0 before the start of the treatment. b) Close up view of one plant on Day 0. c) Control or untreated plants exhibiting severe slug infestation after three weeks of the start of the experiment. Note the partially eaten leaves and leaf curl. d) Rows of control plants by the end of the experimental period. Note the slower growth compared to its treated counterpart. e) & f) Rows of treated plants by the end of the experimental period. Note the healthy, bushy appearance of the plants.

an electric pump foliar sprayer for five consecutive applications at two days interval. This was done as a preventative measure. The experiment started on May 29, 2021 and continued only for two weeks until June 12, 2021.

Experiment 4. ***Effects of MiteXstream, a biopesticide on controlling spider mites of mature plants of CBD Dana, a Hemp variety grown in field condition***

Randomly selected young female plants of CBD Dana, an industrial hemp variety, were grown outdoor in a test plot. After three weeks of growing period, two rows, each consisting of twenty healthy, mature plants were selected and were used for the current experiment (Fig: 4a). The plants were sprayed only once with MiteXstream on May 29, 2021. This was done as a preventative measure and also to find out the occurrence of any kind of infestation either by spider mites or powdery mildew when not sprayed with MiteXstream any more after the first one. The growth of the treated plants was compared with the one of non treated plants. The experiment started on May 29, 2021 and continued until June 25, 2021.

Experiment 5. ***Effects of MiteXstream, a biopesticide on controlling mild to heavy infestation of powdery mildew and Spider mites affecting different stages of Kush, Sativa and Hemp plants in the vegetative room***

The entire population of Kush, Sativa and Hemp variety female plants starting from juvenile to mature stages grown in the vegetative room were used for the present experiment. In general, some plants in the vegetative room were heavily infected with powdery mildew (Fig: 5a) and exhibited minimal foliage and stunted growth, other plants exhibited slight infestation of powdery mildew and mild to heavy infestation of spider mites (Fig: 6a), whereas the remaining plants were healthy. All of the plants in the vegetative room were sprayed with MiteXstream using Hydro fogger for better coverage; the concentration of MiteXstream was same as mentioned earlier. The treatment started on June 12, 2021 and continued until July 21, 2021. Total number of applications was eleven. All safety and precautionary measures were taken during the application.

3. Results

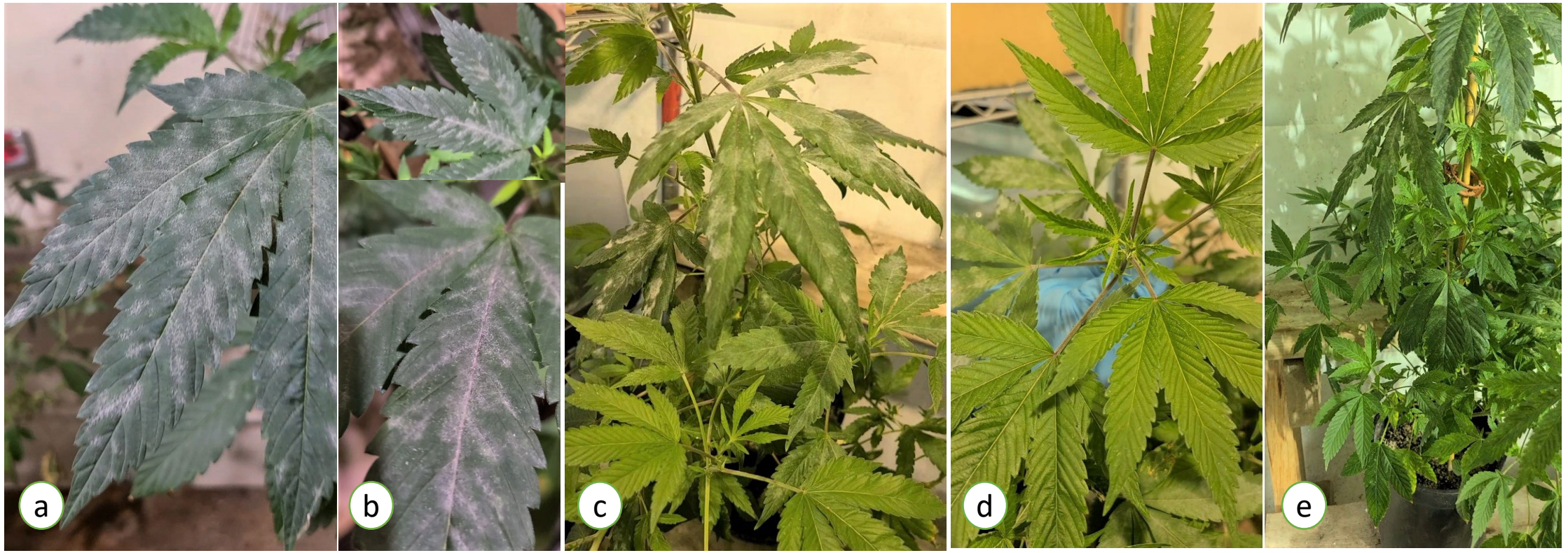

Figure 5. Mother plants from Hemp variety, Kush and Sativa strains grown indoor in the vegetative room which were infected with powdery mildew and were treated with MiteXstream (full strength).

a) Showing the leaves which are severely infected with Powdery mildew on Day 0 of the treatment. b) Two days after the first application of MiteXstream. Note, no further spread of powdery mildew. c) Third application - Leaves showing no further development of powdery mildew and discolouration of the infected portion. d) After third application - Newly formed leaves remained uninfected by powdery mildew. e). Fifth application – The infected plants started to show signs of recovery as evident by the formation of new, healthy, green leaves.

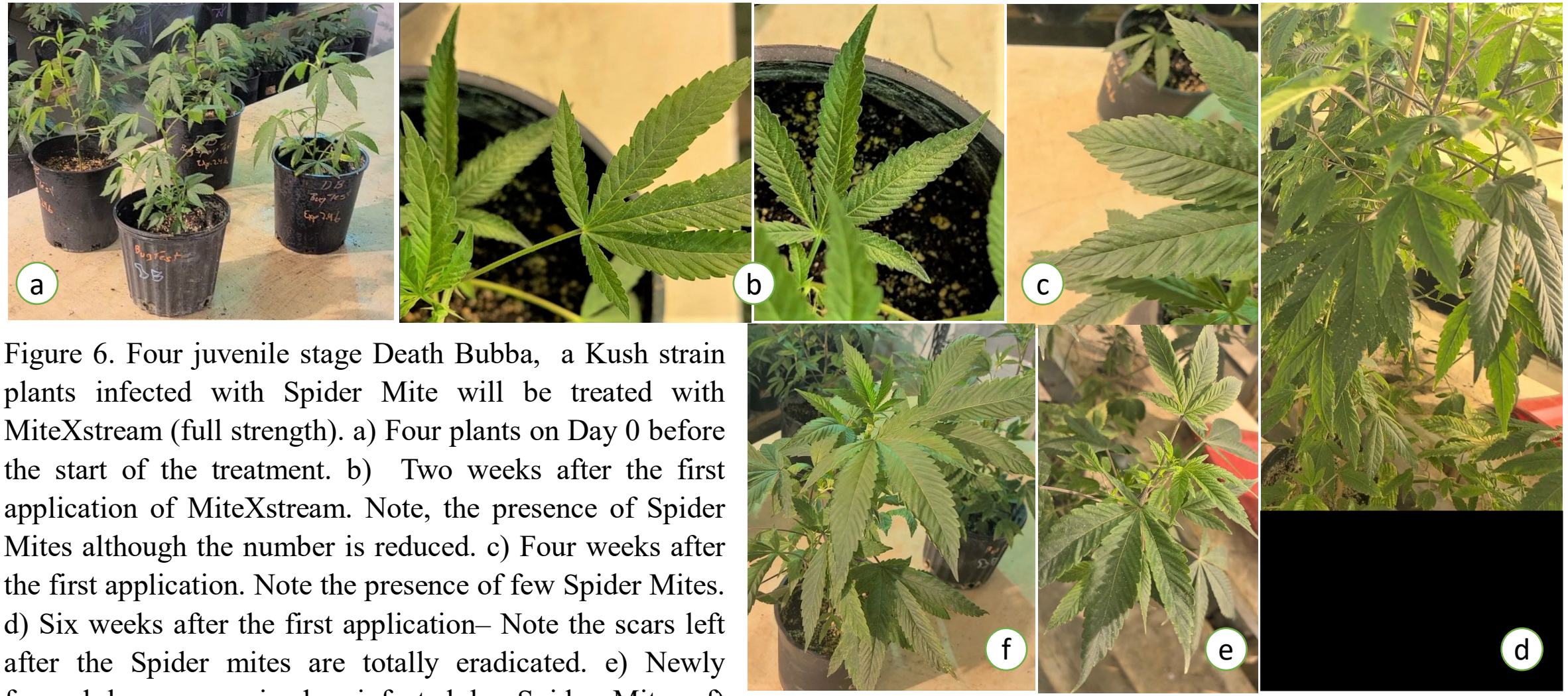

Figure 6. Four juvenile stage Death Bubba, a Kush strain plants infected with Spider Mite will be treated with MiteXstream (full strength). a) Four plants on Day 0 before the start of the treatment. b) Two weeks after the first application of MiteXstream. Note, the presence of Spider Mites although the number is reduced. c) Four weeks after the first application. Note the presence of few Spider Mites. d) Six weeks after the first application– Note the scars left after the Spider mites are totally eradicated. e) Newly formed leaves remained uninfected by Spider Mites. f) Showing the gradual recovery of the infected plants as evident by the formation of new, healthy, green leaves.

The experiment was conducted to examine the effectiveness of MiteXstream, a liquid biopesticide (Wyoming corporation; Flower Mound, Texas) to eradicate plant mites and mildew in Cannabis plants. The adult plant of Kush strain, labelled as Plant #10, growing in the vegetative room which exhibited moderate infestation of Spider mite (Fig. 1c), starting from eggs (Fig: 1b) to adult stages (Fig: 1a, 1b) responded very well to MiteXstream, when applied in full strength. At the time of application, the plant was infected 2/3 from the bottom mainly the fan leaves, and the upper 1/3 portion still was uninfected. After the first application of MiteXstream, the infected fan leaves were stripped off to examine the growth of Spider mites and no further spread was observed although it was not fully eradicated. The migration of spider mites to the top portion did not take place from the onset of first application, thus the top 1/3 portion remained uninfected. The result indicated that due to the application of MiteXstream, either the eggs did not develop or were unable to hatch. After a week, the old, infected fan leaves were removed, and the entire plant was treated with MiteXstream for the second time. After the second treatment, no further spread of spider mites was recorded and gradually the plant started to show rejuvenation (Fig: 1d). For the next two weeks the plants exhibited normal, healthy growth and no sign of infection with spider mites was noticed (Fig: 1e).

In case of control, all of the four Kush strains, Rockstar, Island Pink, Bruce Banner and Godfather OG exhibited normal healthy growth and no sign of infestation with mites or powdery mildew, in the first week after receiving MiteXstream (half strength) with added surfactants. However, after two weeks, deformation of the leaves (Fig: 2b, 2.1c) was very noticeable compared to the untreated ones (Fig: 2a, 2.1b). Leaf curling (Fig: 2.2b & 2.3c) and discoloration of the leaves (Fig: 2.1c, 2.2b & 2.3c) and overall stunted growth of the plants (Fig: 2c. 2.3b & 2.3c) were also recorded, and by the end of the experiment severe twisting of the plants were noted. The results clearly indicate that the plants did not respond well in the presence of surfactants. In contrast, the untreated plants continued normal, healthy growth throughout the experimental period (Fig: 2d, 2.1b & 2.1d). Once the application of MiteXstream with added surfactants was discontinued then gradually the plants started to show signs of recovery (Fig: 2e, 2.1e). Considering all the parameters of growth after one month of experiment it was evident that the addition of surfactant

to the biopesticide did not benefit, rather it adversely affected the overall growth of the plants. The normal, healthy growth (Fig: 2.2c) with lime green leaves of untreated plants (Fig: 2.3d) as opposed to the treated ones supports this documentation (Fig: 2.3c).

In order to comprehend the stage of Cannabis plants at which MiteXstream, when used as a preventative measure will be more effective, four multicelled trays consisting of two weeks old clones of Death Bubba, a Kush strain were sprayed with MiteXstream. During the course of experiment the clones did not show any sign of infestation either with spider mites, powdery mildew or any other bugs but the growth was affected negatively. Almost in all of the clones, slow growth (Fig: 3b) and yellowing of the leaves were noticeable. Prolonging the experiment for a few more days did not show any beneficial effect rather severe yellowing of the leaves happened (Fig: 3c) as a consequence of lack of photosynthesis or nutrients. In addition, as the clones were not being transferred to larger pots, it resulted in gradual deterioration of overall health of the clones (Fig: 3d).

It was very interesting that when the field grown, four weeks old healthy, plants of CBD Dana (Fig: 4a & 4b) were sprayed only once with MiteXstream as a preventative measure, no sign of infestation with spider mites, powdery mildew or any other bugs was recorded throughout the experimental period (Fig: 4e). Whereas the rows of plants which did not receive any treatment were affected by slugs (Fig. 4c) which were feeding on the leaves. Leaf curl (Fig. 4c) and leaf damage due to slug infestation resulted in slowing down of the overall growth (Fig: 4d). Compared to the untreated plants the healthy, green, bushy appearance of the treated plants (Fig. 4e & 4f) shows the benefits of a single dose application of MiteXstream as a preventative measure.

To further appraise the effectiveness and the after effect of the use of biopesticide, mild to severe infestation of powdery mildew (Fig: 5a & 5b) and spider mites (Fig: 6a & 6b) at different vegetative stages of Kush, Sativa and Hemp variety plants in a vegetative room were treated with MiteXstream. From the results it was obvious that plants at any stage, starting from juvenile to mature mother plants of their life cycle responded very well to MiteXstream. The result was phenomenal, as powdery mildew was controlled within 6-7 days of the first application. After the

third application, the infected leaves showed no occurrence of powdery mildew (Fig: 5c) as well as the newly formed leaves remained uninfected (Fig: 5d). However, due to the damage caused earlier by the infestation, discolouration of the infected portion was noted (Fig: 5c) and gradually the leaves lost the ability to photosynthesis. Those infected leaves eventually dried and were removed as they play no role in plant growth. Nevertheless, the formation of new leaves from the tip portion of the branches (Fig: 5e) indicated a good sign of recovery of the treated plants. When four juvenile stage, Death Bubba (Kush strain) plants (Fig: 6a), infected with Spider mites, where treated with MiteXstream, it took a little longer time approximately 2-3 weeks to control them compared to powdery mildew, as the eggs kept hatching with time (Fig: 6b & 6c). Even after the Spider mites were completely eradicated, scars were noted in the infected areas of the leaves (Fig: 6d). However, the spread of spider mites to the top part of the plant was controlled immediately as was evident by the growth of new leaves which never showed the presence of spider mites (Fig: 6e). As expected, formation of new, healthy, green leaves (Fig: 6f) showed a very good sign of recovery by the end of the experimental period.

Discussion

Pest control and/or Pest Management is a crucial factor in the cultivation of Cannabis, like any other agricultural or horticultural crop. It is needed in order to achieve the optimal growth, disease-free, high quality plant and the maximum return of the investment. To control pests, biopesticides also known as biological pesticide are used as a promising alternative to chemical pesticides and are a preferred choice for many reasons, mainly it is friendly to non-target species including humans because they are target-pest specific. In our experiment when MiteXstream, a newly developed liquid biopesticide was applied in full strength, plants starting from juvenile to adult mother plants, infected with powdery mildew responded very well from the onset of first application. It took only 6-7 days to control infestation and eradicate completely or 100 percent.

In every application the plants were sprayed thoroughly which damaged the mycelium and spores and it was not possible for the wet spores to be carried away by wind and spread to other parts and if they cannot infect a plant within a specific time the spores die. After the application, the recovery was very good as newly developed leaves never showed any sign of infestation. Use of biopesticide in combination with chemical fungicide has been reported earlier to control powdery mildew infection in squash (Zhang *et al*, 2016). In our case MiteXstream biopesticide alone effectively controlled the spread and eradicated it completely.

The time required to control spider mites was comparatively longer, approximately 14-21 days; the reason could be that the survived spider mites continued to lay eggs which usually takes 48 hours to hatch. The time interval between two applications of MiteXstream was a minimum 48 hours; the right amount of time for the eggs to hatch. It was very interesting to note that the spread of spider mites to the top portion stopped immediately and with time the number of spider mites started to reduce. The possible reason for this could be that MiteXstream was not only targeting the adults but also interfering with egg development process. The results would agree with the findings of Takeshi Suzuki (2021) who reported that when spider mites eggs were dipped in Suffoil, a food-ingredient-based biopesticide, it prevented the spider mite embryo from rotating within its eggshell which is essential for hatching; and thus the rotation stopped or was absent. The results also demonstrated that once almost 99-100% spider mites were eradicated, the infected portion of leaves turned yellow. This is most likely because the spider mites feed on leaf tissues and suck out the leaf sap, as a result the chlorophylls are gone which plays a significant role in food production.

Furthermore, when the healthy plants were sprayed with MiteXstream (half strength) with added surfactants, a wetting agent called SM-90 by Nutralife as a preventative measure it had a negative effect on plant growth such as leaf curling, leaf discolouration and slow growth, compared to the lime green leaves and normal, healthy growth of untreated ones. In general, the overall growth of plants were higher when they were treated with full strength MiteXstream without any surfactants as a preventative measure. Those plants never developed any pests or disease infestation which may have played a role in the improved growth. Age of the plant is also an important factor when

treating the plants with a single dose application of MiteXstream as a preventative measure. Younger, two weeks old plants exhibited extremely slow growth or no growth as a response to MiteXstream spray and prolonging the experiment for a few more days resulted in yellowing of the leaves. Lack of photosynthesis and lack of space may also have caused a detrimental effect on plant growth which eventually resulted in poor growth performance. In comparison, mature, four weeks old plants receiving the same single dose application exhibited higher growth performance and a healthy, bushy appearance. The result confirms that to use MiteXstream as a preventative measure four to five weeks old mature plants should be selected. In a separate experiment, when rows of outdoor grown plants did not receive any single dose application of MiteXstream, slug infestation occurred at the beginning of the experimental period and affected the overall growth compared to the rows receiving MiteXstream. The results indicate another advantage of using MiteXstream as a preventative measure.

In general, water-soluble pesticides that are applied as foliar applications often create moist conditions on plant surfaces that could lead to further germination of the fungal spores as the gemination depends on the availability of moisture. Therefore, ventilation of the room is also a crucial factor. The experiment was carried out in a well-ventilated room and the wait time was at least 48 hours before the second application was applied to the indoor plants. In addition to this, the amount, duration and frequency of the application was directly related to the condition of the pests. Once the pests were completely eradicated the entire plant was thoroughly washed with water in order to get rid of any surface residues. It should be mentioned here that as the biopesticide was used only in the vegetative stage and the infected leaves were removed, by the time the plants entered the reproductive stage the entire plant was completely free from any kind of surface residues.

To summarize, the major findings of the study are: MiteXstream biopesticide can be a safe alternative of chemical pesticides and to achieve the maximum benefit the use of full strength concentration without any addition of surfactant is recommended. It can effectively control or eradicate the spider mites and powdery mildew as well as work as a preventative measure when applied at the appropriate dose, time and stage. The use of MiteXstream is not limited to Cannabis-

it can be used to control pest infestation in a wide range of plants. Further study is required to investigate the effectiveness of MiteXstream to control pests other than spider mites and powdery mildew. There is a huge scope for growth of the biopesticide, MiteXstream in both agricultural as well as the horticultural field.