PERFORMANCES OF CUCUMBER *(CUCUMIS SATIVUS)* AT DIFFERENT HEIGHTS OF THE PREVAILING WIND SPEEDS

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ABSTRACT

Cucumber fruit yield and its characters are dependent on wind speed and wind heights but the effects have not been clearly determined, hence this research was carried out to assess effects of prevailing wind on cucumber (*Cucumis sativus*) fruit yield and some of its morphological characters using different wind heights. Three cucumber varieties used in the research were: Nagano F_1, Poinsett and Marketmore. Three different heights of wind level measured were 0 m, 1 m, and 2 m, each at 90^0 to the direction of the prevailing wind. At three replicates, the factorial design was 3× 3× 3. Parameters measured were plant height and number of branch plant^{-1}, number of leaf plant^{-1} and leaf area, number of fruit plant^{-1}, fruit length, fruit girth and vine length. Also, parameters of cucumber measured include number of male flower, number of days to male flowering, number of female flowers and number of days to female flowering, days to first fruiting and fruit yield plant^{-1}. The result revealed a highly significant variety by treatment interaction for days to male flowering (range 16.80±0.81 to 18.85±1.22). Nagano F_1 portrayed the shortest days to male flowering (16.60±1.42 at 2 m wind height), the same Nagano F_1, had the highest days to male flowering (18.85±1.22 at 0 m wind height) while Nagano F_1 displayed the shortest days to female flowering (3.07±0.41 at 2 m wind height) and 25days to first fruiting. Nagano F_1had highest fruit yield plant^{-1}, 72.71±0.22 compare to Marketmore highest fruit yield of 75.77±0.19 tha^{-1}. In all, cumulative yield ranges between 69 tha^{-1} and 76 tha^{-1}.There was linear increase in the growth parameters, in the yield components and in the cumulative yield from 0 m to 1 m and to 2 m wind heights in all the varieties. Wind speed and wind heights affect the performances of the cucumber via growth parameters, yield components and cumulative yields.

Keywords: fruits, leaf area, male flowers, variety, yield

1. INTRODUCTION

Cucumber *(Cucumis sativa)* is a tropical fruit, a plant with a berry that is eaten raw. Both the skin, pulp and seeds of cucumber have been shown to have antioxidant properties; hence they are of possible benefits to human health. The plant has a climbing stem that grows long enough to curl round the stake. It is grown in soils of pH as low as 4.5 to 5.8, in an environment that is free from frost and also in partial shade with high humidity. It is tolerant to drought, love sunshine and very good in sloppy lands (Murtadha *et al*., 2016).

Wind speeds affect airflow and the microclimates around the crops (Tanny *et al*., 2008; Cleugh, 1998). At times, quiet zone may be created due to air movement around the plant and the microclimates that result; so also resulting in turbulent mixing layers as different temperature, humidity, heat and evaporation fluxes are created. Temperature for example has been shown to affect crop growth, a factor that prompted determination of threshold temperatures or cardinal temperatures for different crops (Cleugh, 1998). For each phase in the growth of cultivar, there is a temperature range within which growth and development is optimum. These temperature ranges are called cardinal temperature**.** Also, shades are established around the plant as a result of turbulent mixing layers of airflow and microclimates and these may modify the heating/cooling in the quiet zone (Cleugh, 1998; Cleugh *et al*., 1998). Wind as an important environmental factor has apparently not been researched into like other factors in plant growth and especially its height and speed to the surface of the earth. Since there are different orientations of the wind directions and there are different wind speeds and plants are expected to be exposed to them, we hypothesized that there may be anatomical and morphological modifications occurring in plants possibly in response to moisture stress (Grace, 1988). Also, carbondioxide that plant uptakes to release oxygen was found to depend on wind speed (Tanny *et al*., 2008). Nevertheless, the heights of wind movement from soil surface upward that will enhance crop productivity, the orientation of the crop to the prevailing wind direction have to be intensively studied if crop positive performance is needed in future farming activities. Furthermore, many works have been done on cucumber, such as health usefulness and preservation, its growth using different management practices, different organic and inorganic media, all to increase its yield. However, less work has been done on performances of cucumber in order to ascertain its productivity when exposed to different orientations of wind directions

and when staked up to different heights.

In most of the countries, production of cucumber using different varieties, staked and unstaked methods of production and many other different soil management practices were challenges to producers as yields potential is far reach (Moulia *et al*., 1992). Moreover, staking of cucumber has been found to have added more yields to cucumber in recent times than unstaked practices, (Murtadha *et al*., 2016) but the researchers did not included the role of wind performances on the yield observed in their study. Thus, the ideas of planting at different orientations and at different wind heights are highly needed to elucidate on the effects of wind component on cucumber fruit yield. It is also necessary to determine by study if planting and staking at different heights (different heights of wind movement on soil surface) of the prevailing wind direction could be able to add positively to the growth and yield of cucumber.

2. MATERIALS AND METHODS

2.1 Soil Analysis

The experiment was conducted from May to June 2018 at the Teaching and Research Farm of the College of Agriculture, Osun State University, Ejigbo Campus, Ejigbo in Osun State of Nigeria lies on Latitude 4^{o} 28'E and Longitude 7^{o} 20'N.

The site were clearly mapped and cleared of the vegetation. Composite samples of the experimental site were taken, air dried and sieved through 2mm sieve and analysed for physical and chemical properties of the soil. All samples belonging to the same depth were thoroughly mixed to form composite samples. Nitrogen determination was done by Kjedhal method using automated Kjeltec distillation apparatus (more details of the apparatus e,g serial number, model and manufacturer..), Exchangeable bases were done using flame photometer, available phosphorus was done using UV/visible spectrophotometer at a specified wavelength. Organic carbon and matter were done by titration method of samples against ferrous sulphate using appropriate indicator. Particle size analysis was done by hydrometer method, and pH was done using pH meter. Table 1 shows the results of the soil analysis, both physical and chemical properties of the soil before and after planting.

Seeds of three cucumber (*Cucumis sativus*) varieties used in the research were: Nagano F_1variety, Pointsett variety and Marketmore variety, they were all obtained from a seed supplier

in Ibadan, Nigeria. The different heights of the staked cucumber used in the research are 0 m, 1 m and 2 m. The idea is that, though, cucumber may yield more when the height of staked is more than 2 m, but the ease of harvest for the farmers will be difficult and therefore may not be reasonable, thus the research is limited to 2 m wind level height^{-1}. Also, the idea of staked cucumber was borne out from the earlier experiment (Murtadha *et al*, 2016). The 0 m height or no height is the cucumber growing and creeping on the earth surface, the height from the ground is assumed zero. The experimental design was a randomized block with three replicates, in factorial arrangement of 3 x 3, referring to three varieties of cucumber and 3 different wind heights, 0 m, 1m and 2 m. All the plantings were applied with 120 tha^{-1} poultry manure rate.

2.2 Parameters measured

Among the parameters determined to evaluate the performances of the cucumber at different stages of growth and at harvest are physical properties of cucumber namely fruit length, fruit girth and vine length; also measured were growth parameters of cucumber which include number of male flower, number of days to male flowering, number of female flowers and number of days to female flowering. Besides, measured in the research also are some yield components of cucumber which include days to first fruiting and fruit yield plant^{-1}of cucumber harvested at 5-6 days intervals and the cumulative yields.

2.3 Statistical Analysis

The data collected were subjected to ANOVA using non linear mixed function variance of Statistical Analysis Software (SAS, 2002). Comparison of means of yield parameters and its related characters was done using the Least Significant Differences (LSD≥0.05).

3. RESULTS AND DISCUSSION

The physical and chemical properties of the soil where the experiment was performed are shown in Table 1.The soil pH was acidic (6.65). Also, light soil texture is a characteristic feature of soil developed on basement complex rock parent materials even as the soil reaction is within acceptable range for nutrient availability needed for optimum growth and yield of arable crop such as cucumber (Aduloju *et al.*, 2014). The total N was 0.1 while soil organic matter content was 1.36%. These soil characteristics depict good and favourable soil for the cucumber and its

attendant growth and yield parameters considered in the research. The weekly averages of wind speeds in knots at 3m heights and the maximum temperatures collected from meteorological station in Ido-Osun, an adjoining town to Osogbo are shown in Table 3.

Table 1: Physical and chemical properties of soil in the experimental site

Properties	Value
Sand %	70.00
Clay %	13.00
Silt %	17.00
Textural class	Sandy loam
pH (H_20)	6.65
Carbon %	0.80
Organic matter %	1.36
Nitrogen %	0.1
Phosphorus (mg/kg)	7.81
Ca^{2+} (cmol/kg)	1.62
Mg^{2+} (cmol/kg	0.65
K^{+} (cmol/kg)	0.20
Na^{+} (cmol/kg)	0.15

3.1 Effect of different heights of wind movement on some physical properties of cucumber

According to the result, Marketmore had the longest vine (22.00 ± 0.63 at 1 m wind height; 21.98 ± 0.48 at 3 m wind height), Table 2 compared with pointsett (18.38 ± 1.26 at 1 m wind height; 17.34 ± 0.56 at 2 m wind height).The wind speed values 3m in knots recorded during the period were within the range of 10.14 ± 0.69 and 11.43 ± 1.62, Table 3. In 1 m and 2 m in knots wind speed of 3 m in knots could have been able to induce or alter growth rates or leaf morphology, thus the differences in the fruit lengths and fruit girths in the varieties, Table 2. The same was observed by Cleugh *et al*, (1998) on some crops. Although, the differences between Marketmore and Nagano F1 in their fruit lengths and girth development at 1 m and 2 m heights could be linked with varietal differences. The significance of these different wind speed values for the growth parameters in cucumber indicates that treatments were predominantly affecting

the expression of these characters. This wind speed and heights could have added to improved ecological variations in the experimental site and thus these findings could be surmised to be inconsonance with the results of Golabadi *et al.* (2013) and Barker *et al*. (1989) in their studies on determining relationships between different horticultural traits like fruit girth and length in *Cucumis sativus* genotypes and finding the effects of wind on cotton growth and yield.

Nagano F_1 exhibited the lowest fruit length(16.24±1.70 at 0 m height of wind.In addition, Marketmore had the highest fruit girth (18.21±0.68) in 2 m, The effect of different levels of wind speed on the performance of different cucumber varieties is in Table 3; the result reveals that 0 meter height recorded the lowest vine lengths (14.26±1.72; 16.26±1.26; 14.35±0.94) in all treatments. 1 m has the highest fruit girth (18.00±0.75) in Poinsett,while the 2 m height in this variety showed the highest (18.32±0.67) fruit girth in all. Nagano F_1 displayed the highest fruit length (18.06±1.08 in 1 m wind height) in 1 m level of wind while Marketmore displayed the highest fruit length (22.26±0.68) in 1 m and (22.88±0.48) in 2 m height. Also, Marketmore had the highest fruit girth (18.32±0.68) in 2 m.The LSD values are less in the growth parameters measured, this shows that the varieties are distinct and that there were differences among the wind heights treatment used. Moreover, the wind direction recorded throughout the experimental time was East West (EW) direction, this could have possibly responsible to the low wind speed, low temperatures (range between 27.55 ± 1.50 and 32.01 ± 1.47, which were referred to as cardinal temperatures in crops' comfortability in tropical regions, (Cleugh, 1998) in Table 3 and the accompanying favourable growth parameters and yield components and cumulative yields in the cucumber.

Table 2: Effects of various wind heights on mean growth components of cucumber varieties

Varieties	Treatments	Vine length (cm)	Fruit length, (cm)	Fruit girth, (cm)	No. of male flower plant^{-1}
Nagano F_1	0	14.26±1.72	16.24±1.70	15.18±1.47	3.12±0.62
	1	17.96±1.24	18.06±1.08	16.70±0.99	4.10±0.48

	2	17.97±1.38	18.76±1.40	16.75±1.14	4.78±0.48
Point-sett	0	16.26±1.26	16.26±1.63	14.70±1.51	3.17±0.54
	1	17.98±1.60	19.38±1.66	16.12±1.42	4.18±0.56
	2	20.66±0.37	20.66±0.27	18.32±0.67	5.12±0.47
Market-more	0	14.35±0.94	14.37±1.42	15.00±1.36	3.58±0.71
	1	22.00±0.63	22.26±0.68	18.00±0.75	4.02±0.44
	2	22.18±0.48	22.88±0.48	18.32±0.68	4.58±0.24
LSD		20.80	4.89	4.72	1.12

Table 3: Weekly mean values of wind speed 3m in knots and temperatures

Weeks	Wind speed, 3m in knots	Temperature, ^{o}C
1	11.43 ± 1.62	32.01 ±1.47
2	10.43 ± 1.62	30.06 ± 0.91
3	11.43 ± 2.76	31.1 ± 1.25
4	10.14 ± 1.22	31.37 ± 1.59
5	10.43 ± 0.77	31.06 ± 1.18
6	10.71 ± 1.98	30.7 ± 1.91
7	10.43 ± 1.99	30.69 ± 1.05
8	10.14 ± 0.69	28.16 ± 1.34
9	9.6 ± 0.55	29.32 ± 10.58
10	10.29 ± 1.60	28.36 ± 1.91
11	9.71 ± 1.11	29.7 ± 0.83
12	9.86 ± 0.90	28.7 ± 1.70
13	9.11 ± 1.11	27.55 ± 1.50

Note: Wind direction = EW

3.2 Effect of different height of wind movement on some growth parameters of cucumber

The mean growth parameters of three varieties of cucumber in response to various height levels of wind movement is presented Table 2 the result revealed a highly significant variety by treatment interaction for days to male flowering (range 16.80±0.81 to 18.85±1.22). Nagano F_1 portrayed the shortest days to male flowering (16.60±1.42 at 2 m wind height), the same Nagano F_1, had the highest days to male flowering (18.85±1.22 at 0 m wind height) while Nagano F_1displayed the shortest days to female flowering (3.07±0.41 at 2 m wind height) and 25days to first fruiting, but conversely accompanying it is its highest fruit yield plant^{-1}, 72.71±0.22 compare to Market-more highest fruit yield of 75.77±0.19 tha^{-1}, Table 4. The wind speed 3m in knots could be surmised to have influenced the shorter number of days to female flowering, this could be that cooler temperatures (lowest point on cardinal temperatures, 30-37^{o}C; (Cleugh, 1998) and low wind speed have positive morphological and physiological changes resulting in

these shorter period to female flowering (Grace, 1988). At the same time, Market-moredisplayed the lowest number of male flowers (16) and also had the shortest fruit length (14.37±1.42).The reason is because the leeward side of the plant recorded lesser number of male flowers than the windward side, thus in average, lower number in all. The lower number of male flowers in Market-more is not good morphologically, it could also be as a result of combined effect of the temperatures and wind speeds at 1 m, 2 m which are both within the 3 m in knots.

Table 4. Mean of interacting effects of cucumber varieties and different wind level on yield components of cucumber cultivars

Varieties	Treatment	Days to male flowering	No. of male flowers	Days to Female flowering	No. of female flowers	Days to first fruiting	Cumulative Yield, tha^{-1}
Nagano F_1	0	18.85±1.22	16.69±1.54	5.10±0.26	15.60±1.50	25.45±0.66	68.33±0.16
	1	18.06±1.22	16.98±0.99	4.03±0.84	16.98±1.32	25.71±0.28	70.58±0.21
	2	16.60±1.42	18.51±1.42	3.07±0.41	17.54±1.42	24.48±0.42	72.71±0.22
Pointsett	0	19.20±1.16	18.10±1.05	4.72±0.45	17.10±1.05	26.38±0.22	69.38±0.22
	1	18.38±1.26	18.98±1.44	4.00±0.35	18.88±1.60	25.00±0.36	70.29±0.16
	2	17.34±0.56	20.13±0.37	3.32±0.42	20.31±0.40	24.28±0.43	75.08±0.83
Marketmore	0	17.85±1.59	16.00±1.34	4.18±0.71	16.40±1.45	25.36±0.27	72.63±0.21
	1	17.96±0.93	19.00±0.52	4.42±0.44	18.40±0.25	25.17±0.10	75.47±0.12
	2	16.80±0.81	21.12±0.53	3.28±0.24	20.22±0.58	24.96±0.19	75.77±0.19
							42.38

3.3 Effect of different height of wind movement on yield and yield components of cucumber

According to the result, Marketmore with the longest vine (22.00±0.63 at 1 m wind height) displayed 25 days to first fruiting have high order of harvest values of 17 at an harvest, Figure 1. Eventually, Marketmore variety showed the highest yield $plant^{-1}$ (75.77±0.19 at 2 m wind height), Table 4. The wind speed more than 50 km $hour^{-1}$ leads to lodging of crops leading to heavy loss (Anonymous, 2012), since the wind speeds recorded were less than 50 $kmhr^{-1}$, Table 4, thus no loss could have been recorded in the number of flowers of both male and female and then the resulting growth and yield parameters and cumulative yield recorded in Tables 2,3,4 and

Figure 1. These could have been possible for marketmore variety, maybe because of its genetic factor, or the ecological conditions that respond additively to low wind speed, 11.43 at 3 m in knots highest in the period.

The wind at 1 and 2m would even be lesser in values, the increase in the growth components of cucumber during the period is in agreement with Cleugh (1998) which states that moderate wind aids in some morphological and physiological processes like pollination which also could have contributed to the growth components. It may also be because the cucumber were all allowed to grown vegetatively at will, thus facing any of the leeward and windward directions and which could have also help since the wind speed in knots was reduced at the time (between9.11 ± 1.11and 11.43 ± 2.76). The LSD values, (Tables 2, 4) are less in all the growth components, Table 2, and in the cumulative yield values, Table 4; this shows that the varieties are distinct and that there were differences among the wind heights treatments used. However, in the case of yield, it is higher, denoting that the yields were close in values and especially in the 1 m and 2 m heights, both heights are within the 3m knots wind. Moreover, the recorded cumulative yield of range between 69 tha^{-1} and 76 tha^{-1} in the experiment were far ahead of the yield recorded in FAO (2004) of yield of cucumber of 15tha^{-1}- 22 tha^{-1}. They are also far ahead of those recorded in Nigeria as the highest cucumber harvest recorded so far were 500 bags $acre^{-1}$ with a bag weighing 40kg, that is 20 $tacre^{-1}$ equaling 50 tha^{-1} even at staking (Akinfolarin, 2019). The reason could be because of the staking method applied to secure 1 m and 2 m heights and also could be the proceed from the application of poultry manure (120 t/ha) to all the farm plots which was not part of the experiment. It could also be because of the wind effects on the morphological and physiological changes in the crops or may be the contribution of other soil factors, Table 1. These were 38 % - 52 % in the staked cucumber of recent times and 245 % - 360% increase over the earliest times of yields of cucumber documented.

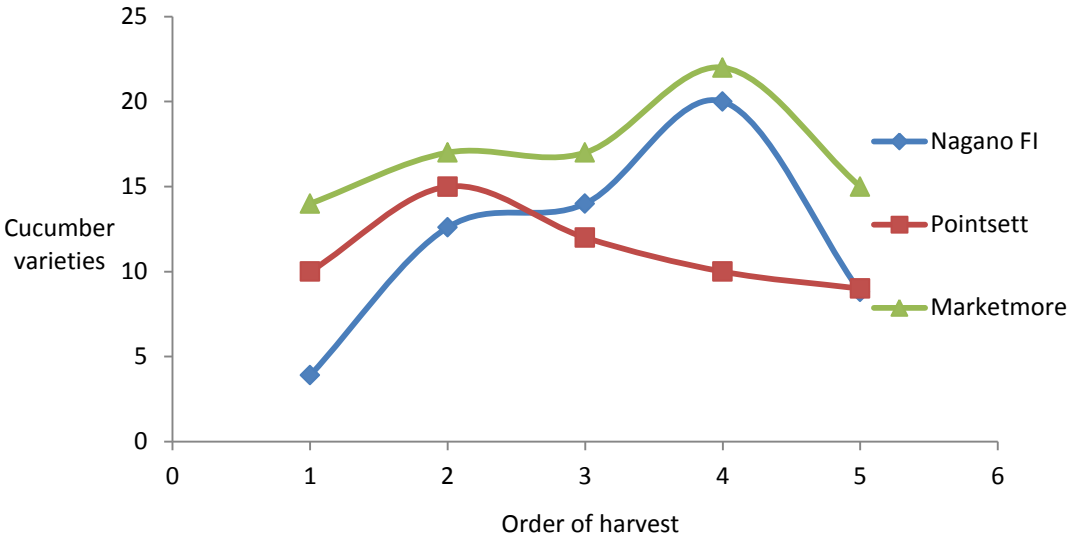

Figure 1: Order of harvest record of the yields of cucumber varieties

There were linear increase in the growth parameters, in the yield components and in the cumulative yield from 0 m to 1 m and to 2 m wind heights as shown in Table 2, thus, effect of different wind heights and wind speeds on the performances of cucumber varieties were linearly increase. Moreover, the regression models below developed to these effects depict higher R^2 values (ranging between 0.77 to 0.95).

$Y_{Nagano\ F1} = -0.825x^3 + 4.910x^2 - 2.664x + 2.96$ $R^2 = 0.89$

$Y_{Pointsett} = 0.75x^3 - 7.535x^2 + 21.71x - 4.8$ $R^2 = 0.95$

$Y_{Marketmore} = -0.75x^3 + 5.678x^2 - 10.57x + 20$ $R^2 = 0.77$

4. CONCLUSION

Wind speed and wind heights affect the performances of the cucumber via growth parameters, yield components and cumulative yields of the cucumber (*Cucumis sativus*). At 1 m and 2 m wind heights and cardinal temperatures, there were increase in yields of cucumber which were greater than those recorded earlier. Thus, planting and staking of cucumber up to 2 m heights to the prevailing wind movement from the soil surface will add positively to the its growth and yield.

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