****

**AMHARA REGIONAL AGRICULTURAL RESEARCH INSTITUTE (ARARI)**

**Sekota dry land agricultural research center (SDARC)**

**TITLE:-Effect of different planting patterns on growth, yield and insect pest control of cabbage and onion intercropping.**

**Prepared by:-Belet Ameshe**

 **October, 2023**

 **Sekota, Ethiopia**

# Back ground and Justification

## Introduction

Intercropping may be defined as the cultivation of two or more crops at the same time in the same field; such that the period of overlap is long enough to include the vegetative stage ( Gomez and Gomez, 1983; Ouma and Jeruto, 2010). Intercropping, double cropping and other mixed cropping practices that allow more efficient uses of on farm resources are among the agricultural practices associated with sustainable crop production (Kangasniemi, 1993). Intercropping provides year-round ground cover, or at least for a longer period than monocultures, in order to protect the soil from desiccation and erosion. By growing more than one crop at a time in the same field, farmers maximize water use efficiency, maintain soil fertility, and minimize soil erosion, which are the serious drawbacks of mono-cropping (Hoshikawa, 1991).

(Willey, 1979)  clearly and evidently proposed that intercropping gives higher yields in a given season and greater stability of yields in different seasons compared with sole cropping. (Mead and Willey, 1980) stated in detail that in intercropping systems, yields are more stable. Its relation to yield stability is the notion of risk, in terms of either productivity or income or both.

Intercropping provide insurance against risk and give stable returns even under unfavorable weather conditions. Intercropping practices lead to more monetary return and better utilization of land and inputs (Quayyum *et al*., 1985).

The profits of intercropping are risk minimization, efficient use of available inputs, effective use of labour, increased crop productivity, degradation control and food security (Addo-Quaye *et al*., 2011). The advantage is often attributed to the fact that different crops complement each other and make better use of resources when grown together rather than separately (Ahmed *et al*., 2018). Besides, intercropping also acts as insurance for resource poor farmers if one crop fails, they get some yield of another crop (Islam *et al.*, 2014).

Many scholars confirmed that application of intercropping can increase the land equivalence ratio (Bala *et al*., 2012). Who reported that the maximum land equivalence ratios were recorded from the 1:1 cabbage with onion intercrop whereas the sole cabbage and sole onion record the nil LER. Furthermore, the highest plant height of 17.9 cm for cabbage and 40.8 cm were recorded from a combination of 1:2 (cabbage: onion). Similarly, the highest individual yield of 33 t/ha for cabbage and 2.4 t/ha of onion bulbs were recorded from one row of cabbage and one row of onion. (Guvenc and Yildirim, 2006) stated that the LER of 1.00 for sole cabbage and 1.20 cabbages: onions were recorded. Additionally in another season LER of 1.00 for sole cabbage and 1.17 were recorded from the combination of cabbage: onion intercropping. (Guvenc and Yildirim, 1999). In addition, intercropping has a great potential for pest and disease reduction (Theunissen, 1994). The peasant farmers generally prefer the intercropping system because it produces higher total crop yield per unit area, provides insurance against total crop failure, and also decreases situations of pests and diseases (Lyocks *et al*., 2013).

Cabbage (*Brassica oleracea var.capitata* L.), is an important Cole crop, belonging to family Cruciferae or Brassicaceae, is rich in phyto nutrients and antioxidants. Cabbage is also among the widely grown vegetable crops in Ethiopia. Ethiopia produces 56, 104.234 tons cabbage on 6,649.67 hectare of land with the productivity of 8.437 t/ha. Similarly, in Amhara region and Wag Himra zone cabbage produced around 3,543.803 and 12.284 tons on 629.98 and 2.43 hectares of land with the productivity of 56.25 and 50.55t/ha respectively (CSA, 2021).

Cabbage is well known for its medicinal properties, such as treating cough, fever, skin diseases, peptic ulcers, urinary discharge and hemorrhoids. Fresh cabbage juice is reported to contain a heat labile antipeptic ulcer component, anti-bacterial activity, and anti-cancer activity (Asfaw Zeleke and Eshetu Derso, 2015). However; aphids are highly attack in this crop and farmers are applying over dose of chemical which is harmful for human health and environment. The cabbage aphid is an insect that feeds on plain sap and causes severe distorted leaves, defoliation, and stunted growth. Aphids multiply very fast and can result in yield loss if not controlled. Aphids can also carry virus diseases of vegetables. Therefore, strong smelling plants like onions can be intercropped with cabbage are best alternative option to reduce aphids. Onions produce a chemical that is repellent to many aphids, diamondback moth and also to other insects (Mulenga *et al.*, 2014).

According to (Mohammed and Alyousuf, 2021) intercropping of cabbage with onion reducing diamondback moth on the average densities of larvae ranged from 0.49 larvae/plant on (1 cabbage: 1 onion) to 0.06 larvae/plant on (2 cabbage: 1 onion), compared with the highest larvae density of 1.21 larvae/plant on cabbage planted in monoculture system in the control treatment. In addition to this the lowest average number of aphid insect densities 1.65 insects/plant were recorded from in the two treatments (2 cabbage: 1 onion) and (1 cabbage: 1 onion), compared with the control treatment (cabbage monoculture), which reached the highest insect densities of 6.87insects/plant. He suggested that the reason for decreasing of density of aphids on the intercropping cabbage with the onion plant may be returned also to volatile compounds emitted from companion ‘onions’ that confusing olfactory of aphids. Similarly,(Debra & Misheck, 2014) reported that onion intercropped with cabbage between rows has a higher repellent effect than the intercrops where the onion was planted within the cabbage rows. Because onion is capable of repelling insect pests on leaf crops.

In the study area cabbage is produced widely; however cabbage aphid and Diamond back moth which are major insect pests in cabbage crop. Therefore, farmers are using different chemicals to reduce the severity of insect pests. But the chemicals used for reducing the insect pests are harmful for human heath as well as environmental. Regarding this view, an attempt is undertake to get maximum benefit with reducing insect pests from intercropping of cabbage with onion by using optimum planting pattern.

##  Objectives

### General objective

* To evaluate the effect of different planting patterns on growth, yield, and insect pest control of cabbage and onion intercropping.

###  Specific objectives

* To determine the best planting pattern on growth and yield of cabbage and onion intercropping.
* To evaluate the effect of intercropping cabbage with onion on cabbage Aphid and other insect pest populations.

# Materials and Methods

## 2.1. Description of the experimental area

The study will be conducted in Lasta-Lalibela (( Kechin abeba) and Sekota (Woleh) districts for two consecutive years of 2023/24 and 2024/25 irrigation season. The site is situated at about 2061 at Woleh, and 2204 at Kechin-Abeba m.a.s.l. respectively.

## 2.2. Experimental design and treatment

The experiment will be laid out in randomized complete block design (RCBD) with three replications. With a total of six treatments comprising four planting variations and two sole cropping will be in the trial by using Additive series intercropping. The experiment will be conduct at (Woleh and Lalibela) 2024/2025 irrigation season. For the experiment Copenhagen Market cabbage hybrid variety and Bombay red onion variety experimental materials will be used.  The treatments include; one line of cabbage/one line of onion(1;1),one line of cabbage/two line of onion(1;2), two line of cabbage/one line of onion(2;1), two line of cabbage/ two line of onion(2;2), sole cabbage and sole onion. Total plot size will be 5m × 4.2m and the total experimental area will be 35 m × 14.6 m. The distance between adjacent plots is 1 m and distance between block will be 1 m. Transplantation of Cabbage will be done as a recommended spacing of 60 cm between row and 40 cm between plants and onion transplantation between cabbage intercrop will be done by 15X5 between row and plant respectively and sole onion will be double row method of 40X15X5cm between furrow, bed and plant respectively as recommended by woramit center. Other agronomic management practices will be done as a recommended.

### 2.3. Data collection and analysis

### 2.3.1. Data collection

 Data to be collected for cabbage and onion

* Days to 90% maturity
* Number of leaves per plant
* Plant height
* Bulb length
* Bulb diameter
* Average bulb weight
* Marketable yield
* Unmarketable yield
* Total bulb yield
* Days to 90% maturity
* Number of leaves per plant
* Plant height
* Marketable yield
* Un marketable yield
* Total head yield
* Head diameter(cm)
* Head height(cm)
* Days to head initiation
* number of damaged heads at harvest
* numbers of damaged leaves at harvest

## For both crops insect pest data will be recorded a week interval. The biological efficiency of the cabbage – onion intercropping system will be measured different indices:-

Land equivalent ratio (LER) is a measure of the land-use efficiency in an intercropping system. It assesses the efficiency of an intercropping in using environment resources compared with pure cropping (Adeniyan *et al*., 2014).

LER was calculated as follows:

LER = (LER cabbage + LERonion)

LER Cabbage=Yci/Yc and LERonion=Yoi/Yo.

Where YC Yield of cabbage as sole crops, Yo is the yield of onion as sole crops, Yci is the yield of cabbage as intercrop and Yoi is the yield of onion as intercrop.

When LER > 1, the intercropping favors the growth and yield of the associated crop species. In opposite, when LER < 1, there is no intercropping gain and the interspecific competition is stronger than the interspecific interaction within an intercropping system.

The Area Time Equivalent Ratio (ATER) provides more realistic comparison of the yield advantage intercropping over monocropping in terms of time taken by component crops in the intercropping systems (Bedoussac and Justes, 2011).

ATER was evaluated using the following formula;

ATER=(LERCabbage \*tc) +(LEROnion\*to)/T|

Where tc is the Cabbage growth cycle duration;to is the onion growth cycle duration and T is the duration in days of the species with the longest growing cycle. ATER > 1 implies yield advantage from intercropping; ATER = 1 suggest no effect of intercropping; ATER < 1 indicates yield disadvantage as a consequence of crop intercropping.

Land-use Efficiency (LUE). We evaluated the LUE as suggested by (Yaseen et al., 2014)

LUE=LER+ATER/2 X 100

Agressivity (A) indicates the relative yield increase in “a” crop is greater than of “b” crop in an intercropping system (McGilchrist, 1965). The agressivity can be derived from the following formula.

A cabbage = {Yab / (Yaa X Zab)} – {Yba / (Ybb X Zba)}, if the value of A is zero, both crops are equal. İf the value of A is positive then cabbage is dominant over intercrops. If the value is negative then intercrops are dominant species over cabbage. Similarly, agressivity of intercrops can also be calculated by the Formula:-

 A intercrops = {Yba / (Ybb X Zba) } – {Yab / (Yaa X Zab)}

Where Zab is sown proportion of cabbage in intercropping, Zba is sown proportion of intercrop in intercropping, Yab is the yield of cabbage in intercropping, Yba is the yield of intercrop in intercropping, Yaa is the yield of cabbage in monocropping and Ybb is the yield of intercrops in intercropping.

### 2.3.2. Data Analysis

Analysis of variance (ANOVA) will be done using SAS system (version 9.1.3), and mean difference will be tested using LSD at 1% or 5% significance level.

2.3.3. Expected output:-
The best planting pattern of cabbage with onion intercropping in the study area will be recommended.

**Duration:** Two year

**Budget:**- **102,080**
**Location:** Lalibela (Kechin Abeba) and Woleh
**Initiator**:-Belet Ameshe
**Person responsible:**Horticulture case team and protection case team.
**Executive Center:** SDARC

# Logistics and Budget

**3.1.** Budget requirement of the experiment

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Budget category** | **Unit**  | **Quantity** | **Unit price** | **Years- I**  | **Year II** | **Total price** |
| **Labor** | Man/ day | 50 | 100 | 5000 | 5000 | 10000 |
| **Per Diem** | Man /day | 25 | 270 | 6750 | 6750 | 13500 |
| **Fuel & Lubricants**  | Liter | 100 | 50 | 5000 | 5000 | 10000 |
| **Watering & other managements** | Man/Day | 4 | 2500 | 10000 | 10000 | 20000 |
| **Guarding** | Month | 4 | 3000 | 12000 | 12000 | 24000 |
| **Seed cost of cabbage**  | Kg | 0.75 | 6400 | 4800 | 4800 | 7200 |
| **Seed cost of onion** | Kg | 0.75 | 3800 | 2850 | 2850 | 5700 |
| **Sub Total** |  - | - | 16120 | 46400 | 46400 | 92800 |
| **Contingency (10%)** |   |  | 1612 | 4640 | 4640 | 9280 |
| **Grand total** |   |   | 17,732 | 51040  | 51040 | **102,080** |

# Work Plan

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Activities** |  |  | **Year- I**  | Year- Ⅱ |
| January | February | Apr | May | June | July | Aug | Septum | October | November | December | January | February | Apr | May | June | July | Aug | Septum | October | November | December |
| Site selection  |  |  |  |  |  |  |  |  | **X** | **X** |  |  |  |  |  |  |  |  |  | **X** | **X** |  |
| Land preparation |  |  |  |  |  |  |  |  |  | **X** | **X** |  |  |   |  |  |  |  |  |  | **X** | **X** |
| Seedling preparation |  |  |  |  |  |  |  |  |  | **X** | **X** |  |  |  |  |  |  |  |  |  | **X** | **X** |
| Lay out |  |  |  |  |  |  |  |  |  |  | **X** |  |  |   |  |  |  |  |  |  |  | **X** |
| Planting | **X** |  |  |  |  |  |  |  |  |  | **X** | **X** |  |  |  |  |  |  |  |  |  | **X** |
| Weeding and cultivation | **X** | **X** | **X** |  |  |  |  |  |  |  |  | **X** | **X** | **X** |  |  |  |  |  |  |  |  |
| Data collection | **X** | **X** | **X** | **X** |  |  |  |  |  |  |  | **X** | **X** | **X** | **X** |  |  |  |  |  |  |  |
| Harvesting |  |  |  | **X** |  |  |  |  |  |  |  |  |  |  | **X** |  |  |  |  |  |  |  |
|  Data analysis |  |  |  | **X** | **X** |  |  |  |  |  |  |  |  |  | **X** | **X** |  |  |  |  |  |  |
| Report writing |  |  |  |  |  | **X** | **X** |  |  |  |  |  |  |  |  |  | **X** | **X** |  |  |  |  |

# Reference

Addo-Quaye, A. A., Darkwa, A. A., & Ocloo, G. K. (2011). Growth analysis of component crops in a maize-soybean intercropping system as affected by time of planting and spatial arrangement. *ARPN Journal of Agricultural and Biological Science*, *6*(6), 34–44.

Adeniyan, O. N., Aluko, O. A., Olanipekun, S. O., Olasoji, J. O., & Aduramigba-Modupe, V. O. (2014). Growth and yield performance of cassava/maize intercrop under different plant population density of maize. *Journal of Agricultural Science*, *6*(8), 35.

Ahmed, B., Shabnam, D., Shabnam, S., Hossain, M. A., & Islam, M. M. (2018). Intercropping grasspea with chilli at varying plant population. *Int. J. App. Res*, *4*(1), 58–61.

Asfaw Zeleke, & Eshetu Derso. (2015). *PRODUCTION AND MANAGEMENT OF MAJOR VEGETABLE CROPS IN ETHIOPIA: Vol. I*.

Bala, M. G., M.S.Askira, Yadumma, J. J., Idris, B. A., & Mukhtar, F. B. (2012). Effects of Different Planting Patterns on the Growth and Yield of Cabbage and Onion Intercrops. *Biological and Environmental Sciences Journall for the Tropics*, *9*(2), 1–5.

Bedoussac, L., & Justes, E. (2011). A comparison of commonly used indices for evaluating species interactions and intercrop efficiency: Application to durum wheat–winter pea intercrops. *Field Crops Research*, *124*(1), 25–36.

CSA (CENTRAL STATISTICAL AGENCY). (2021). *THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA CENTRAL STATISTICAL AGENCY AGRICULTURAL SAMPLE SURVEY: Vol. VOLUME I R*.

Debra, K. R., & Misheck, D. (2014). Onion (Allium cepa) and garlic (Allium sativum) as pest control intercrops in cabbage based intercrop systems in Zimbabwe. *IOSR Journal of Agriculture and Veterinary Science*, *7*(2), 13–17. https://doi.org/10.9790/2380-07221317

Guvenc, I., & Yildirim, E. (1999). Multiple cropping systems in vegetable production. *Proceedings of the Organic Agriculture Symposium*, 288–296.

Guvenc, I., & Yildirim, E. (2006). Increasing productivity with intercropping systems in cabbage production. *Journal of Sustainable Agriculture*, *28*(4), 29–44.

Hoshikawa, K. (1991). Significance of legume crops in improving the productivity and stability of cropping systems. *Phosphorus Nutrition of Grain Legumes in the Semi-Arid Tropics. ICRISAT, India*, 173–181.

Islam, H. M. S., Choudhury, R. U., Ahmed, B., Shabnam, S., & Rahman, M. M. (2014). Adoption of Mixed Cropping in Rabi Season by the Farmers of Madaripur Sadarthana under Madaripur District. *International Journal of Business, Social and Scientific Research*, *1*(3), 168–171.

Kangasniemi, J. (1993). Sustainable Agriculture and the Environment in the Humid Tropics. *Culture & Agriculture*, *13*(47), 24–25.

Lyocks, S. W. J., Tanimu, J., & Dauji, L. Z. (2013). Growth and yield parameters of ginger as influenced by varying populations of maize intercrop. *Journal of Agricultural and Crop Research*, *1*(2), 24–29.

McGilchrist, C. A. (1965). Analysis of competition experiments. *Biometrics*, 975–985.

Mead, R., & Willey, R. (1980). The concept of a ‘land equivalent ratio’and advantages in yields from intercropping. *Experimental Agriculture*, *16*(3), 217–228.

Mohammed, I. Q., & Alyousuf, A. A. (2021). *Effect Of Intercropping Systems On Diamondback Moth ( Plutella Xylostell L .) And Turnip Aphid ( Lipaphis Erysimi Ka ) Infesting Cabbage , Brassica Oleracea Var . Capitate*. *8*(6), 2245–2262.

Mulenga, M. M., Matimelo, M., & Ministry, H. M. (2014). *Intercrop cabbage with onion against aphids*. ©CAB International. Www.Plantwise.Org.

Ouma, G., & Jeruto, P. (2010). Sustainable horticultural crop production through intercropping: The case of fruits and vegetable crops: A review. *Agriculture and Biology Journal of North America*, *1*(5), 1098–1105.

Quayyum, M. A., Akanda, M. E., & Islam, T. (1985). Effect of intercropping maize with groundnut at varying levels of plant population and nitrogen level. *Bangladesh Journal of Agriculture (Bangladesh)*.

Theunissen, J. (1994). Intercropping in field vegetable crops: pest management by agrosystem diversification—an overview. *Pesticide Science*, *42*(1), 65–68.

Willey, R. (1979). Intercropping-its importance and its research needs. Part I. Competition and yield advantages. *Field Crop Abstr.*, *32*, 1–10.

Yaseen, M., Singh, M., & Ram, D. (2014). Growth, yield and economics of vetiver (Vetiveria zizanioides L. Nash) under intercropping system. *Industrial Crops and Products*, *61*, 417–421.