The Effect Of Intercropping Of Pepper With Maize And Sweet Potato On Infection Of Pepper (Capsicum Annuum L.) By Potyviruse And Yield Of Pepper In, Southern Ethiopia

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ABSTRACT: *Potyvirus is a very large viral group and contains many economically important viruses affecting various crops including pepper. This study was conducted with the main objective of identifying the effects of intercropping pepper with maize and sweet potato on potyvirus incidence, 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. Each treatment was replicated four times at both locations. The incidences of potyvirus infected plants were monitored once a week and data on yield and yield components were taken at harvest and then yield data was calculated by using land equivalent ratio method (LER). Results of the experiment revealed that intercropping of pepper with maize significantly ($p<0.001$) reduced the onset of potyvirus incidence. The use of maize and sweet potato with pepper also significantly ($p<0.001$) reduced the occurrence of potyvirus incidence. High incidences of potyvirus, 34.25% and 35.25%, were on control plots at Meskan and Mareko, respectively. The study showed that intercropping pepper with maize can serve as disease management strategy against potyvirus infection and aphid infestation. It also improves pepper yield.*

Key Words: *Capsicum annuum*, intercropping; potyvirus

Abbreviation

MP	=	Maize with pepper,
Swp	=	pepper with Sweet potato
MPSw	=	Pepper with maize and Sweet potato
Pe	=	pepper only
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 [1]. Pepper is primarily grown for its pungency and utilization as spice commodity and for domestic and economic purposes. Pepper has a high concentration of alkaloid, capsoicinoid that makes it an important ingredient used for spice commodity in the world [6; 9]. The production and marketable quality of hot pepper is low in the tropical regions mainly due to virus infection and lack of effective virus management strategies. *Potyvirus* are the major problems of many economically important crops in tropical areas [20]. The two major *potyviruses* causing heavy damages either in single/mixed infections in Ethiopia are *Potato Virus Y* (Y) and *Ethiopian Pepper Mottle Virus* (EPMV) [25; 23]. While PVY has worldwide distribution, EPMV is endemic to Ethiopia [23] Field observations revealed that the production of the crop has been abandoned in some years due to unacceptable high proportion of viral infection [22]. In spite of the increasing importance of the *Potyviruses* in hot pepper in Ethiopia. Previously conducted studies have been limited to the identification and characterization of viruses [2; 25; 23]. Furthermore, pepper varieties that resist the viruses are not available in the country [23; 9].The associated viral infections require development of efficient and locally viable management strategies in resource poor production system. Intercropping practices is an important way to establish ecologically and economically friendly measures, which provide resource poor farmers with sustainable approach to pest management. Intercropping reduce the infection of Pepper Veinal Mottle virus (PVMV) incidence when pepper was intercropped with maize, cassava and plantain by 90%, 95% and 92.7%, respectively [7]. Planting cereal cropping in and round Sugar beet had been effective in reducing virus diseases of the crop and has been commercially practiced in Europe [24]. The objectives of these investigations was to: determine the effect of intercropping on the infection pepper by potyvirus and yield and yield attribute of pepper

MATERIALS AND METHODS

The experiments were conducted at Mareko and Meskan woredas, Guraghie Zone of South Nation, Nationalities and Peoples Region. They are found at altitudes of 1650 and 1800 masl, respectively. The locations have a bimodal rain fall type with the first rainy season from February to end of April, and the second rainy season from mid of June to mid of September. Both locations are characterized by sub humid climatic conditions.

Treatments and experimental design

The experiments were carried during the rainy season from April to October 2011 at both locations. The designs were randomized complete block (RCBD) with four replications. The most commonly grown 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 weeks 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 A total of three rows of maize and three rows pepper/plots. A total of three rows of sweet potato and three rows pepper/ plots. A total of two rows of maize, two rows pepper and two rows sweet potato/ plots. Six rows of pepper as a control

Monitoring of incidences of Potyvirus

Starting two weeks after transplanting, all pepper plants per plot were monitored weekly for the incidence of potyvirus infection. The incidences were rated using symptoms based evaluation methods established for Potyvirus [19].

Analysis of data

The data on disease incidence and yields of pepper were subjected to analysis of variance (ANOVA) using the SAS computer package, version 9.11 [19]. LSD test at the 0.05 probability level were used for mean comparison.

RESULTS AND DISCUSSION

Disease incidence

A total of 16 observations were made on the incidence of potyvirus over a period of three months at Mareko and Meskan (Figures 1 and 2). The use of maize as intercropping with pepper reduced virus incidence significantly ($P<0.001$) as compared to the other treatments, and results were constant across locations (Tables 1) At Mareko, disease incidence remained low (ca. 0%) up to mid June regardless of treatments but showed an increase starting from mid June onwards across treatments. However, both the increase and final disease incidence varied among treatments (Fig. 1). At the end of the experiments disease incidence reached (35.3 %) in the control plots and (9.2 %) in plots, of pepper intercropped with maize.

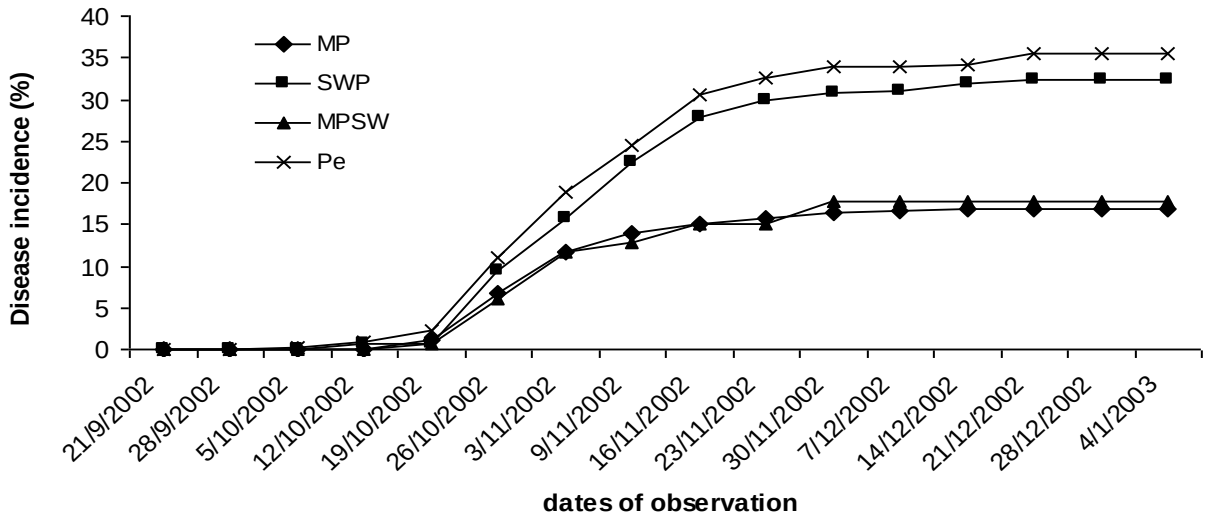

Fig.1. The effect of intercropping on temporal progress of potyvirus incidence in pepper at Mareko

At Meskan, the disease incidence ranged from 12.75 % in pepper-maize intercropping to 34.4% in the control plots (Table 1). Progress of potyviruse had a more or less similar trend with that in Mareko. Disease incidence was low (<5%) during the first 5-6 assessments, which was followed by a sharp rise of disease incidence across treatments before the populations stabilizes (Fig. 2).

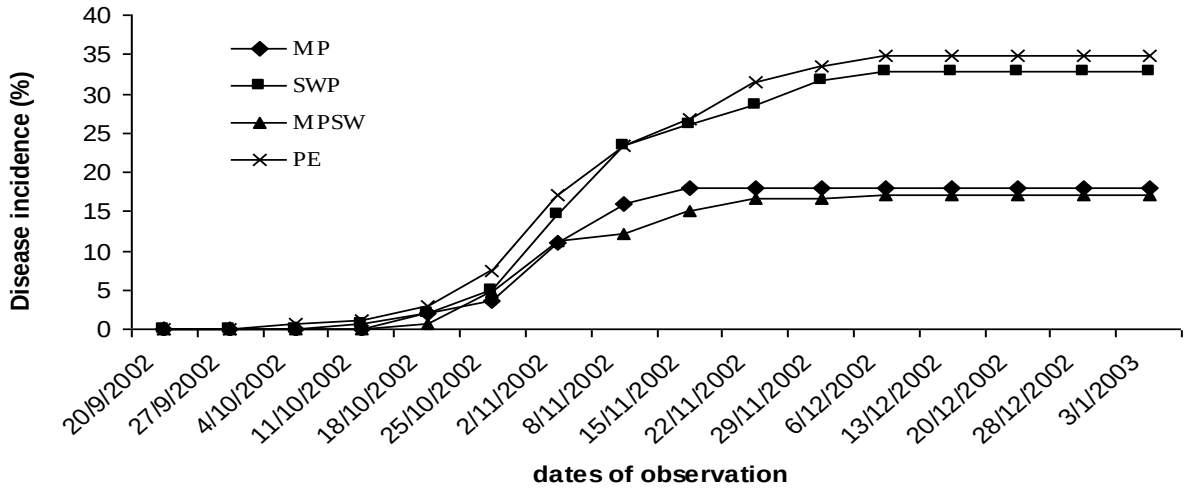

Fig. 2. Effect of intercropping on temporal progress of potyvirus incidence in Pepper at Meskan

On both locations higher potyvirus incidence were observed when the crop was at intermediate stage. This might be related to ontogenic resistance of pepper to viral infections. The result is in agreement with Ryden et al.[18], who linked higher PVY pressure with increase in the virus sources and vectors depending on the growth stages of the potato. Sigvald [21] also suggested that the risk of PVY infection on potato increases when the vectors become numerous and the plant is still young, but decreased when the crop plant developed some resistance. Beemster [5 and 6] reported that translocation of viruses within young plant systems occur faster than in old plants following an infection. Concorde and Kuala [7] reported suppression of *Cucumber Mosaic virus* (CMV) incidence on hot pepper by taller grain maize compared to the shorter sweet corn but there were no difference between CMV incidence on chilli in plot with maize in the same or alternate ridges to the pepper. Ong [17] also found that planting of maize with pepper was effective in controlling *Chilli Veinal Mottle Potyvirus* (CVMV). The significantly lower potyvirus incidence in plots, where pepper is intercropped with maize or maize and sweet potato as shown in Figs 1 the successful use of intercropping in protecting pepper plants from the disease. This might be attributed to the ability of maize in preventing aphid landing on pepper as shown in the previous section.

Marketable yield

Marketable yield was higher (ca. 16 and 15qt/ha) when pepper was intercropped with maize. The LER value for intercropping of pepper with maize increased in the marketable yield of pepper by 39 and 33% at Mareko and Meskan, respectively. This may be due to the lower occurrence of disease under this treatment. Marketable yield was lower (ca. 9qt/ha) when pepper was intercropped with both maize and sweet potato. The LER value indicated 23 and 29% pepper yield reduced at Mareko and Meskan, respectively (Table 1&2). On the other hand, for this combination intercropping pepper with sweet potato alone neither increased nor decreased marketable yield significantly ($P<0.01$) as compared to the check as evidenced from the LER value, which is one.

Unmarketable yield

Like pod number and marketable yield, unmarketable yield also different significantly ($P<0.01$) among the treatments both at Mareko and Meskan (Table 1&2). In both locations the highest unmarketable yield was harvested at the control (ca. 0.6 qt/ha) next to the control intercropping of pepper with the second higher unmarketable yield was harvested (ca 0.5qt/ha), while the lower unmarketable yield (0.32 and 0.3 qt/ha) was obtained from intercropping pepper with maize in relative to the control at Mareko and Meskan (Table 1 and 2). Unlike marketable yield, intercropping pepper with both maize and sweet potato at the same time significantly reduce unmarketable yield as compared to pepper-sweet potato at the same time intercropping consistently, both at Mareko and Meskan. Unmarketable yield obtained from intercropping of pepper with both maize and sweet potato were more or less the same as those obtained from pepper intercropping with maize alone at both locations. 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. [13] 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% [15, 16].

Total yield

Total yield was significantly ($P<0.001$) higher (ca.16 and 15qt/ha) when pepper was intercropped with maize and increase the total yield of pepper the LER value by 33 and 23% in relative to the control at Mareko and Meskan, respectively. Total yield lower (ca. 9qt/ha) when intercropping of pepper both maize and sweet potato. The LER value 13 and 14% reduce the total yield of pepper Mareko and Meskan, respectively. Intercropping of pepper with sweet potato neither increase nor decrease the total yield of pepper as evidenced from the LER value which is one (Table 1&2). These resulted were in agreement with Bennison and Corless [5]), Midmore [14], and Mansour et al. [13] suggested that maize intercropping with pepper as effective management strategy in reduction viral disease incidence in pepper that increase yield. The reduction virus transmitting aphids is additional advantage in intercropping pepper with tall compatible crops.

Conclusion

In the current experiment, planting of pepper in mono-crop leads to, higher incidence of potyviruse and unmarketable yields; and lower total and marketable yields in pepper fields compared with intercropping of pepper with maize. But monocropping was better than pepper-sweet potato and pepper-maize - sweet potato intercropping at both locations as shown from the LER value. 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 LER, 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 and infection by potyvirus. 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 both from disease and insect management as well as yield increment point of view. Therefore, farmers in Ethiopia, particularly those in the rift valley region can practice maize-pepper intercropping owing to the above advantages.

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Table 1. Effect of intercropping on mean incidence of potyviruse and yield of pepper at Mareko

Treatment	Disease Incidence %	MY (Q/ha)	LER_m	UMY (Q/ha)	Total yield (Q/ha)	LER_t
Control	35.25[a]	10.87[bc]	1.00	0.62[a]	13.11[b]	1.00
MP	9.23[c]	15.08[a]	1.39	0.32[c]	15.89[a]	1.33
SwP	31.25[b]	12.65[b]	1.00	0.47[b]	11.49[b]	1.00
MPSw	11.88[c]	8.75[c]	0.77	0.36[c]	9.11[c]	0.87
LSD	5.06	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 at p<0.05.

Table 2. Effect of intercropping on mean of incidence of potyvirus, marketable, unmarketable, Total yield in pepper at Meskan

Treatment	Disease Incidence (%)	MY Q/ha	LERm	UMY Q/ha	Total Yield (Q/ha)	LERt
Control	34.25a	11.82b	1.00	0.56a	11.37c	1.00
MP	12.75d	15.02a	1.33	0.26c	15.28a	1.23
SwP	30.05b	12.64b	1.00	0.46b	13.09b	1.00
MPSw	10.38c	9.07c	0.71	0.33c	9.4c	0.86
LSD	3.86	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.

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