RESEARCH ARTICLE Legume Research- An International Journal, Volume 47 Issue 2: 284-290 (Fabruary 2024)

Bio-efficacy of Plants based Formulations for the Management of Cowpea Aphid (*Aphis craccivora* Koch.)

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10.18805/LR-4636

ABSTRACT

Background: The cowpea (*Vigna unguiculata*) is damaged by various insect pests of which cowpea aphid (*Aphis craccivora*) causes heavy damage to the tender leaves of the plant and reduces its yield. Two plant based formulation (prepared in the Chemistry Laboratory) *viz. Polygonum hydropiper* floral parts and Tobacco (*Nicotiana tabacum*) leaf, were used for safe management.

Methods: The studies were done during 2019-2020 in BCKV, Kalyani, West Bengal, India for controlling of cowpea aphid by using plant based formulation. For preparing wettable powder formulation from *Polygonum hydropiper* floral parts and tobacco leaf the different ingredients are required *viz.* china clay, silica gel, wetting agent, dispersing agent *etc.* Physico-chemical analysis was done for preparation of accurate Wettable Powder formulation.

Result: Cowpea aphid causes damage the tender leaves of the plant. It was revealed that imidacloprid (Confidor 17.8 SL) @ 1.0 ml/3L was found the most effective treatment against aphids giving more than 80% control followed by tobacco leaf (50 WP) @ 8 g/L of water (more than 70% control), fipronil (Regent 5% SC) @ 2.5 ml/L of water and *Polygonum* floral parts (50 WP) @ 8 g/L of water (more than 65% control both). The quality parameters of WP (50%) formulation was satisfactory as per the FAO specifications in terms of wet sieved test, wettability, foaming and suspensibility performed on the 0-day and also after 15th day at room temperature, at 65°C and at freezing temperature conditions.

Key words: Bio-pesticides, Botanical formulation, Organic cultivation, Vegetables.

INTRODUCTION

The cowpea (*Vigna unguiculata*), an annual herbaceous legume, is grown as vegetable crop in the semiarid regions. It is also grown for its edible legumes. In addition to their use as a protein-rich food crop, cowpeas are extensively grown as a hay crop and as a green manure or cover crop. Aphid (*Aphis craccivora*) directly feeds on legume crops and also causes damage by transmits viral diseases. This insect pest multiplies rapidly in late spring and its population increases with the increase in temperature (Singh *et al.*, 2000). Severe infestations of this pest cause stunting, crinkling and curling of leaves, delayed flowering which results in reduction of yield. Aphid secretes honey dew which favours the growth of sooty mould on leaves as well as on climbers and reduces the photosynthetic efficiency. It is very difficult to control virus diseases because of complex interrelationships among virus, host (Sorensen and Baker, 1983).

Farmers are dependent on chemical pesticides to which pests develop resistance (Osteen and Szmedra,1989). *A. craccivora* develops resistance to most of the pesticides (Mokbel and Mohamed, 2009). The indiscriminate use of pesticides has lead to problems of pesticide resistance, resurgence and contamination of the environment (Dhaliwal and Kour, 2010). Plant extracts act in different ways for pest control *viz.* feeding deterrents, insect growth regulators (IGR), repellents and confusants (Schmutterer, 1990). *Polygonum* is a well known weed in West Bengal, India locally known as “Biskanthali” (Sarkar and Mukherjee, 2005). Badshah *et al.* (2005) reported that crude leaf and flower extracts of *Polygonum hydropiper* were responsible for mortality rates 10 days after feeding of 28% and 52% for *Heterotermes indicola*. Generally, tobacco plant (*Nicotiana tabacum* L.) contain the chemical, nicotine varies from 5-10% in the leaves (Thacker, 2002). Nicotine, an alkaloid extracted from *Nicotiana tabacum*, is well known plant based insecticide (Ujvary, 1999). Its efficacy against soft-bodied insects *viz.* Aphids, whitefly, thrips is well known. Nicotine was found to be toxic to eggs and neonate larvae of *Helicoverpa armigera* and *Spodoptera litura* and also effective against whitefly (Dhaliwal and Arora, 2001). The *Polygonum* extracts and tobacco extracts were moderately effective against aphids providing 63.49% and 60.54% control respectively (Ghosh, 2017). Imidacloprid 30.5 SC @ 160 ml/ha resulted 88.73% aphid control (Thakoor *et al.*,

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How to cite this article: Ghosh, S.K. (2024). Bio-efficacy of Plants based Formulations for the Management of Cowpea Aphid (*Aphis craccivora* Koch.). Legume Research. 47(2): 284-290. doi: 10.18805/LR-4636.

Submitted: 15-04-2021 **Accepted:** 23-07-2021 **Online:** 11-08-2021

2019). Immidacloprid provided more than 80% aphid (*Aphis craccivora*) control on som plant *(Machilus bombycina*) followed by *Polygonum hydropiper* flower extract (>60% suppression) (Ghosh *et al.,* 2016). Acharya *et al*. (2002) reported that the bio-efficacy of imidacloprid was safer to beneficial insects. Hence, the objective of the research is preparation of plant based formulation from locally available plants and to evolve a safe pest management programme.

MATERIALS AND METHODS

Study period and location

The field experiment was conducted in the farm of BCKV-Agriculture University, Kalyani, West Bengal, India in pre-kharif during 2019-2020. The geographical details of the site are 23° N latitude, 89° E longitude and 9.75 meter above mean sea level (Thakoor *et al*., 2020). The soil was typically gangetic alluvial (Entisol) with sandy clay loam texture, neutral in reaction and moderate in fertility. Soil PH ranges 5.75 to 6.5 (Priyadarsini *et al.,* 2019). The climate of this zone is subtropical humid. The formulation was prepared in the Chemistry Laboratory of BCKV.

Development of wettable powder formulation (50% WP) from polygonum and tobacco

Wettable powders are finely-divided solid pesticide formulations which are applied after dilution and suspension in water. The process for preparation of wettable powder formulations of botanicals comprises a number of steps. Collected the botanicals from crops field and then dried up in a shaded area. Grinding the botanicals plant and mixing the inert filler under slow mixing in a blender. Adding wetting, dispersing, antifoaming agents and fillers and micronizing the powder by a grinder. Sieving the product in the range 75 um mesh size to get wettable powder.

Compositions of wettable powder formulation (50% WP) from polygonum and tobacco

For preparing wettable powder formulation of herbal pesticide from *Polygonum hydropiper* floral parts and tobacco (*Nicotiana tabacum*) leaf the different ingredients are required *viz.* china clay, silica gel, wetting agent, dispersing agent *etc.* Compositions of wettable powder formulation (50% WP) from *Polygonum* and tobacco are presented in Table 1 and Table 2 respectively.

Physico-chemical analysis

Identity

50% WP formulation of *Polygonum* and tobacco will be in the form of a fine powder free from visible extraneous matter and hard lumps.

Particle size: (**Wet sieve test and Particle size distribution)**

Pre weighted (2 g) powder of botanical sample was taken in a previously weighted 75 µm sieve and placed under tap water with gentle flow for 60 second. Then it was dried in a hot air oven (70°C) for 24 hours and weight taken. Difference of these two weights should be below 2% according to FAO specification.

Particle size of the WP formulation of the botanical sample was analyzed by particle size analyzer (Malvern, Mastersizer 2000, Version 5.60, serial no MAL1029349, UK) from Institute of Pesticide Formulation Technology (Gurugram, Haryana, India).

Wettability test

WP formulation of botanical sample (1 g) was taken in beaker containing 100 mL hard water. The time to get w*et* all powder in water was noted.

Foaming test

Pre weighted WP taken in a 100 mL Measuring cylinder with a stopper containing 100 mL standard hard water (342 ppm). Then the cylinder was inversed 180° for 30 times within 2 minutes. Then foam height at the top layer was taken after 1 minute.

Suspensibility test

After taken foam height cylinder was left undisturbed for 30 minutes. After removing the top 90 mL suspension with the help of suction pump, the precipitate was taken in a pre weighted beaker and dried at 70°C to constant weight.

$$\text{Suspensibility percentage calculated} = \frac{1000\ (M-m)}{9M}$$

Where,
M = Initial weight of WP formulation.
m = Weight of precipitated WP formulation.

Storage stability

After storage at three condition at below 10°C, at room temperature (25°C) and at 54±2°C for 14th days, the determined average active ingredient content must not be lower than 97% relative to the determined average content

Table 1: Compositions of wettable powder formulation (50% WP) from *Polygonum.*

Ingredients	% w/w
Powder of *Polygonum hydropiper* floral part	50 gm.
China clay	26 gm.
Silica gel	8 gm.
Wetting agent	7 gm.
Dispersing agent	9 gm.
Total	100 gm.

Table 2: Compositions of wettable powder fsormulation (50% WP) from tobacco.

Ingredients	% w/w
Powder of tobacco *(Nicotiana tabacum)* leaves	50 gm.
China clay	28 gm.
Silica gel	9 gm.
Wetting agent	7 gm.
Dispersing agent	6 gm.
Total	100 gm.

found before storage and the formulation should meet again same result for wet sieve test, suspensibility, wettability, *etc.*

Bio efficacy evaluation of plant based formulation against aphid (*Aphis craccivora*)

Cultivation practices

These two years study was done against cowpea aphid in rice-wheat cropping system after harvesting of wheat and before rice sowing. Cowpea variety "Kashi Kanchan" was grown under recommended fertilizers and cultural practices. Spacing was taken as 20 cm × 30 cm in 5 m × 5 m sized plots with three replications. The 1st season study during pre-*kharif*-2019 was done as, date of showing on 02/02/2019 and the 2nd season study during pre- *kharif*-2020 was done as, date of showing on 20/2/2020.

Treatments details

Two botanical formulation (prepared in the Chemistry Laboratory), *Polygonum hydropiper* floral parts and Tobacco leaf, three treatments for both cases were evaluated and compared with the chemical insecticides, Fipronil (Regent 5% SC) and Imidacloprid (Confidor 17.8 SL).

Treatments details are as follows:

Treatments	Dose ml or g/L
Polygonum hydropiper (50% WP) (T1)	2.0 g/L
Polygonum hydropiper (50% WP) (T2)	4.0 g/L
Polygonum hydropiper (50% WP) (T3)	8.0 g/L
Tobacco (*Nicotiana tabacum)* (50% WP) (T4)	2.0 g/L
Tobacco (*Nicotiana tabacum)* (50% WP) (T5)	4.0 g/L
Tobacco (*Nicotiana tabacum)* (50% WP) (T6)	8.0 g/L
Fipronil (Regent 5% SC) (T7)	2.5 ml/L
Imidacloprid (Confidor 17.8 SL) (T8)	1.0 ml/3L
Untreated control (T9)	Fresh water spray

Data recording

There were three sprays at 12 day intervals in this study. Aphid population was recorded at 3, 7 and 11 days after spraying. Five plants were selected randomly from each plot. Aphid population per leaf from bottom, middle and top leaves was recorded. The results were presented as pest population suppression per cent with comparison to densities on the controlled plot by following the Abbott's formula (Abbott, 1925):

$$\text{Per cent reduction over control} = \frac{\text{Per cent reduction in treatment - Per cent reduction in control}}{\text{100 - Per cent reduction in control}} \times 100$$

Randomized block design (RBD) were followed in this study. Data were analyzed by using INDO-STAT- software for analysis of variance. Treatment means were separated by applying CD Test (critical difference) at 5% level of significance.

RESULTS AND DISCUSSION

Bio-efficacy evaluation of plant based formulation against aphid (*Aphis craccivora*)

Among the treatments studied (Table 3), imidacloprid (Confidor 17.8 SL) @ 1.0 ml/L of water seemed most effective against aphid recording 81.43% suppression, closely followed by tobacco leaf (*Nicotiana tabacum*) (50 WP) @ 8 g/L of water providing 71.09% suppression. It was also found that fipronil (Regent 5% SC) @ 2.5 ml/L provided better control of aphid population (68.29% suppression) closely followed by *Polygonum* floral parts (50 WP) @ 8 g/L of water providing 65.51% suppression. From over all observation it was found that plant based formulation tobacco leaf (50 WP) @ 4 g/L of water and *Polygonum* floral parts (50 WP) @ 4 g/L of water, provided moderate results, recording about 53.11% and 51.25% aphid suppression respectively. Least effectiveness against aphids was found from tobacco leaf (50 WP) @ 2 g/L of water and *Polygonum* floral parts (50 WP) @ 2 g/L of water. These findings are supported by Ghosh *et al.* (2016) and they reported that imidacloprid was the most effective treatment in providing more than 80% aphid suppression on som plant followed by *Polygonum* extract (>60% suppression).

Three days after spraying (Table 3), imidacloprid (Confidor 17.8 SL) @ 1.0 ml/3L of water seemed most effective against aphids providing 79.66% suppression, closely followed by tobacco leaf (50 WP) @ 8 g/L of water providing 73.11% suppression. There were no significant differences among these two treatments. Fipronil (Regent 5% SC) @ 2.5 ml/L also provided better control of aphid population (71.61% suppression) closely followed by *Polygonum* floral parts (50 WP) @ 8 g/L of water providing 64.27% suppression. There were no significant differences among these two treatments. Seven days after spraying, imidacloprid seemed superior insecticide (83.56% suppression) closely followed tobacco leaf (50 WP) @ 8 g/L of water providing 73.83% suppression. There were no significant differences among these two treatments. There were no significant differences among the three treatments of tobacco leaf (50 WP) @ 8 g/L of water, *Polygonum* floral parts (50 WP) @ 8 g/L of water and fipronil (Regent 5% SC) @ 2.5 ml/L recording 73.83%, 70.96% and 69.67% suppression respectively. Eleven days after spraying, also imidacloprid was found to be most effective treatment (81.04% suppression) against aphids. There were no significant differences among the three treatments of tobacco leaf (50 WP) @ 8 g/L of water, *Polygonum* floral parts (50 WP) @ 8 g/L of water and fipronil (Regent 5% SC) @ 2.5 ml/L recording 66.32%, 63.56% and 61.46% suppression respectively.

In the year 2019, (Table 4) imidacloprid (Confidor 17.8 SL) @ 1.0 ml/3L of water seemed most effective against aphids providing 82.49% suppression, followed by tobacco leaf (50 WP) @ 8 g/ L of water (72.66% suppression), fipronil (Regent 5% SC) @ 2.5 ml/L (69.36% suppression) and

Table 3: Overall efficacy of plant based formulation against Aphid (*Aphis craccivora* Koch.) on cowpea (Grand mean of 2019 and 2020).

Treatments	Dose	Pre-treatment	Overall efficacy (Grand mean of 2019 and 2020)			
	Ml or g/Litre	Obs. Aphid/Leaf	3 DAT	7 DAT	11 DAT	Mean
Polygonum (50% WP)	2.0 g/L	5.50	38.68	43.06	37.43	39.72
(T1)			(38.38)	(41.64)	(37.68)	(39.23)
Polygonum (50% WP)	4.0 g/L	5.83	49.93	55.65	48.15	51.25
(T2)			(44.33)	(48.59)	(43.88)	(45.61)
Polygonum (50% WP)	8.0 g/L	5.61	64.27	70.96	61.46	65.51
(T3)			(51.27)	(56.97)	(51.57)	(53.27)
Tobacco (50% WP))	2.0 g/L	5.61	41.07	42.26	37.67	40.34
(T4)			(39.61)	(40.13)	(37.85)	(39.20)
Tobacco (50% WP)	4.0 g/L	5.51	55.11	55.15	49.07	53.11
(T5)			(48.05)	(48.09)	(43.89)	(46.67)
Tobacco (50% WP)	8.0 g/L	6.05	73.11	73.83	66.32	71.09
(T6)			(58.12)	(58.94)	(54.33)	(57.13)
Fipronil (Regent 5% SC)	2.5 ml/L	5.36	71.61	69.69	63.56	68.29
(T7)			(57.68)	(55.33)	(53.02)	(55.35)
Imidacloprid (Confidor 17.8 SL)	1.0 ml/3L	5.06	79.66	83.56	81.04	81.43
(T8)			(63.05)	(66.36)	(64.13)	(64.52)
Untreated control (T9)	-	5.50	0.00	0.00	0.00	-
			(4.05)	(4.05)	(4.05)	
S Em (±)	-	-	1.70	1.98	1.78	-
CD at 5%	-	NS	5.09	7.43	5.28	-

Figure in the parenthesis are angular transformed values, DAT = Days after treatment, NS = Not significant.

Polygonum floral parts (50 WP) @ 8 g/L of water (66.24% suppression. In the year 2020, (Table 4) imidacloprid (Confidor 17.8 SL) @ 1.0 ml/3L of water seemed most effective against aphids providing 80.36% suppression, followed by tobacco leaf (50 WP) @ 8 g/L of water (69.52% suppression), fipronil (Regent 5% SC) @ 2.5 ml/L (67.22 % suppression) and *Polygonum* floral parts (50 WP) @ 8 g/L of water (64.77% suppression.

From the overall observations of the studies it was revealed that imidacloprid (Confidor 17.8 SL) @ 1.0 ml/3L was found the most effective treatment against aphids giving more than 80% control followed by tobacco leaf (50 WP) @ 8 g/L of water (more than 70% control), fipronil (Regent 5% SC) @ 2.5 ml/L and *Polygonum* floral parts (50 WP) @ 8 g/L of water (more than 65% control both). Tobacco and *Polygonum* are bio-pesticides; plant based formulation and may be used as alternative of chemical pesticides. The treatments *Polygonum* plant extracts and tobacco extracts were effective against aphids providing 63.49% and 60.54%, control respectively (Ghosh, 2017). But imidacloprid and fipronil both are toxic synthetic chemical insecticide, so there is every possibility to contaminate vegetables with the toxic chemicals. As cowpea is vegetables and consumed after little cooking faces problems for using of chemical pesticides. So we can avoid the use of toxic insecticides like imidacloprid, fipronil and other chemical insecticides. Das *et al.* (2010) reported that a rapid degradation was found in imidacloprid and neem oil. So imidacloprid as small amount may be recommended mixing with plant based insecticides for general use of aphid control in cowpea for its higher efficacy and rapid degradation. Rahardjo *et al*. (2020) reported that the application of plant extract that has an insecticidal effect is considered as one promising alternative in reducing the negative effects of synthetic pesticides.

Test result of physico-chemical properties of plant based formulation of tobacco WP (50%) and *Polygonum* WP (50%)

An attempt has been made to prepare wettable powder (WP) formulation of *Polygonum hydropiper* floral parts and Tobacco leaf. Solid active ingredients with high melting points are used for WP formulations which are suitable for dry grinding through a mechanical grinder such as a hammer or pin type mill. WP usually contains dry surfactants such as powder wetting and dispersing agents and inert carriers or fillers. They frequently contain more than 50% active ingredient and the upper limit is usually determined by the amount of inert material such as silica required to prevent the active ingredient particles aggregating together during processing in the dry grinding mills. Inert filler such as kaolin or talc is also needed to prevent the formulated product from caking or aggregating during storage.

Wettable Powder formulation of *Polygonum* floral parts and Tobacco leaf (50% WP) was prepared by adsorbing it in precipitated silica. However, the quality of the formulation did not accurately satisfy the FAO specification for wettable powder formulation in terms of wet sieved test, wettability, foaming and suspensibility as shown in Table 1 and Table 2. Therefore, wettable powder formulationof *Polygonum* floral parts was prepared by using 50% *Polygonum* floral parts

Table 4: Efficacy of plant based formulation against Aphid (*Aphis craccivora*) on cowpea (2019 and 2020).

Treatments	Dose Ml or g/Litre	Overall efficacy (% reduction) 2019					Overall efficacy (% reduction) 2020				
		Pre-treatment Obs. Aphid/Leaf	3 DAT	7 DAT	11 DAT	Mean	Pre-treatment Obs. Aphid/Leaf	3 DAT	7 DAT	11 DAT	Mean
Polygonum	2.0 g/L	5.33	39.00	42.14	37.39	39.50	5.67	38.36	43.97	37.47	39.93
(50% WP) (T1)			(38.52)	(40.69)	(37.59)	(38.93)		(38.24)	(42.58)	(37.77)	(39.53)
Polygonum	4.0 g/L	5.33	50.48	54.47	48.97	51.31	6.33	49.39	56.83	47.34	51.19
(50% WP) (T2)			(44.82)	(48.23)	(44.39)	(45.81)		(43.85)	(48.96)	(43.38)	(45.40)
Polygonum	8.0 g/L	4.89	65.26	71.04	62.41	66.24	6.33	63.28	70.52	60.51	64.77
(50% WP) (T3)			(51.27)	(57.37)	(52.52)	(53.72)		(51.28)	(56.57)	(50.62)	(52.82)
Tobacco	2.0 g/L	5.48	41.13	41.26	38.06	40.15	5.75	41.01	43.27	37.28	40.52
(50% WP) (T4)			(39.68)	(39.62)	(38.08)	(39.13)		(39.55)	(40.65)	(37.62)	(39.27)
Tobacco	4.0 g/L	4.99	53.33	54.82	47.96	52.04	6.04	56.89	55.48	50.18	54.18
(50% WP) (T5)			(47.12)	(46.94)	(43.38)	(45.81)		(48.99)	(49.24)	(44.40)	(47.54)
Tobacco	8.0 g/L	5.67	74.11	77.58	66.28	72.66	6.44	72.12	70.06	66.37	69.52
(50% WP) (T6)			(59.13)	(61.42)	(54.29)	(58.29)		(57.12)	(56.41)	(54.37)	(55.96)
Fipronil	2.5 ml/L	5.05	73.23	72.44	62.41	69.36	5.67	70.00	66.95	64.72	67.22
(Regent 5% SC) (T7)			(59.15)	(58.11)	(51.74)	(56.33)		(56.21)	(52.56)	(54.31)	(54.36)
Imidacloprid (Confidor	1.0 ml/3L	4.67	80.88	84.25	82.33	82.49	5.46	78.44	82.87	79.76	80.36
17.8 SL) (T8)			(63.99)	(66.74)	(64.71)	(65.15)		(62.12)	(65.98)	(63.56)	(63.89)
Untreated control (T9)	-	4.67	0.00	0.00	0.00	-	6.33	0.00	0.00	0.00	-
			(4.05)	(4.05)	(4.05)			(4.05)	(4.05)	(4.05)	
S Em (±)	-	-	1.75	2.05	1.83	-	-	1.65	1.92	1.72	-
CD at 5%	-	NS	5.24	7.61	5.45	-	NS	4.94	7.25	5.12	-

Figure in the parenthesis are angular transformed values, DAT = Days after treatment, NS = Not significant.

Table 5: Test results of the physico-chemical properties of WP (50%) formulation.

Time and test condition	Parameter	Standard value as per FAO specification	WP (50%) *Polygonum* Observed value	Remarks	WP (50%) Tobacco Observed value	Remarks
0 days	Wet sieved test	<2%		Passed		Passed
	Wettability test	<60 second	90% dropping in 5 min.	Passed	90% dropping in 5 min.	Passed
	Foaming test	<24 mL	Foam <10 mL.	Passed	Foam <10 mL.	Passed
	Suspensibility test	>70%	Ability of the disperse particle to stayin suspension for adeque period of time.	Passed	Ability of the disperse particle to stay in suspension for adeque period of time.	Passed
After 15th days at room temperature	Wet sieved test	<2%		Passed		Passed
	Wettability test	<60 second	90% dropping in 5 min	Passed	90% dropping in 5 min	Passed
	Foaming test	<24 mL	Foam <10 mL.	Passed	Foam <10 mL.	Passed
	Suspensibility test	>70%	Ability of the disperse particle to stay in suspension for adeque period of time.	Passed	Ability of the disperse particle to stay in suspension for adeque period of time	Passed
After 15th day at 65°C	Wet sieved test	<2%		Not passed		Passed
	Wetability test	<60 second	90% dropping in 5 min	Passed	90% dropping in 5 min	Passed
	Foaming test	<24 mL	Foam <10 mL.	Passed	Foam <10 mL.	Passed
	Suspensibility test	>70%	Ability of the disperse particle to stay in suspension for adeque period of time.	Passed	Ability of the disperse particle to stay in suspension for adeque period of time	Passed
After 15th day at freezing temperature	Wet sieved test	<2%		Passed		Passed
	Wettability test	<60 second	90% dropping in 5 min	Passed	90% dropping in 5 min	Passed
	Foaming test	<24 mL	Foam <10 mL	Passed	Foam <10 mL	Passed
	Suspensibility test	>70%	Ability of the disperse particle to stay in suspension for adeque period of time.	Passed	Ability of the disperse particle to stay in suspension for adeque period of time.	Passed

FAO: Food and Agriculture Organisation; W.P.: Wettable powder.

powder and 8% precipitated silica to absorb the material properly along with 26% china clay used as diluents, 7% wetting agent and 9% dispersing agent. The results of qualitative and quantitative tests performed on 50% WP formulation are presented in Table 1. The wettable powder formulation of tobacco leaf was prepared by using 50% tobacco leaf powder and 9% precipitated silica to absorb the material properly along with 28% china clay used as diluents, 7% wetting agent and 6% dispersing agent. The results of qualitative and quantitative tests performed on 50% WP formulation are presented in Table 2. The quality parameters of WP (50%) formulation was satisfactory as per the FAO specifications in terms of wet sieved test, wettability, foaming and suspensibility performed on the 0-day and also after 15th day at room temperature, at 65°C and at freezing temperature conditions as shown in Table 5.

Particle size distribution of the formulation (50% WP) on 15th day was measured by Particle Size Analyser (Malvern, Mastersizer). About 90% of the particles were observed under 73.422 µm, 50% particle under 13.373 µm and 10% particle under 2.898 µm well within the specification of 75 µm (WHO).

CONCLUSION

An attempt has been made to prepare wettable powder (WP) formulation of *Polygonum hydropiper* floral parts (locally available weeds) and Tobacco leaf. The quality of the formulation satisfies the FAO specification in terms of wet sieved test, wettability, foaming and suspensibility. So this procedure may be followed for preparation of the plant based formulation of wettable powder (WP). Tobacco leaf formulation (50 WP) @ 8 g/L of water gave more than 70% control and *Polygonum* floral parts formulation (50 WP) @ 8 g/L of water gave more than 65% control. Tobacco and *Polygonum* are bio-pesticides; may be used as alternative of chemical pesticides for eco-friendly management of insect pest.

Conflict of interest

All authors declared that there is no conflict of interest.

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