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Effect of P^H on Sex Expression in *Cucumis Sativus*

Ukaoma, Adanma A.
Department of Biological Science, FUTO.

Abstract: **The experiment was conducted to examine the effect of P^H the development of cucumber for productivity enhancement using various soil pH strengths in the greenhouse facility of School of Agriculture and Agricultural Technology, FUTO in the summer of 2012. Soil pH of 6 and 8 were used to ascertain the effect on flowering in *cucumissativus,* the experiment was laid out in a complete randomised design with three replications .The results revealed that the soil pH affected the morphological traits of cucumber as well as the floral traits significantly though days to flowering was not significantly influenced.**

Keywords: **Sex Expression, P^H, Influence, Flowering, Significantly and Productivity.**

1. Introduction

Cucumber (*cucumissativus* L.) is a widely cultivated plant in the gourd family,classified as cucurbitaceae which includes squash (cucurbita specie), water melon (*citrulluslanatus*) and melon (*cucumismelo* L.). After tomato(*solanumlycopersicum* L.) and water melon,*cucumi ssativus* and melon are cultivated more broadly than any other vegetable specie (faostat.fao.org;Pitrat*et al*.,1999).Th e *cucurbita* consist of two subfamilies- *Zanonionideae* and the *Cucurbitoideae* (Kirkbride 1993).The*Cucurbitoideae* houses eight tribes ,one of which (*Melothrieae)* includes the genus *cucumissativus*, where the basic chromosome number 2n=2x=24. *Cucumissativus* is partitioned into two sub genera designated as *cucumis* (2n=2x=14 and 24) and melo (2n=2x=24) that contain five cross sterile species groups (Jeffrey 1980).The sub genus *cucumis* comprises three or four Siro-Himalayan specie, including *cucumissativus*(2n=2x=24) and *cucumishystrix* Chakr.(2n=2x=24).*cu cumissativus* is the only species in the genus *cucumis* with a chromosome number of n=7,which is known to have evolved from a presumed ancestral karyotype with n=12,but details in this reduction in chromosome number have remained unclear (Pitrat*et al.,* 1999).*Cucumissativus*houses several botanical varieties including var. *sativus,* the cultivated cucumber and the wild , free living var.*hardwickii* (R) Alef. (Kirkbride 1993).

Unlike gourds, *cucumissativus* are pepos- fleshy, mostly edible fruits that do not split when mature.

However, much like tomatoes and squash, they are often perceived and eaten as vegetables. They have a high water content of about 90% (Haifa.2007).Cucumber is commonly a monoecious, annual, trailing or climbing vine (Wikipedia), having hirsute or scabious stems with triangular ovate leaves with shallow and acute sinuses. The plant prefers a warm climate and do well in areas with 30^{0}C temperature during day and 18-24^{0}C at night. Below 15^{0}C and above 35^{0}C temperature do harm to the natural plant growth and thereby reduce the yield (Rashid and Singh, 2000).

*Cucumissativus*fruits contain the following: 3.63g carbohydrate, 1.67g sugars, 0.5g dietary fiber, 0.11g fat, 0.65g protein, 0.027mg thiamine (vitamin B1), 0.033mg riboflavin (vitamin B2), 0.098mg niacin (vitamin B3), 0.259mg pantothenic acid (vitamin B5), 0.040mg vitamin B6,2.8mg vitamin C, 16mg calcium, 0.28mg iron, 13mg magnesium, 24mg phosphorus, 147mg potassium, 0.20mg zinc (USDA Nutrient database 2008).

Fig.1. Cucumber Fruits

The high water content makes cucumber a diuretic and it also has a cleansing action within the body by removing accumulated pockets of old waste material and chemical toxins. Cucumbers help eliminate uric acid which is beneficial for those who have arthritis, and its fiber-rich skin and high levels of potassium and magnesium helps promote nutrient functions .*Cucumissativus* is cultivated because its extract has a soothing, cleansing and softening preparation which is important for cosmetics industry. It also serves as a pesticide because of its steroid content including cucurbitacins (Wang *etal*., 2007). Cucumberhas been shown to have some anticancer activities include fisetin, lutein, caffeic acid and cucurbitacins. Caffeic acid has been shown to have antiproliferative and apoptotic effects on human breast cancer cells in the laboratory.

Furthermore, the cucurbits are model for the study of vascular biology, as both xylem and phloem sap can readily be collected for studies on long - distance signalling events that function in the integration of physiological and developmental processes at the whole plant level. *Cucumissativus* exhibit a fascinating range of floral morphology, including staminate, pistillate andhermaphroditic flowers occurring in various arrangeme -nts and yielding several types of sexual expression.

Cucumissativus has served as a model for system forsex determination studies since 1950s, driven by breeding programs for hybrid seed production. *Cucumissativus* and other vine crops are monoecious plants i.e. having separate male n female flowers on the same plant. The plant possesses unique properties with its genome. *Cucumissativus* is a highly polymorphic specie with variations in both vegetable and fruit characteristics and it displays a low level of DNA polymorphism (Kennard *et.al*., 1994)

Three genomes of *Cucumissativus* show different transmission, maternal for chloroplast, paternal for mitochondrial and biparental for the nuclear DNA (Havey*et al*., 1997). The mitochondrial genome is the largest of all eukaryotes. Nevertheless, cucumber has a narrow genetic base, with a genetic variety of only 3-8% (Irem, 2009). It has been reported that a number of environmental variables such as light intensity, temperature, carbon (iv) oxide level as well as exogenous treatment of hormones or other growth regulating substances can influence plant sex expression (Shaogui et al. 2010).

This study sought to investigate how varying degree of soil acidity or alkalinity influence the development of floral organs in *cucumissativus* and to investigate the interactive effect of soil pH level on growth and development of cucumber.

Flower and Fruits:

Cucumissativus are monoecious plants which have separate male and female flowers on the same plant. The male flowers appear first and the female flowers shortly after. The female flower have small and immature fruit at the base of the flower and male flowers do not possess any. Pollen is transferred from male to female by bees or other insects. When pollinated properly, female flower develops into fruits.

Monoecious cultivars first produce clusters of five male flowers at the leaf nodes on the main stem. Subsequently, the plant produces both male and female flowers. Most current hybrids are gynoecious (all female flowers). Gynoecious hybrids are widely used because they are generally earlier and more productive. The term 'all female' is somewhat misleading as 5% of the flowers are male under most conditions. These have several advantages: as they bear only female flowers, the tiresome routine of removing male flowers is unnecessary .Also they are much more resistant to disease and rather more prolific. However, there are two drawbacks- the fruits tend to b shorter than the ordinary varieties and a higher temperature is needed.

2. Literature Review

Sex expression:

Sex determination in flowering plants refers to the balance between expression of female versus male sexuality within a plant and is a trait that is directly connected with the success and evolution of sexually reproducing organisms (Malepszy and Niemirowcz-Szczytt, 1991). In flowering plants, strategies for sex determination have evolved to prevent self-fertilization that may lead to loss of fitness due to inbreeding (Darwin, 1876). One of these strategies involves the production of unisexual flowers, in which male and female gametes are segregated on different flowers of the same plant (monoecious species) or on separate individuals (dioecious species).

Differences occur in the manner in which the reproductive organs are arrested. Sex determination system in plants have evolved many times from hermaphroditic ancestors (including monoecious plants with separate male and female flowers on same individual), and sex chromosome system have arisen several times in flowering plant evolution. Consistent with theoretical models for the evolutionary transition from hermaphroditism to monoecy, multiple sex determining genes are involved, including male sterility and female sterility factors (Tanurdzic M., 2004).

Sex determination is a process that leads to the physical separation of male and female gamete, producing structures to different individuals of a species, even though sexually reproducing species have only three possible options; (Milos and Jo Anns, 2004)

Flower development is a critical factor influencing plant reproduction and crop yield. While most specie produce bisexual flowers possessing both male (stamen) and female (carpel) organs, various specie throughout the plant kingdom have evolved mechanisms to produce unisexual flowers (Ainsworth *et al.,* 1998, Tanurzdic and Banks, 2004). *Cucumissativus* is the specie most extensively studied in the *cucurbitaceae* for the production of hybrid seed. The physiology of*cucumissativus* growth and productivity has been investigated as a requirement for optimising greenhouse production (Wien, 1997). Additionally, understanding the genetic and hormonal control of flower sex expression has contributed to improving hybrid seed production in *cucumissativus.*

The *cucurbitaceae* family is noted for a diversity of sex expression types (Perl – Treves, 1999; Roy and Saran 1990). Monoecious specie such as cucumber (*cucumissativus*) and squash (*cucumispepo* L.) bear separate male and female flowers on the same plant, while andromonoecious specie, such as many melon genotypes (*cucumismelo* L.) produce male and bisexual flowers. In both cases, male flowers are produced early in plant development, followed by a mixture of either female or male, or bisexual or male flowers.

Several, other plant species follow a sex determining pathway that also involves the arrest of preformed sexual organs in bisexual primordial. In wild species of *cucumissativus*, clusters of staminate flowers form on the same plant. All immature floral buds contain stamen and pistil primordial, and sex differences are established by the arrested development of the inappropriate sex organs (Malepszy and Niemirowicz-Szycytt, 1991).

Flowering in cucumber:

Cucumber sex phenotypes are mainly monoecious (staminate and pistillate flowers), or gynoecious (pistillate flowers only), androecious (staminate flowers only), hermaphroditic(perfect flowers), andromonoecious(staminate and perfect flowers) and trimonoecious (staminate, perfect and pistillate flowers) also exist. The three major genes include Acr/acr, M/m and A/a responsible for the inheritance of these different sex forms in cucumber. The development of plants with pistillate flowers is dependent on the genes Acr/acr and M/m. The dominant Acr allele affects the whole plant as a promoter of the female phase by acceleration of the male and mixed phases. Therefore Acr/acr locus is responsible for the quantum of male flowers and flowers containing pistils. The gene M/m governs the selectivity of the development of the pistillate initials on the level of the single flower.

The M allele is completely dominant over the m allele. In dominant conditions the M/m gene inhibits the development of male sex organs and leads to pistillate flowers and thus, gynoecious flowers in recessive conditions to monoecious and hermaphroditic plants. It can be noticed that the dominance of Acr allele over acr allele is not always complete in the heterozygous condition at Acr/acr locus and the sex expression is strongly dependent on the genetic background and the environmental factors. Therefore sometimes staminate flowers occur in gynoecious and hermaphroditic types (Engelke et al., 1999). In the same genetic background the dominance of the Acr gene, can be complete in field and incomplete in greenhouse. These three genes are inherited independently from each other (Tatlioglu, 1993).

In addition to the sex-determining genes, plant growth regulators have been found beneficial both for the induction of pistillate flowers and reduction of staminate flowers in *cucumissativus*. There are a number of reports on the effects of plant growth regulators on the modification of sex expression in cucumber (Vadigeri*et al.*2001, Rafeekher*et al.* 2002).

Effect of Hormones on Sex Expression:

Growth regulators have tremendous effects on sex expression and flowering in various cucurbits leading to either suppression of male flowers or an increase in the number of female flowers (Al-Masoum and Al-Masri, 1999) without imposing any deleterious effect on the environment and human health.

Recently it was demonstrated that in some plant responses, auxin may exert its effect through ethylene evolution and that gibberellins have generally an opposing effect to ethylene. Since it has been known that unsaturated hydrocarbons induce femaleness in *cucumissativus,*it appears that ethylene, the most unsaturated hydrocarbon affecting plants may be the active factor for inducing femaleness. Current theory holds that sex expression in *cucumissativus* is regulated by a balance between, auxin, gibberellins (Roy and Saran, 1990). While ethylene is considered the primary plant hormone affecting femaleness, gibberellins regulate male sex expression (Rudich*et al.,* 1972). The genetically controlled sex expression in *cucumissativus* varies in response to environmental and hormonal cues and ethylene is a major regulator responsible for the sex of *cucumissativus* flowers (reviewed in Yin and Quinn, 1995; Yamasaki *et al*., 2005). Recently it was proposed that ethylene signals influence the M gene product and thereby inhibit stamen development in flower buds (Yin and Quinn, 1995; Yamasaki *et al*., 2001). Because the ability to produce and respond to ethylene appears to account for the different sex expression genotypes in *cucumissativus*, it was hypothesized that the site for ethylene biosynthesis of sex differentiation resides in the flower buds (Yamasaki *et .al*., 2001).

In particular, plants or shoot apices of gynoecious lines produce more ethylene than monoecious lines (Rudich*et.al .,* 1972; Trebitsh*et al*.,1997). The F locus governs the ethylene biosynthesis that is correlated with the development of the female flower (Trebitsh*et al.,* 1997; Mibus and Tatlioglu, 2004).

Gibberellin (GA) and ethylene application and the use of GA and ethylene inhibitors can subvert the genotypic constitution of the plant, with GA acting mainly as a masculinizing agent and ethylene acting as a feminizing agent (Perl-Treves, 1999). Anatomical studies of the sex organs revealed that application of certain growth substances induce the transformation of staminate flower buds into pistillate flower buds. This may be the possible reason for appearance of early female flowers on the lower nodes along the main axis of the treated plant. Exogenous application also caused a significant decrease in node position of the first female cucumber flower on monoecious plants and significant increase in the number of female flowers (Susila*et al 2010*).

By treating monoecious and andromonoecious cucumber plants with various combinations of GA and ethrel or GA and ethylene (silver nitrate) inhibitors, Yin and Quinn (1995) demonstrated that ethylene is the main regulator of sex determination, with GA functioning upstream of ethylene, possibly as a negative regulator of endogenous ethylene production. These findings led them to propose a model for how sex determination might occur (Yin and Quinn, 1995), with ethylene serving both as a promoter of the female sex and an inhibitor of the male sex. The basic tenets of the model are that the F gene should encode a molecule that would determine the range and gradient of ethylene production along the shoot, thereby acting to promote femaleness, whereas the M gene should encode a molecule that perceives the ethylene signal and inhibits stamen development above threshold ethylene levels. This model is consistent with how unisexual flowers might arise very early and very late during shoot development; however, the model also predicts an entire range of intermediate types rarely or never seen in cucumber. As suggested by Perl-Treves (1999), variations in the model of Yin and Quinn and the incorporation of additional factors in the sex-determining process in cucumber could account for the observed lack of intermediate types.

The effects of gibberellins, namely stimulation of thefo-rmation of male flowers, have been noted by many investigators in different species (Rudich *etal*., 1972, Kaushik and Bisaria 1974). Studies show that gibberellins promote male bloom development clearly (Witter and Bukovac, 1996). However, the molecular impact of gibberellins on sex development with cucumber could not be cleared up (Yin and Quinn, 1995). Treatment of genetically female hemp plants with gibberellins resulted in the formation of intersexes and male flowers with normal pollen. Studies by Chailakyhan (1998) also showed parallel results with same plants species. Treatments with exogenous gibberellins increased maleness in cucumber or delayed pistil flower formation. Higher levels of gibberellins were found in monoecious plants.

Effect of Environmenton Sex Expression:

Although sex expression is determined genetically, it is modified by several environmental factors. High nitrogen, short days, low light intensity, low carbon (iv) oxide level and low night temperature are among the factors which favour femaleness. Reverse conditions tend to favour maleness (Shuichi *et al*., 1972).

In most monoecious cucurbit plants, the ratio of staminate to pistillate flowers greatly varies when the plants are grown under different environmental conditions including temperature,photoperiod, pH and treatment with hormones (Lau and Stephenson, 1993; Swaider*et. al*., 1994).

Effect of Soil pH:

The soil pH value is a measure of soil acidity or alkalinity. Soil pH directly affects nutrient availability. The pH value of soil is one of a number of environmental conditions that affects the quality of plant growth. The soil pH value directly affects nutrient availability. Plants thrive best in different soil pH ranges. Azaleas, rhododendrons, blueberries and conifers thrive best in acid soils (pH 5.0 to 5.5). Vegetables, grasses and most ornamentals do best in slightly acidic soils (pH 5.8 to 6.5) (Diane, 2011). Soil pH values above or below these ranges may result in less vigorous growth and nutrient deficiencies.

Nutrients in soil are strongly affected by soil pH due to reactions with soil particles and other nutrients, so infact the availability of many nutrient has been determined as a function of soil pH (Donald, 2012; Kelly *et.al*., 2000),it also affects how the nutrients will react with each other. At low pH, many elements become less available to plants, while others such as iron, aluminium and manganese become toxic to plants. At high pH, calcium ties up phosphorus, making it unavailable to plants, and molybdenum becomes toxic in some soils (Carole and Micheal, 2005). Evidently, cucumber plants have the capacity to recover and compensate for initial decreases in foliage and flower production, and the reproductive stage is not particularly susceptible to simulated acidic rain (Alan *et. al.,* 2011, Jay *et.al*., 1990). These findings support previous results indicating that considerable increases in acidity of ambient rain would have to occur before the yield of crops would be significantly reduced.

The effect of soil pH is great on the solubility of minerals or nutrients. Fourteen of the seventeen essential nutrients are obtained from the soil. Before a nutrient can be used by plants it must be dissolved in the soil solution. Most minerals and nutrients are more soluble or available in acid soils than in neutral or slightly alkaline soils (www.ehow.com).

The soil pH can also influence plant growth by its effect on activity of beneficial microorganisms, bacteria that decompose soil organic matter are hindered in strong acid soils. This prevents organic matter from breaking down, resulting in an accumulation of organic matter and they tie up nutrients, particularly nitrogen that are held up in the o-rganic matter (Papadopoulos, 1994, Gomez *et.al*., 2003).

Soil for *cucumissativus* should be well drained with a pH of 6.5-7.5, a low soil pH favours the tendency for staminate flowers (Grubben and Denton2004; Wang *et.a.,l* (2007) also noted that cucumber prefer light textured soil that are well drained, high in organic matter with a pH value of 6-6.8. *Cucumissativus* are well adapted to acid soils, down to 5.5 (Marie, 2010), Anonymous (2009) reported that pH values higher than 7. 2 resulted in the burning of cucumber roots due to excessive salt. Greenhouse cucumbers generally grow quite well in a wide range of soil pH (5.5-7.5), but a pH of 6.0-6.5 for mineral soils and 5.0-5.5 for organic soil are generally accepted as optimum. A slightly alkaline soil promotes proliferation of pistillate flowers (Haifa, 2007)

Morphological studies have shown that male, female and perfect flowers are formed from an anatomically similar ‘presexual’ primordium. Subsequent differentiation and regulation of the flower sex is under genetic environmental and hormonal control (Wien, 1997). Flowers of *cucurbitaceae* species are borne in leaf axils generally solitary. They are bell shaped and have five fused yellow or white petals. Female flowers have an inferior ovary that forms the fruit called a pepo. Male flowers have five stamens.

Gynoecious plants have only female flowers, because of having only female flowers in every node, gynoecious plants result in the highest yield among the sex types of cucumber. Therefore in commercial production in the last couple of years, nearly all varieties are gynoecious.

Monoecious*cucumissativus* flowers commonly go through three phases of sex expression. The sequence of flowering follows this pattern, firstly, an early period in which only male flowers are produced, secondly a long period in which both male and female flowers are borne on the main axis and secondary branches in cycles, and lastly, a final relatively short phase when female flowers are largely in the majority (Swiader*et.al.,*1996). In a typical monoecious sex form of *cucurbits* the ratio of staminate and pistillate flowers may range from 25 to 30:1 to 15:1, the later condition is advantageous and economical, because consequently it results in higher fruit set and yield (Rashid and Singh, 2000).

Male *cucumissativus* flowers have very short stems, they are composed of four whorls of organs (from the outer to the inner of the whorl): five yellow petals, five sepals, five stamens, and three arrested carpel primordial in the fourth whorl. In contrast, stamens are arrested in their development in the female flower and the three carpel primordial develop further to an inferior ovary, a short style and three separated stigmas (Kater*et.al.,* 2001).

Cucumissativus flower buds differentiate as lateral organs and leaf axils. In general the initiation of floral bud differentiation is observed on nodes situated 3/4 nodes below the apical meristem in *Cucumissativus* shoot. In C*ucumissativus* flower buds, primordial of the sepal, petal, stamen and pistil are formed centripetally from the outside. El-gamriny(1988) confirmed that sex differentiation in *Cucumissativus* takes place at the 2-true leaf stage.

At the early stage of development, floral buds contain primordial of both stamen and pistil, sex determination occurs in flower buds situated at 10-12 nodes below the apical meristem irrespective of the age of the plant. (Fujieda, 1995).

3.MATERIALS AND METHODS

*Seedtreatment:*Treated seeds were collected from Agricultural Development Program (ADP), Owerri, Imo State.Seeds of pickling cucumber were treated with thiram fungicide (141mg a.i per 100g seed). All treatment were applied in a rotary Pan treater with binder Disco A with water (1:1) and conditioning powder MJJ10-E. Seed treatment insecticides were thiamethoxam (cruiser 5SC, Syngenta crop protection,Inc, Greensboro, N.C) at 0.75mg per seed.

Soil samples at depths, 0 -15cm and 15-30cm were taken from various location in the FUTO community. The soil samples were stored in a greenhouse and allowed to air dry. Analysis was conducted to ascertain the soil pH in the Department of Soil science Laboratory, FUTO. The procedure is as follows:Weight 20g of soil sample into a sample bottle using an electronic weighing scale. Add 50ml of distilled water and stir for about 3-5min .Allow mixture to settle.

Test for pH level using a pH meter.pH of water used = 6.95pH of soil sample = 6.23

Treated cucumber seeds of variety Royal Poinsett were planted in loam soil by direct means into each bag in July 2012 in a greenhouse in School of Agriculture and Agricultural Technology, FUTO. 3 seeds were sown in each bag to a depth of about 2cm. Judious watering was done immediately. Soil sample at pH 6.23 was treated using concentrated hydrochloric acid.250ml hydrochloric acid was diluted in 2.25L distilled water per 200g of soil to increase the acidity of the soil sample. Liming was done using calcium carbonate powder to increase the pH of the soil sample above the original pH level of 6.23.The soil sample was treated to different pH levels of 6, 7 and 8.

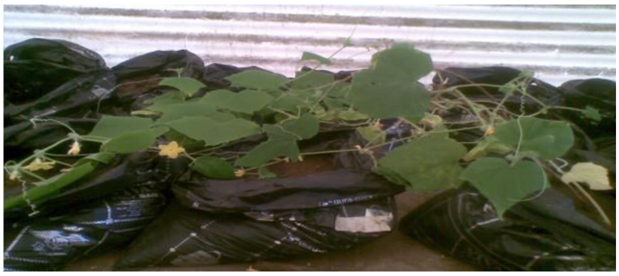

Fig.2. Layout of Plants in Greenhouse

Soil sample were packaged weighing 20kg each in black polythene bags in a greenhouse without supplemental lighting.The experiment was laid out in a completely randomised design CDR. There were three treatments, with five bags per treatment, replicated three times

Regular watering, hand weeding was done. Gradual thining began when plants had obtained 2-leaf stage. The plants were staked using thin sticks with branches 4weeks after germination.

Analysis of data was done using the GenStat analysis of variance software (ANOVA). Differences between means were determined using the Least Significant Difference (LSD) test at 0.05 level ofSignificance.

Parameters studiedVegetative growth parameters:

Days to germination: 5 days after sowing, germinated seeds were counted per treatment to check the rate of germination or germination percentage, to find out viability of seeds.

Germination percentage: the bags were observed for germination percentage based on the expected number seedlings sprouting from the soil.

Plant height: plant height was measured weekly from the soil level to the tip of the plant starting from 14 days after germination.

Number of leaves per plant on main stem: Leaves were counted 14 days after germination and thereafter at 7 days intervals until the appearance of the first flower.

Number of nodes on main stem: these were counted 14days after germination and thereafter at 7 days intervals.

Leaf area: the area of leaves was measured 21days after germination.

Root length: the length of root was measured on eachplant

Reproductive growth parameters:

Number of days to staminate flower: recorded on each plant and the average was taken.

Number of days to pistillate flower: recorded on each plant and the average was taken.

Sex ratio: ratio of pistillate to staminate flowers at the flowering stage, counted from the appearance of the first flower until the last flower on each tagged plant.

Nodes at which first female flower appeared on main stem.

Nodes at which first male flower appeared.

4. RESULTS

The results obtained on the growth and floral characters during the experiment are presented in the table below. All the morphological traits such as main stem, leaf area, number of node, leaf area, were all significantly affected by the different soil treatments.

Table 1. Effect of Soil pH Treatments on Cucumber Plants

Parameter	Leaf number	Length of stem	Number of node	Root length	Leaf area	Number of pistillate flower	Number of staminate flower	Days to flowering
6	5.023b	28.31b	5.980b	5.193b	28.400b	7.267b	6.000b	52
8	5.923a	29.94a	6.810a	6.344a	35.184a	6.135a	5.133a	52.5
7	5.361c	30.100c	22.03c	4.38c	31.225c	7.109b	5.250ab	54

LSD	0.739	1.413	0.685	0.521	3.854	1.139	1.325	NS

Table 2.Effect of Soil pH Treatments on Cucumber Plants Weekly.

	Leaf number	Length of main stem	Number of node	Root length	Leaf number
Wk1	2.00f	14.220e	4.065d	2.150f	8.955e
Wk2	3.136e	20.250d	5.635e	2.915f	14.255d
Wk3	4.600c	30.610c	5.630c	4.480e	28.020c
Wk4	6.100c	31.800c	6.665ab	5.500d	36.740b
Wk5	7.835b	34.645ab	7.335a	6.700c	46.420a
Wk6	9.165a	35.765a	7.670a	8.700b	45.165a
Wk7		36.600a	7.765a	9.965a	42.960ab
LSD	1.28	1.896	0.685	0.976	7.21

Table 3. Mean Values for Flower Types

Treatment	Flower type	Staminate	Pistillate
pH 6		7.3	6.1
pH 8		5.6	8.6
pH7		4.9	5.3

Growth parameters:

Length of stem: Table (i) shows the effect of the different pH strengths on plant height of *cucumissativus*. Statistical analysis obtained ($p< 0.05$) showed significant effect of treatment in all weeks of growth except for week 6 in which the mean values for stem length was insignificant ($p<0.05$).

Leaf number : In the tables i and ii above, statistical analysis of the mean values obtained at p(< 0.05) showed no significant effect of pH treatments at 28DAG, however in comparison with control, pH8 plants produced significantly greater number of leaves ($p<0.05$), with a maximum leaf number at 10.53 while control had the least at 5.33.

Number of nodes: Based on per unit length, the number of nodes for pH 6 treatment from statistical analysis was significantly different from those of pH 8 at ($p<0.05$). pH8 treated plants produced a higher number of nodes at wk 8 in comparison to control and pH6 treated plants.

Root length: The mean number of root length of cucumber plants at 28DAG was significantly different among the different pH strengths, but in comparison with control at p (<0.05) there was no significant difference with pH6 treated plants in the same period.

Leaf area: In both treatments, based on statistical analysis obtained at ($p<0.05$), plants showed significant difference at 28DAG (Days after germination). The plants grown in pH 8 treated soil had a maximum area of 807.5cm while those in pH 6 treatment had 579.4cm. In comparison to control, the treated soil, produced a significantly higher mean number for leaf area.

Fig.4. Male Flower

Number of staminate flowers:

Figure (i) shows the effect of pH on staminate flower anthesis in *cucumissativus*, statistical analysis obtained at p(<0.05) indicates significant effect among treatments with pH 6 recording a maximum of 7.3 staminate flowers at wk 7, while the control produced a lower number at 4.9.

Fig.5. Female Flower

Number of pistillate flowers: Figure (i) shows the effect of pH on pistillate flower anthesis in *cucumissativus*, statistical analysis obtained ($p<0.05$) showed significant effect of treatment in the number of flower. Plants grown in pH8 soil produced maximum number at 7.26 per plant compared to the control which recorded the lowest number of pistillate flowers at 5.3.

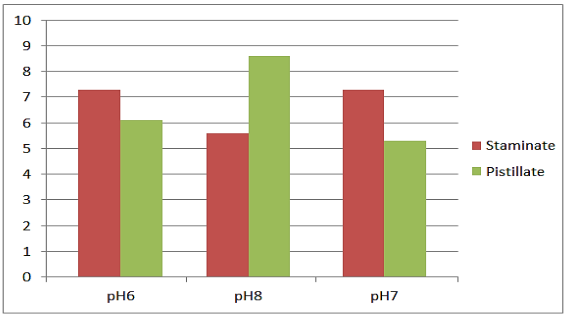

Fig.6. Mean Values of Flower Types

Flowering pattern of *cucumissativus*in the experiment shows that at 52sdays all plants had developed male flower buds with a few showing female anthesis at the 3rd node. For most plants, irrespective of treatment, first female flower were found at either the 5th or 6th nodes.

5. Discussion

Morphological traits:

The results revealed that the influence of pH strength was variable on the morphological parameters of cucumber. Both pH 6 and pH 8 were effective in reducing the length of the main stem and the inhibition of apical growth may have been due to the effect of cessation on cell division (Graulach and Atchinson, 1953) and plant polar auxin transport (Arora *et al*., 1982). At pH 6, plants showed more severe and lasting inhibition on vegetative growth (Abdel-Rahman and Thompson, 1999). Similar findings were reported by Arora *et. al.* (1994) in longmelon and by Murthy *et al*. (2007) in gherkin.

The number of nodes on the main stem, based on per unit length and internodal distance was found to be significantly enhanced. A possible reason might be cessation of the mitotic processes in the meristem of root and shoot, thereby affecting the length of the plant (Hayashi *et al.,* 2001). Inhibition of both cell division and cell elongation has been found with the application of growth retardants, resulting in production of shorter shoots and leaves in melon (Rajala and Peltonen-Saino, 2001). Similar reports have been published by Ouzounidou*et al.* (2008) in *Cucumismelo* L.

The lowest stem length of cucumber plants as noticed in the experiment for pH6 strength could be remained comparatively restricted due to the reduced nutrients uptake (Joana, 2011).

Root length: root growth and development in containers is rarely a perfect representative of root growth in soil (www.plantstress.com), as root development can be a function of the containing vessel. There was a rather reduced growth in the plants grown in pH 6 treated soil in the early stage of the experiment, however, there was a significant improvement at the later stages. It was also found out that leaf expansion with both treatments showed no significant result, this may have been due to reduced nutrient uptake.

Floral traits:

The results of the present study indicated that soil acidity had a significant effect on floral characters, which agreed with other research workers (Kooner*et al.,* 2000; Sulochanamma, 2001; Bhat *et al.,* 2004), shifted sex expression towards femaleness. The results showed that at pH6, higher number of staminate flowers developed while at pH 8, more pistillate flowers developed. pH6 may have provided a stressed condition which resulted in higher number of staminateflowers,such effects could be attributed to the fact that a lower concentration of nutrients slightly inhibited vegetative growth, increased lateral development, reduced respiration (thus increasing carbohydrate levels) and enhanced the development of early staminate flowers (Al-Masoum and Al-Masri,1999).

Days to First Flowering :

The days from sowing to first flowering in different ranged between 52.78 to 53.84 days, although it was not significant at different soil pH. This result is consistent with the findings of Tsay*et. al.* (1987), Imai (1987), Karatky (2003) with regards to the first flowering in cucumber remained in the same range as here.

On pistillate development, similar flowering patterns occurred in all treatments irrespective of pH strength. Generally the first male flower developed at the 2nd node while the first female flower developed at the 3rd node from soil level on the main stem. The second female flower was found at either the 5th or 6th node while the third female flower occurred between the 7th and 9th nodes.

For male/ female flower ratio, more male flowers were produced across treatments in the first 60days, but later floral development showed that female flowers were more in number across treatments. Papadopoulos (1994) indicated in his research that monoecious cucumber plants which experienced such conditions produced more male than female flowers. However, it should be noted that, monoecious cultivars by virtue of their genetic make-up produce fewer female flowers than the gynoecious type which could produce 13 times more female flowers than those obtained in monoecious cultivars (Hector *et al.*, 1993; Schultheis*et. al.,* 1998).

6. Conclusion

The findings has shown that at different levels of pH affect both the vegetative growth and floral development and hence, pH8 is recommended for cucumber cultivation as more pronounced pistillate flowering enhances increased cucumber production. Although most crop plants are not considered model systems—and sex determination is not a problem that can be addressed in the model angiosperm c*ucumissativus*—the economic value in manipulating the sexual phenotypes of crop plants should continue to drive interest in this area of research.

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AUTHOR'S PROFILE

UkaomaAdanmaAugustinaobtained a first degree in Botany from University of Nigeria Nsukka, Enugu State, Nigeria; a masters' degree in Botany from Abia State Unversity, Uturu, Abia State, Nigeria; and a Doctor of Philosophy in Biotechnology from Abia State University, Uturu, Abia State Nigeria and currently pursing another Doctor of Philosophy Degree in Plant Genetics from MichealOkpara University of Agriculture, Umudike, Abia State, Nigeria. She is currently a senior lecturer at the department of Biological Sciences, School of Science, Federal University of Technology, Owerri Imo State.