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Insecticidal effect of the mixture of Potassium soap and Pyrethroids on Potato Leaf roll Virus (PLRV) found on Potato Plants

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ABSTRACT

The potato is best known for its carbohydrate content. It is the world's fourth-largest food crop, following rice, wheat and maize.Plant pests and diseases are the major contributors to biotic stresses that limit realization of yield potential of crop-plants [1]. The annual losses of crop produce in India are estimated at 25%. This indicates importance and need for strengthening of the existing bio-security system more so with the advances in agriculture, and changes in agricultural practices, in climatic conditions, and in indigenous pests, evolving into more virulent forms over the years. The diseases continue to spread over large areas. Diseases like Potato leaf roll virus (PLRV) of potato plants are caused by whiteflies directly or indirectly were treated by insecticidal soaps (Potassium palmitate and pyrethroides), Potassium palmitate and pyrethroides. These three insecticides were applied weekly and bi-weekly on the whiteflies and note down the results after fourth week of application. A specific insecticide formulation consisting potassium palmitate soaps and pyrethroides together exhibits effective combination to provide enhanced insecticidal efficacy and residuality as compared with the individual components [2]. They are effective against soft bodies insects like whiteflies, aphids, and spider. These soap based insecticides of different concentrations were prepared and applied on the plants having whiteflies. The synthesized soap compounds were characterized by elemental analysis, IR spectral studies and molar conductance measurements.

Keywords: Soap, fatty acid, I.R, whiteflies, insecticidal soap, non-persistent insecticides.

INTRODUCTION

In recent years, India faced losses of over Rs 11,800 million due to late blight of potato caused by whiteflies and Aphids; affecting potato field over 1.4 million hectares **[**3]. One-hundred and fourteen virus species are transmitted by whiteflies (family Aleyrodidae).The tremendous increase in crop yields associated with the 'green' revolution has been possible in part by the discovery and utilization of chemicals for pest control. The potato contains vitamins and minerals, as well as an assortment of phytochemicals, such as carotenoids and natural phenols. Chlorogenic acid constitutes up to 90% of the potato tuber natural phenols. Whiteflies are small sucking insect related to aphids, leafhoppers, and mealybugs [4]. They are usually found on the undersides of young leaves and have the capacity for rapid reproduction when conditions are favorable. When leaves are disturbed in infected crops, clouds of white

flying insects indicate their presence. Warm weather, nearby whitefly host crops or weeds and poor hygiene in protected cropping structures increase the risk of whitefly infection. Whitefly can damage plants by sucking sap from the plants, causing reduced growth, leaf yellowing, stunting, and yield reduction. Damage is similar to that caused by aphids. Sticky, sugary secretions called honeydew from whitefly can result in the development of sooty mould, which in turn affects the photosynthetic (food-producing) abilities of the leaves. Adults and nymphs are usually found feeding on the underside of leaves. When synthetic pyrethroids [5] mixed with potassium salt of fatty acids, it is found to be an effective combination to provide enhanced insecticidal efficacy and residuality. These soap based insecticides of different concentrations were prepared and applied on the plants having whiteflies. This soap based insecticides which is easy to handle and to apply or safe to use.

MATERIALS AND METHODS

The acid was purified by distilling under reduced pressure. The purity of acid was checked by determining their boiling / melting points. The purified palmitic acid M.P. 61^{o}C and B.P. 50^{o}C.

Preparation of Potassium salt of fatty acids (Soap): Potassium salts of fatty acids (soap) were prepared by refluxing equivalent amounts of corresponding fatty acids and aqueous solution of potassium hydroxide for 6-8 hours on a water bath. The soap was purified by recrystallisation with benzene-methanol mixture and dried under reduced pressure. The purity of the soap was checked by the determination of their melting point. The melting point of purified potassium palmitate was 117^{o}C. The specifications of Potassium palmitate are given in table1.

Table 1: specifications of Potassium palmitate

Appearance	White granular powder
Free fatty acids	3 % Max.
Moisture	10 % Max.
Free alkali	5 % Max.
Feel	Soapy
P^{H} of 10 % aqueous solution	10
Solubilty	Slow in cold water / alcohol, freely soluble in hot solvents.

Pyrethroids: Pyrethrum/Pyrethrins/Pyrethroids are broad-spectrum insecticides. Pyrethrum powders are made directly from the flowers of a species of Chrysanthemum and pyrethrins are the active compounds from the pyrethrum flower. Pyrethroids are synthesized pyrethrins. These materials disrupt the nervous system of insects and cause paralysis [6]. They are fast acting and often used for their "knock-down" effects to quickly reduce large insects pest population. They are moderately toxic to humans and other mammals and break down quickly from sunlight, moisture and oxygen, leaving no residues [7,8].These natural pyrethrins have the disadvantage that they are rapidly decomposed by light. The structure is shown in fig.1

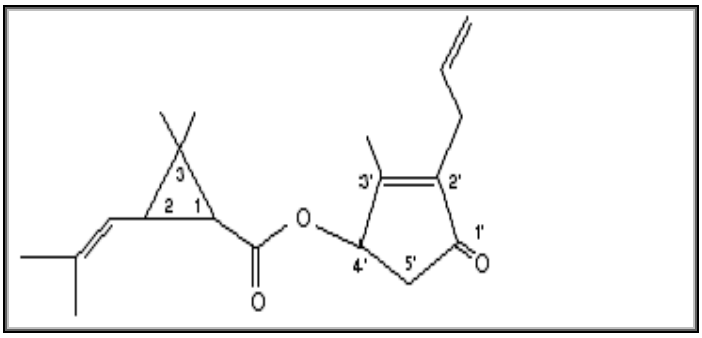


Fig.1 The Structure of pyrethroid

RESULTS AND DISCUSSION

In the IR spectrum of potassium salts of fatty acids, the absorption bands of C-H stretching vibrations viz. the symmetrical vibration of CH_2 at 2860-2850 cm^{-1}, the asymmetrical stretching vibration of CH_2 at 2920-2910 $cm^{-1,}$ the asymmetrical stretching vibration of CH_3 at 2960-2940 cm^{-1} and the deformation of CH_2 at 1498-1320 cm^{-1} are observed in the spectra of potassium salts of fatty acids as well as in fatty acid. The evenly spaced progressive bands near 1350-1188 cm^{-1} which are characteristic of the hydrocarbon chain of acid remain unchanged on preparing the carboxylate from the corresponding fatty acid. The absorption bands observed near 2660-2640, 1700, 930-900, 575-530 cm^{-1}, in the spectra of fatty acid have indicated the presence of localized –COOH group in the form of dimeric structure and the existence of intermolecular hydrogen bonding between two molecules of the acid.

The appearance of two absorption band of carbonyl group corresponding to the symmetric and asymmetric vibrations of carboxylate ion near 1470-1410 and 1560-1540 cm^{-1} respectively in the spectra of potassium salts of fatty acids indicate that there is a complete resonance in the C-O bonds of carbonyl group of the carboxylates molecules and the two bonds become identical with the force constant assuming the value intermediate between those of normal double and single bonds. It is therefore concluded that the resonance character of the ionized carboxyl group is retained in these metal carboxylates and the fatty acids exist with dimeric structure through hydrogen bonding whereas the metal-to-oxygen bonds in these metal carboxylates are ionic in character. It is therefore concluded that the soap molecules do not show appreciable aggregation below the CMC and there is a marked increase in the aggregation of the soap molecules at this definite soap concentration. The CMC (critical micelle concentration) of potassium palmitate is 3.1×10^{-3} dm^3 L^{-1}. Many samples of various concentration having different pH have been prepared by mixing potassium palmitate and pyrethroids of different dilution (%), and then sprayed on plant to check the efficacy of this insecticidal spray on daily and bi-weekly interval.

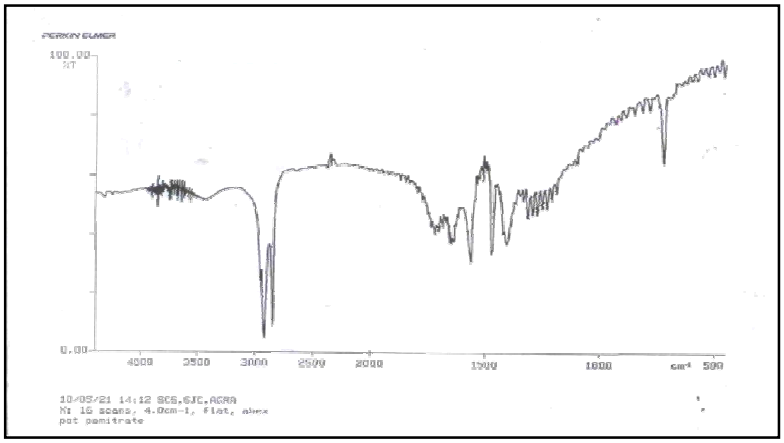


Fig. 2 I R Spectra of potassium palmitate

APPLICATIONS

Application of Insecticides: We applied individually Potassium palmitate, pyrethroides and mixture of Potassium palmitate and pyrethroides. These three insecticides were applied weekly and bi-weekly on the whiteflies and note down the results after fourth week of application. After the single application of potassium palmitate these was little impact on plants whiteflies, table **2**. Pyrethroids are highly toxic to insects like whiteflies [9], aphids but also has an adverse effect on the plants and environment**,** Table 3. After fourth week of application some whiteflies were dead but not much improvement in the plants leaf as they were still affected and unhealthy. So we made a formulation of potassium soap (palmitate) and pyrethroides [10].

Table 2. Impact of Potassium palmitate (CMC 3.1×10^{-3} gm dm^{-1}) on Whiteflies

Sr. No	Plant	pH value of potassium palmitate	Effect on plants (after weekly application)	Effect on plants (after bi-weekly application)	Toxicity
1	First plant	7.90	No impact	Needs frequent application	Less toxic
2	Second plant	8.30	No impact	Needs frequent application	Less toxic
3	Third plant	8.50	No impact	Needs frequent application	Less toxic
4	Fourth plant	8.76	No impact	Needs frequent application	Less toxic
5	Fifth plant	8.95	No impact	Needs frequent application	Less toxic
6	Sixth plant	9.10	No impact	Less effective	Less toxic
7	Seventh plant	9.30	No impact	Less effective	Less toxic
8	Eighth plant	9.65	No impact	Less effective	Less toxic

Table3. Impact of pyrethroids (synthetic pyrethrum) on whiteflies

Sr. No	Plants	pH value of pyrethroids	Effect on plants (after weekly application)	Effect on plants (after bi-weekly application)	Toxicity
1	First plant	7.90	Needs frequent application	Effective	Toxic
2	Second plant	8.30	Needs frequent application	Effective	Toxic
3	Third plant	8.50	Needs frequent application	Effective	Toxic
4	Fourth plant	8.76	Needs frequent application	Effective	More toxic
5	Fifth plant	8.95	Needs frequent application	Effective	More toxic
6	Sixth plant	9.10	Less effective	Effective	More toxic
7	Seventh plant	9.30	Less effective	Effective	More toxic
8	Eighth plant	9.65	Less effective	Effective	More toxic

In first row there were two sections and each section have fifteen plants affected by a disease potato leaf roll virus **(PLRV)** which is caused by whiteflies. Leaflets roll upwards from the margin and progress towards the midribs until the entire lamina is involved. Leaflets are thick leathery brittle and rattling sound when disturbed. Few tubes cluster around the stem. These are the main symptoms of PLRV disease caused by whiteflies (pictures 1-4).

We have prepared fifteen spray solutions of mixture of potassium palmitate and pyrethroids of different concentration having pH 8.68, 8.76, 8.94, 9.09, 9.32, 9.66, 9.71, 9.73, 9.80, 9.96, 10.13, 10.29, 10.44, 10.69, and 10.80. The second, third, fourth, fifth and sixth plants were treated with the insecticidal solution containing potassium palmitate and pyrethroids having pH 8.68, 8.76, 8.94, 9.09 and 9.32 showed the same symptoms of PLRV (potato leaf roll virus). The leaflet roll upwards from the margin and infected plants are stunted and have a light yellow to pale green color, few tubes cluster around the stem. After the bi-weekly and weekly application of these solutions and even the fourth weeks of the application. There was not much impact on plant status. These spray solution need frequent application. As their mortality was also very low and do not have good efficacy against whiteflies. Seventh, eighth plants which were treated with the insecticidal solution having pH 9.66, 9.71 of potassium palmitate and pyrethroids showed less impact even after the fourth week of bi-weekly and weekly application as their mortality was not high. Ninth, tenth, eleventh, twelfth, thirteenth and fourteenth, plants were treated with the solution having pH 9.73, 9.80, 9.96, 10.13,10.29 and 10.44 of potassium palmitate and pyrethroids. They have curling of leaf and infected plants are stunted have a light yellow to pale green color. After the fourth week of application of bi-weekly in the beginning and weekly (after two weeks of application), the mortality of these solutions were also greater than the other solution of potassium palmitate and pyrethroids, the leaves were healthy and plants were growing normally. So there solutions having pH 9.73-10.44 of potassium palmitate and pyrethroids were found to be effective for controlling potato leaf roll virus (PLRV) disease. Fifteenth and sixteenth plants of this section were treated with the soap solution of potassium palmitate and pyrethroids having pH 10.69-10.80 were suffering from the same disease and having same symptoms. Their leaflets are malformed, tubers develop necrosis. Even after the fourth week application their mortality rate was low and could not control the whiteflies. So, the plants did not grow normally and there leaves were healthy only with the repeat application of the soap solution. We found that the insecticidal solution of potassium palmitate and pyrethroids having pH 9.73-10.44 were effective [11]and their mortality were high for controlling PLRV disease of potato plants (Table 4.)

Pic.1. Potato healthy plants

Pic.2. Whiteflies present on Potato plants

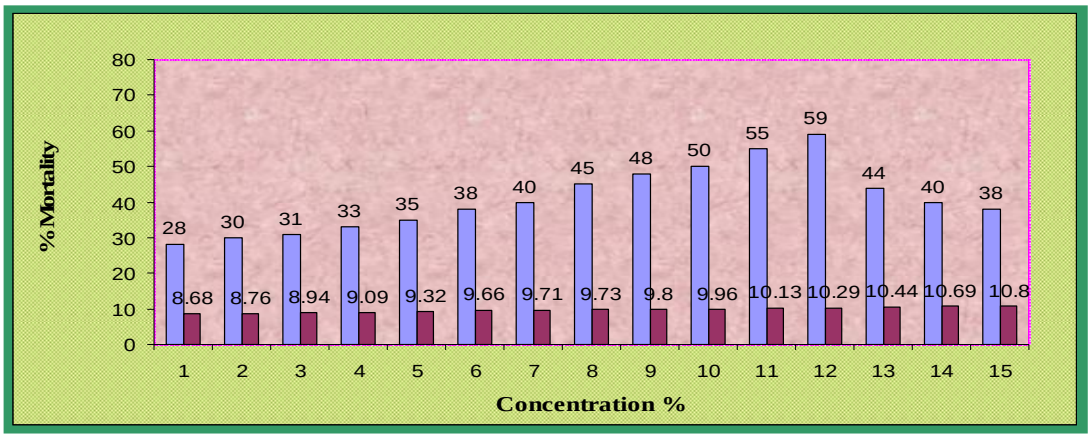

Pics.3-4. Potato Leaf roll virus (PLRV) symptoms

Table 4. Impact of mixture of potassium palmitate (CMC 3.1×10^{-3} gm dm^{-3}) and pyrethroids on potato plants (PLRV)

Sr. No	First row (section :2)	Concentration of pyrethroids	pH value of potassium palmitate (CMC 3.1×10^{-3} gm / dm^3) and pyrethroids spray	Effect on plants	% mortality
1	First plant	-------	-------	-------	-----
2	Second plant	1	8.68	Not effective	28
3	Third plant	2	8.76	Not effective	30
4	Fourth plant	3	8.94	Not effective	31
5	Fifth plant	4	9.09	Not effective	33
6	Sixth plant	5	9.32	Not effective	35
7	Seventh plant	6	9.66	Need frequent application	38
8	Eighth plant	7	9.71	Need frequent application	40
9	Ninth plant	8	9.73	Effective	45
10	Tenth plant	9	9.80	Effective	48
11	Eleventh plant	10	9.96	Effective	50
12	Twelfth plant	11	10.13	Effective	55
13	Thirteenth plant	12	10.29	Effective	59
14	Fourteenth plant	13	10.44	Effective	44
15	Fifteenth plant	14	10.69	Need frequent application	40
16	Sixteenth plant	15	10.80	Need frequent application	38

CONCLUSIONS

A specific insecticide formulation consisting of potassium palmitate and pyrethroids found to be an effective combination for PLRV disease in potato plants to provide enhanced insecticidal efficacy and residuality. It is effective to control of a broad range of whiteflies in PLRV disease in potato plants table4. These insecticides reduce pest populations kill the pest but not other organisms. Break down quickly and have low toxicity to human and other mammals. The use of insecticides has greatly enhanced agricultural productivity but it has positive impact on the environment as well as on the plant also. They are moderately toxic to humans and other mammals and break down quickly from sunlight, moisture and oxygen, leaving no residues. We found that the insecticidal solution of potassium palmitate and pyrethroids having pH 9.73-10.44 were effective and their mortality were high for controlling PLRV disease of potato plants(Graph-1).



(Graph: 1) Concentration VS Mortality of Potassium Palmitate and Pyrethroids (PLRV)

pH Value Mortality of potassium palmitate

We therefore conclude that mixture of soap based insecticide containing pyrethroids (synthetic pyrethrum) is an eco-friendly, safe. This insecticidal soap solution having potassium salt of fatty acid and pyrethroids fulfills the main objectives of inventing an eco-friendly pesticide against whiteflies.

REFERENCES

[1] B. Swanson, *Journal of International Agricultural and Extension Education,* **2006,** 13(3), 5–17.
[2] R.G. Belz, *Pest Manage. Sci.* **2007**, 63, 308.
[3] V. Sulaiman, A.W.Rasheed and van den Ban. Agricultural Extension in India- The Next Step, **2000.**
[4] J.H. Martin, Whiteflies (Hemiptera: Aleyrodidae)- their systematic history and the resulting problems of conventional taxonomy, with special reference to descriptions of aleyrodes proletella (Linnaeus, 1758), **2003.**
[5] Anonymous. Method for determination of synthetic pyrethroids in agricultural and food commodities, IS 14913, New Delhi. **2001.**
[6] J.R. Bloomquist, *Biochem. Physiol*, **1993,** 106c, 301-314.
[7] F. E. Rickett, Allergenicity of pyrethrum oleoresin and its Cross-reaction.
[8] J.C.Mitchell, Dupuis, G.H.N. The roles of Pyrethrosion. **1972.**

[9] Anonymous, Toxicological profile for Pyrethrins and Pyrethroids, Public Health Center, U.S.A, 1-4, **2003.**

[10] R.Saravanan, In ICTs for agricultural extension: Global experiments, innovations and experiences, ed. R. Saravanan. New Delhi, India, **2010.**

[11] Hayes, W.J., Laws, E. R., Eds. Handbook of Pesticide Toxicology, Classes of Pesticides; Academic Press: NY, Vol. 3, **1990**.