Effect Of Intercropping On Aphid Vectors And Yield Of Pepper (Capsicum Annum L.) In Southern Part Of Ethiopia

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ABSTRACT: Hot Pepper (Capsicum spp.) is an important spice and vegetable crop in Ethiopia. In nature, potyvirus is transmitted non persistently by at least five aphid species. Therefore, this study was conducted with the objective of identifying the effects of intercropping pepper on aphid population, yield and yield components of pepper. Field experiments were conducted in two localities; Mareko and Meskan of southern Ethiopia from April to October 2011. The experiments were conducted with RCBD design with four replication. Treatments were combination of pepper with maize, pepper with sweet potato, pepper with maize and sweet potato and sole pepper as a control. Aphids were collected by using yellow water traps two times a week. Data on yield and yield components were taken at harvest. Results of the experiment revealed that intercropping of pepper with maize significantly ($p<0.001$) reduced aphid populations. In addition, it significantly ($p<0.01$) increased marketable pod yield and reduced unmarketable yield. The largest numbers of aphids (ca. 25 aphids at each location were caught from control plots while only about 12 and 10 of pepper intercropped with maize and sweet potato in Mareko and Meskan, respectively. Intercropping pepper with maize increased the marketable and total yield of pepper by 39% and 33% at Mareko 33% and 23% at Meskan. Intercropping of pepper with sweet potato neither increases nor was decrease the yield of pepper and LER value one. On the other hand, intercropping of pepper with maize and sweet potato reduced the pepper yield by 13% and 14% as compared to the control at Mareko and Meskan, respectively. Therefore, intercropping of pepper with maize can serve as reduction of aphid vectors infestation and improves pepper yield.

Key words: Aphid, Capsicum annuum, Intercropping; LER

LIST OF ABIRIVAITION

MP: pepper with maize
SwP: Sweet potato with pepper
MPSw: pepper with pepper and sweet potato
PE : pepper
LER_m: land equivalent ratio of marketable yield
LER_t: land equivalent ratio of total yield
MY: Marketable yield
UMY: Unmarketable yield.
Q/ha=quintal per hectare

Introduction

Hot pepper (Capsicum annuum L.) is one of the most important vegetable and spice crop grown in different parts of the world [3] . Pepper is primarily grown for its pungency and utilization as spice commodity and for domestic and economic purposes. The world's second most important Solanaceous vegetable after tomatoes. In Africa Nigeria is the largest producer of pepper, accounting for about 50% of the African production [3] Hot pepper has been cultivated in Ethiopia since the 17th century [12] It is an economic and traditionally important crop in Ethiopia ([27]. The adaptability and the wide use of pepper by the society and spice companies created diverse market for pepper growers in various places across the country including Hawassa, Halaba, Ziway, Mareko, Boditti, Humbo, Meki, Meskan and Koka [27] This makes rift valley the most important region of pepper production in Ethiopia. In these areas, hot pepper serves as additional income generating crop for off-farm activities of farmers particularly in the time of cereal deficit [27]. Mixed cropping which is widely practised in the humid tropics has been shown to be more efficient than sole cropping [1]. As increased diversity of the physical structure of plants in an intercropping system produces many benefits ([7]. Intercropping encourages biodiversity which helps to limit outbreak of insect pests ([20] Under local conditions, this is a rational strategy as there is greater stability of yield over different seasons, better use of land resources, possibility of better control of weeds, pests and diseases [14]. Pepper is not a primary host of most of the noncolonizing aphid species. The aphids might have migrated into pepper fields from other host including weeds [6]. Transmission efficiency of PVY and CMV to pepper in both green peach aphid and cotton aphid was reduced by 50% or more when aphids had access periods on maize and sorghum prior to ultimate access to pepper [10]. Insecticides against aphid vectors are not available to resource poor farmers [27] In addition, most insecticides are ineffective to control non-persistently transmitted viruses by controlling the vector, as aphids transmit such viruses before the insecticides act to kill them ([26 & 15]. Lessons from other studies showed that intercropping reduces infection by different non- persistently transmitted viruses and infestation by their aphid vectors [9]. The objective of this study was to determine the effect of intercropping aphid vectors and yield and component of pepper.

MATERIALS AND METHODS

Treatments and experimental design

The experiments were conducted at Mareko and Meskan woredas, Guraghie Zone of South Nation, Nationalities and Peoples Region of Ethiopia. The designs were randomized complete block (RCBD) with four replications. The most commonly grown Hot pepper (Mareko fana), sweet potato (Gadessa) and maize (Giba) varieties in the area were used in the experiment. Intra spacing of the variety was 0.3, 0.25 and 0.6m pepper, maize and sweet potato respectively while inter row spacing for all treatments was 0.7m. Each plot had a size of 4.2 X 4.2m and there were six rows per plot. Each plots were separated by a 2m gang ways in order to reduce inter-plot effects. Pepper seedlings were raised on bed with a size of 5mX1m. Transplanting of pepper seedling was done when they were two month old and after planting of maize and sweet potato. In each rows 14 pepper plants were planted. Weeding and other agronomic practices such as hoeing were carried out according the farmers' practices of the areas. DAP was applied once times at transplanting and Urea two times were made at the rate of 14g/plant. The first application was made at transplanting and the second application was before flowering of pepper. The treatments of the experiment level. Three rows of maize and three rows pepper/plots. Three rows of sweet potato and three rows pepper/ plots. Two rows of maize, two rows pepper and two rows sweet potato/ plots, six rows of pepper as a control.

Data collection

Monitoring of aphids

Alate aphids were monitored by using Yellow Water Traps (YWT). The YWTs were made from yellow plastic container with size of 10x35x20cm [6]. One YWT was placed in the middle of each plot. The traps were filled with water up to small outlets. Water filled below the rim. The heights of the traps were adjusted according to the crop canopy. Moreover, to keep the aphids intact and avoid birds drinking it, 5ml of formaldehyde (10%) was added per trap. The solution in YWT was changed every week. Aphids trapped in YWT were collected twice a week until the pepper crop fully matured.

Yield and yield components

At crop maturity, the pepper pods were harvested from the two inner rows of each plot and sun dried. Then pods were sorted into marketable from fully developed and healthy looking pods and unmarketable (infected, short, distorted and discolored pods) based on the presence or absence of green mottling, swelling, pod size colors and shape deformation. Weights of marketable, unmarketable and total fruits were measured and compared among treatments. The yield was calculated by using land equivalent ratio (LER). LER shows the effectiveness of intercropping on crop productivity [17].

$$LER = \frac{\text{Intercropping crop}}{\text{Monocropping}} \times 100$$

Analysis of data

The data on disease incidence, mean aphid trap caches and yields of pepper were subjected to analysis of variance (ANOVA) using the SAS computer package, version 9.11 [24]. LSD test at the 0.05 probability level were used for mean comparison.

RESULTS AND DISCUSSION

Aphid population

At Mareko the aphid populations were low until the eighth week followed by an increase in aphid population across treatments (Fig. 1). Significant variations ($P<0.001$) existed between treatments in terms of aphids population. Number of aphids caught in the yellow water traps varied between 12.5 in pepper-maize intercropping to 25 in control plots (Table 1 and Fig. 1). The second highest number of aphids (21) was caught from plots with pepper-sweet potato intercropping. However, as compared to the control intercropping of sweet potato with pepper significantly reduced the aphid population. Variations in aphid populations were not significant between intercropping of pepper with maize, and pepper with maize and sweet potato (Table 1 and Fig 1). Similarly, at Meskan aphid population varied significantly ($P<0.01$) among treatments (Table 2). The highest mean number of aphids (24.73) was recorded in the control plots followed by intercropping of sweet potato with pepper, from which ca. 20 aphids were recorded. The lowest aphid population size (9.62, mean value) was recorded when pepper was intercropped with maize. The aphid population in Meskan was low until the fourth week and kept increasing between the fourth and seventh week across treatments. From the seventh to ninth week the aphid population decreased regardless of treatments, this may be the amount of rainfall. This was followed by a population build up starting from the ninth week (Fig. 2).

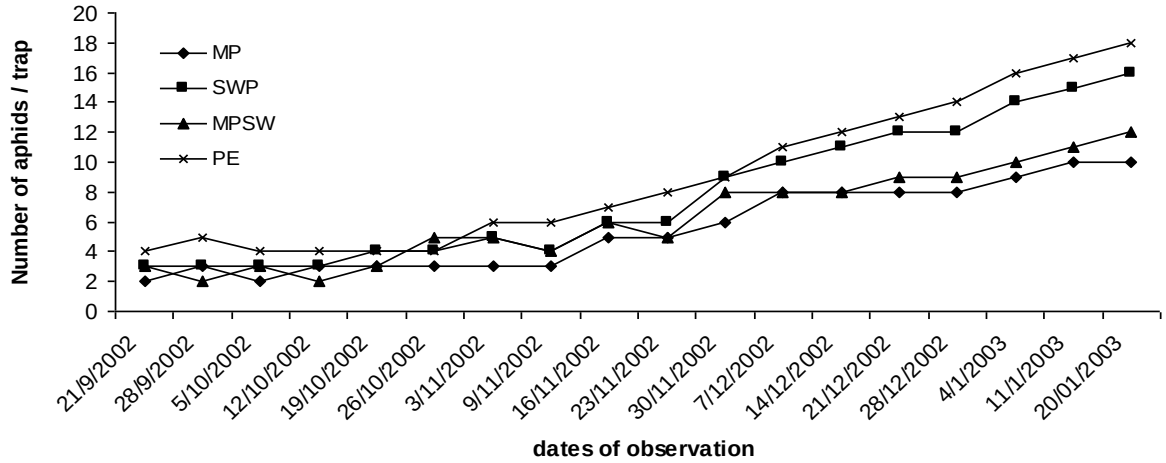

Fig. 1. Effect of intercropping practices on aphid Vectors dynamics at Mareko

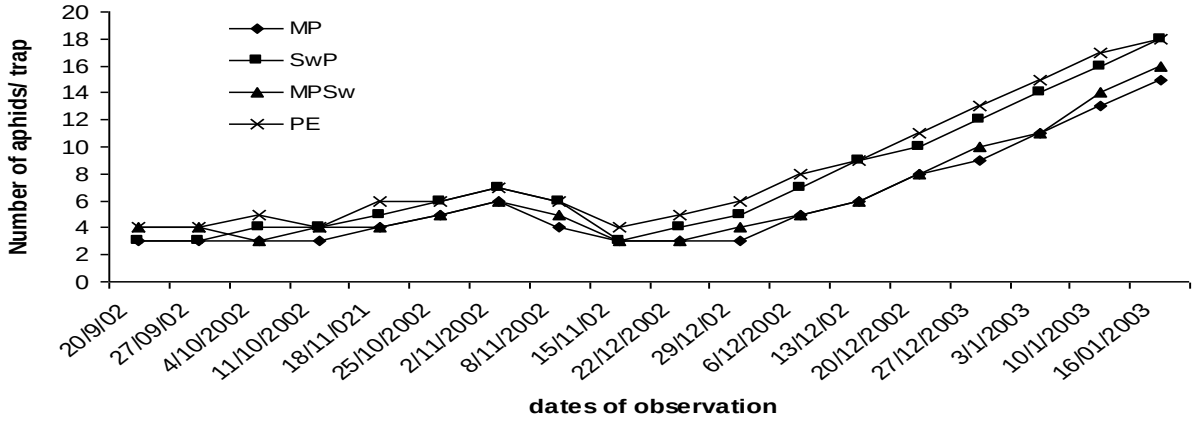

Fig. 2. Effect of intercropping practices on aphid vectors dynamics at Meskan

Results from both at Mareko and Meskan sites revealed the efficacy of maize in protecting pepper plants from aphid infestation. This is because maize plants are taller than pepper. Hence, maize may be used to effectively block the flight of aphids to pepper plants. [4] also recommended intercropping pepper with maize as one of the cultural practices aimed at reducing the vector population. [25] found that sunflower decreased PVY virus spread by blocking alate aphids, which prevented them from landing on neighboring pepper plants because aphids had difficulties flying through the intercropping and thus flew over it. Hussein and Samad [13]conducted to evaluate the effectiveness of intercropping chilli (C. annuum) plants with maize to suppress A. gossypii and associated Chilli veinal mottle virus (CVMV) Virus spread was faster and trap catches of winged vectors were greater in monoculture as compared to intercropping chilli pepper.

Yield and yield components of pepper

Number of pods per plant

Significant variations (P<0.01) were observed among treatments in the number of pods per plant both at Mareko and Meskan (Table1&2). Pod numbers per plant were highest 41 and 40 at Mareko and Meskan, respectively, on the control plots but majority of pods were unmarketable pod size. The lowest number of pods was harvested from plots, where pepper was intercropped with maize and sweet potato at both locations. Generally, it could be concluded that intercropping of pepper with maize and sweet potato at the same time may reduce the number of pods per plant. This is probably due to the competitive ability of the intercropped plant. The result was in agreement with Osiru and. Ikeorgu [23; 2] also suggested that intercropping does not always increase crop due to competitive effects, a claim supported by [8].

Marketable yield

The result shows that intercropping has a significant (P<0.01) effect on marketable yield of pepper at both location. The higher yield was harvested at intercropping of maize with pepper by 15.01qt/ha and 15.075qt/ha Meskan and Mareko respectively. As compared to the control intercropping of pepper with maize is increasing the pepper yield by 33% and 39% (Table 1 and 2). Whereas, the second higher yield was harvested at intercropping pepper with sweet potato and at the control. The lower yield was harvested at intercropping pepper with sweet potato and

maize as compare to the control it is reducing the pepper yield by 29% and 23% (Table 1 and 2).

Unmarketable yield

The result shows that intercropping has a significant **(**P<0.01) effect in reducing the unmarketable yield as compared to the control. In both location the lowest unmarketable yield was harvested at intercropping maize with pepper which is the means of 0.32qt/ha and 0.26qt/ha followed by pepper with maize and sweet potato where as the highest unmarketable yield was harvested at the control with the means of 0.62qt/ha and 0.56qt/ha at Meskan and Mareko respectively (Table 1 and 2).This result was in agreement with Fuchs and Mainzenmeayers ([11] , who registered >25% reduction in cotton fruit yield in crop with higher disease incidence and severity. Meyers et al. [18] also reported up to 50% yield reduction in C. chinense var. Scotch Bonnet due to TEV. Early infection by potyvirus can cause reduction of pepper yield by 60% (Ong et al., [21; 22].

Total yield

The result shows that intercropping has a significant (P<0.001) effect on total yield of pepper. In both locations the higher pepper yield was harvested at intercropping of peppers with maize followed by intercropping of pepper sweet potato which is the mean of 15.28qt/ha and15.89qt/ha at Meskan and Mareko respectively and also intercropping of pepper with maize is increasing the total yield by 33% and 23% as compared to the control. The lowest yield was harvested at intercropping of pepper with maize and sweet potato. As compare to the control intercropping of pepper with sweet potato and maize can reduce the pepper yield by 14% and 13% at Meskan and Mareko respectively (Table 1 and 2) . Maize intercropping with pepper as effective in pepper that increase yield. These resulted were in agreement with Bennison and Corless ([5; 19] and Mansour et al. [16], suggested that maize intercropping with pepper is effective to reduce virus transmitting aphids.

Correlation among potyvirus disease incidence, aphid vectors, marketable yield, unmarketable yield Meskan table yield, and total yield at Marko and Meskan

The highest positive correlation (R=O.86515 and R=0.88565) between the aphid vectors and disease incidence at Marko and Meskan respectively. This shows that by using intercropping the aphid vector can reduce the disease incidence but a negative correlation between marketable yield and total yield correlated with disease incidence at both locations which was a highly significant difference among the treatment. Unmarketable yield was positive correlation highly significant with potyvirus (Table 3).

CONCLUSION

Variations in aphid populations were insignificant between the two locations. At Mareko the marketable and total yield was increased by 39 and 33%, respectively while in Meskan marketable yield and total yield increased by 33 and 23% when pepper was intercropped with maize. Intercropping of pepper with both maize and sweet potato reduces the pepper yield by 13 and 14% at Mareko and Meskan, respectively. The use of maize as intercropping component of pepper is effective in protecting pepper fields from aphid infestation. It results in improving the quality and quantity yield of pepper. Both maize and pepper are among the crops that are preferred by farmers in Ethiopia and hence intercropping them is advantageous from insect management as well as yield increment point of view. Therefore, intercropping maize-pepper is recommended to manage the aphid vectors and increase the pepper yield.

Table 1. Effect of intercropping on aphid vectors, Pod per plant, Marketable yield, Unmarketable yield, Total yield of pepper at Mareko

Treatment	Aphid Population	Pod Per plant	Marketable yield (Q/ha)	LERm	Unmarketable Yield (Q/ha)	Total Yield (Q/ha)	LERt
Control	25.195a	40.75a	10.87bc	1.00b	0.62a	13.11b	1.00b
MP	13.25c	33.04b	15.08a	1.39a	0.32c	15.89a	1.33a
SwP	21.00b	24.85c	12.65b	1.00b	0.47b	11.49b	1.00b
MPSw	12.05c	16.77d	8.75c	0.77c	0.36c	9.11c	0.87c
LSD	4.83	7.31	2.21	0.17	0.09	2.23	0.15

Means in a column followed by the same letter are not significantly different according to LSD test at p<0.05

Table 2. Effect of intercropping on mean of aphid vectors, pod per plant, marketable yield, unmarketable yield, Total yield in pepper at Meskan

Treatment	Aphid Population	Pod per plant	MY (Q/ha)	LERm	UMY (Q/ha)	Total Yield(Q/ha)	LERt
Control	24.73a	40.35a	11.82b	1.00b	0.56a	11.37c	1.00b
MP	9.62c	31.28b	15.02a	1.33a	0.26c	15.28a	1.23a
SwP	16.54b	26.05c	12.64b	1.00b	0.46b	13.09b	1.00b
MPSw	13.2c	18.62d	9.07c	0.71c	0.33c	9.4c	0.86c
LSD	5.58	7.04	2.12	0.14	0.08	2.07	0.15

Means in a column followed by the same letter are not significantly different according to LSD at p<0.05.

Table 3. Correlation among potyvirus disease incidence, aphid vectors, marketable yield, unmarketable yield Meskan table yield, and total yield at Marko and Meskan

	aphid vectors	Marketable yield	unmarketable yield	Total yield
Marko Disease Incidence %	0.86515***	-0.67823**	0.87942***	-0.66724**
Meskan Disease incidence %	0.88565***	-0.55207*	0.91310***	-0.51531*

*=p<0.05, **=p<0.01, ***=P<0.0001

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