Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(3): 273-275
Received: 28-03-2017
Accepted: 29-04-2017

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Physical compatibility of agro-chemicals in laboratory

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Abstract
Experiment was conducted at Department of Agricultural Entomology, University of Agricultural Sciences, Dharwad to assess the compatibility of some agrochemicals. The physical stability in terms of emulsion stability of thiamethoxam 25 WG, acetamiprid 20 SP, profenofos 50 EC, diafenthiuron 50 WP, spinetoram 12 SC and nimbecidine when mixed with other agrochemicals *viz.*, carbendazim 50 WP, copper oxychloride 50 WP, $MgSO_4$ and NAA revealed creamy matter or sediment formation not attained more than 2.0 ml at each top or bottom of the 100 ml cylinder. Formation of sedimentation in treatments with nimbecidine + copper oxychloride and copper oxychloride alone was the result of increase in pH values (> 7) which has shown alkaline condition as compared to all other treatments. The alkaline conditions might be the reason for the degradation of chemicals, it indicating that the chemicals were susceptible to alkaline decomposition. The inability of mixture of agrochemicals to form sediments or creamy matter indicates their compatibility with each other.

Keywords: Agrochemicals, Compatibility

1. Introduction
It is often economical and convenient to apply a mixture of two or more pesticides and nutrients when a wide range of pests or maladies are to be managed. This saves time, labour and cost which are the three major valuable inputs in agricultural systems nowadays. Physical incompatibilities usually show up as a precipitation in the spray solution. Hence, knowledge on the physical compatibility of mixtures is necessary. In this background, an experiment was designed to know the physical compatibility of few selected agrochemicals at laboratory level before their usage in the field.

2. Materials and Methods
The studies were carried out at Department of Agricultural Entomology, University of Agricultural Sciences, Dharwad, Karnataka during 2014–2015. Observations on the physical stability of agrochemicals (Table 1) were examined individually and in combinations using emulsion stability test as prescribed by Indian Standards specifications (IS, 1973) and also pH of all the treatments (Table 2) was measured by using pH meter under laboratory conditions.

2.1 Emulsion Stability Test Procedure
Standard hard water was prepared by dissolving 0.304g anhydrous calcium chloride ($CaCl_2$) and 0.139g magnesium chloride ($MgCl_2$) in one liter of distilled water. This solution had hardness equivalent of 342 ppm calcium carbonate and was used to prepare the insecticide test solutions. To such formulated insecticide suspension (30ml), 30ml of either of the proposed combination chemical (carbendazim or copper oxychloride or NAA or $MgSO_4$) was added separately and transferred to a clean dry graduated cylinder and the volume was made upto 100ml with standard hard water. The mixture was shaken well and kept in a thermostat at 30±1 °C for 1 h without any disturbance. The observations were taken visually on the formation of creaming matter or sediment not exceeding 2.0 ml at the top or bottom of the 100 ml cylinder, respectively which was considered as the criteria for the compatibility.

2.2 Procedure for Measurement OF Ph
After turn on the pH meter, the pH value was adjusted to 7 by immersing pH probe and temperature probe in distilled water, which was used as reference. The measurement of the pH of a solution was dependant on the temperature of the solution, so the temperature probe was positioned close to the pH probe for accurate readings. The standard reference temperature used for calibration was 25 ºC.
For taking observations, electrode was submerged along with temperature probe in the sample of pesticide solutions and stirred for a few seconds, further allowed the values to stabilize and

finally recorded readings. Similarly, pH values were observed in all pesticide solutions (Table 2) by rinsing the probe with distilled water before taking the pH readings. The observations were taken on pH of all pesticide mixtures before and after subjecting samples to emulsion stability test.

3. Results and Discussion

Investigations were carried out to study the physical stability in terms of emulsion stability on six insecticides tested *viz*., thiamethoxam 25 WG , acetamiprid 20 SP, profenofos 50 EC, diafenthiuron 50 WP, spinetoram 12 SC and Nimbecidine with other agrochemicals like carbendazim 50 WP, copper oxychloride 50 WP, NAA and $MgSO_4$ with a total of thirty five combinations (Table 1). The results revealed that the treatments having carbendazim 50 WP, copper oxychloride 50 WP combinations shown sedimentation at each end of cylinder compared to rest of the combinations (NAA and $MgSO_4$). But however, the sedimentation level had not crossed 2.0ml and hence, it would not pose significant effect on emulsion stability criteria. Hence, none of the mentioned agrochemical mixtures produced creaming matter or sediment i.e. more than 2.0 ml at each top or bottom of the 100 ml cylinder, respectively. Hence all treatments were physically compatible with each other. The results are in agreement with the reports of Stanley (2010) [5] who noted that combination of diafenthiuron with carbendazim or copper oxychloride did not show any sediment or creamy matter.

The treatments nimbecidine + copper oxychloride and copper oxychloride alone varied in the pH values in the span of 1 hour *i.e.* before and after incubation, which ranged from 6.28 - 7.59 and 6.75 - 7.85, respectively (Table 2). In both the treatments, there was an increase in pH values above 7.0 compared to all other treatments *i.e.* solutions were showing alkaline condition, after volumetric cylinder subjected to 1 hour of incubation. The alkaline condition of hard water (7.26 - 7.20), which was used as solvent for preparation of test chemicals didn’t affect the pH values of all the chemical mixtures except nimbecidine + copper oxychloride and copper oxychloride. Alkaline condition has influenced the degradation of chemical mixtures, which lead to the formation of higher amount of sedimentation in nimbecidine + copper oxychloride and copper oxychloride alone treatments i.e. these chemicals were susceptible to alkaline decomposition. In all other treatments, the pH values were more or less equal to the neutral pH, though some of treatments shown pH above 7.0, there was no much degradation of chemical mixtures and formation of sedimentation. It indicates that all the chemical treatments were resistant to alkaline degradation. The outcome of present study are in line with the findings of Seaman and Riedl (1976) [4] who revealed that azadirachtin (Azatin XL) should be maintained at pH 3-7 and applied soon after mixing which otherwise will rapidly hydrolyzes in more acidic or alkaline conditions. The copper oxychloride was largely stable in neutral media, but decomposes by warming in alkaline media and yields oxides as reported by Richardson (1997) [3]. Further, Morrissey *et al.* (2015) [2] reported that all neonicotinoids have long half-lives in soil and in water, where they are resistant to hydrolysis at neutral or acidic pH or low alkaline conditions.

The results proved that all the tested treatments were physically compatible with each other and hence, these combinations can be takeover to the semi-field and field conditions for further tests like biological and phytotoxic compatibility studies.

Table 1: Physical compatibility of agrochemicals by emulsion stability test

Treat ment No.	Treatments	Dosage (g/ml)	Sediment at the bottom (ml)	Emulsion at the top (ml)	Compatibility reaction
T_1	Thiamethoxam 25 WG	0.2 g	0.0	0.0	Compatible
T_2	Thiamethoxam 25 WG + Carbendazim 50 WP	0.2 g + 1.0 g	0.03	0.0	Compatible
T_3	Thiamethoxam 25 WG + Copper oxychloride 50 WP	0.2 g + 2 g	0.05	0.0	Compatible
T_4	Thiamethoxam 25WG + NAA	0.2 g + 20 ppm	0.0	0.0	Compatible
T_5	Thiamethoxam 25 WG + $MgSO_4$	0.2 g + 10 g	0.0	0.0	Compatible
T_6	Profenofos 50 EC	2 ml	0.01	0.0	Compatible
T_7	Profenofos 50 EC + Carbendazim 50 WP	2 ml + 1.0 g	0.10	0.0	Compatible
T_8	Profenofos 50 EC + Copper oxychloride 50 WP	2 ml + 2 g	0.10	0.0	Compatible
T_9	Profenofos 50 EC + NAA	2 ml + 20 ppm	0.01	0.0	Compatible
T_{10}	Profenofos 50 EC + $MgSO_4$	2 ml + 10 g	0.0	0.0	Compatible
T_{11}	Spinetoram 12 SC	1 ml	0.0	0.0	Compatible
T_{12}	Spinetoram 12 SC + Carbendazim 50 WP	1 ml + 1.0 g	0.05	0.0	Compatible
T_{13}	Spinetoram 12 SC + Copper oxychloride 50 WP	1 ml + 2 g	0.0	0.0	Compatible
T_{14}	Spinetoram 12 SC + NAA	1 ml + 20 ppm	0.0	0.0	Compatible
T_{15}	Spinetoram 12 SC + $MgSO_4$	1 ml + 10 g	0.10	0.0	Compatible
T_{16}	Diafenthiuron 50 WP	0.6g	0.02	0.0	Compatible
T_{17}	Diafenthiuron 50 WP + Carbendazim 50 WP	0.6g + 1.0 g	0.05	0.0	Compatible
T_{18}	Diafenthiuron 50 WP + Copper oxychloride 50 WP	0.6g + 2 g	0.10	0.0	Compatible
T_{19}	Diafenthiuron 50 WP + NAA	0.6g + 20 ppm	0.0	0.0	Compatible
T_{20}	Diafenthiuron 50 WP + $MgSO_4$	0.6g + 10 g	0.0	0.0	Compatible
T_{21}	Acetamiprid 20 SP	0.2 g	0.0	0.0	Compatible
T_{22}	Acetamiprid 20 SP + Carbendazim 50 WP	0.2 g + 1.0 g	0.05	0.0	Compatible
T_{23}	Acetamiprid 20 SP + Copper oxychloride 50 WP	0.2 g + 2 g	0.10	0.0	Compatible
T_{24}	Acetamiprid 20 SP + NAA	0.2 g + 20 ppm	0.0	0.0	Compatible
T_{25}	Acetamiprid 20 SP + $MgSO_4$	0.2 g + 10 g	0.0	0.0	Compatible
T_{26}	Nimbecidine	5 ml	0.0	0.0	Compatible
T_{27}	Nimbecidine + Carbendazim 50 WP	5 ml + 1.0 g	0.10	0.0	Compatible
T_{28}	Nimbecidine + Copper oxychloride 50 WP	5 ml + 2 g	0.15	0.0	Compatible
T_{29}	Nimbecidine + NAA	5 ml + 20 ppm	0.0	0.0	Compatible
T_{30}	Nimbecidine + $MgSO_4$	5 ml + 10 g	0.02	0.0	Compatible
T_{31}	Carbendazim 50 WP	1.0 g	0.10	0.0	Compatible

T_{32}	Copper oxychloride 50 WP	2 g	0.15	0.0	Compatible
T_{33}	NAA	20 ppm	0.0	0.0	Compatible
T_{34}	$MgSO_4$	10 g	0.0	0.0	Compatible
T_{35}	Untreated check		-	-	-

Table 2: Changes in pH due to combination of Agrochemicals

Treat ment No.	Treatments	Dosage (g/ml)	Before incubation	After incubation
T_1	Thiamethoxam 25 WG	0.2 g	6.70	6.79
T_2	Thiamethoxam 25 WG + Carbendazim 50 WP	0.2 g + 1.0 g	6.69	6.74
T_3	Thiamethoxam 25 WG + Copper oxychloride 50 WP	0.2 g + 2 g	6.54	6.65
T_4	Thiamethoxam 25WG + NAA	0.2 g + 20 ppm	6.58	6.75
T_5	Thiamethoxam 25 WG + $MgSO_4$	0.2 g + 10 g	5.85	6.32
T_6	Profenofos 50 EC	2 ml	6.58	7.43
T_7	Profenofos 50 EC + Carbendazim 50 WP	2 ml + 1.0 g	6.81	7.11
T_8	Profenofos 50 EC + Copper oxychloride 50 WP	2 ml + 2 g	6.73	7.03
T_9	Profenofos 50 EC + NAA	2 ml + 20 ppm	6.94	7.15
T_{10}	Profenofos 50 EC + $MgSO_4$	2 ml + 10 g	5.8	6.93
T_{11}	Spinetoram 12 SC	1 ml	7.10	7.83
T_{12}	Spinetoram 12 SC + Carbendazim 50 WP	1 ml + 1.0 g	6.80	7.43
T_{13}	Spinetoram 12 SC + Copper oxychloride 50 WP	1 ml + 2 g	6.78	7.33
T_{14}	Spinetoram 12 SC + NAA	1 ml + 20 ppm	6.52	7.38
T_{15}	Spinetoram 12 SC + $MgSO_4$	1 ml + 10 g	5.45	6.95
T_{16}	Diafenthiuron 50 WP	0.6g	6.90	7.30
T_{17}	Diafenthiuron 50 WP + Carbendazim 50 WP	0.6g + 1.0 g	6.75	6.98
T_{18}	Diafenthiuron 50 WP + Copper oxychloride 50 WP	0.6g + 2 g	6.65	7.00
T_{19}	Diafenthiuron 50 WP + NAA	0.6g + 20 ppm	6.41	6.80
T_{20}	Diafenthiuron 50 WP + $MgSO_4$	0.6g + 10 g	5.52	6.05
T_{21}	Acetamiprid 20 SP	0.2 g	6.83	7.03
T_{22}	Acetamiprid 20 SP + Carbendazim 50 WP	0.2 g + 1.0 g	6.81	7.09
T_{23}	Acetamiprid 20 SP + Copper oxychloride 50 WP	0.2 g + 2 g	7.10	7.65
T_{24}	Acetamiprid 20 SP + NAA	0.2 g + 20 ppm	6.9	7.07
T_{25}	Acetamiprid 20 SP + $MgSO_4$	0.2 g + 10 g	5.18	6.65
T_{26}	Nimbecidine	5 ml	5.79	6.21
T_{27}	Nimbecidine + Carbendazim 50 WP	5 ml + 1.0 g	6.21	6.32
T_{28}	Nimbecidine + Copper oxychloride 50 WP	5 ml + 2 g	6.28	7.59
T_{29}	Nimbecidine + NAA	5 ml + 20 ppm	6.06	6.12
T_{30}	Nimbecidine + $MgSO_4$	5 ml + 10 g	5.54	6.60
T_{31}	Carbendazim 50 WP	1.0 g	6.55	6.75
T_{32}	Copper oxychloride 50 WP	2 g	6.75	7.85
T_{33}	NAA	20 ppm	6.27	6.50
T_{34}	$MgSO_4$	10 g	4.60	5.50
T_{35}	Untreated check	-	7.26	7.20

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