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Control of fruit drop in hot pepper *(Capsicum frutescens)* via Intercropping

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ABSTRACT

The study was carried out to evaluate various selected crops which were used as intercrops to control fruit drop in hot pepper *(Capsicum frutescens)*. A Randomized Complete Block Design (RCBD) was used. There were six treatments and four replications. The treatments were control (pepper), Pepper-tomato, Pepper-mint, Pepper-citronella, Pepper-onion and Pepper-garden eggs intercrops. It was observed that there were significant differences between the mean total number and weight of harvested marketable pepper fruits but the other means were not significantly different for the other parameters that were observed. Pepper-citronella recorded the highest number of harvested pepper fruits. Pepper-tomato intercrop recorded the least number of harvested pepper fruits. Percentage fruit drop in the pepper fruit was high in all treatments.

Introduction

Pepper is a herbaceous annual dicotyledonous plant of the family solanaceae and genus capsicum. It is sometimes described as perennial due to its ability to survive under harsh conditions for years. Pepper originated from the tropics of America but is now widely spread throughout the world. The spread to other parts of the world could be due to long liability of the seeds, the case transport and dispersal of fruits. Pepper is important for a number of reasons such as; it's domestic and export markets for income, medicinal value and nutritional value.

Today, it is considered the world most second vegetable after tomato and utilized worldwide more as spice rather than a vegetable (AVRDC, 1989). It is used as a spice because of how pungent it is due to an alkaloid capsaicin (Pursglove, 1977). However, in the developed world, hot pepper is used by physicians in analgesic creams that are applied to relieve the pain of arthritis, shingle, custer headaches and other ailments (Levetin and McMahon, 1999). It is also an excellent form of vitamin C, approximate nutrient value per 100g fresh edible portion is energy 46 Cal, protein 2.0g, fat 2.0g, total sugar 55g, Phosphorus 45mg, potassium 240mg, calcium 18mg, magnesium 27mg, sodium 2mg (Norman, 1992).

In Ghana, pepper is grown mostly in the southern part such as Kete Krachi, Akropong, Nsawam, Hohoe, Kibi, Asamankese, Begro, Accra, Aburi and Takoradi (Boateng, 1963). Pepper is found in all the agro-ecological regions of Ghana and is a common vegetable that is conserved income mixed with other crops (Kassam, 1976). As at 2006 Ghana was ranked fifteenth in the world and third in Africa for pepper production (AVRDC, 2006). However, there are several problems associated with pepper production or cultivation. Some of these problems include environmental factors such as temperature, rainfall, pH of soil, disease and pest. Among these problems is fruit drop which hampers the production of pepper in the country. It is caused by insect and pest attack, environmental factors such as windy condition and severe temperature that causes wilting that leads to the drop of the fruits. Fruit drop in pepper can be controlled by several measures such as; physical control such as use of intercrops in pepper cultivation, chemical control (insecticides and pesticides) and biological control.

For the farmers in the tropics, pepper is of great economic importance for ensuring their cash income. Growth and development of the pepper plant are important factors in the determination of yield components. However, several factors hinder the farmers in the tropical regions to produce pepper with high growth rate, better development and yield. Many control measures have been put in place to control fruit drop in pepper such as intercropping. It is in view of this that, this study was undertaken to use different crops as intercrops to control fruit drop in hot pepper (*Capsicum frutescens*).

Materials and Methods

Soil and climate

The project was carried out at the Teaching and Research Farms, University of Cape Coast. The soil at the project site belongs to the Brenya series of the Edina Brenya-Udu compound association (Asamoah, 1973). The soil is clayey-loam. The location of the project site lies within coastal savanna thicket and the most semi-deciduous forest zone. The area has double maximum rainfall regime. The area has a mean rainfall of about 950mm. the temperatures of the site are relatively uniform through the year. The minimum mean annual temperature is about $25^{O}C$ and relative humidity of 70-90% in humid days but reduces considerably in dry periods.

Plant Materials

The pepper cultivar used for the study was Legon 18. These pepper seeds were developed at the University of Ghana. The intercrops used were garden eggs, tomato, African marigold, onion, citronella and mint. These were obtained from the Teaching and Research Farms, University of Cape Coast.

Experimental Design

The experimental design used for the project was Randomized Complete Block Design (RCBD). There were six

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treatments and one variety of the pepper plant and the treatments were replicated four times. The treatments are as follows;

- Control (Legon 18 pepper)
- African marigold (intercrop)
- Tomato (intercrop)
- Onion (intercrop)
- Garden eggs (intercrop)
- Mint (intercrop)
- Citronella (intercrop)

Main Field Preparation

The experimental site was prepared a week before the seedlings were transplanted. The land was then lined and pegged to mark the area into 28 plots with a total dimension are of 30m*30m.

Nursery Procedure

The nursery measuring 2.3m*1.2m was prepared. The seeds were nursed and transplanted at the three leaf stage to the main field.

Transplanting

When the seedlings were four weeks old, they were transplanted unto the main field. The total number of seedlings was 336 on 28 plots.

Data collection

Data was recorded for the following parameters,

- Weeks to 50% flowering
- Height of plants at first harvest
- Number and weight of harvest fruits
- Number and weight of harvested marketable fruits
- Total number and percentage of harvested unmarketable fruits
- Number and weight of harvested unmarketable fruits with holes
- Number and weight of harvested unmarketable fruits with rots
- Total number of produced fruits and percentage dropped fruits

Statistical analysis

Data collected for the parameters discussed above were subjected to analysis of variance and the means of the means of those which showed significant variations were compared using GenStat programme.

Results

Table.1. Weeks to 50% flowering

Treatments-intercrop	Mean weeks to flowering
Control (pepper)	1.75a
Pepper-tomato	2.00a
Pepper-mint	1.75a
Peppr-citronella	3.25b
Pepper-onion	1.75a
Pepper-marigold	2.00a
Pepper-garden eggs	2.00a

Means in the columns followed by the same letters are not statistically different according to the Duncan Multiple Range Tests

Table.2. Plant height at first harvest

Treatments-intercrop	Mean height of plant (cm)
Control (pepper)	56.9ab
Pepper-tomato	55.3ab
Pepper-mint	55.0ab
Pepper-citronella	62.0b
Pepper-onion	55.6ab
Pepper-marigold	53.8a
Pepper-garden eggs	58.3a

Means in the columns followed by the same letters are not statistically different according to the Duncan Multiple Range Tests.

Table.3. Mean Number and Weight of Harvested Fruits

Treatments-intercrop	Mean number of harvested pepper fruits	Mean weight of harvested pepper fruits (g)
Control (pepper)	14.7a	43.8a
Pepper-tomato	9.1a	31.9a
Pepper-mint	16.2a	52.6a
Pepper-citronella	36.5c	134.8c
Pepper-onion	27.8b	85.6ab
Pepper-marigold	26.3b	94.1ab
Pepper-garden eggs	26.6b	101.9b

Means in the columns followed by the same letters are not statistically different according to the Duncan Multiple Range Tests

Table.4. Mean Total Number and Weight of Harvested Marketable Pepper Fruits

Treatments-intercrop	Mean total number of harvested marketable pepper fruits	Mean weight of harvested marketable pepper fruits (g)
Control (pepper)	3.75a	11.40ab
Pepper-tomato	2.30a	5.10a
Pepper-mint	4.30ab	12.70ab
Pepper-citronella	9.75b	32.40b
Pepper-onion	4.55ab	14.60a
Pepper-marigold	8.90b	23.40b
Pepper-garden eggs	7.40b	20.80b

Means in the columns followed by the same letters are not statistically different according to the Duncan Multiple Range Tests.

Table.5. Mean Total Number and Percentage of Harvested Unmarketable Pepper Fruits

Treatments-intercrop	Mean total number of harvested marketable pepper fruits	Mean percentage of unmarketable pepper fruits (%)
Control (pepper)	10.90a	53.9a
Pepper-tomato	6.80a	43.3a
Pepper-mint	11.80ab	40.5ab
Pepper-citronella	27.89c	50.4c
Pepper-onion	18.20c	43.2c
Pepper-marigold	17.90c	44.8c
Pepper-garden eggs	22.80c	52.6c

Means in the columns followed by the same letters are not statistically different according to the Duncan Multiple Range Tests.

Table.6. Mean number and weight of harvested unmarketable fruits of pepper with holes

Treatments-intercrop	Mean number of harvested pepper fruits with holes	Mean weight of harvested pepper fruits with holes (g)
Control (pepper)	0.20ab	0.35
Pepper-tomato	0.00a	0.00
Pepper-mint	0.10a	0.27
Pepper-citronella	0.90b	2.34
Pepper-onion	0.20ab	0.48
Pepper-marigold	0.10a	0.14
Pepper-garden eggs	0.05a	2.35

Means in the columns followed by the same letters are not statistically different according to the Duncan Multiple Range Tests. There was no significant difference between mean weights of harvested pepper fruits with holes.

Table.7. Mean Number and Weight of Harvested Unmarketable Fruits (Rotten Pepper Fruits)

Treatments-intercrop	Mean number of harvested rotten pepper fruits	Mean weight of harvested rotten pepper fruits (g)
Control (pepper)	5.93a	12.50a
Pepper-tomato	4.05a	7.50a
Pepper-mint	7.00a	14.80a
Pepper-citronella	14.40ab	35.50b
Pepper-onion	9.60ab	20.60a
Pepper-marigold	9.00ab	19.10a
Pepper-garden eggs	10.85ab	24.40a

Means in the columns followed by the same letters are not statistically different according to the Duncan Multiple Range Tests.

Table.8. Mean Total Number of Produced Fruits and Percentage of Dropped Fruits

Treatments-intercrop	Mean total number of pepper fruits produced	Mean weight of harvested rotten pepper fruits (g)
Control (pepper)	20.2a	34.5
Pepper-tomato	15.7a	45.5
Pepper-mint	29.1ab	50.1
Pepper-citronella	55.3c	43.5
Pepper-onion	42.1c	44.5
Pepper-marigold	39.9c	43.5
Pepper-garden eggs	43.3c	42.7

Means in the columns followed by the same letters are not statistically different according to the Duncan Multiple Range Tests. There was no significant difference between mean weights of harvested rotten pepper fruits.

Discussion

Flowering is very important in pepper plant or generally in plants. This is because flowers are unique modified structures that aid in physiological processes like meiosis and pollination (Levetin and McMahon, 1999). This process aids in the development and production of fruits by the pepper plant.

The control (pepper) treatment had the lowest mean number of weeks to 50% flowering as compared to pepper –citronella intercrop. This indicates that the control plants produced flowers earlier than that of the pepper-citronella intercrop. The pepper or control treatment was harvested first, since its fruits developed earlier than pepper-citronella intercrop. This means that pepper without an intercrop will produce fruits early due to early flower setting. This might be due to the fact that the pepper (control) was not impeded in any way by an intercrop for nutrients or sunlight which all aid in flowering. There were significant differences among the mean number and weight of the total harvested pepper fruits. This can be related to insect attack and diseases. The repelling property of citronella could have caused the increase in the number of harvested pepper fruits. It has been reported that citronella is highly aromatic due to the presence of essential oil in it leaves and stems which can repel insects from attacking plants (Addo-Quaye *et al.* 1993). Pepper-citronella intercrop had the highest number of pepper fruits produced as well as the highest percentage of dropped pepper fruits. Whiles pepper intercropped with tomato had the lowest number of pepper fruits produced. This indicates that pepper-tomato intercrop served no other purpose aside providing a favourable microclimate for the harboring of insects, since pepper and tomato are in the same Solanaceae family and as such can easily have common insect pest attacks (Purseglove, 1998). The pepper-citronella intercrop had the highest total number of fruits produced because it was able to repel the insects attacking the pepper due to its aromatic properties (Addo-Quaye *et al.*1993). The pepper-citronella intercrop gained the highest percentage of dropped pepper fruits. This might be due to the fact that citronella intercropped with pepper produced a larger number of harvested fruits; this made it possible to obtain higher number of harvested marketable pepper fruits than pepper-tomato intercrop. Also because the number of pepper fruits production was higher on the pepper plants due to the repelling activity of the citronella plant which was used as an intercrop, small amounts of the pepper dropped due to the windy effect on the pepper fruits that had set. This caused some of the pepper fruits to drop which exceeded all the other treatments that experienced fruit drop. The unmarketable harvested fruits with holes indicate the extent of fruit drop caused by insect attack. This can be supported by a research made by Dawson (1982), that there is a positive correlation between the number of fruits bored by insect and fruit drop in pepper and also observed that the greatest proportion of fruit drop in cape coast was caused by insect attack.

The pepper citronella intercrop had the highest harvested fruits with holes. This can be attributed to the fact that the repelling properties of the citronella plants were less effective and or could have been due to low population density plants which were used as intercrops. Pepper-tomato intercrops recorded lowest and virtually no insect attack. This could have been because there was less number of fruits produced by the pepper as compared to the tomato that were used as intercrops. This could have caused the insects to feed on the tomato fruits than that of the pepper since the insects normally want to parasite for longer time in other to live. More so the tomato could have provided a microclimate for the insect that could have attacked the pepper plant.

The pepper-citronella intercrop recorded the highest mean number of harvested rotten fruit. This could have resulted because of the low population density of the citronella plants which allowed insects to create holes in the fruits which allowed insects to create holes in the fruits which served as entry points for other pathogens that caused the rotting of the pepper fruits.

Pepper-mint intercrop had the highest percentage of dropped fruits. This could have happened because of the low population density of the mint. The pepper-citronella intercrop had higher dropped fruits. It could be that the repelling properties were less due to the low population density. This could have caused the insect attack to the fruits leading to the drop. The pepper-citronella intercrop had the highest unmarketable fruit. This could have happened because, this intercrop system produced the highest number of harvested fruits and since it had the highest number of harvested fruits and because of low repelling properties due to the low population density of the citronella intercrop, the insects could have caused more damage to the fruits.

The pepper-marigold intercrop did not perform well on any of the plots because it has been revealed that intercropping with marigold worked more slowly but provide more stable and long lasting control if they are pruned always to prevent flowering since flowering reduces the efficacy of the repelling property of the marigold plant (Baker and Coke, 1974). This could have caused the low performance of the pepper-marigold intercrop since they flowered throughout the experiment.

Conclusion and Recommendation

None of the intercrops was able to control the fruit drop in hot pepper. However, it was realised that the pepper intercropped with citronella gave the highest yield of pepper but on the contrary recorded the highest number of fruits that

dropped. There should be a variation in the population density of the intercrops that were used in other to find out whether a higher population stand of the intercrops is directly related to the repelling of the insect attack that caused the fruit drop in hot pepper.

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