INTERNATIONAL JOURNAL OF CURRENT RESEARCH IN CHEMISTRY AND PHARMACEUTICAL SCIENCES

(p-ISSN: 2348-5213: e-ISSN: 2348-5221)

www.ijcrcps.com

Coden: IJCROO(USA) Volume 3, Issue 4 - 2016

Research Article

SOI: http://s-o-i.org/1.15/ijcrcps-2016-3-4-3

ECO FRIENDLY, ECONOMICALLY VIABLE PLANT PROTECTION PRODUCTS

#SUSAN VERGHESE P and DHEERAJ JAIN

#Associate Professor, Department of Chemistry, St Johns College, Agra

*Corresponding Author: susan.jaison @yahoo.com

Abstract

Beans is one of the most consumed and widely grown vegetable crops in the world, but their yield is suppressed by many diseases caused by whiteflies and other insects. Whiteflies can also transmit many viral diseases on bean .Bean common mosaic virus (BCMV), Bean Yellow mosaic virus (BYMV), Bean Golden mosaic virus(BGMV)etc. A number of synthetic pesticides have been used for the control of insects in agriculture, which damage the plant and also have negative impact on the environment, but their adverse impact on the environment calls for more environmentally friendly methods for pest management. This paper deals with the synthesis, physico-chemical characterization and application of mixture of potassium palmitate and pyrethroids; pyrethroids and potassium stearate as non- persistent insecticides against whiteflies found on bean plants, also used T - test to compare the efficacy of prepared insecticidal formulations.

Keywords: Beans, Whiteflies, synthesis, physico-chemical characterization and, Protection products.

Introduction

Pesticides are plant protection products; also known as crop protection products, which in general protect plants from damaging influences such as weeds, diseases or insects. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including non-target species, air, water and soil (Aldridge WN.1990).

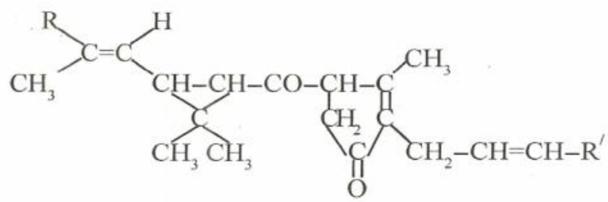
Soap is a naturally occurring material having no known long-term environmental effects. Insecticidal soap seems to work better when they are wet. Therefore, it would be very valuable to find a way to keep the soap wet for as long as possible in order to increase the time during which the solution is insecticidal active. Insecticidal soap is typically made of potassium salts of fatty acids, also called soap salts. They are produced by adding potassium hydroxide to fatty acids extracted from plant oils. While it is a non-specific insecticide, soft-bodied insects are more susceptible to its action. The soap has a very short half-life of less than one day, as they are readily broken down by micro-organisms in the environment. Their effects on the environments are expected to be minimal when kept on land (Susan V P et.al 2013,2015).

Pyrethrum/Pyrethrins/Pyrethroids are broad-spectrum insecticides. Pyrethrins are a combination of six natural chemicals extracted from the commercial flowers Chrysanthemum cinerariae folium and Chrysanthemum cineum (Hunter, W.B et.al .2003) crushed and powdered Chrysanthemum plants were used as an insecticide by the Chinese as early as 1000 BC. The flowers contain about 1-2 % Pyrethrins, relative to its dry weight, but approximately 94% of the total yield is concentrated in the seeds of the flowers. (Ray, D.E. 1991). Pyrethrins were developed as pesticides from extract of dried and powdered flower heads of *Chrysanthemum cinerariaefolium. (Leahey,* J.P. 1985). They are esters of chrysanthemumic acid (R^1 = CH_3) or pyrethric acid (R^1 = CH_3O_2C) (both cyclopropane (three membered ring) carboxylic acids), with one of three cyclopentanone alcohols (cinerolone, R^2 = CH_3; jasomolone, R^2 = CH_2CH_3; or pyrethrolone, R^2 = $CHCH_2$), giving six possible structures (Pic 1). Pyrethroids are synthesized pyrethrins. These materials disrupt the nervous system of insects and cause paralysis.(Bloomquist, J.R. 1993) 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. These natural pyrethrins have the disadvantage that they are rapidly decomposed by light

Table-1 Consumption of pesticides in various states during 2005-06 to 2009-10 in tones

S.No.	States/Uts	2005-06	2006-07	2007-08	2008-09	2009-10
1.	Andhra Pradesh	1997	1394	1541	1381	1015
2.	Assam	165	165	158	150	19
3.	Arunachal Pradesh	2	17.10	16	10.00	10.0
4.	Bihar	875	890	870	915	828
5.	Chhattisgarh	450	550	570	270	205
6.	Gujarat	2700	2670	2660	2650	2750
7.	Goa	5	9	2.30	8.90	10.30
8.	Haryana	4560	4600	4390	4288	4070
9.	Himachal Pradesh	300	292	296	322	328
10.	Jammu & Kashmir	1433	829	1248	2679.27	1640
11.	Jharkhand	70	82	81	85	88.5
12.	Karnataka	1638	1362	1588	1675	1647
13.	Kerala	571	545	780	272.69	631
14.	Madhya Pradesh	787	957	696	663	645
15.	Maharashtra	3198	3193	3050	2400	4639
16.	Manipur	28	26	26	30.36	30.36
17.	Meghalaya	6	9	6	-	6.1
18.	Mizoram	25	40	44	44.25	39.05
19.	Nagaland	5	5	5	17.83	13.58
20.	Orissa	963	778	N/A	1155.75	1588
21.	Punjab	5610	5975	6080	5760	5810
22.	Rajasthan	1008	3567	3804	3333	3527
23.	Sikkim	No cons. As Organic State	2	6	2.68	4.22
24.	Tamil Nadu	2211	3940	2048	2317	2335
25.	Tripura	14	19	27	38.00	55
26.	Uttar Pradesh	6671	7414	7332	8968	9563
27.	Uttaranchal	141	207	270	221.10	222
28.	West Bengal	4250	3830	3945	4100	NA
29.	Andaman & Nicobar	3	N/A	N/A	6.24	14
30.	Chandigarh	0.78	N/A	N/A	-	NA
31.	Delhi	39	N/A	57	57	49
32.	Dadra & Nagar Haveli	4	N/A	N/A	-	NA
33.	Daman & Diu	1	N/A	N/A	-	NA
34.	Lakshadweep	1	N/A	N/A	-	NA
35.	Pondicherry	41	40	41	39.00	39.29
	Total (in round fig.)	39773	41515	43630	43860	41822
#	Source-Directorate of,	Plant	Protection	quarantine	and storage	Faridabad

1. Structure of the Natural Pyrethrins.



	R	R′
Pyrethrin I	CH_3	$-CH=CH_2$
Pyrethrin II	CH_3OCO-	$-CH=CH_2$
Cinerin I	CH_3-	$-CH_3$
Cinerin II	$CH_3O.CO-$	$-CH_3$
Jasmolin I	CH_3-	$-CH_2\ CH_3$
Jasmolin II	$CH_3O\ CO-$	$-CH_2-CH_3$

2. Structure of the Synthetic Pyrethroids:

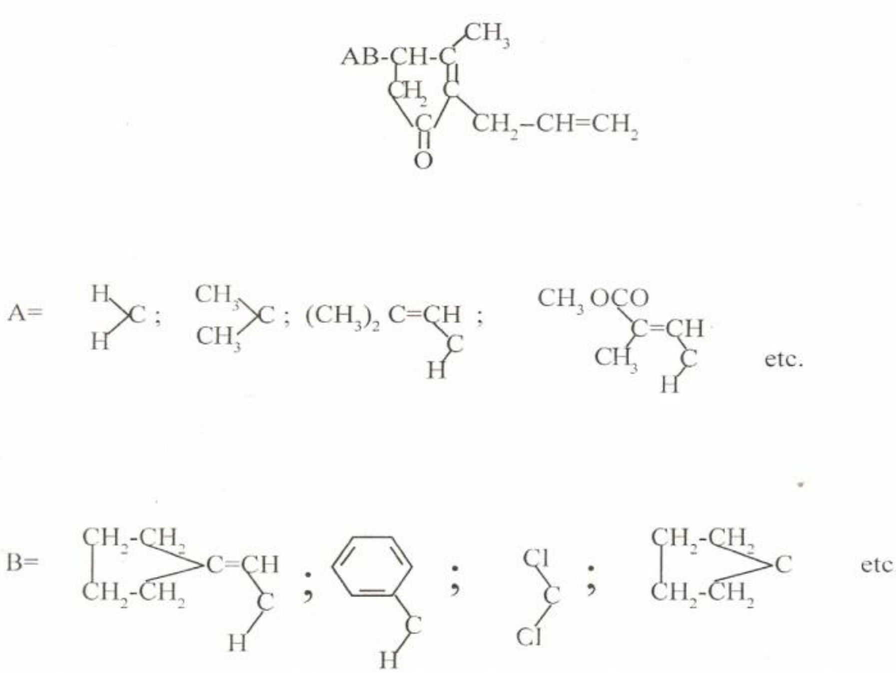


Figure 1 Structure of Natural Pyrethrins and Synthetic Pyrethroids

Experimental Method and Techniques

Various physical techniques, pH by pH meter and electrical conductivity measurements by Conductivity meter were employed in the characterization of potassium palmitate and pyrethroids ;potassium stearate and pyrethroids.

Applied various concentration of different pH insecticidal formulations (solutions of potassium palmitate and pyrethroids ;potassium stearate and pyrethroids) on beans plant for Bean common mosaic virus (BCMV), Bean Yellow mosaic virus (BYMV), Bean Golden mosaic virus(BGMV)etc and determined LD50 of insecticidal formulations and applied ANNOVA technique to correlate the properties of insecticidal formulations.

Results and Discussion

The specific conductance, k of the solution of potassium carboxylates (Palmitate, Stearate) in distilled water increases with increasing soap concentration, C. The increase in specific conductance may be due to ionization of potassium soap (Palmitate, Stearate) into simple metal cations K^+, fatty acid anions R-COO^- (Where R is $C_{15}H_{31}$ and $C_{17}H_{35}$ for palmitate and stearate respectively) in dilute solution and due to the formation of ionic micelles at higher soap concentration. The plots of specific conductance, k Vs soap concentration, C of potassium palmitate (CMC-0.052 mg/l), potassium stearate (CMC-0.043mg/l) in distilled water are characterized by an intersection of two straight lines at a definite soap concentration corresponding to the CMC of soap and in these solutions. The results show that the values of the CMC increas e with increasing concentration of soap.

The micellization occurs when the energy released as a result of aggregation of hydrocarbon chains of the monomers is sufficient to overcome the electrical repulsion between the ionic head groups and to balance the decrease in entropy accompanying aggregation. The CMC increases with the increase in soap concentration since the kinetic energy of the monomers increases with concentration. The molar conductance, μ of the solution of potassium carboxylates(palmitate, stearate) decreases with increasing soap concentration. The decrease in molar conductance is attributed to the combined effect of ionic atmosphere, solvation of ions and decrease of mobility and ionization with the formation of micelles. The plots of molar conductance, μ Vs. $C\mu^2$ are not linear which indicates that the soap behaves as a weak electrolyte in distilled water.

The values of the degree of dissociation, α at different carboxylates concentration (potassium palmitate, potassium stearate) have been calculated by assuming it as equal to the conductance ratio, μ / μ_0 and using the value of μ_0 obtained from the plots of $C\mu^2$ Vs μ . The values of degree of dissociation, α decreases with increasing concentration (potassium palmitate, potassium stearate) which shows that the potassium carboxylates behaves as a weak electrolyte in these solutions. It, is, therefore, concluded that potassium carboxylates (palmitate and stearate) are weak electrolytes in distilled water.

There are many insecticides available for the control of whiteflies found on beans plants but all of them have negative impact on the plants as well as in nature. A formulation of potassium soaps (palmitate and stearate) and pyrethroid have been prepared and investigated its impact on the whiteflies found on bean plants. Whiteflies can also transmit many viral diseases on Bean ,Bean common mosaic virus (BCMV), Bean Yellow mosaic virus (BYMV), Bean Golden mosaic virus(BGMV)etc. Applied various insecticidal formulations containing potassium palmitate and pyrethroid; potassium stearate and pyrethroid of different concentrations having distinct P H individually on bean plants against whiteflies. They have been applied weekly and bi-weekly on the whiteflies and studied its impacts after the fourth week of application.

We conclude that in both of sections of first row the liquid spray insecticidal mixture contains potassium stearate(CMC-0.043mg/l) and pyrethroids having P^H 10.29 and solutions of potassium palmitate (CMC-0.052 mg/l)and pyrethroids of PH 10.29 is found to be equally effective in controlling white flies than ; potassium stearate, and potassium palmitate individually as their mortality rate was also highest among all to control PLRV disease (Figure. 2).

Figure 2 Effect of insecticidal formulations on Whiteflies

LD_{50} is the dose required to kill half the members of population after specified test duration. The smaller the LD_{50} value, the pesticide will be more toxic. Experiments for mortality were conducted to find out the effect of five insecticidal sprays at different concentrations (10, 100, 1000 ppm) on whiteflies. These whiteflies were stored /collected in a container, which were taken in Peter's counting chamber & insecticidal sprays of fatty acids and pyrethroid of various concentrations were added to it and the mortality was noted. The pyrethroid (which is already an insecticide) has highest/ maximum effect on whiteflies, but its LD_{50} value is very low so, it has very toxic effect or has more toxicity in nature. The order of toxicity as follows pyrethroid^ potassium stearate and pyrethroid=Potassium palmitate and pyrethroid ;potassium stearate= potassium palmitate on whiteflies.

T- Test to check the efficacy of mortality of insecticidal soap solution containing mixture of potassium palmitate and pyrethroid ;potassium stearate and pyrethroid concludes that there is no significant difference between the mortality of whiteflies due to different mixture of soap solution (Potassium palmitate, Potassium stearate) and pyrethroid. As $P > 0.05$, so all these insecticidal soap mixture ,Potassium palmitate and pyrethroid;,Potassium stearate and pyrethroid are equally effective for controlling all five disease due to whiteflies found on bean plants.

We, therefore, concluded that mixture of soap solutions (potassium palmitate and potassium stearate) based insecticide containing pyrethroid (synthetic pyrethrum) is an eco-friendly, safe insecticide when pyrethroid is mixed with potassium salt of fatty acids. It is found to be an effective combination to provide enhanced insecticidal efficacy and residuality. This liquid soap based pesticides which is easy to handle, apply and safe to use. This insecticidal soap solution having potassium salt of fatty acid and pyrethroid fulfills the main objectives of inventing an eco-friendly pesticide against whiteflies.

This insecticidal spray of potassium palmitate and pyrethroide, potassium stearate and pyrethroide has reduced immensely the disease on beans plant spread by whiteflies. Hence an attempt has been made to develop an eco friendly economical product for integrated pest management strategy. They have very low mammalian toxicities and potent insecticidal action, are photostable with low volatilities and persistence. They are broad-spectrum insecticides and may kill some natural enemies of pests. They do not bioaccumulate and have few effects on mammals, but are very toxic to aquatic invertebrates and fish.

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How to cite this article:
Susan Verghese P and Dheeraj Jain. (2016). Eco friendly, economically viable plant protection products. Int. J. Curr. Res. Chem. Pharm. Sci. 3(4): 23-28.