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Evaluation of the Efficacy of Crude Extracts of Tick Berry *Lantana camara* and Mexican Marigold *Tagetes manuta* Against Cabbage Aphids *Brevicoryne brassicae*

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Abstract

The efficacy of two plant extracts; *Lantana camara, Tagetes manuta* and a combination of *Lanatana camara* and *Tagetes manuta* applied to the cabbage plants at differeent concentrations against cabbage aphids were tested at St. Mary's College Rushoroza Demonstration farm, Kabale district in 2015. The purpose of the study was to evaluate the efficacy of selected botanical plants' crude extracts against the cabbage aphid *Brevicoryne brassicae L.* The specific objectives of the study were to compare the aphid populations on cabbage plants sprayed with *Lantana camara*, *Tagetes manuta* extracts and their combination, to determine the effective concentration of *Lantana camara, Tagetes manuta* and their combination that could protect the crop against cabbage aphids and to determine the yield of cabbage under different treatments of *Lantana camara, Tagetes manuta* and their combination on aphids. A field experiment was laid in a Randomized Complete Block Design (RCBD) with four blocks, three treatments replicated four times and a control experiment. Each experimental plot was 3 M by 2.5 M (7.5 M^2 area) per plot and separated by 0.9 m between plots to avoid interplot and interblock interference. Data collected were aphid infestations (adults and nymphs) per three leaves, reduction in aphid populations after application of sprays, and percentage marketable yield. Data were subjected to one way Analysis of Variance (ANOVA) in Genstat software (eleventh edition) programme to compare the aphid population means in treated groups and untreated groups of cabbage. The plant extracts treatments of *Lantana camara, Tagetes manuta* and their combination on cabbage plants significantly reduced the number of aphids than on the untreated plants during the trial seasons.

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The populations of aphids were not significantly different ($p>0.05$) at 5% and 10% concentrations between *Lantana camara*, *Tagetes manuta*, their combination, and the control experiment but showed significant difference ($P<0.05$) for 15% and 20% concentrations and the control experiment due to their high dosage rates. All the treatments at higher concentrations showed protection of cabbage against the aphids. The highest percentage aphid reduction was given by *lantana camara* extract at 20% concentration. A combination of *Lantana camara* and *Tagetes manuta* and *Tagetes manuta* at 20% concentration were also found effective. The cabbage plots sprayed with a 20% concentration of *Lantana camara* were found to have the biggest mean weight and percentage of marketable yield. It was concluded that the extracts of *Lantana camara*, *Tagetes manuta* and their combination had both pesticide and repellent roles in the control of cabbage aphids and therefore could be good insecticidal options for Integrated Pest Management Programmes in the control of cabbage aphids. It was therefore recommended that pending further research, these extracts could be used in pest management to minimize environmental problems resulting from use of synthetic pesticides.

Keywords: Efficacy; concentrations; Marketable yield; *Brevicoryne brassiceae*; *Brassica oleracea L.*

1. Introduction

Cabbage is a popular crop of the species of *Brassica oleracea* Linn., family Brassicaceae. It is one of the most important leafy vegetables worldwide and is of choice by many smallholder farmers in Africa [1, 2]. In Kabale, it is grown by both small and large scale farmers for consumption in schools, towns and for export to neighbouring Countries. The common production constraints of cabbage include drought, diseases such as downy mildew, black leg, clubroot, damping off, bacterial soft root and black rot while pests are diamondback moth, *Plutella xylostella*, cabbage aphid, *Brevicoryne brassicae* and cabbage webworm, *Hellula undalis* [3]. The most notorious pest of cabbage is the aphid *Brevicoryne brassicae* which causes a serious reduction in yield. Infection by this pest leads to stunted growth, curling, wilting and yellowing of plants, leading to a decline in marketable yield [4]. Severely infested plants become covered with a mass of small sticky aphids (due to honeydew secret ions), which can eventually lead to leaf death and decay [5]. This pest must be immediately controlled to avoid big economic loss to the farmer. Different control measures including chemical, biological cultural and physical methods have been used, each with its strength and weaknesses. There has been increased use of synthetic pesticides such as, fenoxycarb, bifenthrin, metasystox, cyhalothrin-lambda, dimethoate, diazinon and malathion to control this pest. This practice led to environmental destruction, affecting human health and a reduction in species diversity [6] and aphids have developed resistance, pest resurgence and pesticide substitution [7, 8]. The normal pre-harvest period for the chemicals used has not been followed in vegetable growing and the crops are often consumed when the chemical is still in the tissues [9]. The risks emanate from shortcomings in chemical handling practices, large deviations from recommended chemical doses, and chemical drift to non target organisms and run off into the soil and ground water [10]. The greatest concern with use of chemical insecticides in vegetable production is their potential poisonous effects on human health through dietary exposure [11, 12]. As modern consumers explore for safe food, and as environmentalists try to minimize loss of biodiversity, alternative control measures such as plant derived extracts that are environmentally friendly are being promoted and used in the control of plant pests. Plant derived pesticide extracts commonly referred to as plant botanicals provide insecticides properties in several ways; as repellents

by driving the insects away due to smell or taste, as antifeedants which cause insects on the plants to reduce their food intake and hence starve them to death; as oviposition deterrents, by preventing insects from laying egg; or as inhibitors by interfering with the life cycle of the insects [13]. Similarly, [14] found that botanical insecticides are attractive alternatives to synthetic chemical insecticides for pest management because they allegedly pose little threat to the environment and human health. *Lantana camara* and *Tagetes manuta* are some of the plants that have been reported to have pesticidal effects on different pests [15]. Thus, the present study is aimed at the use of some plant extracts from *Lantana camara* and *Tagetes manuta* crude extracts against cabbage aphids in Kabale district, southern Uganda.

2. Methods and Materials

The experimental field was conducted at St. Mary's College Rushoroza Demonstration Farm, Kabale district, located on latitudes 1°15'45.86" , longitude 29°59'17.23" E at an altitude of 1805m above sea level from 22nd Janurary 2015 to 7th May 2015. The mean annual rainfall is 1200mm, mean annual temperature is 21ºC and relative humidity ranges between 90% - 100% in the mornings and decreases to between 50-65% in the afternoons during all the months. Agriculture activities are the main occupation of the area [16].

Preparation and Application of Extracts

1. Fresh leaves of *Lantana camara* and *Tagets manuta* were harvested at full maturity. The extracts of the two plant species were prepared by weighing 1kg each separately and crushed with a mortar and pestle. The crushed plant parts were put in separate containers containing one litre of water. These were allowed to settle for 12 hours and the suspension filtered to obtain stock solutions. From the stock solutions, 100, 200, 300 and 400 ml each of the solution were diluted with quantities of water to make 5, 10, 15 and 20 % concentration respectively [17]. These dilutions were each taken as a treatment in this experiment. The unsprayed plots known as control experiment were included for comparison. Foliar application was done using knapsack sprayer which commenced three weeks after transplanting [18] and repeated at weekly intervals until harvesting [15]. The extracts of *Tagetes manuta* and *Lantana camara* were also combined equally and sprayed in the same concentrations as a separate treatment. Spraying was done in the evenings to ensure that the active ingredient did not break down in sunlight [19].

The experiment was laid in a Randomized Complete Block Design (RCBD) with four blocks, three treatments replicated four times and a control experiment. Each experimental plot was 3 M by 2.5 M (7.5 M^2 area) per plot and separated by 0.9 m between plots to avoid interplot and interblock interference. The experiment was laid as follows:

Treatment 1 used *Lantana camara* crude extract, treatment 2 used *Tegates manuta* crude extract and treatment 3 used a combination of *Tegates manuta* and *Lantana camara* crude extracts, all at different concentrations of 5%, 10%, 15% and 20% crude extract in water and a control experiment where there was no spraying of cabbage plants against aphids until harvesting.

Cabbages were planted at a spacing of 60 cm between rows and 60 cm between plants per plot. This made a

total of thirty plants per plot. The compost manure was applied a week before planting, applied by mixing it with soil in all the plots at a rate of 40 ton ha^{-1} (4.0kg m^{-2}). In each plot, management practices such as mulching, disease control and irrigation were carried out similarly in all plots. The first spray was given three weeks after transplantation. By this time, incidence of *Brevicoryne brassicae* was observed in the field. The sprays were repeated after every 7 days, carried out in the evening so as to avoid bright sunlight immediately after spraying. The outcomes of the experiments were on the basis of pest infestations, percentage reductions and yield comparisons.

Data Collection Parameters

The data collected were aphid infestations (adults and nymphs), reduction in aphid populations after application of sprays and cabbage yield per plot after harvesting. Twenty plants were randomly selected in each plot. Live *Brevicoryne brassicae* (both adult and nymphs) were counted on three top leaves from the terminal shoot per plant on a weekly interval, three weeks after planting and lasted for 11 weeks. Aphid count was done before spraying, and 48 hours after spraying aided by a hand lens. The total number of aphids observed were counted and the mean number determined. Aphids incapable of moving after a slight touch with a fine stick were considered as dead.

The cabbage crop was harvested manually after maturity. The yield obtained for each treatment was measured in Kilograms and using Salter weighing scale made in England with a maximum capacity of 200 Kg.

Data Analysis

Data obtained from counts of *Brevicoryne brassicae* infestations were subjected to one way Analysis of Variance (ANOVA) in Genstat software (eleventh edition) programme to determine if there were significant differences between treatments and untreated groups over time schedules. The efficacy of *Lantana camara, Tagetes manuta* and a combination of *Lantana camara* and *Tagetes manuta* extracts on cabbage aphids was determined by comparing the aphid population means in treated groups and untreated groups of cabbage. Significance tests were computed at 5% level of significance. Data for weights of marketable cabbages were presented in Kilograms. All the graphic presentations were carried out using Microsoft office Excel 2007.

3. Results

The results were generated focusing on cabbage aphid population, percentage aphid reduction on cabbages and yield differences among the treated and untreated experiments. Aphid infestations were observed in the second week after transplanting, but were sufficient to be recorded in the third week. The pre-treatment observation on the presence of aphid on cabbage was in range of 1.9 to 3.1. Generally, all the crude extracts of *Lantana camara, T*agets *manuta* and a combination of *Lantana camara and T*agetes *manuta* had an effect on reduction of cabbage aphid populations, although, the effect differed from treatment to treatment and from concentration to concentration of the crude extracts. In all plots that were sprayed with extracts, aphid population reduced. However, where there was no spraying in the control plots, aphid populations kept on increasing up to the 9^{th} week (figures. 1,2,3,and 4). Aphid populations for all the treatments were highest in the 9^{th} week but reduced in

the subsequent weeks up to harvesting period. The highest mean population of *Brevicoryne brassicae* observed on untreated cabbages was 39.6 and this number reduced towards harvesting. After spraying with the plant extracts, the numbers of *Brevicoryne brassicae* were reduced on the treated plants at different concentrations.

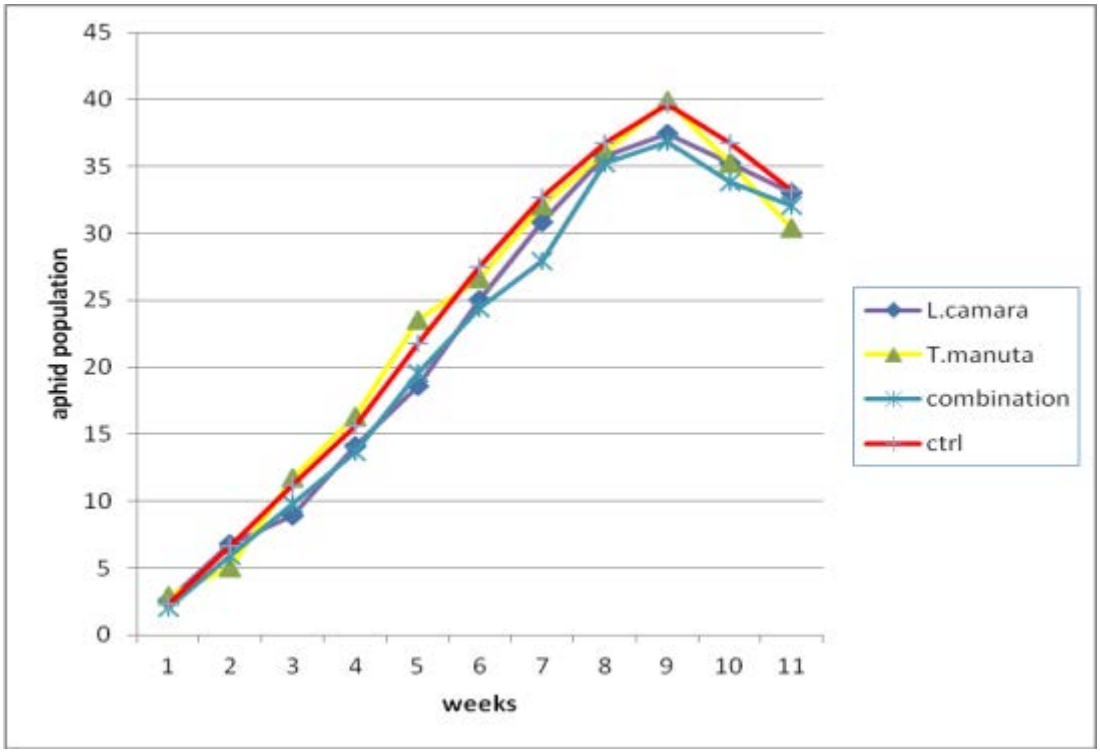

Figure 1: Aphid population at 5% concentration

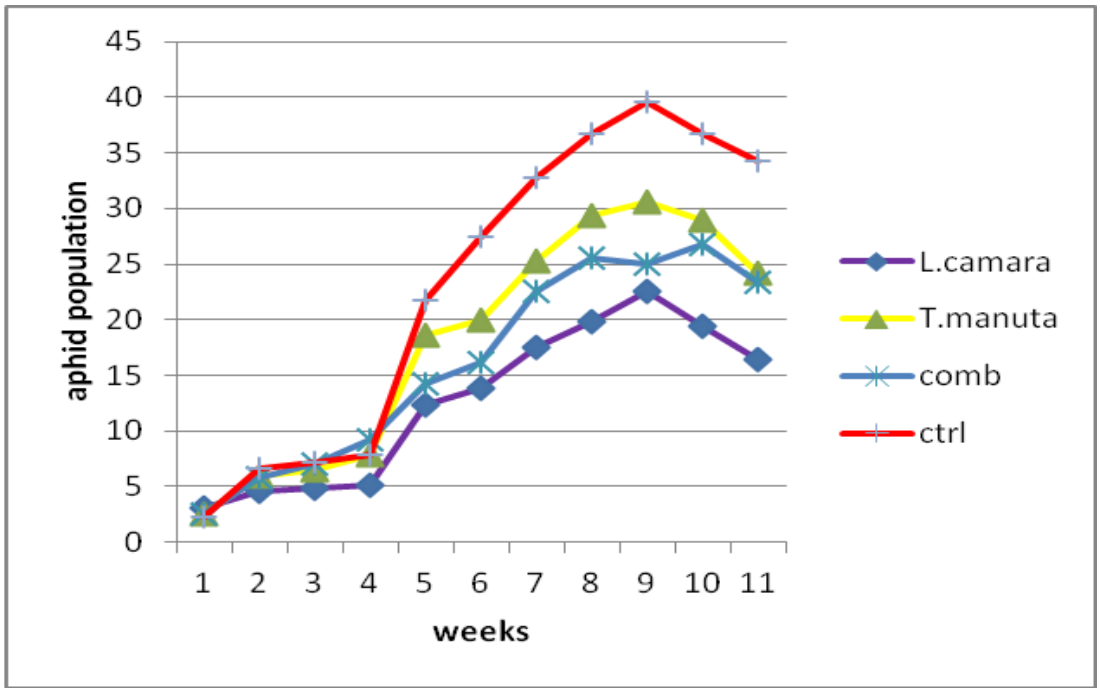

Figure 2: Aphid population at 10% concentration

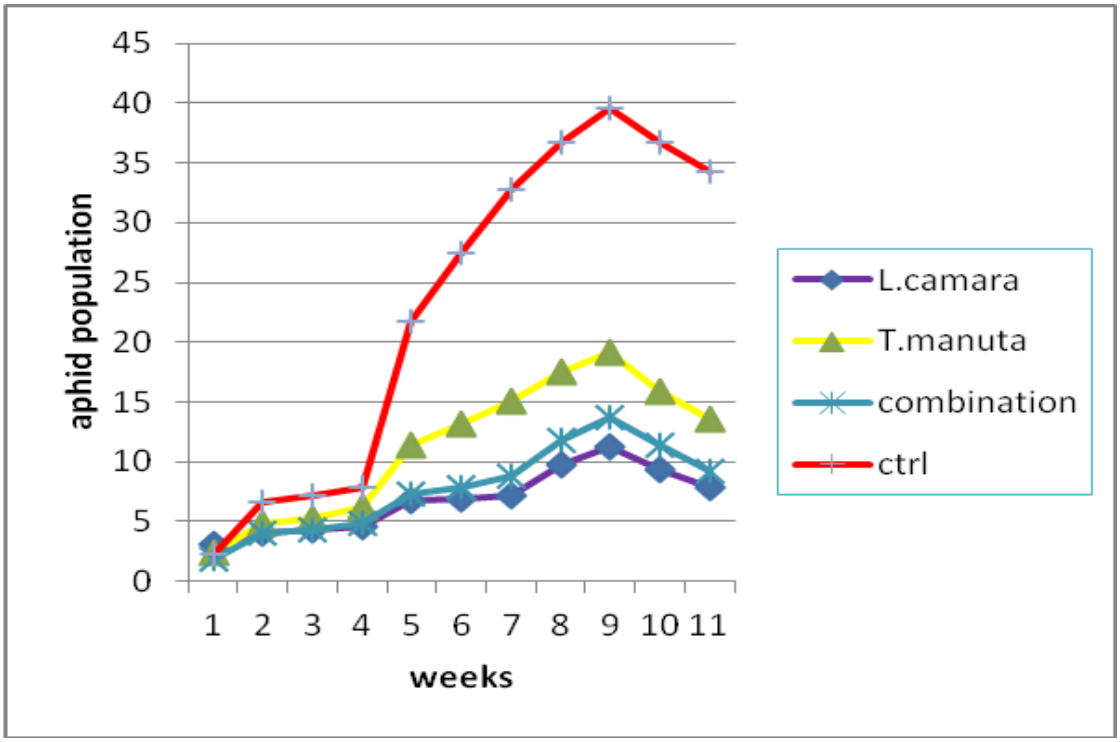

Figure 3: Aphid population at 15% concentration

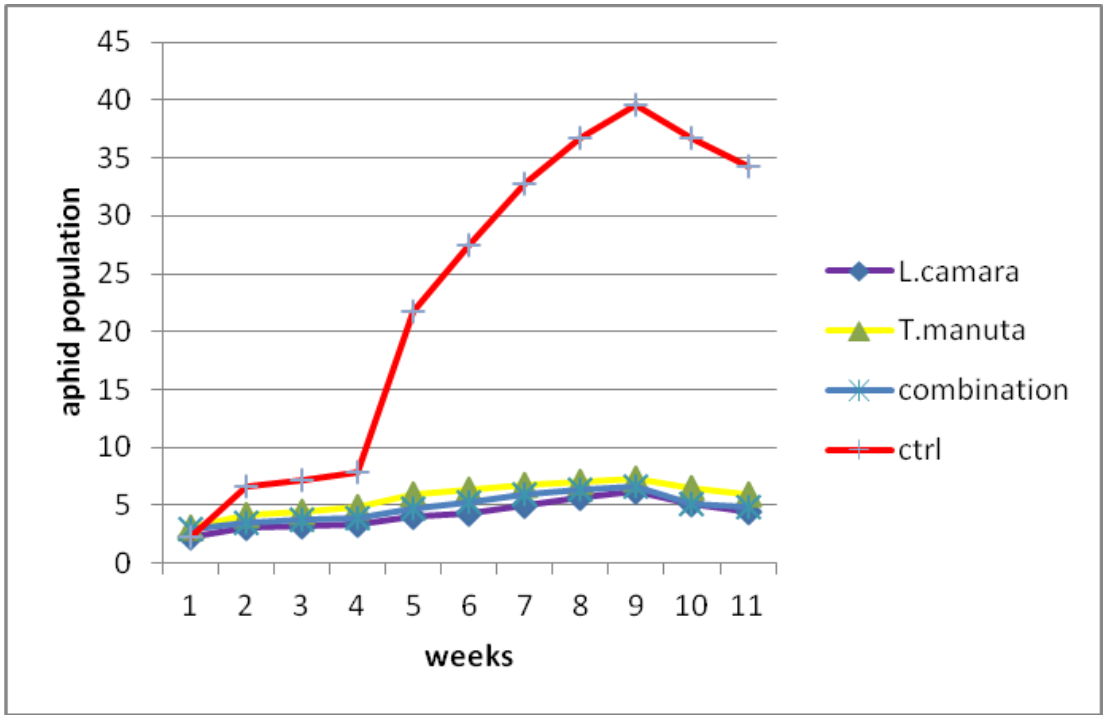

Figure 4: Aphid population at 20% concentration

When the densities of the aphids were compared statistically, the analysis of variance for *Brevicoryne brassicae* populations showed no significant difference ($p>0.05$) at 5% and 10% concentrations between *lantana camara*, *Tagetes manuta*, their combinations, and the control experiment but showed significance difference ($P<0.05$)

for 15% and 20% concentrations and the control experiment due to their high dosage rates. Treated plants with 20% concentration recorded the least number of *Brevicoryne brassicae* while plants that were used as control; with no spraying had very high aphid infestation and were severely infested.

The extracts of *Lanata camara, Tagetes manuta* and a their combination were not significantly different at 5% (p=0.981373) and 10% (P= 0.363601) concentrations and were not significantly different from the control experiment at (p=0.981373) and (P=0.158639) respectively at 5% level of significance. However, treatments with the extracts of *L.camara, T. manuta* and a combination of *Lantan camara* and *Tagetes manuta* were significantly different at 15% (0.043083) and 20% (p= 0.035018) and differed significantly from the control experiment at 15% (0.0000798) and 20% (0.000000261). The mean number of aphid infestations on cabbages was much lower in plots sprayed with 20% *L.camara*, followed by 20% of a combination of *Lantana camara and Tagetes manuta. Interestingly, f*or all the treatments and the control, mean population of *Brevicoryne brassicae* reduced from the 9th week of the field experiment.

The results in table 1 reveal a percentage reduction of *Brevicoryne brassicae* in all the three treatments but which differed significantly from treatment to treatment and concentrations of the extracts. The plant crude extracts of *Lantana camara*, *Tagetes manuta* and a combination of *Lantana camara* and *Tagetes manuta* at 5%, 10%, and 15% concentrations were not as effective as 20%. 20% *Lantana camara* extract reduced the cabbage aphids by over 50%, a combination of *Tagetes manuta* and *Lantana camara* reduced aphids by over 45% while *Tagetes manuta* extract reduced the aphids by over 40%.

The Analysis of Variance results indicate that there was no significant difference between *Lantana camara, Tagetes manuta* and a combination of *Lantan camara* and *Tagetes manuta* on the reduction of *Brevicoryne brassicae* for 5% concentration *(*P= 0.111057) and 10% concentration (P= 0.435709). However, it was significantly different at 15% (P= 0.00000000281) and 20% (P= 0.00000000000034) concentrations. Cabbages yield was greatly affected by aphid infestations (figures 5,6,7 and 8).

The unsprayed plots were heavily infested with aphids and gave the lowest mean weight per plot. Plots which were sprayed with higher concentrations gave more weight yield than those which were sprayed with lower concentrations. The highest mean weight per plot was recorded on cabbage plants treated with 20% *Lantana camara* leaf extract while the least weight yield was recorded on the untreated experiment and treated cabbage plants at 5% concentrations.

The cabbages in plots not sprayed and those sprayed with 5% concentration of extracts were heavily damaged and gave very low average weight yield per plot. Plots sprayed with 10% concentration of extracts were also seriously infected and recorded low weights per plot. The marketable yield was lower in the plots heavily attacked by aphid populations (figure. 6,7, 8 and 9). The unsprayed plots had the lowest percentage marketable yield. Plots which were sprayed with higher concentrations had bigger percentage marketable yield than those which were sprayed with lower concentrations. *Lantana camara*, *Tagetes manuta* and a combination of *Lantana camara* and *Tagetes manuta* all had 100% percentage marketable yield while the untreated plots had 36.4 % marketable yield.

Table 1: Percentage Aphid Reduction Per Three Selected Leaves on Cabbage Plant Per Week Following Plant Extract Sprays

Treatment	**Conc**		**Percentage aphids reduction per three selected leaves on cabbage per week following spray**									
		Wk1	**Wk2**	**Wk3**	**Wk4**	**Wk5**	**Wk6**	**Wk7**	**Wk8**	**Wk9**	**WK10**	**Wk11**
L.camara	5%	3.85	4.41	5.63	2.70	4.30	4.00	5.84	6.42	4.81	4.518	4.55
		5.26	4.00	5.79	4.17	4.26	3.76	4.05	4.72	3.76	3.70	3.62
T. manuta	5%	5.00	5.08	4.41	6.41	4.59	4.09	5.73	6.25	5.71	5.33	4.67
Tc &Tm	5%											
	P= 0.111057											
L.camara	10%	12.90	15.21	14.29	15.69	14.52	14.49	14.85	14.14	14.22	15.46	12.80
		15.38	15.00	15.38	12.82	13.44	14.57	15.81	15.02	13.72	14.53	12.40
T. manuta	10%	16.00	15.51	15.71	14.13	12.59	15.43	13.77	15.23	15.20	15.67	14.53
Tc &Tm	10%											
	P= 0.435709											
L.camara	15%	32.26	30.00	32.56	36.95	30.88	30.43	33.33	28.86	32.74	30.85	28.21
		20.83	22.45	24.53	25.81	24.56	25.76	24.67	23.42	23.95	22.64	20.59
T. manuta	15%	27.78	24.39	28.89	29.17	28.77	27.82	29.55	25.42	27.74	26.32	25.00
Lc & Tm	15%											

	P= 0.00000000149											
L.camara	20%	52.17	64.52	62.50	55.88	56.09	53.49	62.00	57.89	62.90	58.82	63.64
		41.93	42.86	38.00	40.82	43.33	39.68	41.18	44.29	43.83	40.00	46.67
T.manuta	20%	48.28	48.57	45.95	46.15	44.68	47.17	47.46	49.21	48.48	49.02	52.08
Lc&Tm	20%											
	P= 0.00000000000034											

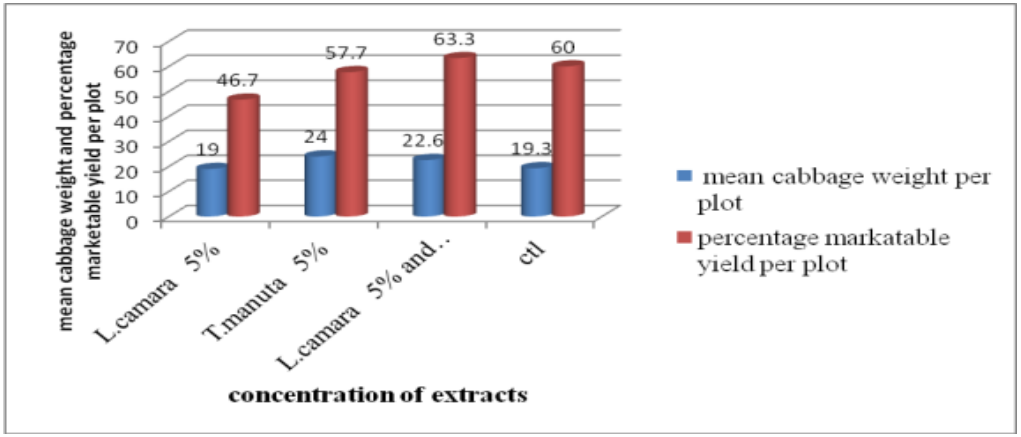

Figure 5: Mean cabbage weight and percentage marketable yield per plot at 5% concentration

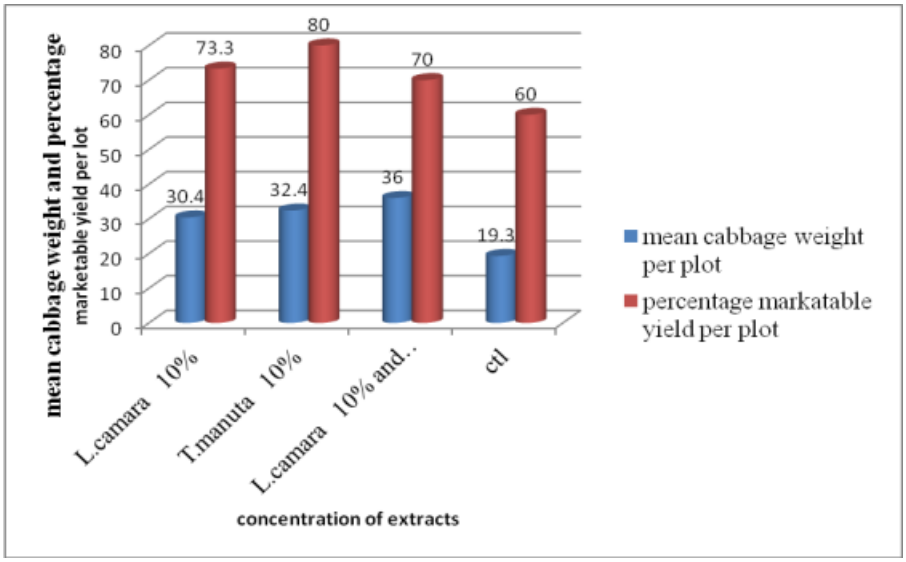

Figure 6: Mean cabbage weight and percentage marketable yield per plot at 10 % concentration

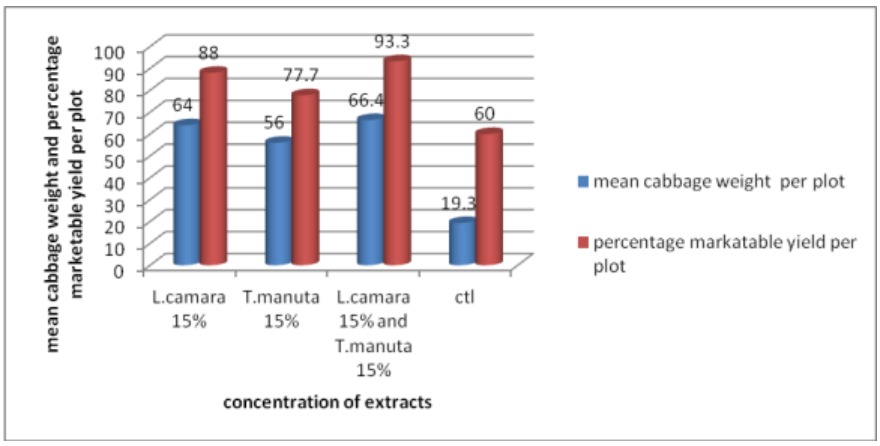

Figure 7: Mean cabbage weight and percentage marketable yield per plot at 15 % concentration

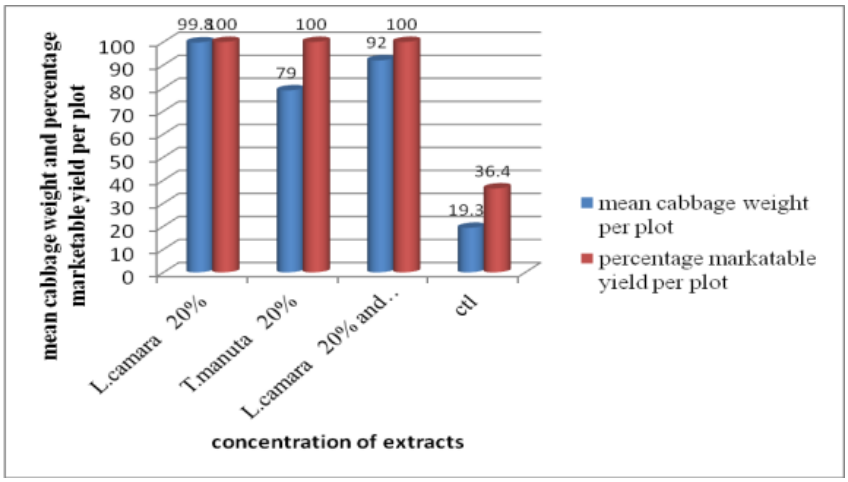

Figure 8: Mean cabbage weight and percentage marketable yield per plot at 20 % concentration

4. Discussions

In all cabbage plots that were treated with crude extracts of lantana camara, tagetes manuta and their combination, aphid population reduced, though with different levels of concentrations of the crude extract. In the unsprayed control plots, aphid populations kept on increasing up to the 9th week. *Lanatana camara* showed the best response in controlling the aphids compared to other treatments. The reduction in the aphid population after spraying was an indication that the plant extracts possessed pesticidal properties. As [20, 21] noted, most plants have oils and alkaloids which are effective as control agents against a number of insect pests including cabbage aphids. The effect of *lantana camara* as a pesticide had been reported by previous studies, though did not indicate the levels of concentrations that were effective. The results obtained are supported by authors like [22, 23] who found out that extracts from the leaves of *Lantana camara* exhibited antimicrobial, fungicidal, insecticidal and nematicidal activities because it contains flavanoids, triterpenoids and alkaloids such as lantanine which have insecticidal action [24, 25, 26]. Although *Tagetes manuta* extract was not as effective as *Lantana camara*, it also showed substantial reduction of aphids and could also be used as a pesticide if its concentration is increased above 20%. [27, 28] found insecticidal properties in *Tagetes manuta*. Similarly, [29] reported the mean mortality of *Brevicoryne brassicae* reaching 51 % for *Tagetes manuta* extract under laboratory conditions.

With yield greatly reduced by pests, the findings are supported by [30] who found out that pest infestation normally leads to reduction in market value and in some cases total crop failure. As noted, there was general decline in the aphid populations after the 9th week during treatment, including the untreated, although the untreated still had more aphids that the treated plots. The general reduction was due to heavy rains that came in following a dry season. The weight of rain droplets rubbed off some of the aphids from the cabbage leaves.[31] found that heavy rains dislodge aphids from plants.

5. Conclusion

All the treatments reduced the cabbage aphid, although, higher concentrations were found most effective against the pest. Therefore, the extracts of *lantana camara*, *Tegates manuta* and a combination of *Lantana camara* and *tagets manuta* plant extracts had both pesticide and repellent roles in the control of cabbage aphids. As the concentration increased, the was more reduction in the population of aphids. Basing on this, it can be concluded that appropriate concentrations of the plant crude extracts could be obtained and then used as alternative pesticide in the control of the notorious cabbage aphid, bearing in mind its friendliness to the environment.

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