

EFFICACY OF PLANT EXTRACTS AGAINST APHID LIPAPHIS ERYSIMI (KALT) IN BROWN MUSTARD BRASSICA JUNCEA L

KUNAL KAUSHIK¹ AND RAJESH KUMAR^{2*}

¹Department of Horticulture, Assam Agricultural University, Jorhat 785013, Assam, India ²Department of Horticulture, Sikkim University, East Sikkim 737102, Sikkim, India *Email: rkumar@cus.ac.in (corresponding author): ORCID ID 0000-0002-9275-8518

ABSTRACT

Brown mustard is one of the widely consumed leafy vegetables in Sikkim, India. The present investigation was an effort to find out an alternative approach to control aphid incidence organically, by using locally available plant extracts with high spray efficacy on mustard aphid *Lipaphis erysimi* (kalt) in the organic state of Sikkim. The experiment included six plant extracts viz. *Schima wallichii, Datura stramonium, Athyrium filix-femina, Piper betle, Alnus nepalensis* and *Artemisia vulgaris* along with cow urine and neem oil at two concentrations. Results revealed that maximum reduction in incidence was observed with *Schima wallichii* @5%. Growth, yield and quality components were also found to be significantly superior in the treatment with *S. wallichii*.

Key words: Efficacy, brown mustard, *Brassica juncea*, *Lipaphis erysimi*, spray, plant extracts, yield, aphid, control, *Schima wallichii*, *Datura*, *Athyrium*, *Piper*, *Alnus*, *Artemisia*, Sikkim, organic

Brown mustard (Brassica juncea L.) commonly known as Indian mustard one of the most commonly consumed leafy green vegetable crop in Sikkim. It is a fast-growing winter vegetable, and highly susceptible to aphid infestation. The state is blessed with diverse climatic condition, results in the huge genetic diversity among different vegetable crops (Debnath et al., 2020). Aphids (Hemiptera: Aphididae) are one of the primary sucking pests of crop plants, mainly attack Brassica crops. Among the aphid species, Lipaphis erysimi (Kalt) and Myzus persicae (Sulz) are the most common. Aphids also act as vectors for many disease-causing viruses and pathogens and further contribute to the vield losses. In commercial fields, Brassica pests are controlled primarily through pesticide applications (Sauckeet al., 2000). It is necessary to identify some alternative biopesticide, which can control the pest in a short period. In Sikkim, farmers are facing challenges to control the pests and diseases. Also new invasive pests like Tuta absoluta is also being reported (Kumar et al., 2020). In organic farming system, neem oil has been found to have activity against a wide range of insect pests and show both insecticidal and fungicidal properties. Being an organic state, in Sikkim, farmers frequently use the neem oil in pest management. Besides, the farmers traditionally use some locally available crude plant extracts such as Dokhrey, wild fern, wild betel vine, Utis, Titepati etc. to control insect infestation. However, these plant extracts are not used commercially as pesticides. In this study, samples of

locally available plants were collected and evaluated to determine the spray efficacy of these extracts against mustard aphid. The extracts are ecofriendly, and safe to human health. The present study highlights the potential use of ecofriendly bioproducts and their effect on growth, yield quality attributes of brown mustard.

MATERIALS AND METHODS

The experiment was carried out at the Department of Horticulture, Sikkim University, Gangtok (27.30N, 88.58E) during rabi 2020-21. Healthy and disease-free seedlings were used as planting material. The fresh leaf samples were collected from close vicinity of East District, Sikkim. These include ten plants i.e., Ageratum conyzoides, Alnus nepalensis, Ageratina adenophora, Piper betle, Athyrium filix-femina, Musa acuminata, Lantana camara, Artemisia vulgaris, Datura stramonium and Schima wallichii. The samples were cleaned, dried and made as fine powder and further subjected for qualitative preliminary phytochemical examination i.e., presence of tannins, saponins, alkaloids, flavonoids, terpenoids, glycosides, steroids and phenols, using ethanol (50%) as a solvent through standard procedure suggested by Bargah (2015) and Edeoga (2005). Aphid inoculation was done with nymphs and adults, collected from brown mustard growing region. Isolation chambers were made using insect proof net for each treatment in order to avoid entry of other insects including natural enemies, till

it colonized in the crop and crossed the economic threshold level (ETL). Within a month, the plants were equally infested and crossed ETL level. The identification of aphid was carried out by sending the adult insect sample to Department of Entomology, Dr. Y S Parmar University of Horticulture & forestry, Solan, Himachal Pradesh. A total of six plant extracts i.e., Schima wallichii, Piper betle, Alnus nepalensis, Athyrium filix-femina, Artemisia vulgaris and Datura stramonium were selected for further study based upon the results obtained through preliminary phytochemical screening. There were 16 treatments replicated thrice including six plant extracts at two concentrations i.e., 5 and 10% and cow urine (a) 5ml/ ℓ and 10 ml/ ℓ and neem oil (a) $5ml/\ell$ and $10 ml/\ell$. These treatments were sprayed on both sides of the leaves during the morning hours with hand sprayers. Total three sprays were given in the interval of seven days.

Observations were taken from five randomly selected plants in each replication. Initiation of spraying was done upon the pest population reaching economic threshold level (ETL). Pretreatment observations were taken 24 hr before spraying Post-treatment observations were recorded after 1st, 3rd, 5th and 7th days of each spray except third spray, where the observation was made

at one day after spray only. The aphids were counted manually with magnifying glass and % reductions in incidence was worked out (Mvumi and Maunga, 2018). All morphological and quality attributes were recorded at the maturity of the plants. Data were recorded upon plant height (cm), leaf length (cm), leaf width (cm), number of primary branches/ plant, number of leaves/ plant, weight of leaf (g), and leaf yield/ plant (g). Ascorbic acid (mg/ 100 g) was estimated as per the method of Rangana, (1976) and moisture content (%) was recorded through hot air oven drying method. The data was recorded from five randomly selected plants under each replication and mean was worked out. The experiment was statistically laid out as pot experiment in complete randomized design (CRD) with three replications and tested for least significant difference (p=0.05).

RESULTS AND DISCUSSION

Qualitative preliminary phytochemical screening among ten plant extracts was done for the presence of phytochemicals. Compounds like phenolics, flavonoids, terpenoids, tannins and steroids were higher in *Alnus nepalensis, Piper betle, Athyrium filix-femina, Artemisia vulgaris, Datura stramonium*

Tuble 1. Effect of plant entracts of E. er ystiller merdenee off of oth mustar	Table 1.	Effect of	f plant extrac	ts on L. e.	rysimil	incidence	on brown	n mustard
--	----------	-----------	----------------	-------------	---------	-----------	----------	-----------

S. No.	Treatments	Aph a	id incid fter 1 st s	ence com pray (%	ntrol	Aph a	id incid fter 2 nd s	ence con spray (%	ntrol 6)	Aphid incidence control after 3 rd spray (%)
		1 st	3 rd	5 th	7^{th}	1 st	3 rd	5 th	7 th	1 st day
		day	day	day	day	day	day	day	day	
1	T ₁ (Schima wallichii@ 5%)	60.81	90.22	90.30	78.52	70.36	85.18	93.14	82.28	57.26
2	T ₂ (Schima wallichii@ 10%)	45.84	54.22	71.21	62.53	38.40	46.32	77.19	60.79	38.06
3	T_{3} (<i>Piper betle</i> @ 5%)	12.60	21.48	24.36	15.69	19.59	20.20	28.80	17.40	16.13
4	T_4 (<i>Piper betle</i> (a 10%)	25.35	47.55	48.41	40.43	29.29	55.57	68.24	54.48	28.06
5	T_{5} (Alnus nepalensis @ 5%)	31.35	61.16	69.87	55.05	42.45	58.23	75.41	58.47	43.03
6	$T_{6}(Alnus nepalensis @ 10\%)$	20.40	42.15	67.25	63.19	24.11	40.00	66.78	64.45	21.30
7	T_{7} (Athyrium filix-femina@ 5%)	39.35	49.22	61.86	53.61	36.19	49.50	79.52	65.89	30.13
8	T_{8} (Athyrium filix-femina@ 10%)	28.68	45.39	59.17	53.48	28.54	50.12	75.60	63.12	21.33
9	T _o (Artemisia vulgaris @ 5%)	43.08	69.08	86.09	77.58	48.20	73.26	90.60	81.44	54.26
10	T_{10} (Artemisia vulgaris @ 10%)	27.96	53.23	78.42	68.49	32.38	58.42	72.48	67.22	38.18
11	T_{11}^{10} (Datura stramonium @ 5%)	42.37	58.35	75.45	69.57	45.63	61.28	70.62	60.45	35.11
12	$T_{12}^{(1)}$ (Datura stramonium @ 10%)	39.41	53.55	67.36	57.51	42.36	56.31	66.33	54.37	20.66
13	$T_{13}^{(12)}$ (Neem oil @ 5%)	45.13	60.37	73.60	63.24	43.31	61.20	81.22	72.41	48.11
14	T_{14} (Neem oil @ 10%)	40.06	53.32	71.65	58.56	34.52	56.56	76.51	58.31	43.59
15	T_{15}^{14} (Cow urine @ 5%)	NA	NA	NA	NA	NA	NA	NA	NA	NA
16	T_{16}^{13} (Cow urine @ 10%)	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CD (p=0.05)	3.54	6.19	6.99	4.88	4.67	4.76	5.03	5.24	5.57
	SE(m)	1.21	2.12	2.40	1.67	1.60	1.63	1.72	1.80	1.91

NA: Aphid incidence was not countable

mary length (cm) of leaves/lear (g) plant (g) content .hes (cm) plant $(\%)$ $(\%)$ $(\%)$.3 28.14 20.20 18.43 25.58 480.00 90.29 .4 24.29 17.65 16.43 23.57 379.41 85.19	ry length (cm) of leaves leaf (g) plant (g) content s (cm) plant (%) (%) 28.14 20.20 18.43 25.58 480.00 90.29 24.29 17.65 16.43 23.57 379.41 85.19 17.67 13.36 13.42 18.44 255.26 74.42	length(cm)01 leaves/leat (g)plant (g)content(cm) $plant$ (m) (m) (m) (m) 28.1420.2018.4325.58480.0090.2924.2917.6516.4323.57379.4185.1917.6713.3613.4218.44255.2674.4218.1213.9213.6919.34273.6675.59	Length (cm) of leaves/ plant leaf (g) (%) point (g) (%) content (%) 28.14 20.20 18.43 25.58 480.00 90.29 24.29 17.65 16.43 23.57 379.41 85.19 17.67 13.36 13.42 18.44 255.26 74.42 18.12 13.92 13.69 19.34 273.66 75.59 21.24 15.81 14.61 21.26 348.65 78.42	ngun (cm) of leaves leaf (g) plant (g) content cm) plant (g) content 8.14 20.20 18.43 25.58 480.00 90.29 4.29 17.65 16.43 23.57 379.41 85.19 7.67 13.36 13.42 18.44 255.26 74.42 8.12 13.92 13.69 19.34 273.66 75.59 1.24 15.81 14.61 21.26 348.65 78.42 0.44 15.26 14.42 21.31 303.84 77.22	gun (cm) or leaves/ plant lear (g) plant (g) content (%) 14 20.20 18.43 25.58 480.00 90.29 29 17.65 16.43 23.57 379.41 85.19 67 13.36 13.42 18.44 255.26 74.42 12 13.92 13.69 19.34 273.66 75.59 24 15.81 14.61 21.26 348.65 78.42 44 15.26 14.42 21.31 303.84 77.22 16 16.56 15.47 22.67 376.49 81.18	In (cm) of leaves/ plant lear (g) (%) plant (g) (%) content (%) 4 20.20 18.43 25.58 480.00 90.29 9 17.65 16.43 23.57 379.41 85.19 7 13.36 13.42 18.44 255.26 74.42 2 13.92 13.69 19.34 273.66 75.59 4 15.81 14.61 21.26 348.65 78.42 6 16.56 15.47 22.67 376.49 81.18 8 16.61 15.29 22.16 336.23 80.25	(cm) or leaves/ plant lear (g) (%) plant (%) 20.20 18.43 25.58 480.00 90.29 17.65 16.43 23.57 379.41 85.19 17.65 16.43 23.57 379.41 85.19 13.36 13.42 18.44 255.26 74.42 13.92 13.69 19.34 273.66 75.59 15.81 14.61 21.26 348.65 78.42 15.26 14.42 21.31 303.84 77.22 16.56 15.47 22.67 376.49 81.18 16.61 15.29 22.16 336.23 80.25 18.63 14.47 24.58 440.21 88.51	(cm)of leaves/ plantlear (g)plant (g)content20.2018.4325.58480.0090.2917.6516.4323.57379.4185.1917.6516.4323.57379.4185.1913.3613.4218.44 255.26 74.4213.9213.6919.34273.6675.5915.8114.61 21.26 348.65 78.4215.2614.42 21.31 303.84 77.2216.5615.47 22.67 376.49 81.18 16.6115.29 22.16 336.23 80.25 18.6314.47 24.58 440.21 88.51 17.3516.19 22.54 377.09 82.46	(cm)of leaves/ plantlear (g)piant (g)content 20.20 18.43 25.58 480.00 90.29 17.65 16.43 23.57 379.41 85.19 13.36 13.4218.44 255.26 74.42 13.92 13.6919.34 273.66 75.59 15.81 14.61 21.26 348.65 78.42 15.26 14.42 21.31 303.84 77.22 16.56 15.47 22.67 376.49 81.18 16.61 15.29 22.16 346.23 80.25 18.63 14.47 24.58 440.21 88.51 17.35 16.19 22.54 377.09 82.46 17.52 14.60 20.38 313.12 76.53	(cm) of leaves/ plant leaf (g) (%) paint (g) (%) content (%) 20.20 18.43 25.58 480.00 90.29 17.65 16.43 25.57 379.41 85.19 13.36 13.42 18.44 255.26 74.42 13.36 13.42 18.44 255.26 74.42 13.36 13.42 18.44 255.26 74.42 15.81 14.61 21.26 348.65 78.42 15.81 14.61 21.26 348.65 78.42 15.26 14.42 21.31 303.84 77.22 16.56 15.47 22.67 376.49 81.18 16.61 15.29 22.16 336.23 80.25 18.63 14.47 22.54 377.09 82.46 17.35 16.19 22.54 377.09 82.46 17.35 14.50 20.38 313.12 76.53 14.51 13.98 19.67 265.61 76.53	(cm) of leaves/ plant leat (g) (%) plant (g) (%) content (%) 20.20 18.43 25.58 480.00 90.29 17.65 16.43 23.57 379.41 85.19 17.65 16.43 23.57 379.41 85.19 13.36 13.42 18.44 255.26 74.42 13.92 13.69 19.34 273.66 75.59 15.26 14.42 21.21 303.84 77.22 15.26 15.47 22.67 376.49 81.18 16.56 15.47 22.67 376.49 81.18 16.51 15.29 22.16 336.23 80.25 18.63 14.47 24.58 440.21 88.51 17.35 16.19 22.54 377.09 82.46 14.51 13.98 19.67 265.61 76.53 14.51 13.98 19.67 265.61 76.53 18.33 15.19 24.37 411.73 87.09	n(cm)or leaves/ lear (g)plantcontent $plant$ $plant$ (%) 17.65 18.43 25.58 480.00 90.29 17.65 16.43 23.57 379.41 85.19 17.65 16.43 23.57 379.41 85.19 17.65 16.43 23.57 379.41 85.19 13.36 13.42 18.44 255.26 74.42 13.92 13.69 19.34 277.66 75.59 15.81 14.61 21.26 348.65 78.42 15.26 14.42 21.26 348.65 78.42 16.56 15.47 22.67 376.49 81.18 16.56 15.47 22.67 376.49 81.18 16.56 15.47 22.54 377.09 82.46 17.35 16.19 22.54 377.09 82.46 17.35 16.19 22.54 377.09 82.46 17.35 16.19 22.54 377.09 82.46 17.35 16.19 22.54 377.09 82.46 17.35 16.19 22.54 377.09 82.46 17.35 16.19 22.54 377.09 82.46 17.56 18.33 15.19 24.37 411.73 87.09 17.56 16.28 23.10 387.95 84.40	n(cm)of leaves/ plantlear (g)piant (g)content4 20.20 18.43 25.58 480.00 90.29 9 17.65 16.43 23.57 379.41 85.19 7 13.36 13.42 18.44 255.26 74.42 2 13.92 13.42 18.44 255.26 74.42 4 15.81 14.61 21.26 348.65 78.42 4 15.26 14.42 21.26 348.65 78.42 6 16.56 15.47 22.67 376.49 81.18 8 16.61 15.29 22.16 336.23 80.25 8 16.61 15.29 22.16 377.09 82.46 0 14.59 14.47 24.58 440.21 88.51 1 77.35 16.19 22.54 377.09 82.46 0 14.51 13.98 19.67 265.61 76.53 1 14.51 13.98 19.67 265.61 76.14 2 17.35 16.19 22.34 317.12 76.53 1 14.51 13.98 19.67 265.61 76.14 2 17.36 16.28 23.10 387.95 84.40 2 11.31 7.10 13.08 90.14 70.15	(m)(cm)or leaves/ leat (g)plant(%)0 $plant$ (%)(%)420.2018.4325.58480.0090.29917.6516.4323.57379.4185.19713.3613.4218.44255.2674.42213.9213.6919.34273.6675.59415.2614.4221.26348.6578.42616.5615.4722.67376.4981.18816.6115.2922.16336.2380.25218.6314.4724.58440.2188.51817.3516.1922.54377.0982.46914.5113.9819.67265.6176.53014.5113.9819.67265.6176.5317.5616.2823.10387.9584.40218.3315.1924.37411.7387.09217.5616.2823.10387.9584.4011.317.1013.0890.1470.159.068.1414.37114.7968.12
thes (cm) plant .3 28.14 20.20 18.43 25.58 480.00 .4 24.29 17.65 16.43 23.57 379.41	s (cm) plant 28.14 20.20 18.43 25.58 480.00 24.29 17.65 16.43 23.57 379.41 17.67 13.36 13.42 18.44 255.26	(cm) plant 28.14 20.20 18.43 25.58 480.00 24.29 17.65 16.43 23.57 379.41 17.67 13.36 13.42 18.44 255.26 18.12 13.92 13.69 19.34 273.66	(cm) plant 28.14 20.20 18.43 25.58 480.00 24.29 17.65 16.43 23.57 379.41 17.67 13.36 13.42 18.44 255.26 18.12 13.92 13.69 19.34 273.66 21.24 15.81 14.61 21.26 348.65	plant plant 8.14 20.20 18.43 25.58 480.00 4.29 17.65 16.43 23.57 379.41 7.67 13.36 13.42 18.44 255.26 8.12 13.92 13.69 19.34 255.26 1.24 15.81 14.61 21.26 348.65 0.44 15.26 14.42 21.31 303.84	m) plant 14 20.20 18.43 25.58 480.00 29 17.65 16.43 25.58 480.00 67 13.36 13.42 18.44 255.26 12 13.92 13.69 19.34 255.26 24 15.81 14.61 21.26 348.65 44 15.26 14.42 21.31 303.84 16 16.56 15.47 22.67 376.49	plant 4 20.20 18.43 25.58 480.00 9 17.65 16.43 23.57 379.41 7 13.36 13.42 18.44 255.26 2 13.92 13.42 18.44 255.26 4 15.81 14.61 21.26 348.65 4 15.26 14.42 21.26 348.65 6 16.56 14.42 21.31 303.84 8 16.61 15.29 22.16 336.23	plant 20.20 18.43 25.58 480.00 17.65 16.43 23.57 379.41 13.36 13.42 18.44 255.26 13.92 13.69 19.34 255.26 15.81 14.61 21.26 348.65 15.26 14.42 21.26 348.65 15.26 14.42 21.26 348.65 16.56 15.47 22.67 376.49 16.51 15.29 22.16 336.23 18.63 14.47 24.58 440.21	plant 20.20 18.43 25.58 480.00 17.65 16.43 23.57 379.41 13.36 13.42 18.44 255.26 13.92 13.69 19.34 255.26 13.92 13.69 19.34 255.26 15.81 14.61 21.26 348.65 15.81 14.61 21.26 348.65 15.26 14.42 21.31 303.84 16.56 15.47 22.67 376.49 16.61 15.29 22.16 336.23 18.63 14.47 24.58 440.21 17.35 16.19 22.54 377.09	plant 20.20 18.43 25.58 480.00 17.65 16.43 23.57 379.41 13.36 13.42 18.44 255.26 13.92 13.69 19.34 273.66 15.81 14.61 21.26 348.65 15.26 14.42 21.26 348.65 15.26 14.42 21.26 348.65 15.26 14.42 21.26 348.65 15.26 14.42 21.26 348.65 16.56 15.47 22.67 376.49 16.51 15.29 22.16 336.23 18.63 14.47 24.58 440.21 17.35 16.19 22.54 377.09 14.59 14.60 20.38 313.12	plant 20.20 18.43 25.58 480.00 17.65 16.43 23.57 379.41 13.36 13.42 18.44 255.26 13.92 13.69 19.34 255.26 13.92 13.69 19.34 255.26 15.81 14.61 21.26 348.65 15.26 14.42 21.31 303.84 16.56 15.47 22.67 376.49 16.51 15.47 22.57 376.49 16.51 15.47 22.567 376.49 16.51 15.47 22.567 376.49 16.51 15.29 22.16 336.23 18.63 14.47 24.58 440.21 17.35 16.19 22.54 377.09 14.51 13.98 19.67 265.61	plant 20.20 18.43 25.58 480.00 17.65 16.43 23.57 379.41 13.36 13.42 18.44 255.26 13.92 13.69 19.34 255.26 13.92 13.69 19.34 255.26 15.81 14.61 21.26 348.65 15.26 14.42 21.31 303.84 16.56 15.47 22.67 376.49 16.61 15.29 22.16 336.23 18.63 14.47 24.58 440.21 17.35 16.19 22.54 377.09 14.59 14.60 20.38 313.12 14.51 13.98 19.67 265.61 18.33 15.19 24.37 411.73	plant 17.65 18.43 25.58 480.00 17.65 16.43 25.58 480.00 17.65 16.43 23.57 379.41 13.36 13.42 18.44 255.26 13.92 13.69 19.34 255.26 15.81 14.61 21.26 348.65 15.81 14.61 21.26 348.65 15.66 15.47 22.67 376.49 16.61 15.29 22.16 336.23 16.61 15.29 22.16 336.23 17.35 16.19 22.54 377.09 17.35 16.19 22.54 377.09 17.56 14.60 20.38 313.12 14.51 13.98 19.67 265.61 18.33 15.19 24.37 410.71 14.56 16.62 26.36 313.12 14.56 16.63 26.561 375.95 17.56 16.28 23.10 387.95<	plant 4 20.20 18.43 25.58 480.00 9 17.65 16.43 25.58 480.00 7 13.36 13.42 18.44 255.26 8 15.81 14.61 25.53 480.00 7 13.36 13.42 18.44 255.26 4 15.81 14.61 21.26 348.65 4 15.26 14.42 21.26 348.65 6 16.56 14.42 21.26 348.65 8 16.61 15.29 21.16 336.23 8 16.61 15.29 22.16 336.23 9 14.50 15.29 22.54 377.09 0 14.51 13.98 19.67 265.61 0 14.51 13.98 19.67 265.61 1 18.33 15.19 24.37 411.73 2 18.33 15.19 24.37 411.73 2 <	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$
3 28.14 20.20 18.43 25.58 4 24.29 17.65 16.43 23.57	28.14 20.20 18.43 25.58 24.29 17.65 16.43 23.57 17.67 13.36 13.42 18.44	28.14 20.20 18.43 25.58 28.129 17.65 16.43 23.57 17.67 13.36 13.42 18.44 18.12 13.92 13.69 19.34	28.14 20.20 18.43 25.58 28.29 17.65 16.43 23.57 17.67 13.36 13.42 18.44 18.12 13.92 13.69 19.34 21.24 15.81 14.61 21.26	8.14 20.20 18.43 25.58 4.29 17.65 16.43 23.57 7.67 13.36 13.42 18.44 8.12 13.92 13.69 19.34 1.24 15.81 14.61 21.26 0.44 15.26 14.42 21.31	14 20.20 18.43 25.58 29 17.65 16.43 23.57 67 13.36 13.42 18.44 12 13.92 13.69 19.34 24 15.81 14.61 21.26 44 15.26 14.42 21.31 16 16.56 15.47 22.67	4 20.20 18.43 25.58 9 17.65 16.43 23.57 7 13.36 13.42 18.44 2 13.35 13.42 18.44 2 13.92 13.69 19.34 4 15.81 14.61 21.26 4 15.26 14.42 21.31 6 16.56 15.47 22.67 8 16.61 15.29 22.16	20.20 18.43 25.58 17.65 16.43 23.57 13.36 13.42 18.44 13.92 13.69 19.34 15.81 14.61 21.26 15.26 14.42 21.31 16.56 15.47 22.67 16.61 15.29 22.16 18.63 14.47 24.58	20.20 18.43 25.58 17.65 16.43 23.57 13.36 13.42 18.44 13.92 13.69 19.34 15.81 14.61 21.26 15.81 14.61 21.26 15.81 14.42 21.31 16.61 15.47 22.67 16.61 15.29 22.16 18.63 14.47 24.58 17.35 16.19 22.54	20.20 18.43 25.58 17.65 16.43 23.57 13.36 13.42 18.44 13.92 13.42 18.44 13.92 13.69 19.34 15.81 14.61 21.26 15.26 14.42 21.31 16.56 15.47 22.67 16.61 15.29 22.16 18.63 14.47 24.58 17.35 16.19 22.54 14.59 14.60 20.38	20.20 18.43 25.58 17.65 16.43 23.57 13.36 13.42 18.44 13.92 13.69 19.34 15.81 14.61 21.26 15.81 14.61 21.26 15.81 14.42 21.31 16.61 15.47 22.67 16.61 15.29 22.16 18.63 14.47 24.58 17.35 16.19 22.54 17.35 16.19 22.54 14.51 13.98 19.67	20.20 18.43 25.58 17.65 16.43 23.57 13.36 13.42 18.44 13.92 13.69 19.34 15.81 14.61 21.26 15.81 14.61 21.31 15.26 14.42 21.31 16.56 15.47 22.67 16.61 15.29 22.16 18.63 14.47 24.58 17.35 16.19 22.54 14.51 13.98 19.67 18.33 15.19 24.37	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4 20.20 18.43 25.58 7 13.36 16.43 23.57 2 13.92 13.42 18.44 2 13.92 13.69 19.34 4 15.81 14.61 21.26 4 15.26 14.42 21.31 6 16.56 15.47 22.67 8 16.61 15.29 22.16 9 17.35 16.19 22.54 0 14.51 13.98 19.67 14.51 13.98 19.67 15.56 16.19 22.54 16.61 15.39 19.67 0 14.51 13.98 19.67 17.35 16.19 20.38 14.51 13.98 19.67 17.56 16.28 23.10 17.31 7.10 13.08	4 20.20 18.43 25.58 9 17.65 16.43 25.58 7 13.36 13.42 18.44 2 13.92 13.42 18.44 2 13.92 13.69 19.34 4 15.26 14.42 21.31 6 16.56 15.47 22.67 8 16.61 15.29 22.16 2 18.63 14.47 24.58 8 17.35 16.19 22.54 0 14.51 13.98 19.67 2 17.35 16.19 22.54 0 14.51 13.98 19.67 2 17.35 16.19 22.34 0 14.51 13.98 19.67 2 17.35 16.19 22.34 0 14.51 13.98 19.67 2 17.36 16.19 22.34 2 17.36 16.28 23.10 2 17.36 16.28 23.10 3 9.06 8.14 14.37
3 28.14 20.20 18.43 4 24.29 17.65 16.43	28.14 20.20 18.43 24.29 17.65 16.43 17.67 13.36 13.42	28.14 20.20 18.43 28.129 17.65 16.43 17.67 13.36 13.42 18.12 13.92 13.69	28.14 20.20 18.43 28.14 20.20 18.43 24.29 17.65 16.43 17.67 13.36 13.42 18.12 13.92 13.69 21.24 15.81 14.61	8.14 20.20 18.43 8.14 20.20 18.43 4.29 17.65 16.43 7.67 13.36 13.42 8.12 13.92 13.69 1.24 15.81 14.61 0.44 15.26 14.42	14 20.20 18.43 29 17.65 16.43 67 13.36 13.42 12 13.92 13.69 24 15.81 14.61 44 15.26 14.42 16 16.56 15.47	4 20.20 18.43 9 17.65 16.43 7 13.36 13.42 2 13.92 13.69 4 15.81 14.61 4 15.26 14.42 6 16.56 15.47 8 16.61 15.29	20.20 18.43 17.65 16.43 13.36 13.42 13.92 13.69 15.81 14.61 15.26 14.42 16.56 15.47 16.61 15.29 18.63 14.47	20.20 18.43 17.65 16.43 13.36 13.42 13.92 13.69 15.81 14.61 15.26 14.42 16.56 15.47 16.61 15.29 18.63 14.47 17.35 16.19	20.20 18.43 17.65 16.43 13.36 13.42 13.92 13.42 13.92 13.69 15.81 14.61 15.26 14.42 16.56 15.47 16.61 15.29 18.63 14.47 17.35 16.19 17.35 16.19 14.59 14.60	20.20 18.43 17.65 16.43 13.36 13.42 13.92 13.69 13.92 13.69 15.81 14.61 15.82 14.42 15.66 15.47 16.61 15.29 18.63 14.47 17.35 16.19 14.51 13.98 14.51 13.98	20.20 18.43 17.65 16.43 13.36 13.42 13.92 13.69 15.81 14.61 15.26 14.42 16.56 15.47 16.61 15.29 18.63 14.47 16.61 15.29 18.63 14.47 17.35 16.19 14.51 13.98 18.33 15.19	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4 20.20 18.43 9 17.65 16.43 2 13.36 13.42 2 13.92 13.42 4 15.81 14.61 4 15.26 14.42 6 16.56 15.47 8 16.61 15.29 9 17.35 16.19 0 14.51 13.98 0 14.51 16.19 <td>$\begin{array}{c ccccccccccccccccccccccccccccccccccc$</td>	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
.3 28.14 20.20 64 24.29 17.65	28.14 20.20 24.29 17.65 17.67 13.36	28.14 20.20 24.29 17.65 17.67 13.36 18.12 13.92	28.14 20.20 24.29 17.65 17.67 13.36 18.12 13.92 21.24 15.81	8.14 20.20 4.29 17.65 7.67 13.36 8.12 13.92 1.24 15.81 0.44 15.26	14 20.20 29 17.65 67 13.36 12 13.92 24 15.81 44 15.26 16 16.56	4 20.20 9 17.65 2 13.36 2 13.92 4 15.26 6 16.56 8 16.61	20.20 17.65 13.36 13.92 15.81 15.81 15.81 15.66 16.61 18.63	20.20 17.65 13.36 13.92 15.81 15.81 15.26 16.56 16.61 18.63 17.35	20.20 17.65 13.36 13.36 13.92 15.81 15.26 16.61 18.63 17.35 17.35	20.20 17.65 13.36 13.32 13.92 15.26 16.56 16.56 16.61 18.63 17.35 14.59	20.20 17.65 13.36 13.36 13.92 15.81 15.81 16.61 18.63 16.61 18.63 17.35 14.59 14.51 18.33	17.65 17.65 13.36 13.35 13.35 13.36 13.35 13.35 13.36 13.35 13.36 15.26 16.61 16.61 17.35 17.35 17.35 17.35 17.35 17.35 17.35 17.35 17.35	4 20.20 9 17.65 2 13.36 4 15.81 4 15.26 6 16.61 8 16.61 0 14.59 0 14.59 0 14.51 13.35 17.35 9 17.35 11.31	4 20.20 9 17.65 2 13.36 2 13.35 4 15.81 4 15.26 6 16.56 8 16.61 2 18.63 8 17.35 0 14.59 0 14.59 0 14.51 13.35 17.35 0 14.51 0 14.59 0 14.51 0 14.51 0 14.51 0 14.51 0 14.51 0 14.51 0 14.51 0 14.51
.3 28.14 54 24.29	28.14 24.29 17.67	28.14 24.29 17.67 18.12	28.14 24.29 17.67 18.12 21.24	8.14 4.29 7.67 8.12 1.24 0.44	14 29 24 12 14 16	46724498							4 0 7 7 4 4 9 8 7 8 0 0 7 7 0	4 6 7 7 4 4 9 8 7 8 0 0 7 7 6 5
0.4 0.4				ñ n = = n ñ	28. 24. 21. 22. 22. 22. 22. 22. 22. 22. 22. 22	28.1. 24.2. 17.6 18.1. 21.2. 21.2. 21.2. 21.6 21.6	28.14 24.29 17.67 18.12 21.24 21.24 20.44 20.44 21.68 21.68 21.68	28.14 24.29 17.67 18.12 21.24 20.44 20.44 22.16 22.16 22.16 23.48 23.48	28.14 24.29 17.67 18.12 21.24 21.24 20.44 21.68 21.68 21.68 21.68 23.48 23.48 23.48	28.14 24.29 17.67 18.12 21.24 20.44 22.16 22.16 22.16 22.16 23.48 23.48 23.48 20.30 19.40	28.14 24.29 17.67 18.12 21.24 20.44 22.16 22.16 22.16 22.16 23.48 23.48 23.52 19.40 19.40	28.14 24.25 17.67 18.12 20.44 20.46 23.48 20.30 23.52 24.42 24.42 24.42	28.1- 28.1- 29.1-29.29.29.4.6. 21.2, 23.29.4.6. 21.2, 23.29.4.6. 21.2, 23.29.4.6. 21.2, 23.29.4.6. 21.2, 24.6. 21.2, 24.6. 21.	28.1 24.2 17.6 17.6 18.1 18.1 18.1 21.2 20.3 20.4 20.3 25.1 20.3 25.1 20.3 25.1 20.3 25.1 20.3 20.4 20.3 20.4 20.3 20.4 20.4 20.4 20.4 20.4 20.4 20.4 20.4
7.4 6.6	7.43 6.64 4.31	7.43 6.64 4.31 4.55	7.43 6.64 4.31 5.63	7.43 6.64 4.31 5.63 5.35	7.43 6.64 4.31 5.63 5.35 5.33	7.43 6.64 4.31 5.63 5.35 5.53 5.56	7.43 6.64 4.31 5.63 5.53 5.53 6.64	7.43 6.64 4.31 5.63 5.35 6.64 6.64 5.76	7.43 6.64 7.43 6.64 5.35 6.64 6.64 5.36 5.36 5.36 5.36 5.36	7.43 6.64 7.43 6.64 5.35 5.53 6.64 6.64 7.36 7.36 7.36 7.36 7.36 7.36 7.36 7.46 7.47 7.43 7.43 7.43 7.43 7.43 7.43 7.43	7.43 6.64 7.43 6.64 5.53 5.55 6.64 6.64 6.38 6.38	7.43 6.64 5.35 5.35 6.64 6.64 6.38 6.33 6.57	7.43 6.64 5.35 5.35 6.64 6.38 6.38 6.38 6.38 6.38 7.36 6.38 6.38 7.36 7.36 7.36 7.36 7.36 7.36 7.36 7.36	7.43 6.64 7.43 6.64 5.53 6.64 6.38 6.38 6.33 6.33 7.65 6.33 7.65 7.65 7.65 7.65 7.65 7.65 7.65 7.65
120.57 108.1	120.57 108.1 84.13	120.57 108.1 84.13 89.51	120.57 108.1 84.13 89.51 95.63	120.57 108.1 84.13 89.51 95.63 94.16	120.57 108.1 84.13 89.51 94.16 94.16 99.00	120.57 108.1 84.13 89.51 94.16 99.00 97.53	120.57 108.1 84.13 89.51 95.63 94.16 97.53 97.53	120.57 108.1 84.13 89.51 94.16 94.16 99.00 97.53 116.40	120.57 108.1 84.13 89.51 94.16 99.00 97.53 116.40 102.26 92.41	120.57 108.1 84.13 89.51 99.00 97.53 116.40 102.26 92.41 92.41	120.57 108.1 84.13 89.51 95.63 97.53 116.40 102.26 92.41 90.27	120.57 108.1 84.13 89.51 94.16 97.53 116.40 12.26 92.41 90.27 115.4	120.57 108.1 84.13 84.13 95.63 94.16 97.53 116.40 102.26 102.26 102.26 106.64 115.4 106.64	120.57 108.1 84.13 89.51 95.63 97.53 116.40 102.26 92.41 92.41 92.41 92.41 105.64 115.4 106.64 64.34
hima wallichii@ 5%) hima wallichii@ 10%)	chima wallichii@ 5%) chima wallichii@ 10%) 'iper betle@ 5%)	Schima wallichii@ 5%) Schima wallichii@ 10%) Piper betle@ 5%) Piper betle@ 10%)	(Schima wallichii@ 5%) (Schima wallichii@ 10%) (Piper betle@ 5%) (Piper betle@ 10%) (Alnus nepalensis @ 5%)	(Schima wallichii@ 5%) (Schima wallichii@ 10%) (Piper betle@ 5%) (Alnus nepalensis @ 5%) (Alnus nepalensis @ 10%)	(Schima wallichii@ 5%) (Schima wallichii@ 10%) (Piper betle@ 5%) (Piper betle@ 10%) (Alnus nepalensis @ 5%) (Alnus nepalensis @ 10%) (Athyrium filix-femina@ 5%)	¹ (Schima wallichii@ 5%) ² (Schima wallichii@ 10%) ³ (Piper betle@ 5%) ⁴ (Piper betle@ 10%) ⁵ (Alnus nepalensis @ 5%) ⁶ (Alnus nepalensis @ 10%) ⁷ (Athyrium filix-femina@ 5%) ⁸ (Athyrium filix-femina@ 10%)	¹ (Schima wallichii@ 5%) ² (Schima wallichii@ 10%) ³ (Piper betle@ 5%) ⁴ (Piper betle@ 10%) ⁵ (Alnus nepalensis @ 5%) ⁶ (Alnus nepalensis @ 10%) ⁷ (Athyrium filix-femina@ 5%) ⁸ (Atremisia vulgaris @ 5%)	¹ (Schima wallichii@ 5%) ² (Schima wallichii@ 10%) ³ (Piper betle@ 5%) ⁴ (Piper betle@ 10%) ⁴ (Alnus nepalensis @ 5%) ⁶ (Alnus nepalensis @ 5%) ⁶ (Alnus nepalensis @ 5%) ⁷ (Athyrium filix-femina@ 5%) ⁹ (Artemisia vulgaris @ 5%) ⁹ (Artemisia vulgaris @ 10%) ⁹ (Artemisia vulgaris @ 10%) ⁹	¹ (Schima wallichii(@ 5%) ² (Schima wallichii(@ 10%) ³ (Piper betle@ 5%) ⁴ (Piper betle@ 10%) ⁴ (Alnus nepalensis @ 5%) ⁶ (Alnus nepalensis @ 5%) ⁶ (Athyrium filix-femina@ 5%) ⁸ (Athyrium filix-femina@ 5%) ⁹ (Artemisia vulgaris @ 10%) ¹⁰ (Artemisia vulgaris @ 5%) ¹⁰ (Datura stramonium @ 5%) ¹¹ (Datura stramonium @ 5%) ¹¹	¹ (Schima wallichii@ 5%) ² (Schima wallichii@ 10%) ³ (Piper betle@ 5%) ⁴ (Piper betle@ 10%) ⁶ (Almus nepalensis @ 5%) ⁶ (Almus nepalensis @ 10%) ⁸ (Athyrium filix-femina@ 5%) ⁹ (Artemisia vulgaris @ 5%) ¹⁰ (Artemisia vulgaris @ 5%) ¹¹ (Datura stramonium @ 5%)	$\begin{split} T_1(Schima \ wallichii(@ 5\%))\\ T_2(Schima \ wallichii(@ 10\%))\\ T_3(Piper \ betle(@ 5\%))\\ T_4(Piper \ betle(@ 5\%))\\ T_5(Alnus \ nepalensis (@ 5\%))\\ T_6(Alnus \ nepalensis (@ 5\%))\\ T_7(Athyrium \ filix-femina(@ 5\%))\\ T_9(Attemisia \ vulgaris (@ 5\%))\\ T_{10}(Artemisia \ vulgaris (@ 10\%))\\ T_{10}(Artemisia \ vulgaris (@ 10\%))\\ T_{11}(Datura \ stramonium (@ 5\%))\\ T_{12}(Neem \ oil (@ 5\%)) \end{split}$	$\begin{array}{l} T_1(Schima \ wallichii(@\ 5\%)\\ T_2(Schima \ wallichii(@\ 10\%)\\ T_3(Piper \ betle(@\ 5\%)\\ T_4(Piper \ betle(@\ 5\%))\\ T_6(Alnus \ nepalensis \ (@\ 5\%))\\ T_6(Alnus \ nepalensis \ (@\ 5\%))\\ T_7(Athyrium \ filix-femina(@\ 5\%))\\ T_7(Athyrium \ filix-femina(@\ 5\%))\\ T_9(Artemisia \ vulgaris \ (@\ 5\%))\\ T_{10}(Artemisia \ vulgaris \ (@\ 5\%))\\ T_{11}(Datura \ stramonium \ (@\ 5\%))\\ T_{13}(Neem \ oil \ (@\ 5\%))\\ T_{13}(Neem \ oil \ (@\ 5\%))\\ T_{14}(Neem \ oil \ (@\ 5\%))\end{array}$	$\begin{array}{l} T_1(Schima \ wallichii(@\ 5\%)\\ T_2(Schima \ wallichii(@\ 10\%)\\ T_3(Piper \ betle(@\ 5\%))\\ T_4(Piper \ betle(@\ 5\%))\\ T_6(Alnus \ nepalensis \ (@\ 5\%))\\ T_6(Alnus \ nepalensis \ (@\ 5\%))\\ T_7(Athyrium \ filix-femina(@\ 5\%))\\ T_9(Artemisia \ vulgaris \ (@\ 5\%))\\ T_{10}(Artemisia \ vulgaris \ (@\ 5\%))\\ T_{12}(Datura \ stramonium \ (@\ 5\%))\\ T_{13}(Neem \ oil \ (@\ 5\%))\\ T_{14}(Neem \ oil \ (@\ 5\%))\\ T_{14}(Neem \ oil \ (@\ 5\%))\\ T_{15}(Cow \ urine \ (@\ 5\%))\end{array}$	$\begin{array}{l} T_1(Schima \ wallichii(@\ 5\%)\\ T_2(Schima \ wallichii(@\ 10\%)\\ T_3(Piper \ betle(@\ 5\%)\\ T_4(Piper \ betle(@\ 5\%)\\ T_6(Alnus \ nepalensis \ (@\ 5\%))\\ T_6(Alnus \ nepalensis \ (@\ 5\%))\\ T_7(Athyrium \ filix-femina(@\ 5\%))\\ T_9(Artemisia \ vulgaris \ (@\ 5\%))\\ T_{10}(Artemisia \ vulgaris \ (@\ 5\%))\\ T_{11}(Datura \ stramonium \ (@\ 5\%))\\ T_{12}(Neem \ oil \ (@\ 5\%))\\ T_{13}(Neem \ oil \ (@\ 5\%))\\ T_{16}(Cow \ urine \ (@\ 5\%))\\ T_{16}(Cow \ urine \ (@\ 5\%))\\ \end{array}$
hima wallichii@ 10%)	'chima wallichii@ 10%) iiper betle@ 5%)	Schima wallichii@ 10%) Piper betle@ 5%) Piper betle@ 10%)	(Schima wallichii@ 10%) (Piper betle@ 5%) (Piper betle@ 10%) (Alnus nepalensis @ 5%)	(Schima wallichii@ 10%) (Piper betle@ 5%) (Piper betle@ 10%) (Alnus nepalensis @ 5%) (Alnus nepalensis @ 10%)	(Schima wallichii@ 10%) (Piper betle@ 5%) (Piper betle@ 10%) (Almus nepalensis @ 5%) (Almus nepalensis @ 10%) (Athyrium filix-femina@ 5%)	² (Schima wallichii@ 10%) ³ (Piper betle@ 5%) ⁴ (Piper betle@ 10%) ⁵ (Alnus nepalensis @ 5%) ⁶ (Alnus nepalensis @ 10%) ⁷ (Athyrium filix-femina@ 5%)	² (Schima wallichii@ 10%) ³ (Piper betle@ 5%) ⁴ (Piper betle@ 10%) ⁵ (Alnus nepalensis @ 5%) ⁶ (Alnus nepalensis @ 10%) ⁷ (Athyrium filix-femina@ 5%) ⁸ (Athyrium filix-femina@ 10%) ⁶ (Artemisia vulgaris @ 5%)	² (Schima wallichii@ 10%) ³ (Piper betle@ 5%) ⁴ (Piper betle@ 10%) ⁶ (Alnus nepalensis @ 5%) ⁶ (Alnus nepalensis @ 10%) ⁷ (Athyrium filix-femina@ 5%) ⁸ (Athyrium filix-femina@ 10%) ⁹ (Artemisia vulgaris @ 5%)	² (Schima wallichii(\overline{a} 10%) ³ (Piper betle(\overline{a} 5%) ⁴ (Piper betle(\overline{a} 5%) ⁶ (Almus nepalensis (\overline{a} 5%) ⁶ (Almus nepalensis (\overline{a} 5%) ⁷ (Athyrium filix-femina(\overline{a} 5%) ⁸ (Athyrium filix-femina(\overline{a} 10%) ⁹ (Artemisia vulgaris (\overline{a} 5%) ¹⁰ (Artemisia vulgaris (\overline{a} 5%)	² (Schima wallichii@ 10%) ³ (Piper betle@ 5%) ⁴ (Piper betle@ 5%) ⁵ (Alnus nepalensis @ 5%) ⁶ (Alnus nepalensis @ 5%) ⁷ (Athyrium filix-femina@ 5%) ⁸ (Atthyrium filix-femina@ 10%) ⁹ (Artemisia vulgaris @ 5%) ¹⁰ (Artemisia vulgaris @ 10%) ¹¹ (Datura stramonium @ 5%)	$\begin{array}{c} T_1^{(S} Chima \ wallichii(\underline{a} \ 10\%)\\ T_3^{(Piper \ betle(\underline{a} \ 5\%))}\\ T_4^{(Piper \ betle(\underline{a} \ 10\%))}\\ T_5^{(Alnus \ nepalensis \ (\underline{a} \ 5\%))}\\ T_6^{(Alnus \ nepalensis \ (\underline{a} \ 5\%))}\\ T_7^{(Athyrium \ filix-femina(\underline{a} \ 5\%))}\\ T_9^{(Athyrium \ filix-femina(\underline{a} \ 5\%)))}\\ T_{10}^{(Attemisia \ vulgaris \ (\underline{a} \ 5\%)))}\\ T_{11}^{(Datura \ stramonium \ (\underline{a} \ 5\%)))}\\ T_{12}^{(Detmovil \ Betal \ S\%))}\\ T_{13}^{(Neem \ oil \ (\underline{a} \ 5\%)))} \end{array}$	$\begin{array}{c} T_{1}(Schima \ wallichii(\textcircled{a}\ 10\%)\\ T_{3}(Piper \ betle(\textcircled{a}\ 5\%))\\ T_{4}(Piper \ betle(\textcircled{a}\ 5\%))\\ T_{5}(Alnus \ nepalensis(\textcircled{a}\ 5\%))\\ T_{6}(Alnus \ nepalensis(\textcircled{a}\ 5\%))\\ T_{7}(Athyrium \ filix-femina(\textcircled{a}\ 5\%))\\ T_{9}(Artemisia \ vulgaris(\textcircled{a}\ 5\%))\\ T_{10}(Artemisia \ vulgaris(\textcircled{a}\ 5\%))\\ T_{10}(Artemisia \ vulgaris(\textcircled{a}\ 5\%))\\ T_{12}(Datura \ stramonium(\textcircled{a}\ 5\%))\\ T_{13}(Neem \ oil(\textcircled{a}\ 10\%))\\ T_{14}(Neem \ oil(\textcircled{a}\ 10\%))\end{array}$	$\begin{array}{c} T_{1}(Schima \ wallichii(@) \ 10\%)\\ T_{3}(Piper \ betle(@) 5\%)\\ T_{4}(Piper \ betle(@) 5\%)\\ T_{5}(Almus \ nepalensis \ @) 5\%)\\ T_{7}(Athyrium \ filix-femina(@) 5\%)\\ T_{7}(Athyrium \ filix-femina(@) 5\%)\\ T_{9}(Artemisia \ vulgaris \ @) 5\%)\\ T_{10}(Artemisia \ vulgaris \ @) 5\%)\\ T_{11}(Datura \ stramonium \ @) 5\%)\\ T_{12}(Neem \ oil \ @) 5\%)\\ T_{14}(Neem \ oil \ @) 5\%)\\ T_{14}(Neem \ oil \ @) 5\%)\\ T_{15}(Cow \ urine \ @) 5\%)\end{array}$	$\begin{split} T_{1}(Schima wallichii(\underline{a}) 10\%)\\ T_{3}(Piper betle(\underline{a}) 5\%)\\ T_{4}(Piper betle(\underline{a}) 5\%)\\ T_{5}(Alnus nepalensis (\underline{a}) 5\%)\\ T_{6}(Alnus nepalensis (\underline{a}) 5\%)\\ T_{7}(Athyrium filix-femina(\underline{a}) 5\%)\\ T_{9}(Artemisia vulgaris (\underline{a}) 5\%)\\ T_{10}(Artemisia vulgaris (\underline{a}) 5\%)\\ T_{11}(Datura stramonium (\underline{a}) 5\%)\\ T_{12}(Datura stramonium (\underline{a}) 5\%)\\ T_{12}(Datura stramonium (\underline{a}) 10\%)\\ T_{13}(Neem oil (\underline{a}) 5\%)\\ T_{13}(Neem oil (\underline{a}) 5\%)\\ T_{16}(Cow urine (\underline{a}) 5\%)\\ T_{16}(Cow urine (\underline{a}) 10\%)\\ T_{16}(Cow urine (\underline{a}) 10\%)\end{split}$
)	<i>iper betle</i> (<i>a</i>), 5%) 84.13	iper betle(a) 5%) 84.13 4 per betle(a) 10%) 89.51 4	<i>iper betle</i> (<i>a</i>) 5%) 84.13 4 <i>per betle</i> (<i>a</i>) 10%) 89.51 4 <i>nus nepalensis</i> (<i>a</i>) 5%) 95.63	iper betle@ 5%) 84.13 6 per betle@ 10%) 89.51 6 inus nepalensis @ 5%) 95.63 6 inus nepalensis @ 10%) 94.16 6	iper betle@ 5%) 84.13 per betle@ 10%) 89.51 nus nepalensis @ 5%) 95.63 nus nepalensis @ 10%) 94.16 thyrium filix-femina@ 5%) 99.00	iper betle@ 5%) 84.13 per betle@ 10%) 89.51 nus nepalensis @ 5%) 95.63 nus nepalensis @ 10%) 94.16 thyrium filix-femina@ 5%) 99.00 hyrium filix-femina@ 10%) 97.53	iper betle@ 5%) 84.13 per betle@ 10%) 89.51 nus nepalensis @ 5%) 95.63 nus nepalensis @ 5%) 94.16 thyrium filix-femina@ 5%) 99.00 hyrium filix-femina@ 10%) 97.53 temisia vulgaris @ 5%) 116.40	iper betle@ 5%) 84.13 per betle@ 10%) 89.51 nus nepalensis @ 5%) 95.63 nus nepalensis @ 5%) 94.16 hyrium filix-femina@ 5%) 99.00 'hyrium filix-femina@ 10%) 97.53 'temisia vulgaris @ 5%) 116.40 'temisia vulgaris @ 10%) 116.26	iper betle@ 5%) 84.13 per betle@ 10%) 89.51 nus nepalensis @ 5%) 95.63 nus nepalensis @ 5%) 94.16 hyrium filix-femina@ 5%) 99.00 hyrium filix-femina@ 5%) 97.53 temisia vulgaris @ 5%) 97.53 temisia vulgaris @ 10%) 116.40 rtemisia vulgaris @ 10%) 92.41	per betle(0, 5%) 84.13 $per betle(0, 10%)$ 89.51 $nus nepalensis (0, 5%)$ 95.63 $nus nepalensis (0, 5%)$ 95.63 $hyrium filix-femina(0, 5%)$ 94.16 $hyrium filix-femina(0, 5%)$ 97.53 $hyrium filix-femina(0, 5%)$ 97.53 $temisia vulgaris (0, 5%)$ 116.40 $rtemisia vulgaris (0, 5%)$ 92.41 $batura stramonium (0, 10%)$ 92.27	iper betle(0, 5%) 84.13 $per betle(0, 10%)$ 89.51 $nus nepalensis (0, 5%)$ 95.63 $nus nepalensis (0, 5%)$ 95.63 $hyrium filix-femina(0, 5%)$ 94.16 $hyrium filix-femina(0, 5%)$ 99.00 $hyrium filix-femina(0, 5%)$ 97.53 $remisia vulgaris (0, 5%)$ 116.40 $ntremisia vulgaris (0, 10%)$ 102.26 $ntura stramonium (0, 5%)$ 90.27 $hotura stramonium (0, 10%)$ 115.4	per betle(0, 5%) 84.13 $per betle(0, 10%)$ 89.51 $nus nepalensis (0, 5%)$ 95.63 $nus nepalensis (0, 5%)$ 95.63 $nus nepalensis (0, 5%)$ 94.16 $hyrium filix-femina(0, 5%)$ 99.00 $hyrium filix-femina(0, 10%)$ 97.53 $nus argaris (0, 5%)$ 97.53 $remisia vulgaris (0, 5%)$ 116.40 $rtemisia vulgaris (0, 10%)$ 102.26 $atura stramonium (0, 5%)$ 90.27 $batura stramonium (0, 10%)$ 115.4 $batura stramonium (0, 10%)$ 106.64	iper betle(0, 5%) 84.13 $per betle(0, 10%)$ 89.51 $nus nepalensis (0, 5%)$ 95.63 $nus nepalensis (0, 5%)$ 95.63 $hyrium filix-femina(0, 5%)$ 94.16 $hyrium filix-femina(0, 5%)$ 97.53 $hyrium filix vulgaris (0, 5%)$ 97.53 $remisia vulgaris (0, 5%)$ 97.53 $rtemisia vulgaris (0, 5%)$ 92.41 $batura stramonium (0, 10%)$ 92.41 $batura stramonium (0, 10%)$ 90.27 $batura stramonium (0, 5%)$ 90.27 $batura stramonium (0, 5%)$ 90.27 $batura (0, 5%)$ 90.27 $batura (0, 5%)$ 90.27	iper betle((a) 5%)84.13per betle((a) 10%)89.51nus nepalensis ((a) 5%)95.63nus nepalensis ((a) 5%)94.16hyrium filix-femina((a) 5%)99.00hyrium filix-femina((a) 5%)97.53temisia vulgaris ((a) 5%)97.53temisia vulgaris ((a) 5%)97.53temisia vulgaris ((a) 5%)97.53termisia vulgaris ((a) 10%)97.53termisia vulgaris ((a) 5%)97.53termisia vulgaris ((a) 5%)97.53termisia vulgaris ((a) 5%)97.53termisia vulgaris ((a) 10%)92.41termisia vulgaris ((a) 10%)92.41termisia vulgaris ((a) 10%)90.27term oil ((a) 10%)90.27termine ((a) 5%)64.34tow urine ((a) 5%)64.34tow urine ((a) 10%)68.21

Table 2. Effect of plant extracts on growth, yield and quality attributes of brown mustard

3

and Schima wallichii. These extracts were selected for further use in aphid control. Natural antioxidant such as phenolics, flavonoids, and tannins play an important role in protecting cells from free radical-induced damage without causing any side effect (Mansoori et al., 2020). There was significant response after first, second and third application (Table 1). The spray of T, (Schima wallichii@ 5%) imparted maximum control (60.81, 90.22, 90.30 and 78.52%) at 1st, 3rd, 5th, and 7th day after first application, respectively. Similar pattern was observed after second spray and maximum control was in the same treatment. Third application was at 7 days after the second spray. The data was recorded one day after spraying only and Schima wallichii@ 5% was found to be the most effective. The phytochemical compounds in the Schima wallichii, especially the phenolics and steroids are well-known for their insecticidal or repellent quality. These compounds are predominantly responsible for natural plant defence mechanism (Pal and Pal, 2016; Bargah, 2015; Tadasse et al., 2016; Sharma and Patel, 2016; Campos et al., 2019). Some bioactive compounds isolated from S. wallichii such as kaemferol-3-O-ramnosida have bioactivity as rotenone with antimicrobial and insecticidal properties (Widiyarti and Fitrianingsih, 2019). Singh and Lal (2012) found significant effect of locally available plant extracts like panchphuli and garlic leaf extracts. Similar results were also shown by earlier workers against mustard aphid (Baloch et al., 2018; Mvumi and Maunga, 2018; Gouvea et al., 2019). Cow urine spray control the aphid population and found to be ineffective.

All morphological traits were found significantly improved through with application of plant extracts (Table 2). Plant height (120.57cm), number of primary branches/plant (7.43), leaf length (28.14 cm), leaf width (20.20cm), number of leaves/ plant (18.43), weight of leaf (25.58 g) and leaf yield (480g) was found maximum in treatment T₁ (Schima wallichii@ 5%). Significant effect of Schima wallichii@ 5% upon morphological attributes was possibly due to the presence of high amount of phytochemical compounds, which enabled plants to sustain severe infestation of aphids. The resistance results in better photosynthetic activities, which increased these growth and yield attributes and in turn the leaf yield (Meena et al., 2019; Yusuf et al., 2020). There existed a significant variation in ascorbic acid and moisture content with treatments. Moisture content (90.29%) and ascorbic acid (48.14 mg/ 100) was recorded maximum in T₁ (Schima wallichii@ 5%). There was a significant increase in ascorbic acid and

moisture content with application of *Schima wallichii* @ 5% (Reddy et al., 2019).

Based on experiment results, T_1 (*Schima wallichii@* 5%), was found significantly superior over rest of the plant extracts in aphid incidence control, additionally it also improved growth, yield and quality attributes of the crop. Cow urine spray is most common and traditional practice of the farmers for aphid control in Sikkim Himalayas, remained ineffective. The treatment may be further recommended for commercial utilization for plant protection in organic farming system in Sikkim towards the single window standard organic production technology of brown mustard.

ACKNOWLEDGEMENTS

Authors thank the Department of Horticulture, Sikkim University for providing facilities.

AUTHOR CONTRIBUTION STATEMENT

Rajesh Kumar conceptualized and framed the research proposal; Kunal Kaushik conducted the experiment, curated data and prepared original draft.

CONFLICT OF INTEREST

No conflict of interest.

REFERENCES

- Bargah R K. 2015. Preliminary test of phyto-chemical screening of crude ethanolic and aqueous extract of *Moringa pterygosperma* Gaertn. Journal of Phytochemistry and Pharmacognosy 4(1): 07-09.
- Baloch M B, Dostain A, Alizai S H, Jaffar S. 2018. Efficacy of bio pesticides against the cauliflower whitefly in the local condition of Tandojam, Sindh, Pakistan. Case Studies Journal 7(7): 12-16.
- Campos E V, Proença P L, Oliveira J L, Bakshi M, Abhilash P C, Fraceto L F, 2019. Use of botanical insecticides for sustainable agriculture: Future perspectives. Ecological indicators 105: 483-495.
- Debnath A, Kumar R, Prasad S K, Sharma N, Kushwah J K. 2020. Multivariate analysis for genetic diversity estimation among tomato (*Solanum lycopersicum* L.) genotypes. Ecology, Environment and Conservation 26(3): 1208-1211.
- Edeoga H O, Okwu D E, Mbabie B O. 2005. Phytochemical constituents of some Nigerian medicinal plants. African Journal of Biotechnology 4(7): 685-688.
- Gouvea S M, Carvalho G A, Fidelis E G, Ribeiro A V, Farias E S, Picanco M C. 2019. Effect of paracress (*Acmellaoleracea*) extracts on the aphids *Myzus persicae* and *Lipaphis erysimi* and two natural enemies. Industrial Crops and Products 128: 399-404.
- Kumar R, Singh M P, Bag N, Sharma L, Bamaniya B S. 2020. Invasive pest *Tuta absoluta* (Meyrick) on tomato- alert in Sikkim. Indian Journal of Entomology 82(3): 593-594.
- Meena M, Singh H V, Jat R S, Yadav G L, Dotaniya M L, Meena M D, Choudhary R L, Meena M K. 2019. Economics and yield

Efficacy of plant extracts against aphid *Lipaphis erysimi* (Kalt) in brown mustard *Brassica juncea* L 5 Kunal Kaushik and Rajesh Kumar

affected by herbal extracts in Indian mustard *Brassica juncea* L. International Journal of Current Microbiology and Applied Sciences 8(12): 628-633.

- Mansoori A, Singh N, Dubey S K, Thakur T K, Alkan N, Das S N, Kumar A. 2020. Phytochemical characterization and assessment of crude extracts from *Lantana camara* L. for antioxidant and antimicrobial activity. Frontiers in Agronomy 2: 582268.
- Mvumi C, Maunga R P. 2018. Efficacy of lantana (*Lantana camara*) extract application against aphids (*Brevicoryne brassicae*) in rape (*Brassica napus*) over varied periods of time. African Journal of Biotechnology 17(8): 249-254.
- Pal R S, Pal Y. 2016. Pharmacognostic review and phytochemical screening of *Centella asiatica* Linn. Journal of Medical Plants Studies 4(4):132-135.
- Rangana S. 1976. Manual of analysis of fruits and vegetables products, Tata McGraw Hill Co. Pvt. Ltd., New Delhi. 77 pp.
- Reddy Y R, Rai P K, Rai A K, Bara B M. 2019. Study on the effect of different pre-sowing seed treatment on seed quality of mustard *Brassica juncea* L. International Journal of Current Microbiology and Applied Sciences 8(9): 26-32.

Saucke H, Dori F, Schmutterer H. 2000. Biological and integrated control

of *Plutella xylostella* (Lep., Yponomeutidae) and *Crocidolomia pavonana* (Lep., Pyralidae) in brassica crops in Papua New Guinea. Biocontrol Science and Technology 10(5): 595-606.

- Singh A K, Lal M N. 2012. Bio-efficacy of some plant leaf extracts against mustard aphid, *Lipaphis erysimi* Kalt. on *Brassica campertris*. Asian Journal of Biological Science 7(2):159-162.
- Sharma A, Patel S. 2016. Preliminary phyto-chemical analysis of methanolic and aqueous extract of medicinal plant- Nyctanthes arbortristis L. World Journal of Pharmacy and Pharmaceutical Sciences 11(5): 1393-1401.
- Tadesse S, Ganesan K, Nair S K P, Letha N, Gani S B. 2016. Preliminary phyto-chemical investigation of different solvent extracts of *Centella asiatica* L. Family: Apiaceae, an Ethiopian weed. International Journal of Pharmaceutical, Chemical and Biological Sciences 6(1): 97-102.
- Widiyarti G, Fitrianingsih W. 2019. Phytochemical constituents and free radical scavenging activity of Madang Gatal (*Schima wallichii*) Choisy stem bark. Pharmacognosy Journal 11(2).
- Yusuf R, Bahrudin, Masud H, Syakur A, Afriana D S, Kalaba Y, Kristiansen P. 2020. Application of local seaweed extracts on growth and yield of mustard greens *Brassica juncea* L. Earth and Environmental Science 484: 1-7.

(Manuscript Received: September, 2023; Revised: December, 2023; Accepted: February, 2024; Online Published: February, 2024) Online First in www.entosocindia.org and indianentomology.org Ref. No. e24664