Research Article

BIOEFFICACY OF DIFFERENT PLANT EXTRACTS AGAINST MELON FRUIT FLY *Zeugodacus cucurbitae* (Coquillet) IN ZUCCHINI AT BHARATPUR, NEPAL

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ABSTRACT

The management of fruit fly is simply through chemicals, which have hazardous impact on human health and environment. So, the present study on "Bioefficacy of different plant extracts against fruit fly in zucchini" was carried out at Bharatpur-11, Chitwan, Nepal from February 13 to May 18, 2020. The experiment was laid in Randomized Complete Block Design (RCBD) consisting four replications and five different treatments namely: 1) Neem leaf extracts, 2) Parthenium leaf extracts, 3) Garlic clove extracts, 4) Chilli fruit extracts and 5) Untreated control. All treatments were applied 40 days after transplanting and repeated 3 times at 10 days interval. For treatments, the extracts from each botanical were diluted with water in 1:5 ratio then applied with the help of hand sprayer. Data were taken after 3rd, 6th and 9th days of each treatment application. The result showed that Neem leaf extracts reduced adult fruit fly population by 64% over control. This was followed by parthenium leaf extracts (49.6%), garlic clove extracts (43.0%) and chilli fruit extracts (37.0%), respectively. Similarly, minimum flower drop (22.3%) and fruit damage (19.5%) were also observed on neem leaf extract treated plots as compared to all other treatments. The neem leaf extract also give highest marketable yield (15.4 mt/ha). For monitoring of fruit fly population, cue lure trap were installed at corner of the field, which show the maximum number of fruit flies (n = 41) was recorded at an average temperature of about 26.9 ^{0}C. During our research, it was found that fruit fly preferred more young and immature zucchini fruits as compared to mature one. The results of this experiment revealed that botanicals could be used as option of synthetic pesticides for the management of melon fruit flies that would render health benefit to human beings and friendly to environment. Among all botanicals neem leaf extracts performed best with regards to all parameters.

***Keywords**: Summer squash (Zucchini), fruit fly, extracts, damage, cue lure*

INTRODUCTION

Summer Squash (*Cucurbita pepo* L.) belongs to the family Cucurbitaceae, which is a native of Mexico and US. Squashes which include zucchini, are a large group within the cucumber family, Cucurbita, and include gourds, pumpkins, summer and winter squashes. It is tender,

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annual, warm season vegetable crop that is harvested when fruits are immature (Sarhan *et al.*, 2011). Summer squash are high in vitamin A, vitamin C, and niacin and are commonly prepared by steaming, baking, deep-frying (Herbst, 2001). The largest producers of summer squash are Turkey, Italy, Egypt, Spain, U.S.A and Mexico (Paris, 1996). Production, in total, of pumpkins, squash and gourds was 27,449,481 mt in 2,078,450 ha around the world in 2017 (FAO, 2019). In Nepal, the production of summer squash was 28,663 mt from 1,836 ha while Chitwan district covered 201 ha with 2,504 mt in FY 2018/19 (MOAD, 2020).

Despite having appreciable production, declining in productivity which is a major concern in the commercial production of summer squash and the pests are among the main factors contributing towards low production and productivity. Among the different several biotic factors, the melon fly, (*Zeugodacus cucurbitae* Coquillett) (Diptera: Tephritidae) has been most prominent pest over last several decades in Nepal (Adhikari, 2013). The extent of losses varies 30 to 100%, depending upon the susceptibility of crop species and environmental conditions (Sapkota *et al.*, 2010). Fruit fly is the notorious and the most destructive pest of Nepal. This pest has a major limiting factor which causes intense qualitative and quantitative losses in summer squash. It causes enormous economic losses to a wide variety of fruits, vegetables and flowers (Singh *et al*., 2006; Diamantidis *et al*., 2008). The maggots feed inside the fruit and as a result infested fruits become rotten and finally shed up prematurely. Thus these fruit flies directly effect on the quality and quantity of the fruit production (Nassiruddin *et al*., 2004). The pest is distributed widely in temperate, tropical, and sub-tropical regions of the world (Dhillon *et al*., 2005).

Farmers of Nepal are unsafely using different chemical insecticides to overcome this notorious insect pest (Maharjan *et al.*, 2016). Due to unsafe use, the chemicals pesticides enter on human body through ingestion, inhalation or penetration via skin (Spear, 1991). It also creates many other problems such as pest resistance, residues in food, environmental contamination, outbreaks of secondary pests, reductions in populations of beneficial insects (Aqil *et al.*, 2010). Chemicals also affect soil microbes like nitrogen fixing bacteria, mycorrizal fungi and earthworm (Schreck *et al*., 2008). In this situation, alternative control measures such as botanical pesticides should be applied. Plants contain thousands of compounds which are virtually an untapped reservoir of pesticides that can be used directly or as templates for synthetic pesticides (Singh and Sehgal, 2001). Plant extracts are one of several non- chemical control alternatives that inspiring great interest due to their availability reduced human and mammalian toxicity and friendliness to the environment (Aqil *et al*., 2010). This research has attempted to overcome the problems related to fruit fly and synthetic chemical pesticide in considering the economic values of fruit fly and zucchini by managing fruit fly population sustainably.

MATERIALS AND METHODS

The experiment was conducted from 13 February to 18 May, 2020, under field condition of Chitwan, Nepal. Geographically, it is situated at 27˚41’37.45” Northern latitude &

84˚26'58.63" Eastern longitude in an altitude of 408 masl. The meteorological data regarding average temperature (22.79^{0}C), average rainfall (16.1 mm) and average relative humidity (75.1%) were recorded for an entire crop growth period from nearby meteorological station.

Soil was moderately acidic, having pH 6.2, total nitrogen (N), phosphorous (P_2O_5) potassium (K_2O) and organic matter were 0.25%, 472.43 mg/kg soil, 13.95 mg/kg soil and 4.872% respectively. The land was ploughed, harrowed and planked, and bed was raised above 15 cm from ground level. The standard calculated doses of FYM (33 kg/plot) and NPK (260:190:60 gm/plot) respectively, were applied during the field preparation. Half dose of nitrogen was applied during field preparation and remaining half dose was applied in two split doses, first on 30 days of transplantation and remaining at 55 days of transplantation. Summer squash of Anna-1205 variety of was selected for the experiment. Seedlings were prepared in polybag and 25days old seedlings were transplanted in each plot. Uniform cultural practices were applied to all treatments.

Details of Experiment

The experiment was carried out in a Randomized Completely Block Design (RCBD) with 5 treatments, namely neem leaf extracts, parthenium leaf extract, garlic clove extract, chilli fruit extract and control. Each treatment was replicated four times. The selected plant materials were grinded to make paste. Then pastes were kept in muslin cloth and squeezed to drain extract. Then after, the extracts were mixed with tap water in the ratio of 1:5 and sprayed through separate hand sprayer. The individual plot size was 2.5 m x 4.5 m having (1 m × 1 m) plant-plant distance as well as row-row distance. The distance of 1m was maintained within replications and between the treatments as well. There were 20 plots containing 8 plants in each plot. Four plants per plot were randomly selected from middle for observation and data recording. Overall fruit fly population was monitored by installing a cue lure trap at the corner of research field from 14 April 2020. Treatments were applied 40 days after transplanting of seedling and repeated 3 times at 10 days intervals. Data were taken 24 hours before and 3, 6, 9 days after treatment application. Considered different observation parameters are followed.

Fruit fly population count: The number of adult fruit fly was counted from each plot by direct observation method on a sample plant. Adult fruit fly present in the plot was observed and counted by close examine through eye without disturbing the plant. Before taking data confirming of fruit fly species and then numbering was done on data sheet.

Counting of fruit fly population was done on one day before spray (pre-treatment fruit fly population) and on 3rd, 6th, and 9th days after spray. For second and third spray, pre treatment count were 9th day count of first and second spray respectively.

Number of flower: flower numbers were taken from each sample plant in each plot in regular interval of time.

Number of flower drops: Number of flower drops caused by fruit fly was taken in data from each sample plant of every plot. Presence of fruit fly larva inside the flower was confirmed before taking as data.

Number of fruit set: Number of fruit set was count from each sample plant in each plot.

Number of fruit damage: Number of fruit damage caused by fruit fly was count from each sample plant of each plot.

Number of fruit harvested (Marketable quality): The number of fresh fruit harvested and weight of each fruit were taken to analysis amount of marketable fruit obtained from experimental field.

The raw data obtained from field experiment were tabulated by using excel sheet and analyzed by using R-Stat software package and significance means separated by Duncan's multiple range test (DMRT) at 5% level of significance.

Percentage of population reduction over control (PROC)

Percentage of population reduction over control was calculated by using the modified Abbots formula given by Fleming and Ratnakaran, (1985).

$$PROC = [1-\{(Ta\times Cb)/(Tb\times Ca)\}]\times 100\%$$

Where, Ta= Population in treatment after spray,
Tb= Population in treatment before spray,
Ca= Population in control after spray,
Cb= Population in control before spray

The data were statically analyzed by converting them into $\sqrt{x+0.5}$ as suggested by Gomez and Gomez, (1984).

Percentage of flower damage

The flower damage percentage due to fruit fly was calculated by using this formula.

$$\text{Flower damage \%} = \frac{\text{Number of flower drop by fruit fly}}{\text{Total number of flower set}} \times 100$$

Percentage of fruit damage

Fruit damage percentage due to fruit fly was calculated by using this formula.

$$\text{Fruit damage\%} = \frac{\text{Number of fruit damage by fruit fly}}{\text{Total number of fruit set}} \times 100$$

RESULTS AND DISCUSSION

Monitoring of fruit fly population

Number of fruit fly population was taken from cue lure trap, installed at corner of research plot. DATA was recorded at every 5 days interval. Similarly temperature was also averaged accordingly. Almost *Zeugodacus cucurbitae* species were observed during monitoring. Result show that population of fruit fly found increasing with crop age. The maximum number of fruit fly (41) was trapped on 10^{th}-15^{th} May, at mean temperature of about 26.93 ^{0}C. Here, the research found that fruit fly population was also decreased with increasing temperature that might be due to sunny days (Lasker and Chatterjee, 2010) and high relative humidity (Shukla & Prasad, 1985; Su, 1984).

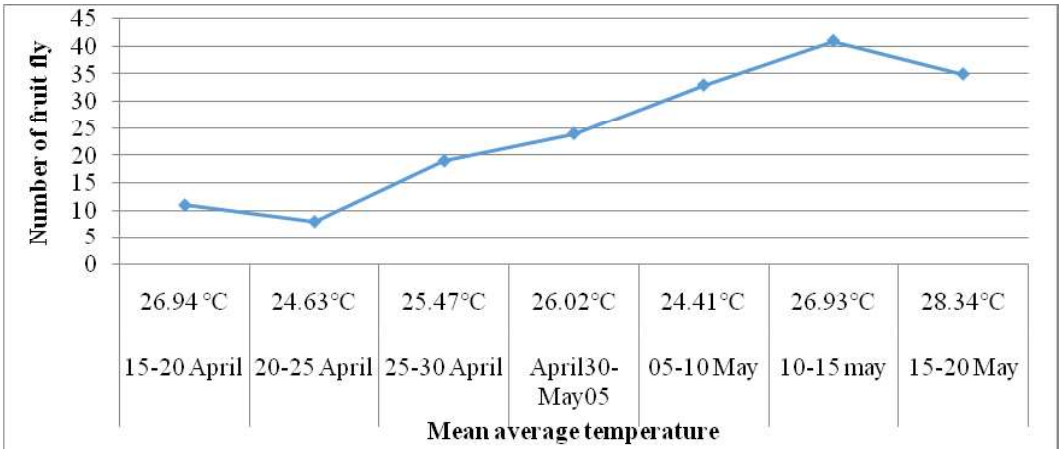

Fig. 1. Fruit fly population at different temperature on different date

Average fruit fly population after first spray

Pre-treatment data was taken one day before spray whereas maximum number of fruit fly population was recorded at control plot. Then on next day, spraying of botanicals extract was done and data of fruit fly population were taken after third day of spraying. On third day of first spray, garlic clove extract showed effective control than other treatments, which was recorded as 30% reduction of fruit fly population over control. This was followed by neem leaf extract, which reduced population up to 24% over control. Similarly, parthenium leaf extract and chilli fruit extract showed lowest number of reduction over control, i.e. 20% and 18.3%, respectively (Table 1). On sixth days of spraying, neem leaf extract showed effective control than other treatments, which significantly reduced fruit fly population up to 18% over control. This was followed by garlic, which reduced fruit fly population upto 15% over control. Here, again parthenium extract and chili extract showed minimum and same level of reduction over control i.e. 7% and 6% respectively that can be sown on Table1. On ninth day of spraying, again neem extract showed effective control than other treatments, which significantly reduced fruit fly population up to 17% over control. Here, parthenium

extract, garlic extract and chilli extract showed almost same level of reduction over control i.e. 10.1%, 8% and 6% respectively.

Table 1 showed that neem extract significantly reduced fruit fly population over control in compare to other treatments. This result was justified by Sapkota *et al*. (2010), concluded that neem leaf extract as the most effective to manage fruit fly in summer squash with qualitative and quantitative increase in yield attributes. The result on Table 1 also showed that all the applied treatments help to reduce fruit fly population at initial stage of spraying as compare to few days after spraying that might be due to washed away of botanicals extract residue by rain or might be sprayed extract particle decomposed by sunrays.

This trend of result showed that, different extracts have low reduction rate at initial stage, i.e. at first spray. But it was increased significantly after second and third spray. The results also show that neem leaves extract caused more reduction in fruit fly population and its damage. The reduction rate of neem ranged from 17% to 64% on an average. This result was supported by Mahfuza *et al.* (2007) who concluded that neem leaf dust and commercial formulation of neem minimize the population and damage of fruit fly species and also blocks the ovary development of flies. Masood *et al.* (2009) studied in field and laboratory trails and concluded that neem and its derivatives can minimize the melon fruit fly (*Z. cucurbitae*) population.

Similarly, result showed that parthenium leaf gave the reduction of fruit fly population at the range of 7-49.6% in different time interval after spraying. This result was supported by Ali *et al.* (2011), they found that the parthenium plant extract have good effect on fruit fly and treated plots showed less population than control plots. Similarly, Datta and Sexna, (2001) also studied that parthenium can be used for insect/pest management.

Above result also showed that garlic clove extracts gave the reduction (8-43%) of fruit fly population over control in different time period of spraying. This result was supported by Areekul *et al*. (1987), they found that water and alcoholic extracts of garlic killed 23% and 27% fruit fly population, respectively. Chakravarthy (2007) found that garlic based Ag (commercial name of bio-pesticide) treated gherkin plants had less incidence of fruit fly (*B. cucurbitae*). The result also showed that chilli fruit extracts gave the minimum reduction of fruit fly population, i.e. 6-37% on an average. This result was supported by Izah (2019),who concluded that *C. frutescens* var. *minima* fruit confers insecticidal potentials. Lamba and Malapa (2020) found that chilli possess insecticidal phytochemicals that act as effective repellent and deterrent against *Plutella xylostella*. Ahemad (2015) concluded that, the aqueous and ethanolic extracts of chilli pepper at concentration of 50 mg/L were toxic to *Anopheles* and *Culex* larvae.

Table 1. Effect of different treatments on fruit fly (*Z. cucurbitae*) population on summer squash after 1st spray in Bharatpur, Chitwan, 2020

Treatments	Number of fruit fly population per plot						
	Pre-treatment	3DAS	Reduction over control	6DAS	Reduction over control	9DAS	Reduction over control
Neem leaf extract	3.05 (1.9)^{b}	1.85(1.5)^{c}	24%	2.13(1.6)^{c}	18%	2.50(1.7)^{c}	17%
Parthenium leaf extract	4.1(2.1)^{a}	2.65(1.8)^{bc}	20%	3.25(1.9)^{abc}	7%	3.63(2.0)^{b}	10.1%
Garlic clove extract	4.00(2.1)^{ab}	2.25(1.7)^{bc}	30%	2.90(1.8)^{bc}	15%	3.63(2.0)^{b}	8%
Chilli fruit extract	4.95(2.3)^{a}	3.25(1.9)^{ab}	18.3%	3.95(2.0)^{ab}	6%	4.58(2.2)^{a}	6%
Control	4.98(2.3)^{a}	4.00(2.1)^{a}		4.25(2.2)^{a}		4.90(2.3)^{a}	
SEM	**0.453**	**0.457**		**0.585**		**0.329**	
CV (%)	**24.13**	**24.13**		**23.21**		**14.93**	
LSD (0.05)	**1.041****	**1.041****		**1.178***		**0.884*****	
Grand Mean	**4.215**	**2.8**		**3.295**		**3.845**	

Treatments means followed by the common letter (ns) within column are non-significantly different among each other based on DMRT at 5% doses of significance. LSD = Least significant difference, SEm = Standard Residual of mean, CV = Coefficient of variation

Average fruit fly population after second spray

The second spray was done after 10 days of first spray. Pre-treatment fruit fly population for second spray was the 9th day population count of first spray. On second spray, the result showed that neem had greater rate of reduction of fruit fly over control among all the treatments, i.e. 32%, 49.7% and 59.2% on 3rd, 6th and 9th days after spraying, respectively (Table 2). This was followed by garlic, which reduced fruit fly population by 32%, 35% and 43% on 3rd, 6th and 9th days after spraying, respectively. Whereas, parthenium reduced fruit fly population by 28%, 34.7% and 49.7% on 3rd, 6th and 9th days after spraying, respectively. The chilli showed lower reduction of fruit fly over control than other botanicals i.e. 20.4%, 25%, and 37% on 3rd, 6th and 9th days after spraying, respectively. After second spray, the result represents that the neem reduced more fruit fly population than other treatments that is presented on Table2. This result was supported by Shafiulla *et al.* (2016), they found that neem leaf

extracts reduced the abundance of the fruit fly in the ash gourd field and resulted in lower level of infestation as compared to other treatments.

Table 2. Effect of different treatments on fruit fly (*Z. cucurbitae*) population on summer squash after 2nd spray in Bharatpur, Chitwan, 2020

Treatments	Number of fruit fly population per plot						
	Pre-treatment	3DAS	Reduction over control	6DAS	Reduction over control	9DAS	Reduction over control
Neem leaf extract	2.50(1.7)^{c}	1.68 (1.5)^{d}	32%	1.28(1.3)^{d}	49.7%	1.03(1.2)^{d}	59.2%
Partheniumleafextract	3.63(2.0)^{b}	2.63 (1.8)^{c}	28%	2.23(1.6)^{c}	34.7%	1.85(1.5)^{c}	49.6%
Garlic clove extract	3.63(2.0)^{b}	2.48(1.7)^{cd}	32%	2.38(1.7)^{c}	35%	2.08(1.6)^{c}	43%
Chilli fruit extract	4.58(2.2)^{a}	3.65(2.0)^{b}	20.4%	3.43(1.9)^{b}	25%	2.95(1.8)^{b}	37%
Control	4.90(2.3)^{a}	4.90(2.3)^{a}		4.98(2.3)^{a}		4.95(2.3)^{a}	
SEM	**0.329**	**0.349**		**0.261**		**0.229**	
CV (%)	**14.93**	**19.26**		**17.89**		**18.66**	
LSD(0.05)	**0.884*****	**0.910*****		**0.787*****		**0.739*****	
Grand Mean	**3.845**	**3.065**		**2.855**		**2.57**	

Treatments means followed by the common letter (ns) within column are non-significantly different among each other based on DMRT at 5% doses of significance. LSD = Least significant difference, SEm = Standard Residual of mean, CV = Coefficient of variation

Average fruit fly population after third spray

The third spray was done after 10 days of second spray. The data of pre-treatment fruit fly population on Table 3 was taken one day before spray i.e. on 9th day of second spray. The fruit fly population was taken only after 3rd and 6th days after third spray due to plant died by hailstorm and cucumber mosaic virus. On third spray, the result also showed that neem had highest rate of reduction over control among all the treatments, i.e. 42% and 64% on 3rd and 6th days after spraying, respectively (Table 3). This was followed by parthenium, which reduced fruit fly population by 21% and 40%, respectively. Whereas, chili reduced fruit fly

population over control by 20.3% and 31% on 3rd and 6th days after spraying, respectively. The garlic showed lower reduction of fruit fly over control than other botanicals i.e. 14% and 29%, respectively. Here, the Table 3 presented that among all botanicals neem extract showed maximum rate of reduction of fruit fly population over control. This result was supported by Masood *et al*. (2009), they studied in field and laboratory trails and concluded that neem and its derivatives can minimize the melon fruit fly (*B. cucurbitae*) population.

Table 3. Effect of different treatments on fruit fly (*Z. cucurbitae*) population on summer squash after 3rd spray in Bharatpur-11, Chitwan, 2020

Treatments	Number of fruitfly population per plot				
	Pre-treatment	3DAS	Reduction over control	6DAS	Reduction over control
Neem leaf extract	1.03(1.0)^{d}	0.58(1.0)d	42%	0.38(0.9)e	64%
Parthenium leaf extract	1.85(1.4)^{c}	1.43(1.4)c	21%	1.15(1.3)d	40%
Garlic clove extract	2.08(1.5)^{c}	1.73(1.5)c	14%	1.5(1.4)c	29%
Chilli fruit extract	2.95(1.7)^{b}	2.28(1.7)b	20.3%	2.08(1.6)b	31%
Control	4.95(2.3)^{a}	4.8(2.3)a		5.03(2.3)a	
SEM	**0.229**	**0.119**		**0.047**	
CV (%)	**18.66**	**15.94**		**10.66**	
LSD	**0.739*****	**0.53*****		**0.33*****	
Grand Mean	**2.57**	**2.16**		**2.025**	

Treatments means followed by the common letter (ns) within column are non-significantly different among each other based on DMRT at 5% doses of significance. LSD = Least significant difference, SEm = Standard Residual of mean, CV = Coefficient of variation

Evaluation of flower drop and fruit damage caused by fruit fly after spraying

Data were taken after spraying of botanical extracts from sample plants of each plot. First of all number of flower set were taken in data then flower drop by fruit fly were taken to calculate flower drop percentage by fruit fly. After that number of fruit set were taken in data and then, fruit damage by fruit fly were taken in data to calculate fruit damage percentage caused by fruit fly. The result showed that less flower drop percentage was found on neem treated plots, i.e. 22.34%. This was followed by parthenium (31.83%), garlic (32.39%) and chilli (40.27%) respectively (Table 4). The highest flower drop (57.54%) was observed on control plots. Similar result was found on fruit damage percentage with the least fruit damage on neem treated a plot (19.15%), which was followed by parthenium (25.19%), garlic (27.88%) and chilli treated plots, respectively (Table4). The highest fruit damage was observed on control plots (47.96%). This result was supported by Waseem *et al*. (2009), reported that the lowest fruit damage (7.33%) due to neem product (Nimbex 0.15%) as against untreated check (54.33%) in cucumber against the melon fruit fly. Similarly, Ali *et al*. (2011) found that the minimum damage (41.94%) was observed on neem seed extract treated plots among five different plant extracts.

Table 4. Effect of different treatments on flower drop and fruit damage percentage caused by melon fly (*Z. cucurbitae*) at Bharatpur, Chitwan, 2020

Treatments	No. of flower set	Flower drop percentage (%)	No. of fruit set	Fruit damage percentage (%)
Neem leaf extracts	4.13^{bc}	22.34^{d}	3.19^{a}	19.15^{d}
Parthenium leaf extracts	4.27^{abc}	31.83^{c}	3.07^{a}	25.19^{cd}
Garlic clove extracts	4.52^{a}	32.39^{c}	2.82^{a}	27.88^{c}
Chili fruit extracts	3.98^{c}	40.27^{b}	2.26^{b}	38.05^{b}
Control	4.31^{ab}	57.54^{a}	1.71^{c}	47.96^{a}
SEM	**0.043**	**20.56**	**0.064**	**28.58**
CV%	**4.91%**	**12.29%**	**9.69%**	**16.89%**
LSD(0.05%)	**0.32***	**6.99*****	**0.39*****	**8.24*****
Grand Mean	**4.24**	**36.87**	**2.61**	**31.65**

Treatments means followed by the common letter (ns) within column are non-significantly different among each other based on DMRT at 5% doses of significance. LSD = Least significant difference, SEm = Standard Residual of mean, CV = Coefficient of variation

Effect of different botanical extracts on yield of summer squash

Non-damaged, fresh, tender and immature fruits were harvested from sample plant of each plot. Number of harvested fruit and weight of harvested fruit were taken on data to calculate yield of summer squash (zucchini). The result showed that neem treated plot has maximum marketable fruit number i.e. 2.56 fruits per plant. This was followed by garlic treated, parthenium treated, chilli treated and control plots extracts respectively i.e. 2.25, 1.81, 1.19

and 0.81 fruits per plant (Table5). The result also showed that yield of zucchini was maximum in neem treated plots i.e. 16.98 mt/ha. This was followed by garlic treated, parthenium treated, chilli treated and control plots respectively i.e. 15.04 mt/ha, 11.52 mt/ha, 7.75 mt/ha and 5.03 mt/ha. The quality of fruits in terms of weight, size, shape and shine, neem treated plots show the better result but statically similar with all treatments. This result was supported by Abhilash *et al*. (2018), they found that spraying with Azadirachtin 1% EC and NSKE 5% were effective in reducing the fruit damage and increasing marketable fruit yield.

Table 5. Effect of different treatments on yield of summer squash (zucchini) at Bharatpur, Chitwan, 2020

Treatments	Number of fruit/plant	Fruit weight(gm)	Yield (ton/ha)
Neem leaf extracts	2.56^{a}	929.25	16.98^{a}
Parthenium leaf extracts	1.81^{b}	924.75	11.52^{ab}
Garlic clove extracts	2.25^{ab}	912.75	15.04^{bc}
Chilli fruit extracts	1.19^{c}	904.75	7.75^{cd}
Control	0.81^{c}	879.00	5.03^{d}
SEM	**0.0875**	**16087.47**	**9.75**
CV%	**17.15%**	**13.94%**	**27.71%**
LSD	**0.46*** **	**195.41(NS)**	**4.81*** **
Gran Mean	**1.725**	**910.1**	**11.265**

Treatments means followed by the common letter (ns) within column are non-significantly different among each other based on DMRT at 5% doses of significance. LSD = Least significant difference, SEm = Standard Residual of mean, CV = Coefficient of variation

CONCLUSION

The study revealed that less population of fruit fly was found on neem treated plots i.e. 64% reduction over control. Similarly, minimum flower drops (22.34%) and minimum fruit damage (19.15%) due to fruit fly was observed on neem treated plots. Among all treatments, the highest yield was also obtained from neem treated plot i.e. 16.98 mt/ha. The neem leaf extracts have been found efficacious and equally or more cost effective than synthetic pesticide through various researches. Definitely extracts of neem cannot completely reduce the infestation of fruit fly but it can maintain population/ infestation near threshold level that could play great contribution in synthetic pesticide minimization and biodiversity maintenance. Same or less performance was shown by parthenium, garlic and chilli extracts.

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