

The Effect of Planting Time on Phytophthora Blight Disease Incidence and Severity on Cucumber (*Cucumis sativus*) in Nsukka, Derived Savanna, Agro Ecology, South Eastern Nigeria

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Abstract

Field experiments were conducted to study the disease incidence and severity of six cucumber lines at different time of planting (April, 12th; May, 12th; June, 12th, July, 12th and September, 12th). Six varieties of cucumber (Marketter, Poinsett 76 Netherlands, Poinsett 76 Holland, Poinsett France, Poinsett Holland and super marketter) during 2013 farming season. It was observed from the results that the planting time of April had the lowest disease incidence (3.48%) and severity on leaves (1.20) and fruits (1.06), followed by September with lower disease incidence (3.60%), disease severity on leaves (1.22) and fruits (1.17) while July had the highest disease incidence (6.27%) and disease severity on leaves (1.56) and fruits (1.74). The yields during the April and September plantings were significantly ($p < 0.05$) higher than other months. April and September had 481.60 and 483.60 tonnes per hectare respectively while July had 19.10 tonnes per hectare. The cucumber lines also showed

significant ($p < 0.05$) response to disease incidence and severity with the Supermarketter having the lowest disease incidence (4.15%) and severity on leaves (1.39) and fruits (1.17) and Poinsette Holland had the highest disease incidence (5.15%) and Poinsette 76 Holland had the highest severity both on leaves and fruits (1.45 and 1.35). The supermarketter gave the highest yield of 221.10 tonnes per hectare. From the observations farmers in derived savanna agro ecology can plant during the month of April and September for maximum yield and less usage of pesticides. Super marketter variety remains the best variety in this study.

Keywords: Disease incidence; Disease severity; Time of planting; Cucumber

Introduction

Cucumber (*Cucumis sativus* L.) belongs to the Cucurbitaceae family. Cucumber is a major vegetable crop worldwide and develops rapidly, with a shorter time from planting to harvest than for most crops [1]. It is a monoecious annual climber or creeper [2] that has been cultivated for over 3,000 years and is still widely cultivated today. It is soft, succulent with high water content. The plant has large leaves that form canopy over the fruit. The vines grow on stakes or on trellises. The fruit is roughly cylindrical, elongated with tapered ends and may be as long in diameter. The fruits are used in unripe matured state, usually eaten raw in salads or pickled, and are also stewed in tropical regions. Although cucumber is less nutritious than most fruits, it is still a very good source of vitamins A, C, K, B6, potassium and it also provides dietary fibres, pantothenic acid, magnesium, phosphorus, copper and manganese. It contains ascorbic acid and caffeic acid, both of which help to smoothen the skin irritation and reduces swelling. Its skin contains chlorophyll and silica, two beneficial elements that are lost when the vegetables are peeled. Its juice is often recommended as a source of silicon to improve the complexion and health of the skin. However, the production of the fruit in Nigeria is very low due to some constraints such as incidences of disease, which reduces pod yield. They are produced mainly in the northern states of Nigeria [2]. It is necessary to increase the production in order to supplement the high intake of carbohydrate in Nigeria, especially the southern parts of Nigeria where there is sparse and over dependence of its supply of salad vegetables and fruits on major suppliers from the north, resulting to relative higher price because of transportation cost and spoilage in the transportation of the fruit. The fruit constitute the dietary system of the populace in the cities as valuable ingredient in vegetable salads and fruit.

In Nigeria, adequate research has not been conducted to find out the best time to plant, fungicides and spray regimes to control the disease outbreak, which is common in the south due to warm weather. Fruit is usually under foliage, shading one another being allowed to creep on the ground thereby having a direct contact with some soil inhabiting disease-causing organisms. Because of its creeping nature, it pre disposes the plant for pests and disease infestation. Torrential rainfall sometimes splash sand on edible pod yield, leading to outright degradation of the market quality of pods.

Materials and Methods

The experiments was conducted at the Department of Crop Science Teaching and Research Farm, Faculty of Agriculture, University of Nigeria, Nsukka (07°29' N, 06°51' E and 400 m.a.s.l.). Nsukka is characterized by lowland humid tropical conditions with bimodal rainfall pattern which starts in late March and ends in late July while the short rainy season extends from September to late October after a dry spell in August. It ranges between 1155 mm to 1955 mm with a mean annual temperature of 29°C to 31°C and a relative humidity of 69% to 79%.

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Field experiment

This experiment evaluated the effect of planting time on disease incidence, severity and pod yield on the six cucumber lines. The planting were carried out for a period of five months starting from April 12th through May 12th, to July 12th and September 12th.

Six cucumber lines including Super marketer, Poinsett France, Poinsett Holland, Poinsett 76 Holland, Poinsett 76 Netherlands and Marketer were used in the study. At each planting, the experiment was laid out in randomized complete block design (RCBD) of three replications.

A portion of land measuring 320 m² was cleared, ploughed and harrowed, before seed beds measuring 2 m × 3 m was prepared. The seeds were sown insitu at two seeds per hill at a spacing of 10 cm within rows and 20 cm between rows with planting depth of 2.5 cm on each bed. Prior to the planting, battery cage poultry manure was applied at 3tonnes per hectare on the readymade bed, one week before planting.

Data collection

In data collection the disease incidence and severity at 2, 4, 6, 8 and 10 weeks after planting and interaction of the various spray regimes used to check the disease incidence measured as percentage of plants showing visible symptom of phytophthora blight, disease severity and pod yield were collected. Disease severity (the proportion of area or amount of plant tissue that is diseased) on both leaves and fruits was also calculated in percentage and was later rated see Table 2. The following parameters were measured to determine the level of disease incidence and severity on these cucumber accessions keeping in mind some developmental qualities:

- Disease incidence at 2 weeks, 4weeks, 6 weeks, 8weeks and 10 weeks after planting.
- Disease severity on leaves at 2, 4, 6, 8, and 10 weeks after planting
- Disease severity on fruits at 6, 8, and 10 weeks after planting
- Variety response to disease incidence
- Variety response to disease severity on leaves
- Variety response to disease severity on fruits
- Yield per plant(kg)

Laboratory analysis

Apart from the visible signs of phytophthora blight, the diseased plant tissues were taken to the laboratory where they were cultured to know the fungal organism present. A strip of transparent sticky tape (10 cm long) is held in between the thumb and the forefinger. The sticky side of the tape is firmly pressed onto the surface of the sporulating colony cultivated on an appropriate medium in the Petri dish. After gently removing the cellophane tape, the sticky surface carrying fungal spores is carefully placed over drops of lacto phenol cotton blue stain kept at the centre of a clean glass slide. The tape is gently pressed and extended end of the tape was held over the ends of the slide. A light microscope 40 m magnification was used to examine the characteristics of spores.

Data analysis

Data collected were subjected to analysis of variance (ANOVA) using GenStat 10th edition release statistical software. Mean separation

was done using Fishers least significance test at 5% probability level as described by Obi [3].

Results and Discussion

Meteorological data of 2013 planting season

The meteorological data from the experimental site shows that there is a marked variation on the climatic elements being considered (Table 1). The distribution of rainfall shows the total rainfall (1537.28 mm) received during the period of the experiment (January to December 2013) with the highest rainfall amount and rain days being in July (283.96 mm and 19days) respectively. Moreover, the mean minimum and maximum temperatures were 21.14°C and 29.54°C for the year. The data also reveal that the mean monthly relative humidity at 10 a.m. and 4 p.m. were 74.67 % and 72.64% respectively for the year.

Laboratory results

The plant tissue analysed showed that there was growth of spores, which indicates the presence of fungal organism. When the characteristics of the spores were examined, the colour as observed showed that the organism present is *Phytophthora capsici*, the causal organism for phytophthora blight of cucumber.

The effect of planting time on incidence, severity on phytophthora blight disease leaves and fruits at 2, 4, 6, 8, and 10 weeks after planting on the six cucumber lines studied.

The results of the effect of planting time on the phytophthora blight disease incidence on six cucumber presented in Table 3 revealed that the month of July significantly (0.05) had the highest phytophthora disease (6.27%), followed closely by the month of May and June (5.57% and 5.31%) respectively. The disease incidence was lowest in April, followed by September (3.48% and 4.85% respectively). From the results, it shows that the best time to plant is April and September.

Month	Total rainfall (mm)	Rain day	Temperature(°C)		Relative humidity (%)	
			mini	max	10 a.m.	4 p.m.
January	21.84	2.00	20.55	31.23	75.00	75.00
February	0.00	0.00	22.18	32.86	75.00	75.00
March	38.10	5.00	22.58	32.81	72.74	62.94
April	183.81	10.00	22.30	30.67	74.00	68.90
May	198.63	11.00	21.61	29.52	74.77	69.87
June	168.60	11.00	21.17	28.67	75.67	72.70
July	283.96	19.00	20.71	27.35	74.90	73.61
August	219.18	12.00	20.26	26.61	76.13	76.16
September	197.60	16.00	20.50	27.43	77.00	77.00
October	167.90	11.00	20.74	28.55	77.00	77.00
November	41.91	2.00	21.70	30.37	77.00	77.00
December	15.75	2.00	19.39	29.35	66.77	66.03
Total	1537.28	101.00	253.69	354.42	895.98	871.66
Mean	128.10	8.42	21.14	29.54	74.67	72.64

Table 1: The total rainfall (mm), rain days, mean temperature (°C) and the relative humidity (%) of the site of the experiment in 2013.

Ratings	Percentage
0	0
1	1-25
2	26-50
3	51-75
4	76-100

Table 2: Disease severity Ratings.

WEEKS AFTER PLANTING (WAP)												
MONTH	2WAP		4WAP		6WAP		8WAP		10WAP		MEAN	
APRIL	8.060	(2.419)	11.530	(3.139)	15.280	(3.667)	15.970	(3.825)	19.720	(4.360)	14.112	(3.482)
MAY	8.610	(2.733)	24.310	(4.860)	30.420	(5.475)	35.970	(5.988)	78.610	(8.810)	35.584	(5.573)
JUNE	11.670	(3.274)	17.220	(3.900)	18.750	(4.127)	40.000	(6.311)	80.560	(8.954)	33.640	(5.313)
JULY	11.670	(3.274)	17.220	(3.900)	18.750	(4.127)	100.000	(10.025)	100.000	(10.025)	49.528	(6.270)
SEPT	5.970	(2.099)	12.08	(3.245)	15.690	(3.762)	16.810	(4.015)	24.030	(4.898)	14.916	(3.604)
MEAN	9.196	(2.760)	16.472	(3.809)	19.778	(4.232)	41.750	(6.033)	60.584	(7.415)	29.556	(4.849)
F-LSD(0.05)		0.4025		0.3673		0.3347		0.2429		0.2413		

Values in parenthesis are square root transformed values to which LSD is applicable.

Table 3: The main effect of planting time on phytophthora blight disease incidence on the six cucumber lines at different weeks after planting.

WEEKS AFTER PLANTING (WAP)												
MONTH	2WAP		4WAP		6WAP		8WAP		10WAP		MEAN	
APRIL	0.708	(1.056)	0.986	(1.188)	1.042	(1.219)	1.097	(1.248)	1.194	(1.294)	1.005	(1.201)
MAY	0.736	(1.088)	1.333	(1.343)	2.111	(1.591)	2.306	(1.640)	3.986	(2.118)	2.094	(1.556)
JUNE	0.875	(1.158)	0.944	(1.189)	1.028	(1.223)	2.306	(1.640)	4.000	(2.121)	1.831	(1.466)
JULY	0.875	(1.158)	0.944	(1.189)	1.028	(1.223)	4.000	(2.121)	4.000	(2.121)	2.169	(1.562)
SEPT	0.514	(0.973)	1.042	(1.213)	1.167	(1.284)	1.181	(1.289)	1.389	(1.363)	1.059	(1.224)
MEAN	0.742	(1.087)	1.050	(1.224)	1.275	(1.308)	2.178	(1.588)	2.914	(1.803)	1.632	(1.402)
F-LSD(0.05)		0.0653		0.0589		0.0607		0.0681		0.0305		

Values in parenthesis are square-root transformed values to which LSD is applicable.

Table 4: The main effect of planting time on Phytophthora blight disease severity on leaves of the six cucumber lines at different weeks after planting.

WEEKS AFTER PLANTING (WAP)												
MONTH	2WAP		4WAP		6WAP		8WAP		10WAP		MEAN	
APRIL	-	-	-	-	0.556	(0.990)	0.722	(1.067)	0.806	(1.112)	0.695	(1.056)
MAY	-	-	-	-	0.958	(1.164)	1.722	(1.470)	1.431	(1.376)	1.370	(1.337)
JUNE	-	-	-	-	0.528	(0.978)	0.681	(1.057)	1.458	(1.387)	0.889	(1.141)
JULY	-	-	-	-	0.528	(0.978)	4.000	(2.121)	4.000	(2.121)	2.843	(1.740)
SEPT	-	-	-	-	0.694	(1.064)	0.986	(1.209)	1.069	(1.249)	0.916	(1.174)
MEAN	-	-	-	-	0.653	(1.035)	1.622	(1.385)	1.753	(1.449)	1.343	(1.290)
F-LSD(0.05)						0.0841		0.0635		0.0543		

Values in parenthesis are square-root transformed values to which LSD is applicable.

Table 5: The main effect of planting time on Phytophthora blight disease severity on Fruits of the six cucumber lines at different weeks after planting.

The results of the effect planting time on the phytophthora blight disease severity on cucumber presented in Table 4 revealed that the month of July significantly (0.05) had the most severe phytophthora disease (1.56%), followed closely by the month of May and June (1.56% and 1.47%) respectively. The severity of phytophthora blight of cucumber was lowest in April, followed by September (1.20% and 1.22% respectively). From the results, it shows that the best time to plant with lowest disease severity on leaves is April and September.

Table 5 shows the results of the effect of planting time on the phytophthora blight disease severity on cucumber fruits and it revealed that the month of July significantly (0.05) had the most severe phytophthora blight disease on the fruits (1.74%), followed closely by the month of May and September (1.34% and 1.17%) respectively. The severity of phytophthora blight of cucumber was lowest in April, followed by June (1.06% and 1.14% respectively). From the results, it shows that the best time to plant with lowest disease severity on Fruits is April and June.

Table 6 revealed that the yield during the April and September planting were significantly (0.05) higher than other months. April and

September recorded 481.60 and 483.60 tonnes per hectare respectively while May, June, July was 35.50, 32.30 and 19.10 tonnes per hectare respectively. The fruit girth, number of fruits per plant, fruit weight and fruit length were also statistically significant(0.05) and it also followed the above trend of April and September being the best and July having the lowest girth, length, number of fruits per plant, fruit weight and diseased fruits.

The effect of the six cucumber lines on the manifestation of phytophthora blight disease incidence, severity on leaves and fruits at 2, 4, 6, 8, and 10 weeks after planting for all the planting times considered.

In Table 7, the different lines of cucumber significantly affected the rate of disease incidence. The poinsett Holland PH, Poinsett 76 Holland P76H, Poinsett France PF, Poinsett 76 Netherland P76N, recorded higher incidences, (5.15, 5.15, 5.05 and 4.81) percentage respectively while marketer M and super marketer SM had a lower incidence at 4.79 and 4.15% respectively. The varieties when compared reveal that the super marketer is the best cucumber line that can resist phytophthora blight disease in this derived savannah.

MONTH	FG(cm)	FL(cm)	FW/Plt(kg)	NFPP	FY(t/ha)	DF(t/ha)
APRIL	5.162	20.010	2.408	5.505	481.6	2.408
MAY	2.383	12.359	0.178	2.271	35.5	0.178
JUNE	2.556	11.608	0.161	2.146	32.3	0.161
JULY	2.440	11.608	0.095	1.982	19.1	0.095
SEPT	5.162	20.010	2.443	5.577	483.6	2.419
MEAN	3.541	15.119	1.057	3.496	210.420	1.052
F-LSD(0.05)	0.1392	0.2097	0.0717	0.2023	12.92	0.0625

FG=Fruit girth, FL=Fruit length, FW=Fruit weight, NFPP=Number of fruit per plant, FY=Fruit yield, DF=diseased fruits

Table 6: The effect of planting time on some yield parameters of the six cucumber lines.

VARIETY	WEEKS AFTER PLANTING (WAP)											
	2WAP		4WAP		6WAP		8WAP		10WAP		MEAN	
M	9.000	(2.707)	17.000	(3.914)	19.170	(4.191)	39.330	(5.735)	61.170	(7.424)	29.134	(4.794)
P76H	10.670	(3.085)	20.170	(4.296)	22.330	(4.586)	42.500	(6.130)	64.000	(7.632)	31.934	(5.146)
P76N	10.500	(2.919)	14.330	(3.561)	18.500	(4.112)	42.000	(6.080)	60.000	(7.380)	29.066	(4.810)
PF	8.830	(2.820)	18.170	(4.061)	22.500	(4.591)	43.670	(6.219)	62.170	(7.571)	31.068	(5.052)
PH	9.830	(2.849)	19.170	(4.119)	23.830	(4.646)	46.000	(6.492)	63.500	(7.643)	32.466	(5.150)
SM	6.330	(2.177)	10.000	(2.903)	12.330	(3.265)	37.000	(5.541)	52.670	(6.844)	23.666	(4.146)
MEAN	9.193	2.760	16.473	3.809	19.777	4.232	41.750	6.033	60.585	7.416	29.556	(4.850)
F-LSD(0.05)		0.4409		0.4024		0.3667		0.2661		0.2643		

M=Marketer,P76H=Poinsett 76 Holland, P76N=Poinsett 76 Netherlands, PF=Poinsett France,PH=Poinsett Holland, S=Super marketer. Values in parenthesis are square-root transformed values to which LSD is applicable.

Table 7: The main effect of the six cucumber lines on phytophthora blight disease incidence at different weeks after planting for the five planting times considered.

VARIETY	WEEKS AFTER PLANTING (WAP)											
	2WAP		4WAP		6WAP		8WAP		10WAP		MEAN	
M	0.583	(1.006)	1.000	(1.211)	1.333	(1.325)	2.567	(1.694)	2.950	(1.816)	1.687	(1.410)
P76H	0.750	(1.090)	1.200	(1.293)	1.450	(1.377)	2.433	(1.673)	2.933	(1.810)	1.753	(1.449)
P76N	0.700	(1.069)	0.933	(1.180)	1.167	(1.272)	1.933	(1.515)	2.900	(1.798)	1.527	(1.367)
PF	0.917	(1.171)	1.233	(1.291)	1.333	(1.338)	2.050	(1.548)	2.933	(1.810)	1.693	(1.432)
PH	0.833	(1.136)	1.200	(1.284)	1.367	(1.336)	2.233	(1.608)	2.950	(1.816)	1.717	(1.436)
SM	0.667	(1.047))	0.733	(1.087)	1.000	(1.203)	1.850	(1.488)	2.817	(1.770)	1.413	(1.387)
MEAN	0.742	(1.094)	1.050	(1.224)	1.275	(1.309)	2.178	(1.588)	2.914	(1.803)	1.632	(1.404)
F-LSD		0.0715		0.0645		0.0665		0.0746		NS		

M=Marketer, P76H=Poinsett 76 Holland, P76N=Poinsett 76 Netherlands, PF=Poinsett France, PH=Poinsett Holland, S=Super marketer. Values in parenthesis are square-root transformed values to which LSD is applicable.

Table 8: The main effects of the six cucumber lines on disease severity on leaves at different weeks after planting for the five planting times considered.

VARIETY	WEEKS AFTER PLANTING (WAP)											
	2WAP		4WAP		6WAP		8WAP		10WAP		MEAN	
M	-	-	-	-	0.717	(1.073)	1.667	(1.392)	1.733	(1.446)	1.372	(1.304)
P76H	-	-	-	-	0.917	(1.167)	1.667	(1.421)	1.750	(1.454)	1.445	(1.347)
P76N	-	-	-	-	0.483	(0.952)	1.633	(1.388)	1.750	(1.451)	1.289	(1.264)
PF	-	-	-	-	0.733	(1.073)	1.650	(1.406)	1.783	(1.456)	1.389	(1.312)
PH	-	-	-	-	0.817	(1.114)	1.683	(1.404)	1.933	(1.514)	1.478	(1.344)
SM	-	-	-	-	0.250	(0.831)	1.433	(1.296)	1.567	(1.373)	1.083	(1.167)
MEAN	-	-	-	-	0.653	(1.035)	1.622	(1.385)	1.753	(1.449)	1.343	(1.290)
F-LSD(0.05)						0.0921		0.0696		0.0596		

M=Marketer,P76H=Poinsett 76 Holland, P76N=Poinsett 76 Netherlands, PF=Poinsett France,PH=Poinsett Holland, S=Super marketer. Values in parenthesis are square-root transformed values to which LSD is applicable.

Table 9: The main effect of the six cucumber lines on disease severity on fruit at different weeks after planting for the five planting times considered.

In Table 8, the response of the six lines of cucumber to disease severity on leaves was statistically significant at 2, 4, 6, 8 weeks after planting but not significant at 10 weeks after planting. The mean disease severity recorded on the leaves was 1.41, 1.45, 1.37, 1.43, 1.44, and 1.39 for M, P76H, P76N, PF, PH and SM respectively. From the

table it indicates that super marketer can resist the phytophthora blight disease, that it is more severe on other varieties than the SM.

In Table 9, the response of the six lines of cucumber to disease severity on fruits was statistically significant at 6, 8 and 10 weeks after planting. The mean disease severity recorded on the fruits was 1.30,

1.35, 1.26, 1.31, 1.34, and 1.17 for M, P76H, P76N, PF, PH and SM respectively. From the table it indicates that super marketer can give out fruits that shows less symptoms of phytophthora blight disease, that other varieties shows more severity of the aforementioned disease on their fruits than the SM.

In Table 10, the six-cucumber lines response to yield and number of fruit per plant was not significant but the fruit girth, fruit length and fruit weight was statistically significant. Though the yield of the supermarketer remains the best but the yield of all the lines and the number of fruits per plant and the bad/diseased fruits were not significant statistically.

The effect of planting time and variety on the phytophthora blight disease incidence, and severity on leaves and fruits at 2, 4, 6, 8, and 10 weeks after planting.

In Table 11, the interaction between the variety and time of planting on phytophthora blight disease incidence was not significant at 2, 4, and 10 weeks after planting, but were highly significant at 6 and 8 weeks after planting which was the onset of fruiting and also the peak of fruiting respectively. Super Marketer recorded the lowest disease incidence (2.652% and 2.759%) at the month of April and September respectively, while the Poinsette France and Poinsette76 Holland recorded the highest disease incidence during the month of July (6.493 and 6.492 respectively). Showing from the arrays of mean displayed on the table, all varieties recorded lower disease incidence in the month of April and September, but the incidences were higher in the month of July. It is also high in May and slightly higher in June.

In Table 12, the interaction between the variety and time of planting on phytophthora blight disease severity on leaves was highly significant at 2, 4, 6 and 8 weeks after planting, but not significant at 10weeks after planting. The variety with highest disease severity (1.655) is the marketer during the month of May while the supermarketer recorded the lowest severity on the leaves (1.104) at the month of April. From the results obtained, the super marketer during the month of April had less severed diseased leaves thereby promoting photosynthetic ability and hence supplying the plant the needed growth nutrients for good yield and ability to resist the disease.

In Table 13, it was recorded that the interaction between the variety and time of planting on phytophthora blight disease severity on fruits was highly significant at 8 weeks after planting, but not significant at 6 and 10weeks after planting. The variety with highest severity (1.789) is the Poinsette 76 Holland during the month of July while the super marketer recorded the lowest severity on the fruits (0.880) during the month of April. From the results, it showed that the super marketer is the best variety and planting during the month of April is the best time to apply while July remains the worst time to plant.

In Table 14, the data collected showed that the interaction between the month and the variety was not significant for the yield and the number of fruit per plant. From the yields recorded, the super marketer planted during the month of April and September remains the best variety and the best time to plant. It recorded 508 and 506 tonnes per hectare for April and September respectively. Where super marketer is not available, Poinsette Holland planted at the month of April can make for the best alternative.

Discussion

Effects of planting time on phytophthora blight disease incidence, severity and the fruit yield of cucumber.

The variation in the phytophthora blight disease incidence and severity on cucumber planted at various months of April, May, June, July and September indicates that April is the best time to plant in Nsukka Agro- ecology. The high yield experienced during the April planting over the May, June, July and September plantings could be attributed to moderate rainfall at the flowering and fruiting stage of the crop, which began in the middle of May. High rainfall during flowering and fruiting can lead to bees' inactivity with subsequent flower abortion with resultant low yield, which may have resulted in the yields experienced during the July planting. This is in agreement with the finding of Papadopoulos [4], who stated that high moisture tend to discourage the activity of bees and resultant high relative humidity which influence water condensing on the plant leaves which may result in the development of pests and diseases.

The significant ($p < 0.05$) increase in disease incidence and severity during the month of July could be attributed to the high rainfall witnessed during that month (283.96 mm), low temperature and high relative humidity. These observations agrees with Babadoost, [5] that *Phytophthora capsici* causes pre and post-emergence damping-off in cucurbits under wet and warm (20-30°C) weather condition, therefore the lower the temperature, the faster the growth of the spores which will in turn increase the disease incidences and severity with low yield. Soil moisture conditions are important for disease development. Sporangia form when soil pores are drained, and they release zoospores when soil is saturated (soil pores are filled with water). The disease is usually associated with heavy rainfall, excessive-irrigation, or poorly drained soil. Frequent irrigation increases the incidence of the disease. Warm conditions are favourable for disease development.

The response of the six varieties of cucumber studied to phytophthora blight disease incidence, severity and yield

The results of this study showed that there were significant differences among the six varieties of cucumber under study. In all cases, Super marketer, Poinsette 76 Netherlands and Marketer varieties

VARIETY	FG(cm)	FL(cm)	FW/Plt(kg)	NFPP	FY(t/ha)	DF(t/ha)
M	3.398	14.580	1.034	3.317	206.7	1.034
P76H	3.368	14.711	1.077	3.473	215.4	1.077
P76N	3.462	15.151	1.001	3.477	200.1	1.001
PF	3.639	15.170	1.058	3.575	211.6	1.058
PH	3.515	14.857	1.037	3.519	207.5	1.037
SM	3.860	16.245	1.136	3.616	221.1	1.107
MEAN	3.540	15.119	1.057	3.496	210.400	1.052
F-LSD(0.05)	0.1525	0.2297	0.0786	0.2216	14.1500	0.0547

M=Marketer, P76H=Poinsett 76 Holland, P76N=Poinsett 76 Netherlands, PF=Poinsett France,PH=Poinsett Holland, S=Super marketer. FG=Fruit girth, FL=Fruit length, FW=Fruit weight, NFPP=Number of fruit per plant and FY=Fruit yield, DF=Diseased fruits

Table 10: The Impact of varieties on Some Yield Parameters Considered on the five planting times considered.

VARXMON	WEEKS AFTER PLANTING (WAP)											
	2WAP		4WAP		6WAP		8WAP		10WAP		MEAN	
MAPRIL	5.830	(2.185)	7.500	(2.607)	8.330	(2.714)	8.330	(2.714)	16.670	(4.013)	9.332	(2.847)
MMAY	9.170	(2.925)	26.670	(5.141)	32.500	(5.675)	35.000	(5.922)	81.670	(9.029)	37.002	(5.738)
MJUNE	13.330	(3.437)	21.670	(4.608)	21.670	(4.608)	39.170	(6.236)	83.330	(9.122)	35.834	(5.602)
MJULY	13.330	(3.437)	21.670	(4.608)	21.670	(4.608)	100.000	(10.025)	100.000	(10.025)	51.334	(6.541)
MSEPT	3.330	(1.552)	7.500	(2.607)	11.670	(3.351)	14.170	(3.777)	24.170	(4.929)	12.168	(3.243)
P76HAPRIL	11.670	(3.082)	14.170	(3.611)	17.500	(4.120)	17.500	(4.120)	20.830	(4.476)	16.334	(3.882)
P76HMAY	10.000	(2.929)	31.670	(5.589)	34.170	(5.804)	38.330	(6.159)	87.500	(9.326)	40.334	(5.961)
P76HJUNE	12.500	(3.562)	20.830	(4.370)	21.670	(4.477)	40.000	(6.298)	85.830	(9.239)	36.166	(5.589)
P76HJULY	12.500	(3.562)	20.830	(4.370)	21.670	(4.477)	100.000	(10.025)	100.000	(10.025)	51.000	(6.492)
P76HSEPT	6.670	(2.292)	13.330	(3.541)	16.670	(4.050)	16.670	(4.050)	25.830	(5.095)	15.834	(3.806)
P76NAPRIL	10.000	(2.764)	10.830	(2.975)	15.830	(3.802)	16.670	(4.013)	19.170	(4.335)	14.500	(3.578)
P76NMAY	7.500	(2.503)	20.000	(4.417)	29.170	(5.353)	35.830	(5.991)	77.500	(8.794)	34.000	(5.412)
P76NJUNE	13.330	(3.358)	14.170	(3.611)	15.830	(3.802)	40.830	(6.360)	80.830	(8.984)	32.998	(5.223)
P76NJULY	13.330	(3.358)	14.170	(3.611)	15.830	(3.802)	100.000	(10.025)	100.000	(10.025)	48.666	(6.164)
P76NSEPT	8.330	(2.611)	12.500	(3.189)	15.830	(3.802)	16.670	(4.013)	22.500	(4.764)	15.166	(3.676)
PFAPRIL	5.000	(1.974)	14.170	(3.446)	19.170	(4.108)	20.000	(4.215)	24.170	(4.831)	16.502	(3.715)
PFMAY	10.830	(3.244)	22.500	(4.667)	29.170	(5.353)	35.000	(5.908)	78.330	(8.798)	35.166	(5.594)
PFJUNE	11.670	(3.455)	19.170	(4.265)	22.500	(4.694)	42.500	(6.521)	80.830	(8.964)	35.334	(5.580)
PFJULY	11.670	(3.455)	19.170	(4.265)	22.500	(4.694)	100.000	(10.025)	100.000	(10.025)	50.668	(6.493)
PFSEPT	5.000	(1.974)	15.830	(3.661)	19.170	(4.108)	20.830	(4.426)	27.500	(5.236)	17.666	(3.881)
PHAPRIL	12.500	(3.061)	15.000	(3.694)	23.330	(4.752)	23.330	(4.752)	24.170	(4.835)	19.666	(4.219)
PHMAY	8.330	(2.714)	28.330	(5.273)	34.170	(5.844)	40.830	(6.395)	80.830	(8.994)	38.498	(5.844)
PHJUNE	9.170	(2.822)	18.330	(3.830)	19.170	(3.937)	43.330	(6.597)	86.670	(9.308)	35.334	(5.299)
PHJULY	9.170	(2.822)	18.330	(3.830)	19.170	(3.937)	100.000	(10.025)	100.000	(10.025)	49.334	(6.128)
PHSEPT	10.000	(2.825)	15.830	(3.967)	23.330	(4.761)	22.500	(4.691)	25.830	(5.050)	19.498	(4.259)
SMAPRIL	3.330	(1.448)	7.500	(2.503)	7.500	(2.503)	10.000	(3.137)	13.330	(3.669)	8.332	(2.652)
SMMAY	5.830	(2.081)	16.670	(4.074)	23.330	(4.822)	30.830	(5.554)	65.830	(8.105)	28.498	(4.927)
SMJUNE	10.000	(3.008)	9.170	(2.718)	11.670	(3.247)	34.170	(5.852)	65.830	(8.105)	26.168	(4.586)
SMJULY	10.000	(3.008)	9.170	(2.718)	11.670	(3.247)	100.000	(10.025)	100.000	(10.025)	46.168	(5.805)
SMSEPT	2.500	(1.340)	7.500	(2.503)	7.500	(2.503)	10.000	(3.137)	18.330	(4.313)	9.166	(2.759)
MEAN	9.194	(2.760)	16.473	(3.809)	19.779	(4.232)	41.750	(6.033)	60.583	(7.415)	29.556	(4.850)
F-LSD(0.05)		NS		1.639		1.190		NS		NS		

M=Marketer,P76H=Poinsett 76 Holland, P76N=Poinsett 76 Netherlands, PF=Poinsett France,PH=Poinsett Holland, S=Super marketer. Values in parenthesis are square-root transformed values to which LSD is applicable.

Table 11: The effect of planting time and variety on phytophthora blight disease incidence at different weeks after planting.

VAR X MON	WEEKS AFTER PLANTING (WAP)											
	2WAP		4WAP		6WAP		8WAP		10WAP		MEAN	
MAPRIL	0.417	(0.909)	0.833	(1.125)	0.917	(1.155)	0.917	(1.155)	1.167	(1.284)	0.850	(1.126)
MMAY	0.833	(1.138)	1.333	(1.344)	2.583	(1.735)	3.333	(1.939)	4.000	(2.121)	2.416	(1.655)
MJUNE	0.833	(1.1380)	1.000	(1.225)	1.000	(1.225)	3.333	(1.939)	4.000	(2.121)	2.033	(1.628)
MJULY	0.833	(1.138)	1.000	(1.225)	1.000	(1.225)	4.000	(2.121)	4.000	(2.121)	2.167	(1.566)
MSEPT	0.000	(0.707)	0.833	(1.139)	1.167	(1.284)	1.250	(1.314)	1.583	(1.433)	0.967	(1.175)
P76HAPRIL	0.750	(1.068)	1.083	(1.241)	1.167	(1.284)	1.167	(1.284)	1.167	(1.284)	1.067	(1.232)
P76HMAY	0.750	(1.095)	1.417	(1.373)	2.417	(1.690)	2.917	(1.837)	4.000	(2.121)	2.300	(1.623)
P76HJUNE	1.000	(1.225)	1.167	(1.284)	1.250	(1.314)	2.917	(1.837)	4.000	(2.121)	2.067	(1.556)
P76HJULY	1.000	(1.225)	1.167	(1.284)	1.250	(1.314)	4.000	(2.121)	4.000	(2.121)	2.283	(1.613)
P76HSEPT	0.250	(0.837)	1.167	(1.284)	1.167	(1.284)	1.167	(1.284)	1.500	(1.403)	1.050	(1.218)
P76NAPRIL	0.667	(1.052)	0.750	(1.095)	1.000	(1.211)	1.083	(1.254)	1.250	(1.314)	0.950	(1.185)
P76NMAY	0.667	(1.052)	1.167	(1.284)	1.750	(1.472)	1.750	(1.472)	4.000	(2.121)	1.867	(1.480)
P76N3XJUNE	0.750	(1.095)	1.000	(1.211)	1.000	(1.211)	1.750	(1.472)	4.000	(2.121)	1.700	(1.422)
P76NJULY	0.750	(1.095)	1.000	(1.211)	1.000	(1.211)	4.000	(2.121)	4.000	(2.121)	2.150	(1.552)
P76NSEPT	0.667	(1.0520)	0.750	(1.095)	1.083	(1.254)	1.083	(1.254)	1.250	(1.314)	0.967	(1.229)
PFAPRIL	1.000	(1.171)	1.250	(1.273)	1.167	(1.271)	1.167	(1.271)	1.250	(1.314)	1.167	(1.260)
PFMAY	0.917	(1.182)	1.417	(1.373)	1.917	(1.535)	1.917	(1.517)	4.000	(2.121)	2.034	(1.546)
PFJUNE	1.000	(1.225)	1.000	(1.225)	1.167	(1.284)	1.917	(1.517)	4.000	(2.121)	1.817	(1.474)

PFJULY	1.000	(1.225)	1.000	(1.225)	1.167	(1.284)	4.000	(2.121)	4.000	(2.121)	2.233	(1.595)
PFSEPT	0.667	(1.052)	1.500	(1.362)	1.250	(1.314)	1.250	(1.314)	1.417	(1.373)	1.217	(1.283)
PHAPRIL	1.000	(1.211)	1.333	(1.344)	1.250	(1.314)	1.250	(1.314)	1.250	(1.314)	1.217	(1.299)
PHMAY	0.750	(1.095)	1.667	(1.457)	2.500	(1.714)	2.333	(1.646)	4.000	(2.121)	2.250	(1.607)
PHJUNE	0.750	(1.095)	0.833	(1.139)	0.917	(1.168)	2.333	(1.646)	4.000	(2.121)	1.767	(1.434)
PHJULY	0.750	(1.095)	0.833	(1.139)	0.917	(1.168)	4.000	(2.121)	4.000	(2.121)	2.100	(1.529)
PHSEPT	0.917	(1.182)	1.333	(1.344)	1.250	(1.314)	1.250	(1.314)	1.500	(1.403)	1.250	(1.311)
SMAPRIL	0.417	(0.923)	0.667	(1.052)	0.750	(1.082)	1.000	(1.211)	1.083	(1.254)	0.783	(1.104)
SMMAY	0.500	(0.966)	1.000	(1.225)	1.500	(1.403)	1.583	(1.427)	3.917	(2.100)	1.700	(1.424)
SMJUNE	0.917	(1.168)	0.667	(1.052)	0.833	(1.139)	1.583	(1.427)	4.000	(2.121)	1.600	(1.381)
SMJULY	0.917	(1.168)	0.667	(1.052)	0.833	(1.139)	4.000	(2.121)	4.000	(2.121)	2.083	(1.520)
SMSEPT	0.583	(1.009)	0.667	(1.052)	1.083	(1.254)	1.083	(1.254)	1.083	(1.254)	0.900	(1.165)
MEAN	0.742	(1.086)	1.050	(1.224)	1.275	(1.308)	2.178	(1.588)	2.914	(1.804)	1.632	(1.402)
F-LSD(0.05)		0.160		0.144		0.149		0.167		NS		

M=Marketer, P76H=Poinsett 76 Holland, P76N=Poinsett 76 Netherlands, PF=Poinsett France, PH=Poinsett Holland, S=Super marketer. Values in parenthesis are square-root transformed values to which LSD is applicable.

Table 12: The effect of planting time and variety on phytophthora blight disease severity on leaves at different weeks after planting.

WEEKS AFTER PLANTING (WAP)												
VARXMON	2WAP		4WAP		6WAP		8WAP		10WAP		MEAN	
MAPRIL	-	-	-	-	0.667	(1.052)	0.583	(1.009)	0.833	(1.139)	0.694	(1.067)
MMAY	-	-	-	-	0.917	(1.155)	2.250	(1.639)	1.417	(1.373)	1.528	(1.389)
MJUNE	-	-	-	-	0.583	(1.009)	0.667	(1.052)	1.417	(1.373)	0.889	(1.145)
MJULY	-	-	-	-	0.583	(1.009)	4.000	(2.121)	4.000	(2.121)	2.861	(1.750)
MSEPT	-	-	-	-	0.833	(1.138)	0.833	(1.138)	1.000	(1.225)	0.889	(1.167)
P76HAPRIL	-	-	-	-	0.917	(1.168)	0.833	(1.138)	0.917	(1.182)	0.889	(1.163)
P76HMAY	-	-	-	-	1.000	(1.192)	1.500	(1.397)	1.500	(1.397)	1.333	(1.329)
P76HJUNE	-	-	-	-	0.833	(1.125)	1.000	(1.225)	1.333	(1.344)	1.055	(1.231)
P76HJULY	-	-	-	-	0.833	(1.125)	4.000	(2.121)	4.000	(2.121)	2.944	(1.789)
P76HSEPT	-	-	-	-	1.000	(1.225)	1.000	(1.225)	1.000	(1.225)	1.000	(1.225)
P76NAPRIL	-	-	-	-	0.333	(0.866)	0.750	(1.082)	0.917	(1.168)	0.667	(1.039)
P76NMAY	-	-	-	-	0.833	(1.138)	1.750	(1.475)	1.500	(1.397)	1.361	(1.337)
P76N3XJUNE	-	-	-	-	0.333	(0.880)	0.583	(1.009)	1.250	(1.314)	0.722	(1.162)
P76NJULY	-	-	-	-	0.333	(0.880)	4.000	(2.121)	4.000	(2.121)	2.778	(1.707)
P76NSEPT	-	-	-	-	0.583	(0.996)	1.083	(1.254)	1.083	(1.254)	0.916	(1.168)
PFAPRIL	-	-	-	-	0.667	(1.052)	1.000	(1.184)	0.667	(1.039)	0.778	(1.092)
PFMAY	-	-	-	-	1.000	(1.157)	1.333	(1.344)	1.417	(1.373)	1.250	(1.291)
PFJUNE	-	-	-	-	0.667	(1.052)	0.833	(1.138)	1.750	(1.492)	1.083	(1.227)
PFJULY	-	-	-	-	0.667	(1.052)	4.000	(2.121)	4.000	(2.121)	2.889	(1.765)
PFSEPT	-	-	-	-	0.667	(1.052)	1.083	(1.241)	1.083	(1.254)	0.944	(1.182)
PHAPRIL	-	-	-	-	0.583	(1.009)	0.750	(1.063)	1.083	(1.222)	0.805	(1.098)
PHMAY	-	-	-	-	1.333	(1.316)	1.833	(1.502)	1.583	(1.433)	1.583	(1.417)
PHJUNE	-	-	-	-	0.750	(1.095)	0.917	(1.168)	1.750	(1.487)	1.139	(1.250)
PHJULY	-	-	-	-	0.750	(1.095)	4.000	(2.121)	4.000	(2.121)	2.917	(1.779)
PHSEPT	-	-	-	-	0.667	(1.052)	0.917	(1.168)	1.250	(1.308)	0.945	(1.176)
SMAPRIL	-	-	-	-	0.167	(0.793)	0.417	(0.923)	0.417	(0.923)	0.334	(0.880)
SMMAY	-	-	-	-	0.667	(1.025)	1.667	(1.462)	1.167	(1.284)	1.167	(1.257)
SMJUNE	-	-	-	-	0.000	(0.707)	0.083	(0.750)	1.250	(1.314)	0.444	(0.924)
SMJULY	-	-	-	-	0.000	(0.707)	4.000	(2.121)	4.000	(2.121)	2.667	(1.650)
SMSEPT	-	-	-	-	0.417	(0.923)	1.000	(1.225)	1.000	(1.225)	0.806	(1.124)
MEAN	-	-	-	-	0.653	(1.035)	1.622	(1.385)	1.753	(1.449)	1.343	(1.290)
F-LSD(0.05)	-	-	-	-		NS		0.156		NS		

M=Marketer, P76H=Poinsett 76 Holland, P76N=Poinsett 76 Netherlands, PF=Poinsett France, PH=Poinsett Holland, S=Super marketer. Values in parenthesis are square-root transformed values to which LSD is applicable.

Table 13: The effect of planting time and variety on phytophthora blight disease severity on fruits at different weeks after planting.

were superior to Poinsette 76 Holland, Poinsette France and Poinsette Holland. Super marketer, Poinsette 76 Netherlands and Marketer varieties records were low in both the disease incidence, disease severity on both leaves and fruits and yield characters. The Super marketer variety had differential yield characters–fruit girth, weight of fruit plant

and fruit lengths, which were significantly different from the other varieties. These differential growth and yield characters of cucumber have been reported by researchers in different parts of the world. The differences in vegetative and yield characters can be attributed to genetic composition of the varieties used; the Ashley variety may have

VAR X MON	FG(cm)	FL(cm)	FW/Plt(kg)	NFPP	FY(t/ha)	DF(t/ha)
MAPRIL	4.958	20.217	2.259	5.484	451.80	2.259
MMAY	2.392	10.781	0.209	1.950	41.90	0.209
MJUNE	2.425	10.843	0.185	1.692	37.00	0.185
MJULY	2.258	10.843	0.119	1.986	23.70	0.119
MSEPT	4.958	20.217	2.397	5.475	479.30	2.397
P76HAPRIL	4.833	19.590	2.371	5.614	474.20	2.371
P76HMAY	2.125	11.696	0.200	2.054	40.00	0.200
P76HJUNE	2.525	11.340	0.182	1.963	36.40	0.182
P76HJULY	2.525	11.340	0.117	1.946	23.40	0.117
P76HSEPT	4.833	19.590	2.514	5.788	502.70	2.514
P76NAPRIL	4.977	19.813	2.302	5.475	460.40	2.302
P76NMAY	2.425	12.536	0.162	2.314	32.40	0.162
P76N3XJUNE	2.467	11.798	0.151	2.328	30.20	0.151
P76NJULY	2.467	11.798	0.076	1.886	15.20	0.076
P76NSEPT	4.977	19.813	2.313	5.380	462.60	2.313
PFAPRIL	5.256	20.098	2.445	5.288	488.90	2.445
PFMAY	2.350	12.441	0.161	2.460	32.20	0.161
PFJUNE	2.800	11.606	0.157	2.379	31.50	0.157
PFJULY	2.533	11.606	0.079	2.134	15.70	0.079
PFSEPT	5.256	20.098	2.449	5.614	489.70	2.449
PHAPRIL	5.143	19.491	2.539	5.383	507.90	2.539
PHMAY	2.242	12.493	0.158	2.373	31.60	0.158
PHJUNE	2.550	11.406	0.122	2.314	24.50	0.122
PHJULY	2.500	11.406	0.075	2.042	15.10	0.075
PHSEPT	5.143	19.491	2.292	5.484	458.30	2.292
SMAPRIL	5.806	20.852	2.531	5.788	508.90	2.531
SMMAY	2.767	14.207	0.175	2.473	35.00	0.175
SMJUNE	2.567	12.658	0.171	2.200	34.10	0.171
SMJULY	2.354	12.658	0.107	1.898	21.50	0.107
SMSEPT	5.806	20.852	2.696	5.722	506.20	2.550
MEAN	3.541	15.119	1.057	3.496	210.41	0.075
F-LSD(0.05)	0.341	0.514	0.1757	NS	NS	NS

M=Marketer, P76H=Poinsett 76 Holland, P76N=Poinsett 76 Netherlands, PF=Poinsett France, PH=Poinsett Holland, S=Super marketer. FG=Fruit girth, FL=Fruit length, FW=Fruit weight, NFPP=Number of fruit per plant and FY=Fruit yield, DF=Diseased fruits

Table 14: The effect of planting time and variety on the yield of six varieties of cucumber.

been quicker in adapting to the environment than the other varieties or the vegetative characters of the Ashley variety may have been more active than the other varieties and therefore had a strong source to sink relationship which resulted in high yields experienced in the variety. The number of fruits per plant was higher than what was reported by Phu [6] and by Jizhe [7] in Thailand. The yields obtained in this varietal studies was higher than what Manyong and Phu [8] reported in Thailand but the same as the yield obtained by Mingbao [9].

From the result of this study, it was found that cucumber can be planted at any time of the rainy season because of the consistent high yields recorded in the varietal trials which were carried out in different months of April, May, June, July and September in 2013. This is in consonance with the findings of Mas who stated that cucumber can be planted at any time of the year provided during the growing period, there is ample moisture and the soil is fertile. The results also agree with the findings of Thoa [10] who observed that cucumber can be planted at anytime of the year and that even in temperate regions, during the winter the crop can be grown under greenhouse conditions

using artificial lighting systems. The high yield which was consistently recorded by the Super Marketer variety throughout the five months of study could be attributed to the genetic composition and its ability to quickly adapt to this environment. Super marketer produced the highest yield per hectare, and the Poinsette Holland, the lowest.

The cumulative effect of variety and time of planting on phytophthora blight disease incidence, severity and yield of cucumber.

The observed significant ($p < 0.05$) variation in the varieties of cucumber (marketer, super marketer, poinsette 76 Holland and Netherlands, poinsette France and Holland) and the time of planting (April, May, June, July and September) having Supermarketer planted in the month of April, is attributed to the genetic make up of this particular variety and environmental condition [5] during the time it was planted. Generally, the varieties planted during the month of April gave the best results as regards the disease incidence, severity on leaves and fruits and the total yield, closely followed by those planted during the month of September. The month of July gave the poorest results; this reflects the substantial contribution of environmental condition in controlling the introduction and subsequent spread of the disease if occurred in a field. The month of July had more rain days and length (19.00 and 283.96) respectively, and these played a significant role on the spread of the disease. Furthermore, the month of July had low temperature and high humidity which helps in spreading phytophthora blight very fast in a crop field [5]. This result also tallied with the assertion of Agrios [11] that the higher the moisture content of the soil and lower the temperature, the higher the spread of phytophthora blight disease of cucurbits. The yield (508.90 t/ha) recorded for the super marketer during the month of April remains the highest, therefore super marketer remains the best variety while April is the best time to grow cucumber in this derived savannah agro-ecology of Nsukka.

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