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# EVALUATION OF NEEM AND ENDOD OIL EXTRACT AGAINST CABBAGE APHID IN NEJO DISTRICT, WESTERN ETHIOPIA

**[1]Bruktayt, B. and [2,] *Kena, K.**

[1] Dembi Dollo University
[2] Nedjo Agricultural Technical and Vocational Education Training (ATVET) College

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**ABSTRACT**

Cabbage (*Brassicae oleracea* L.) is widely grown vegetable that makes significant contribution to household and national economy in Ethiopia. However one of the major constraints to the production of cabbage in Ethiopia is infestation with cabbage aphid (*Brevicoryne brassicae* L.). Field experiment was conducted to evaluate Endod (Phytolacca dodecandra) and Neem (Azadirachta indica) oil extracts against cabbage aphid in Nedjo ATVET College. Three levels (0, 0.575 and 1.15 litter per hectare) of each of Endod and Neem oil extracts were randomly assigned to cabbage plots in randomized complete block design with three replications. Distilled water or Endod: Neem combination of 0:0 litter/ha was used as the control treatment. Data on entomological and Phonological parameters such as ccabbage aphid population, incidence percentages, days to maturity, stand count and cabbage yield were collected. The results obtained indicated that applications (spraying) of different levels and combinations of Endod and Neem oil were effective in the reduction of cabbage aphid load as compared to the to the control treatment groups. The highest reduction in aphid population per plot of 41 and 43% was recorded from the plot assigned to Endod: Neem combination of 1.15:0.0 and 1.15:0.575 respectively. Significantly lower (P<0.05) mean incidence percentage of 23.6% was obtained from the treatment plots receiving Endod: Neem combination of 1.15:1.15, followed by the treatment plots assigned to Endod: Neem combination of 1.15: 0.575. Similarly significantly shorter (P<0.05) mean days to maturity of 94 days was obtained from the treatment plots receiving Endod: Neem combinations of 0.575:0.575 liter per hectare. There was increase in the number of cabbage with increase in levels and combinations of the two treatment oils, indicating that the number of cabbage is directly proportional to the levels and combinations of application of the treatments. Significantly higher (P<0.05) mean stand count of 31.33 was obtained from the treatment plots receiving Endod: Neem combinations of 1.15:1.15 liter per hectare. The highest mean head weight of 2.15 kg per plot was observed at Endod: Neem combination of 1.15:1.15 liters per hectare. The results obtained also showed that maximum yield of 61.66 t ha-1was harvested from the treatment plot at the maximum application level of the two treatment oils (1.15:1.15). Head size of cabbage was significantly (P≤0.05) influenced by the main effect of endod botanical rate and significantly (p ≤0.01) influenced by the main effect of Neem rate. In summary the results of the current study showed that applications (spraying) of different levels and combinations of Endod and Neem oil is effective against cabbage aphid as measured by entomological and Phonological parameters.

***Keywords:*** Concentration level, combination, Biological control, Aphids.

## INTRODUCTION

Cabbage (*Brassicae oleracea* L.) is widely grown vegetable throughout the world and the crop make significant contribution to household and in national economy of Ethiopia (Fikadu and Dandena, 2006). Ethiopia has suitable agro climate and soil characteristics for the production of cabbage. However one of the major constraints to the production of cabbage in Ethiopia is infestation with cabbage aphid (*Brevicoryne brassicae* L.), the most serious pest that damage, reduce yield and affect the quality and market value of cabbage in Ethiopia (Birhanu *et al*., 2011). The control of agricultural pests has been largely dependent on the use of chemical pesticides (Chivasa *et al*., 2002). Chemical pesticides are not affordable, pollute the environment and cause complication in human and animal health. On the other side, there are several naturally occurring crop protectants that are safe to humans and the environment with minimal residual effects (Devi *et al*., 2016). From the ancient time the Ethiopian Farmers use Endod *(Phytolacca dodecandra)* for controlling pests and Diseases in their farmland. Endod *(Phytolacca dodecandra)* plants effectively meet some criteria of affordability and accessibility to small-scale farmers as well as human- and environmental-safety (Isman, 2008). Endod and Neem (*Azadirachta indica)* could be used to extract oil to be used as natural pesticides against cabbage Aphid *(Homoptera:Aphididae*) in different areas of the country (Isman, 2006). Endod is the Ethiopian name for the soapberry plant *Phytolacca dodecandra.*

***Corresponding Author: Kena K.,**
Nedjo Agricultural Technical and Vocational Education Training (ATVET) College.

Endod has small berries which, when dried, powdered, and mixed in water yield a foaming detergent traditionally used in Ethiopia and elsewhere for washing clothes. Neem has more than 100 unique bio-active compounds, which have potential applications in agriculture (Noorul Aneesa *et al*; 2016), to protect against harmful insects (Atawodi and Atawodi, 2009). Therefore, the major objective of this research project was evaluation of Neem (*Azadirachta indica)*and Endod *(Phytolacca dodecandra)* Oil Extracts against Cabbage Aphid, in Nejo District, Western Ethiopia.

## MATERIALS AND METHODS

### Description of the Study Site

This experiment was conducted at Nejo ATVET College located in West Wollega Zone, at a distance of 515 km west of Addis Ababa on the main road to Assosa. The college is situated at 90 30'00'' E longitude and 1735 meter above sea level in sub-humid agro ecological zone (Geremew, 2009). It is amid-altitude area with an annual rainfall of 1200-1600 mm. The rainy season extends from April to October with the peak occurring in July and august. The average min and max temperatures of the study site is 12 and 26 $^{o}$C respectively.

### Experimental Material and Design

Land preparation and rising of seedling at the ATVET College, was done during the big rainy i.e. early August/ 2018. Cabbage seeds of

Copenhagen market variety was used in raising of experimental seedling. The seedlings were watered twice a day during early stages and the watering frequency was reduced as the seedlings grow. Health seedlings with 4-8 leaves were transplanted at an age of 35 days, to well-prepared seed beds (experimental plots), with the spacing of 50 and 40 cm between plants and rows respectively. The blocks and plots were separated by 1 and 0.5m respectively. The numbers of rows per plot and plants per row was 5 and 7 respectively. . Plot size was 2.5 x 2.4m and total plot area was 6 $m^2$ and total land area of 25.6 x9.5m (y 243.2$m^2$ area ) were used to grow the experimental cabbages. All agronomical practices were done according to accepted standard procedure. Data was collected and recorded from the central three rows for each plot.

**Neem and Endod Collection and Processing**

Neem and Endod *leaves* were collected from matured plant, washed by distilled water and oven dried at 37°C. The dried plant materials were pulverized to powder using a Mortar and Pestle and passed through Vibrator Sieve Shaker. The sieved powder was stored in air tight container in the refrigerator at - 4 °C until required for oil extraction. The powder materials were held at room temperature for 30 minutes before extraction. Ten grams of the sample was subjected to ethanol extraction using Soxhlet extraction units as suggested by (Jensen, 1879). The extracted oil was subjected to distillation process according to the method suggested by (Jensen, 1879). Finally, the concentrated oil was labelled and stored in a refrigerator at the temperature below 4 °C until preparation of the diluted oil for spraying (Metcalfe, 1993).

**Preparation of the Experimental Treatments**

Nine experimental treatments containing different levels and combinations (1:33.6 v: v) of Neem and Ended oils were formulated based on the recommendation of Singh, (2000). The treatments shown in Table 1, contained different levels of Neem and Ended oils in water suspension. A total of 30 ml of the treatment oil was used per litter of water per 16.7 $m^2$ , or 18 litter of the treatment oil per 600 litter of water was used to spray a hectare of land for the controlling of cabbage aphid based on the recommendation of (Singh, 2000). Distilled water was used as control treatment and each treatment oils was diluted with distilled water to obtain the desired concentration and each dilution received agent emulsification agent before adding of water for dilution. Finally the experimental treatments combinations were randomly assigned to the cabbage plots in Randomized Complete Block Design (RCBD) with three replication. The treatment applications started within 70 - 75DAS, when the aphid population is expected to established uniformly throughout all the experimental plots. The treatments were sprayed in three rounds at weekly intervals. Total of 64.26 ml of both oils was used per round.

**Table 1. Treatment Combination**

| Treatment | Treatment Combination level (Neem, endod) | Required botanical oil (ml) | Required water (ml) |
|---|---|---|---|
| 1 | (0,0) | None | 415 |
| 2 | (0,0.575) | 2.38 ml endod oil | 412.62 |
| 3 | (0,1.15) | 4.76 ml endod oil | 410.23 |
| 4 | (0.575,0) | 2.38 ml neem oil | 412.62 |
| 5 | (0.575,0.575) | 2.38 ml neem oil + 2.38 ml endod oil | 410.23 |
| 6 | (0.575,1.15) | 2.38 ml neem oil + 4.76 ml endod oil | 407.86 |
| 7 | (1.15,0) | 4.76 ml neem oil | 410.23 |
| 8 | (1.15,0.575) | 4.76 ml neem oil + 2.38 ml endod oil | 407.86 |
| 9 | (1.15,1.15) | 4.76 ml neem oil + 4.76ml endod oil | 405.48 |

**Aphid Insecticidal Bioassay**

Aphid insecticidal bioassay was used to estimate the mode of action, mortality rate, efficacy time, relative median toxicity and knock down time of the treatment, using the method suggested by Chandrasena *et al.* (2011). Representative early stage cabbage leaves was collected, prepared into leaf discs. The treatment oil treated leaf disc was air dried and passed through tea strainer (mesh size 0.5 mm). Thirty five nymphs were released into each treated leaf disc, using fine camel brush. The number of aphid on each treatment leaf disc was monitored and the percentage of repellent activity was calculated. Groups of 30 wingless adults of aphid colony was placed in the metal mesh container, dipped into each treatments for 15 second and transferred to a fresh-cut cabbage leaf (3 x 3 cm) on moist filter paper in a petri dish. The Petri dishes were placed in the growth chamber at 22°C and a photoperiod of 16:8 (L: D) h for 48 h. After 48 h the aphids were classified as dead or alive and counted. Number of newborn nymphs (progeny) per treatment group was also determined as a way of assessing the sub-lethal effects of the treatment on aphid fecundity (reproduction). Enumeration of aphids was performed using a colony count magnifying glass.

**Data Collection**

The experimental data to be collected comprises of entomological and Phonological parameters as indicated below.Cabbage aphid population was estimated as the number of aphid larvae and adult recorded before and after 24 hours of treatment application at weekly interval. A total of nine plants were randomly selected and examined for the presence of the different life stage of cabbage aphid. Percentage incidence (%) expressed degree of infestation of cabbage aphid per plot or per plant before and after application of treatments.

$$\text{Percentage incidence (\%)} = \frac{\text{Number of infested plants assessed}}{\text{Total plant assessed}} \times 100, \text{ at field}$$

Cabbage Aphid Predator was measured by direct counting of any stage existed predator from the assessed plant. Cabbage Aphid Parasitoids was measured by direct counting of any stage of the existed parasitoids from the assessed plant. Days to maturity was measured by counting the actual number of days from planting to hard heading. Stand count at harvest was expressed as the difference between stand counted at establishment of seedlings and harvest. Cabbage head formation was recorded as the total number of cabbage plants with head. Cabbage head weight at harvest was expressed weight in kg /plot, using weighing balance. Yield per plot (Kg/plot) was expressed as weight of harvested head per plot. Cabbage head size at harvest was measured by taking the length / diameter of the head from the central three row yield loss (%) was measured by measuring the difference between yields of protected and yield of un protected and converting the value in percentage base.

$$L\ y(\%) = \{(YP - YUP) / YP \times 100$$

Where,
LY= yield loss in %, YP=yield of protected and YUP= yield of unprotected

Fixed systematic random sampling method with sample size of 5.4 $m^2$ taken from three central rows within the plot was considered during the assessments. Counting of B. Brassicae was done directly. All nymph colony on both sides of the first four leaves from the core was counted. The assessment was done on weekly basis, with the use of hand lens suggested by Karagounis et al., (2006). Data on mortality, mode of action, relative median toxicity, and knock down time was taken using laboratory condition.

**Statistical Analysis :** All the data collected was subjected to the two ways ANOVA with General Linear Model (GLM) procedures using the

SAS version 9.2 (SAS, 2002). Mean separation was carried out using LSD when there is significant difference among the treatments means.

## RESULTS AND DISCUSSION

### Cabbage Aphid Population

The results of the entomological parameters as measured by cabbage aphid population are presented in Table 2 and 3 and Fig 1. The results obtained showed that there was statistically significant difference (P<0.01) between the treatment groups in cabbage aphid population's per plot. Significantly higher (P<0.01) mean aphid population of 132 per plot was recorded from the treatment groups assigned to Endod: Neem combinations of 0:0 liter per hectare, followed by the treatment groups assigned to Endod: Neem combinations of 0.575:0.575 liter per hectare. On the other side, significantly lower (P<0.01) mean aphid population of 75 per plot was recorded from the treatment groups assigned to Endod: Neem combinations of 1.15:0.575 liter per hectare. With the exception of the highest and the lowest mean values, there was no statistically significant difference (P>0.01) between all the other treatment groups in mean cabbage aphid population's per plot. The results obtained indicated that applications (spraying) of different levels and combinations of Endod and Neem oil were effective in the reduction of cabbage aphid load as compared to the to the control treatment groups. Significantly higher (P<0.01) mean aphid population of 132 per plot was recorded from the treatment groups assigned to Endod: Neem combinations of 0:0 liter per hectare. Increasing the level of inclusion of Endod from 0 to 0.0575 and 1.15 liter per hectare resulted in significant reduction (P<0.05) of mean aphid population per plot by 29 and 41% respectively. Similarly, increasing the level of inclusion of Neem from 0 to 0.0575 and 1.15 liter per hectare resulted in significant reduction (P<0.05) of mean aphid population per plot by 22 and 29 and 26% respectively. The results obtained tends to indicated that spraying of Endod oil seems to be effective against cabbage aphid as measured by the mean aphid population per plot.

**Table 2. The Effect of levels and combinations of Endod and Neem oil on Cabbage Aphid Population at Nedjo ATVET College**

| Endod (L ha$^{-1}$) | Neem Level (L ha$^{-1}$) | | |
|---|---|---|---|
| | 0 | 0.575 | 1.15 |
| 0 | 132$^{a}$ | 103.6$^{b}$ | 98.33$^{bc}$ |
| 0.575 | 94$^{bc}$ | 91.65$^{bcd}$ | 96$^{bc}$ |
| 1.15 | 78$^{de}$ | 75$^{e}$ | 84.66$^{cde}$ |
| LSD (0.05) | | 15.4 | |
| CV (%) | | 2.10 | |

Means with the same letter are not significantly different at 5% level of significance; LSD= Least significant difference at P < 0.05; CV = Coefficient of variation (%).

As indicated in Table 2, the application of Endod: Neem combination of 0.575:0.575 and 0.575: 1.15: resulted in significant reduction (P<0.05) of mean aphid population per plot by 31 and 27% respectively. Similarly, the application of Endod: Neem combination of 1.15: 0.575 and 1.15: 1.15 liter per hectare resulted in significant reduction (P<0.05) of mean aphid population per plot by 43 and 36% respectively. The results obtained indicated that the highest reduction in aphid population per plot of 41 and 43% was recorded from the plot assigned to Endod: Neem combination of 1.15:0.0 and 1.15:0.575 respectively. There was no significant difference (P>0.05) between the plots assigned to 1.15 Endod in combination to either 0, 0.575 or 1.15 liter of Neem per hectare in mean aphid population per plot. After spray, aphid population was significantly decreased in all the treated plots, while significantly increased in untreated plot. After 14 days of spray, aphid population was slightly increased in neem extract treated plots (BISWAS, 2013). Saxena (1989) reported that Azadirachtin the main pesticidal component of neem extracts specially neem seed extract possessed feeding deterrent, repellent, toxic, and growth disruption properties against numerous pest species. It was shown that t the Number of Aphids per plants decreased with application of increased level of ether of the two treatment oils and their interaction effect. As seen in Table 2 , the maximum numbers of aphids were recorded from the plots receiving the control treatment and the minimum number of aphids per plant was recorded at highest level of individual oil and their respective combinations. There was significant reduction in aphid population per plant with all the increased level of Endod oil as compared to that of Neem. These results are similar to those obtained by Stark & Rangus (1994) for Acyrthosiphon pisum (Harris) nymphs exposed to bean plants treated with Margosan-O, a commercial neem formulation. According to these authors, the molting process for this species was totally interrupted at the two highest concentrations (80 and 100 mg azadirachtin/L) with a mean of 0.7 molts. For the aphid Toxoptera citricida (Kirkaldy), nymphs reared on citrus seedlings sprayed with Neemix at concentrations from 2.2 to 18 mg of azadirachtin/100 mL showed a similar behavior, undergoing 0.4 molts on average (Tang *et al*., 2002). Azadirachtin, the active principle of neem, causes an interruption in the concentrations of ecdisone and juvenile hormone in the hemolymph, affecting molting, metamorphosis and reproduction (Mordue & Nisbet, 2000).

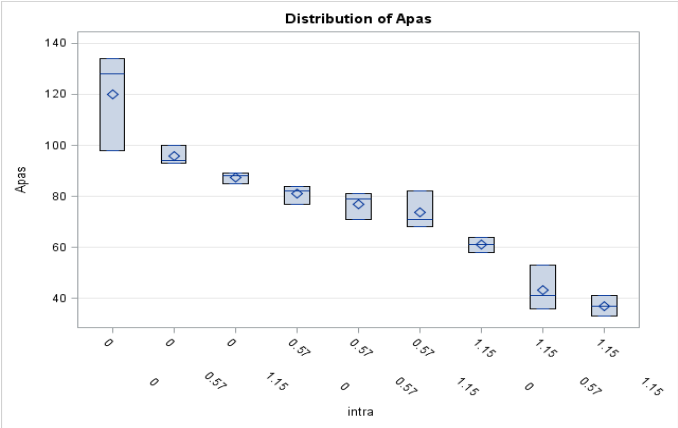


**Fig 1. Distribution of aphid population on the experimental cabbages by treatment levels and combinations at Nedjo ATVET College**

### Percentage incidence

The results of the percentage incidence of the current study are shown in table 3. It is expressed as degree of infestation of cabbage aphid per plot or per plant before and after application of treatments. Percentage incidence could be defined as the number of aphid larva and/or adults in the individual experimental plot divided by the total number of Plants in the plot and measured as the proportion of infested plants within the plot. As shown in Table 3, there was no significant difference between the treatment plots assigned to 0 and 0.575 litter of Endod in incidence percentage. On the contrary, significantly lower (P<0.05) incidence percentage of 32.56% was obtained from the treatment plot receiving 1.15 litter of Endod per hectare. On the other hand, there was significant difference (P<0.05) between all the treatment plots assigned to different levels of Neem (0, 0.575 and 1.15) in mean incidence percentage. Significantly lower incidence percentage of 35.23% was recorded from the treatment plot assigned to 1.15 litter per hectare of Neem. Significantly lower (P<0.05) mean incidence percentage of 23.6% was obtained from the treatment plots receiving Endod: Neem combination of 1.15:1.15, followed by the treatment plots assigned to Endod: Neem combination of 1.15: 0.575. There was decrease in incidence

percentage with increased level individual treatment oil and their respective combinations. The different doses (25g, 50g, 75g/l) of neem leaf extract reduced 63.16-72.55% aphid population over pretreatment, while neem seed extractsreduced 73.00-80.50% aphid population over pretreatment in mustard crop (BISWAS, 2013). The losses of mustard due to aphids varied from 35 to 90 percent depending upon the seasons (Biswas and Das, 2000; Rohilla *et al*., 2004). Similarlyy Shirzad *et al.,* (2011) found that the LC50 values of neem extract and combination with citowett oil for second and third instars larvae were estimated at 4.40, 3.89 and 3.38, 2.16 ppm, respectively. The combination of neem extract with citowett increased the larval mortality rate up to 15%. This implies that the application of the mixture is a sound measure for enhancing lethality impacts.

**Table 3. The Effect of levels and combinations of Endod and Neem oil on incidence percentage of Cabbage Aphid at Nedjo ATVET College.**

| Endod (L ha$^{-1}$) | Neem Level (L ha$^{-1}$) | | |
|---|---|---|---|
| | 0 | 0.575 | 1.15 |
| 0 | 40.4$^{a}$ | 39.86$^{b}$ | 35.23$^{c}$ |
| 0.575 | 43.96$^{a}$ | 34.93$^{c}$ | 42.13$^{ab}$ |
| 1.15 | 32.56$^{cd}$ | 29.13$^{d}$ | 23.6$^{e}$ |
| LSD (0.05) | | 3.74 | |
| CV (%) | | 5.85 | |

Means with the same letter are not significantly different at 5% level of significance; LSD= Least significant difference at P < 0.05; CV = Coefficient of variation (%).

## Days to Maturity

Days to maturity is measured by counting the actual number of days from planting to hard heading. It is expressed as days to 90% physiological maturity. The results of days to maturity of the current study are shown in Table 4. With the exception of the treatment plots receiving Endod: Neem treatment combinations of 0: 1.15 and 0.575: 0.575, there was no statistically significant (P>0.05) difference between all the other treatment plots in mean days to maturity. Significantly longer (P<0.05) mean days to maturity of 100 days was obtained from the treatment plots receiving 1.15 litters of Neem per hectare. On the contrary, significantly shorter (P<0.05) mean days to maturity of 94 days was obtained from the treatment plots receiving Endod: Neem combinations of 0.575:0.575 liter per hectare.

**Table 4 The Effect of levels and combinations of Ended and Neem oil on days to maturity of the experimental cabbages at Nedjo ATVET College**

| Endod (L ha$^{-1}$) | Neem Level (L ha$^{-1}$) | | |
|---|---|---|---|
| | 0 | 0.575 | 1.15 |
| 0 | 94.3$^{bc}$ | 96.33$^{abc}$ | 100$^{a}$ |
| 0.575 | 96.33$^{abc}$ | 94$^{c}$ | 97.3$^{abc}$ |
| 1.15 | 96.00$^{abc}$ | 98.3$^{ab}$ | 96.33$^{abc}$ |
| LSD (0.05) | | 4.00 | |
| CV (%) | | 2.43 | |

Means with the same letter are not significantly different at 5% level of significance; LSD= Least significant difference at P < 0.05; CV = Coefficient of variation (%).

## Stand Count

Stand count at harvest is expressed as the difference between stand counted at establishment of seedlings and harvest. Stand Count is one of the growth parameters of cabbage and other vegetables that contributes to yield. Vegetables with higher stand count could have higher fresh yield. The results of the stand count on cabbage of the current study are shown in Table 5. According to Table 7, with the exception of the treatment plots receiving Ended: Neem treatment combinations of 0: 0.575 and 1.15:1.15, there was no statistically significant (P>0.05) difference between all the other treatment plots in mean stand count of the experimental plots. Significantly lower stand count of 23.33 (P<0.05) was obtained from the treatment plots receiving Endod: Neem combination of 0:0.575 liters per hectare. On the contrary, significantly higher (P<0.05) mean stand count of 31.33 was obtained from the treatment plots receiving Endod: Neem combinations of 1.15:1.15 liter per hectare. The results obtained indicated that there was increase in the number of cabbage with increase in levels and combinations of the two treatment oils, indicating that the number of cabbage is directly proportional to the levels of application of the treatments. The maximum number of stand count was observed at highest level of the treatment oils application. This is also directly correlated with aphid population which is inversely proportional to the number of cabbage. On the contrary there was direct proportionality between stand count and yield of the experimental cabbages. This is consistent with the finding of Asare *et al*. (2010) who indicated that treating cabbage with insecticide reduced the insect population on cabbage and hence better growth of the crop. Nayem and Rokib (2013) also reported that okra grows vigorously when treated with botanical insecticides.

**Table 5. The Effect of levels and combinations of Ended and Neem oil on stand count of the experimental cabbages at Nedjo ATVET College**

| Endod (L ha$^{-1}$) | Neem Level (L ha$^{-1}$) | | |
|---|---|---|---|
| | 0 | 0.575 | 1.15 |
| 0 | 26$^{cd}$ | 23.33$^{e}$ | 26.00$^{cd}$ |
| 0.575 | 23.66$^{de}$ | 28.66$^{abc}$ | 29.33$^{bcd}$ |
| 1.15 | 29.66$^{ab}$ | 28.66$^{abc}$ | 31.33$^{a}$ |
| LSD (0.05) | | 3.58 | |
| CV (%) | | 7.97 | |

Means with the same letter are not significantly different at 5% level of significance; LSD= Least significant difference at P < 0.05; CV = Coefficient of variation (%).

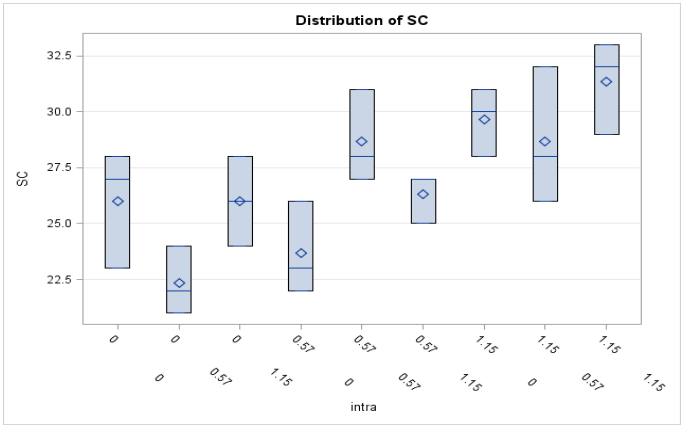


**Fig. 2. Distribution of cabbage crops stand count by levels and combination of the treatment oils**

## Head Weight

Cabbage head weight at harvest is expressed as weight in kg /plot, using weighing balance. The results of the head weight of the current study is presented in Table 6. The results obtained showed that the head weight of the experimental cabbages was significantly (P < 0.01) influenced by the levels and combinations of the treatment oils.

**Table 6. The Effect of levels and combinations of Ended and Neem oil on head weight of the experimental cabbages at Nedjo ATVET College**

| Endod (L ha$^{-1}$) | Neem Level (L ha$^{-1}$) | | |
|---|---|---|---|
| | 0 | 0.575 | 1.15 |
| 0 | 0.49$^{f}$ | 0.63$^{ef}$ | 0.77$^{de}$ |
| 0.575 | 0.94$^{d}$ | 1.30$^{c}$ | 1.28$^{c}$ |
| 1.15 | 1.84$^{b}$ | 1.83$^{b}$ | 2.15$^{a}$ |
| LSD (0.05) | | 0.21 | |
| CV (%) | | 10.54 | |

Means with the same letter are not significantly different at 5% level of significance; LSD= Least significant difference at P < 0.05; CV = Coefficient of variation (%)

Significantly lower (P<0.05) mean head weight of cabbage of 0.49 kg per plot was recorded from the experimental plot assigned to Endod: Neem combination of 0:0 liters per hectare. The highest mean head weight of 2.15 kg per plot was observed at Endod: Neem combination of 1.15:1.15 liters per hectare. There was increase in cabbage head weight from 0.49 to 0.77kg with an increase in level of Neem oil from 0 to 1.15 litter per hectare. Similarly there was increase in cabbage head weight from 0.49 to 1.84 kg with an increase in level of Endod oil from 0 to 1.15 litter per hectare. The reported agree with that, Paul *et al.* (2001) said destruction of the main buds of seedlings by DBM larvae may result in plants with multiple undersized heads. Moreover, according to Asare *et al* (2010) heavy head per plant was recorded for cabbages that received treatments against diamondback moth (DBM) attack when compared with the control. Hasheela *et al*. (2010) reported that as compared to unsprayed cabbage, highest number of marketable cabbage heads was obtained from sprayed cabbage while the highest number of unmarketable cabbage heads was noted on unsprayed one. DBM larvae feeds on the marketable portions of the crop, therefore, synthetic insecticides will remain essential for the management of this pest (Hill & Foster, 2000).The plant extracts compared favorably with the synthetic insecticide in the control of DBM. This could be due to the pungent smell given out by the soaked plant extract which deter animals from eating the plant Sivapragasam and Aziz (1990).

## Fresh Yield

Yield per plot (Kg/plot) was expressed as weight of harvested head per plot. The results of the effect of different levels and combinations of Ended and Neem oil on fresh yield of the experimental cabbages is presented in Table 7. The results obtained indicated that the lowest yield per plot of 33 kg was harvested from the experimental plot assigned to the control treatment (distilled water). There was no significant difference (P<0.05) between the cabbage yield harvested from the experimental plots receiving different levels of Neem (0.0.575 and 1.15litter per hectare). There was increase in cabbage yield per plot from 33.0 to 46.66 with an increase in level of Endod oil from 0 to 1.15 litter per hectare. Significantly higher (P<0.05) fresh yield of 61.66 kg per plot was recorded from the experimental plot receiving Endod: Neem combination of 1.15:1.15 liters per hectare. The results obtained showed that maximum yield of 61.66 t $ha^{-1}$was harvested from the treatment plot at the maximum application level of the two treatment oils (1.15:1.15). The minimum mean yield of 33.0 kg/hectare was harvested from the treatment plot receiving control treatment. So the report is agreed with the gauging the effectiveness of control measures is one of the purposes of estimating yield losses due to pests. Thus the lowest level of yield loss relative to the control was obtained from cabbages sprayed with neem. Moreover, on chili, turmeric and lantana treated cabbage the yield losses ranged from 52.5, 56 and 58% respectively. Similarly Melkassa research center of the Ethiopian Institute of Agricultural Research (EIAR) reported that yield varies for two seasons between November 2001 and June 2002 showed that losses can vary between 36.1 and 91.2 %, which corresponds to 12 and 48.7 tons/ha Gashaw beza ( 2006). Similarly Lidet (2007) reported that yield losses ranged between 62.8 and 74.7 % which equates to 44.8 to 52.9 tons per ha at Melkassa and Wonji, respectively. Also BISWAS, (2013) reported that the highest seed yield of mustard (1440 kg/ha) was obtained from Malataf @ 2ml/l treated plots followed by neem seed extract @ 75g/l treated plots (1365 kg/ha) and 50g/l treated plots (1345 kg/ha (Table 3). But no significantly different yield was produced between 50g/l and 75g/l of neem seed treated plots. Untreated plot produced the significantly the lowest seed yield (1150 kg/ha). The highest MBCR (4.80) was calculated from Malataf treated plot followed by neem seed extract @ 50g/l treated plot (3.88).

**Table 7. The Effect of levels and combinations of Ended and Neem oil on fresh yield of the experimental cabbages at Nedjo ATVET College**

| Endod (L $ha^{-1}$) | Neem Level (L $ha^{-1}$) | | |
|---|---|---|---|
| | 0 | 0.575 | 1.15 |
| 0 | $33.00^{f}$ | $38.00^{ef}$ | $37.33^{ef}$ |
| 0.575 | $39.33^{de}$ | $42.00^{cde}$ | $44.33^{cd}$ |
| 1.15 | $46.66^{c}$ | $53.66^{b}$ | $61.66^{a}$ |
| LSD (0.05) | | 6.23 | |
| CV (%) | | 8.44 | |

Means with the same letter are not significantly different at 5% level of significance; LSD= Least significant difference at P < 0.05; CV = Coefficient of variation (%)

## Head size

Head size is one of yield component parameter that is highly influence the final fresh weight or yield of cabbage. Sometimes the Head size and yield is inversely proportional but most of the time it is directly proportional to the yield this means as the head size gets larger the yield or weight of cabbage also get higher. Head size of cabbage was significantly (P≤0.05) influenced by the main effect of endod botanical rate and highly significantly (p ≤0.01) influenced by the main effect of Neem rate .However, their interaction does not significantly influenced the Head Size .The highest Head size was obtained from the highest application rate (29.6 cm). However the minimum Head size was obtained from the lowest application rate. (18.73 cm) (Table 8). The report is agreed with Paul *et al.* (2001) that he reported destruction of the main buds of seedlings by DBM larvae may result in plants with multiple undersized heads. Moreover, according to Asare *et al* (2010) heavy head per plant was recorded for cabbages that received treatments against diamondback moth (DBM) attack when compared with the control.

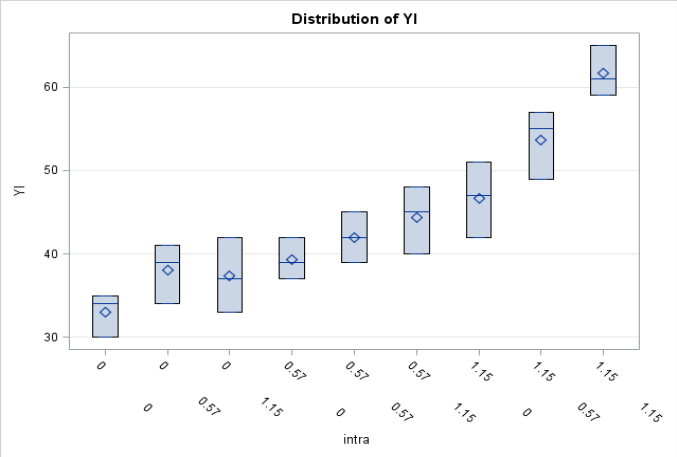


**Fig 3. Distribution of cabbage crops yield across the different levels and combinations of the treatment oils**

**Table 8. The Effect of levels and combinations of Ended and Neem oil on head size of the experimental cabbage at Nedjo ATVET College**

| Endod (L $ha^{-1}$) | Neem Level (L $ha^{-1}$) | | |
|---|---|---|---|
| | 0 | 0.575 | 1.15 |
| 0 | $18.73^{e}$ | $21.73^{d}$ | $22.43^{bcd}$ |
| 0.575 | $24.70^{bc}$ | $21.80^{cd}$ | $24.26^{bcd}$ |
| 1.15 | $24.83^{b}$ | $25.23^{b}$ | $29.6^{a}$ |
| LSD (0.05) | | 2.94 | |
| CV (%) | | 7.62 | |

Means with the same letter are not significantly different at 5% level of significance; LSD= Least significant difference at P < 0.05; CV = Coefficient of variation (%)

## Summary and conclusions

The control of agricultural pests has been largely dependent on the use of chemical pesticides which are not affordable at the household

levels and pollute the environment. On the contrary, there are several naturally occurring crop protectants that are safe to humans and the environment with minimal residual effects. The present experiment was conducted at Nejo ATVET college experimental site, Western Wollega Zone, Oromia Regional State, with the objectives to evaluate the effectiveness of different levels and combinations of Endod and Neem against cabbage aphids. The results obtained indicated that applications (spraying) of different levels and combinations of Endod and Neem oil is effective against cabbage aphid as measured by entomological and phonological parameters. Endod and Neem are widely available in the vicinity of the household farming population. However, there is need for further research in the area of active ingredient extraction and mode of utilization of Endod and Neem at the household level.

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