Pestic. Phytomed. (Belgrade), 26(4), 2011, 409-413
Pestic. fitomed. (Beograd), 26(4), 2011, 409-413

UDC: 632.981.1:632.981.3
Scientific paper * Naučni rad
DOI: 10.2298/PIF1104409G

Oil Dispersion with Abamectin as Active Ingredient

Slavica Gašić, Dragica Brkić and Anđelka Tomašević

Pesticides and Environmental Research Institute, 11080, Belgrade, Banatska 31b, Serbia (slavica.gasic@pesting.org.rs)

Received: July 21, 2011
Accepted: September 7, 2011

SUMMARY

Abamectin was developed as an insecticide, nematocide and acaricide for use on a variety of agricultural and horticultural crops. The products with this active ingredient can be found on the market mostly formulated as emulsifiable concentrate (EC). Usually producers recommend using the EC formulation of abamectin together with some kind of adjuvants (natural oils) to improve efficacy of the active ingredient. To overcome the efficacy problem we tried to formulate the active ingredient abamectin as oil dispersion (OD). Oil dispersion, preferably based on naturally derived oils could improve pesticide efficacy. This type of pesticide formulation contains oil instead of water as in classical suspension concentrate and typically has better retention and coverage. In the case of abamectin, in this investigation soybean oil was used with the mixture of different nonionic emulsifiers. Content of abamecetin in formulation was 1.8 %. The developed formulation was tested for few important parameters. The obtained physicochemical properties for the above mentioned formulation have shown that it is stable and could be used in plant protection.

Keywords: Abamectin; Oil dispersion; Adjuvants; Soybean oil

INTRODUCTION

Despite negative perception of the public, pesticides are still going to be used for many years to ensure food supply for the ever growing world population. It is clear that, although pesticides remain indispensable in agriculture, a great potential still exists to improve their efficiency and thus reduce their input into the environmental and food chain. Proper formulation and efficient delivery systems are the key elements in the performance of different products. One of the most important ways to improve the efficacy of pesticides and minimize their impact on non target organisms is through increased penetration of active ingredient into plant foliage. Recently, the use of vegetable oils (seed oils) has been increased since they are more biodegradable and originate from renewable resources. These oils are very useful in pesticide formulations as the oil and active materials are expected to contribute to the biological activity (Wang and Liu, 2007).

Abamectin was introduced in 1985 as an acaricide, insecticide and nematocide with contact and stomach action by Singenta AG. Abamectin is conventionally formulated as emulsifiable concentrate (EC) and recently as aqueous capsule suspension (CS). The solvents which are used in EC formulations have come under

toxicological and subsequently regulatory pressure. As a result, some of the most common solvents are no longer available. Recently, a new formulation concept has been developed to overcome these problems, that is oil dispersion which contains active ingredient in combination with different kinds of oils. In this way, retention, spreading and penetration can be improved. The better the leaf surface is covered with fluid deposit, the more intensive interaction with the plant and the better uptake of active ingredient is achieved. Easier dosing, easier spray preparation are key features of this type of formulation compared to EC (Vernner and Bauer, 2007).

Oil dispersions (OD) are dispersions of active material in non aqueous phase intended for dilution before use. Oil dispersions provide several important opportunities as the ability to deliver water sensitive active ingredients either alone or in combination with other active ingredients to improve control, and the ability to use an adjuvant fluid instead of water which can increase and broaden pest control. These formulations are also useful for the inclusion of adjuvants that are generally oil based such as certain foliar penetration enhancing compounds (Knowles, 2005).

The objective of this study was to develop oil dispersion of active ingredient Abamectin (1.8%). We used soybean oil and the mixture of nonionic emulsifiers to get stable product.

MATERIAL AND METHODS

Abamectin technical material (95% min.) originated from China, Psyche Chemicals Co., Limited. All reagents and solvents were purchased from commercial sources and used without further purification. Emulsifiers which were used were of commercial quality (Ajinomoto OmniChem, Belgium) and were used without further purification.

The content of Abamectin in technical material and formulations was analysed by HPLC method. For HPLC determination, all solutions were filtered through Sartorius 0.20 μm syringe filters and were analysed at 246 nm and at ambient temperature (25°C) on a Hewlett Packard HP 1050 liquid chromatograph with a UV/VIS detector, equipped with a reversed-phase column type Zorbax Eclipse XDB-C8 150 x 4.6 mm (i.d.) x 5 μm. The mobile phase (flow rate 2.0 ml min^{-1}) was a mixture of methanol and water (90:10, v/v). Sample injection volume was 20 μl and both samples and standards were diluted with methanol. Under the above chromatographic conditions, concentrations of abamectin were determined from the peak area at t_R = 1.8 min.

The formulation was checked for a few important parameters: viscosity, particle size distribution, pH, persistent foam and storage stability. Particle size distribution was measured by CILAS 1064 liquid. Viscosity measurements were performed at 20°C with Haak rheometer. Visual aspect of formulations was checked using Axioskop 40 (Carl Zeiss, 63x Canon camera). The pH was controlled by CIPAC method MT 75, persistent foam CIPAC MT 47.2 and storage stability CIPAC MT 39 and MT 46 (CIPAC, 1995).

Oil dispersion of Abamectin (OD) was prepared as stable suspension of very small particles with the mixture of active material (1.8%), nonionic emulsifiers, wetting and dispersing agents and structuring agents, altogether 16.5%, and the rest was soybean oil (81.7%). The grinding was carried out by Dyno-Mill. Grinding was carried out until mean particle size of less than 5 microns was obtained.

RESULTS AND DISCUSSION

The results are given in Table 1 and Figures 1-5.

A pesticide which has a reasonably high melting point, low solubility in the oil and which is chemically stable in oil could be prepared as oil dispersion (OD). Pesticides having a melting point below 60°C are not convenient to be formulated as ODs by the bead milling process due to temperatures of 60°C or higher being reached in a non cooled bead mill. With cooling it may be possible to keep the mill temperature sufficiently low to mill pesticides with a melting point around 60°C (Mollet and Grubenmann, 2001). Abamectin is an example of a pesticide with suitable melting point for preparation in this way (Tomlin, 2009). Oil dispersions are diluted prior to application, but marketing them in concentrated form enables low cost transportation.

Oil dispersions can be prepared by bead milling the solid pesticide in oil, optionally with one or more emulsifiers to produce a fine oil suspension. It is essential that the oil used dissolve no more than 0.1% by weight of the active ingredient at 20°C. Oils dissolving more active ingredient than this promote the growth of large crystals in storage. For the same reasons it is desirable the oil to be anhydrous. One or more emulsifiers should be included along with anti-settling agents to reduce the rate at which the milled particles settle. It is also important that the solid ingredients of these concentrate have an average particle diameter of less than 5

microns. The optimum time for milling to desired particle size depends on the initial particle size of the solid and it should be determined by inspection. It is known that similar criteria as for SC water based formulations can be applied to oil based dispersions (OD). The difference between these two formulation types is higher amount of emulsifiers which is necessary to emulsify oil. The oil used can be from mineral, vegetable or vegetable esterifies type (Tadros, 2005). We used soybean oil as suitable medium for abamectin as active ingredient (Gašić and Brkić, 2011).

Table 1. Physical and chemical properties of OD formulation after and before stability test

Time Temperature	Fresh formulation room temperature	After 7 days 0°C	After 14 days 54°C
Abamectin content	18.4 g/l	18.1 g/l	17.9 g/l
Density	0.9245 g/cm^3	0.9346 g/cm^3	0.9358 g/cm^3
pH (1%)	5.3	5.0	5.9
Persistent foam	24 cm^3	14 cm^3	10 cm^3
Particle size Distribution (Mean diameter)	3.42 μm	3.58 μm	3.63 μm
Viscosity	172.5 m Pas	177.1 mPas	186.5 mPas

Particularly suitable emulsifiers for preparation of OD formulation are the group of different emulsifiers (alkyl ethoxylates, alkyl ethoxylate phosphate, esters, alkyl sulphates, alkyl ammonium salts, castor oil ethoxylates etc.) and structuring agents (anti-settling) for example bentonite family, silicas or other inorganic thickeners (Knowles, 2006; Jane and Mark, 2010). Anti-settling agents prevent the agglomeration of active material helping its distribution, and ensure the formulation long-term stability. Unfortunately, OD prepared using these agents tend to vary in viscosity depending on the quality, in particular the impurity content,

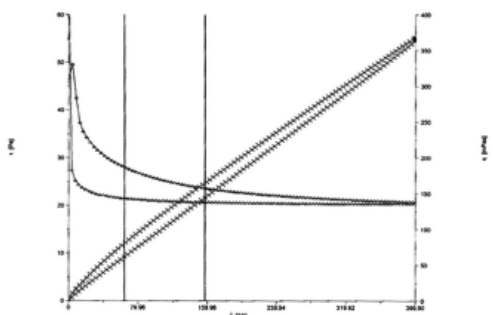

Figure1. Particle size distribution in OD formulation

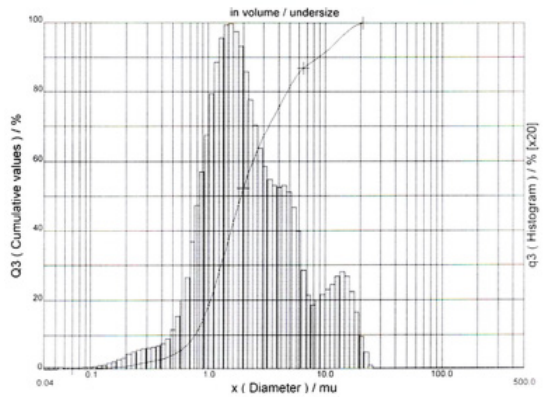

Figure 2. Viscosity measurement of fresh OD formulation

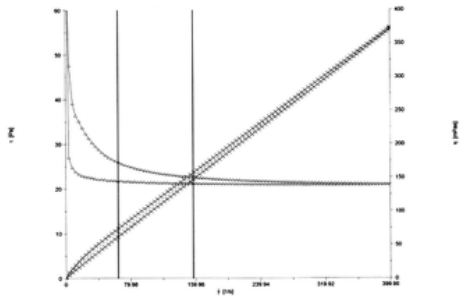

Figure 3. Viscosity measurement of OD formulation after one week storage at 0°C

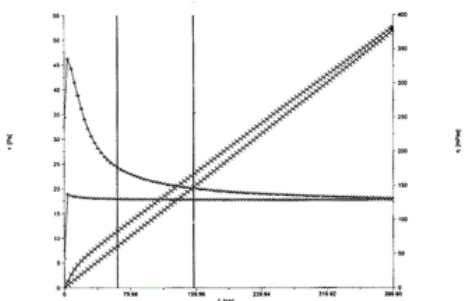

Figure 4. Viscosity measurement of OD formulation after two weeks storage at 54°C

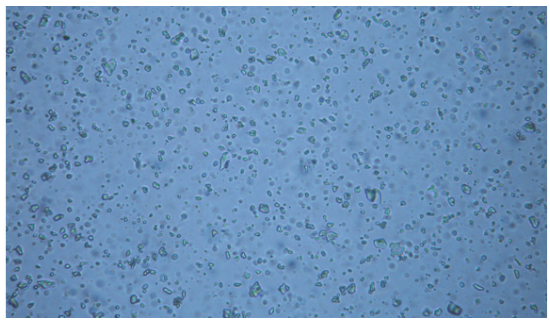

Figure 5. Aspect of aqueous dilute OD formulation of abamectin

of the active ingredient and also the extent of any interaction between the clay-based structuring agent and surface active materials. Inconsistencies in viscosity are commercially unacceptable, causing problems in formulating oil dispersions and in handling and applying them. That is why we tried to provide oil dispersion of more consistent viscosity and it was carefully adapted.

Oil dispersion are instable systems, therefore after storage it may be necessary to re-homogenize the formulation, either by shaking or by stirring. If oil dispersion does not have good balance between the ingredients then it has a tendency to settle into dense deposit, and the crystal size frequently grows. Such formulation can be resuspended and diluted only with difficulty and is inconvenient for spraying because large particles clog the nozzles.

The results showed that particle size distribution varied from 3.42 μm to 3.63 μm. Variation of density was 0.9245-0.9358 g/cm^3. pH value varied from 5.3 to 5.9, and at these pH values the active material is stable (Tomlin, 2009). Persistent foam varied from 10-24 cm^3. Visual aspect of aquous diluted OD formulation showed very fine suspended particles (Figure 5). The content of active substance did not change by more than 3%. These differences are considered to be acceptable (Anonymous, 2010). Also no important changes of viscosity occurred during storage, 172.5 m Pas - 186.5 m Pas (Figures 2-4).

The oil dispersion (OD) of Abamectin after measurements of all controlling parameters seems to be stable. Special attention was paid to viscosity measurements as viscosity measurement could provide more information on the rheological behavior of the oil dispersion (Kuide et al., 2010). The viscosity was adapted to obtain a compromise between low viscosity and good stability. All measured parameters were relatively stable. Like SC formulations, this formulation did not disperse as spontaneously as emulsifiable concentrates during dilution in water. Therefore, spray solution has to be stirred to obtain a homogeneous dispersion prior to application. The next step should be application of prepared OD formulation to check its efficacy.

ACKNOWLEDGMENT

The authors are grateful to the Ministry of Education and Science of the Republic of Serbia for financial support (Project No. III 46008).

REFERENCES

Anonymous: Manual on Development and Use of FAO and WHO specification for Pesticides (Second Revision of the First Edition). Food and Agriculture Organization (FAO), Rome, Italy, 2010.

CIPAC: CIPAC Handbook – Volume F. Physico-Chemical Methods for Technical and Formulated Pesticides (Dobrat W. and Martin A., eds.), Collaborative International Pesticides Analytical Council Ltd., Harpenden, Herts, UK, 1995.

Gašić, S. and Brkić, D.: Oil dispersion of active ingredient abamectin in insecticide and acaricide raspberry protection. Book of Abstract International *Rubus* & *Ribes* Symposium, Zlatibor, Serbia, 2011, p. 89.

Jane, W.K. and Mark, R.J.: Formulations. US Patent Applicatuion 20100331187 Syngenta Crop Protection, 2010.

Knowles, A.: New Developments in Crop Protection Product Formulation. T&F Informa UK Ltd. 2005.

Knowles, A.: Adjuvants and Additives. T&F Informa UK Ltd. 2006.

Kuide, Q., Nelson, K.F. and Paige, O.M.: Assessment of Oil Dispersion Pesticide Formulations Using Rheology and Near Infrared Centrifugation Techniques. SEDL, 7 No.10, 2010.

Mollet, H. and Grubenmann, A.: Formulation Technology. Wiley-VCH Verlag GmbH & Co. KgaA, Weinhein, Germany, 2001.

Tadros,T.F.: Applied Surfactants. Wiley-VCH Verlag GmbH & Co. KgaA, Weinhein, Germany, 2005. pp 187-256.

Tomlin, C.D.S. (Ed.): The Pesticide Manual – A World Compendium (15th Edition). British Crop Production Council (BCPC), Omega Park, Alton, Hampshire GU34 2QD, UK, 2009.

Vernner, R. and Bauer, P.: Q-TEO, a formullation concept that overcomes the incompability between water and oil. Pfalzenschuty-Nachrichten Bayer, 60(1): 7-26, 2007.

Wang, C.J. and Liu, Z.Q.: Foliar aptake of pesticides – Present status and future challenge. Pesticide Biochemestry and Physiology, 87: 1-8, 2007.

Uljna disperzija sa abamektinom kao aktivnom materijom

REZIME

Aktivna materija abamektin ispoljava insekticidno i akaricidno dejstvo, a na našem tržištu se pretežno nalazi formulisana u obliku koncentrata za emulziju (EC). Da bi se povećala efikasnost preparata najćešće se preporučuje njegova primena sa nekim ađuvantom, uglavnom uljem biljnog ili mineralnog porekla. Da bi se prevazišli problemi oko efikasnosti ove aktivne materije, pokušali smo da je formulišemo kao uljnu disperziju (OD) sa sojinim uljem kao disperznom sredinom. Sadržaj aktivne materije u formulaciji iznosio je 1,8%. Razvijena formulacija je ispitivana praćenjem relevantnih parametara i na osnovu dobijenih rezultata zaključeno je da ima potrebnu stabilnost. U narednoj fazi predstoji ispitivanje formulacije pri primeni, odnosno provera efikasnosti.

Ključne reči: Abamektin; uljna disperzija; ađuvanti; sojino ulje