Review Article

A critical review on effect of fertilizers and plant densities on growth, yield and yield attributes of cucurbitaceous crops

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A B S T R A C T

Cucurbits comprise 117 genera and 825 species. Out of this 30 species of nine genera are used as cultivated plants. Most of the cucurbits viz., cucumber, bottle gourd, ridge gourd, bitter gourd, snake gourd, water melon and muskmelons are monoecious and annual in habit. However plants like pointed gourd, spine gourd, ivy gourd and chow-chow are dioecious and perennials. It is of high market demand with a special delicacy for the people of India and it fetches premium price in the market. Though are potential vegetable crops, there is not much standardized scientific cultivation technology available for improving the yield. Agro techniques like nutrition and spacing play an important role in commercial production. Spacing is an important factor which will influence the plant population and affect the nutrient uptake in plants by creating competition between plants for nutrients, water and availability of light to the plants for synthesizing the food. By manipulation of inter and intra row spacing, several workers reported higher yields. Under field conditions, optimum nitrogen, phosphorus and potassium should be supplied to overcome the bottleneck of production. Several workers reported higher yields with nutrients. However, information on spacing, nitrogen, phosphorus and potassium requirements of pointed gourd, spine gourd, chow-chow and ivy gourd is scarce under Indian conditions. The relevant literature pertaining to the fertilizer and plant densities on growth, yield and yield attributes is reviewed and presented here under with the following sub-heads. Fertilizer studies on growth, yield and yield attributes of cucurbits. Plant density studies on growth, yield and quality yield attributes of cucurbits. Interaction studies between different fertilizer and plant densities on growth, yield and yield attributes of cucurbits.

Keywords
Fertilizers, Plant densities, Cucurbits, Growth and yield.

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Introduction

Cucurbits are important and big group of vegetable crops cultivated exclusively in the sub-tropical and tropical countries. These are annual, semi perennial and perennial vegetable crops. These are monoecious and dioecious vegetables which are grown for its taste and nutritive value. The center of origin is tropical Africa. This group consists of wide range of vegetables, either used as salad (Cucumber) or for cooking (all the gourds) or pickling (cucumber) or for desert fruits (muskmelon and water melon) which are more popular now a days. Most of the cucurbits viz., cucumber, bottle gourd, ridge gourd, bitter gourd, snake gourd, water melon and muskmelons are monoecious and annual.
in habit. However plants like pointed gourd, spine gourd, ivy gourd and chow-chow are dioecious and perennial vegetables. They include mostly seed propagated ones, besides few vegetatively propagated like pointed gourd, spine gourd, ivy gourd and chow-chow. The cucurbits are long tap root system. Leaves are dark green, simple cordate, ovate and oblong. Flowers are tubular, white and fruits are round, oblong and smooth. Cucurbits are high nutrient vegetables compared to other vegetables as it is rich in proteins, vitamin A and C, fat, carbohydrates and minerals like calcium, potassium and phosphorus (Singh, 1989). In severe winter it becomes dormant and sprouts again in summer and it is available for ten months in a year *i.e.* February to November. The green tender and mature fruits are consumed as a vegetable. However new tender shoots and leaves are also used as vegetable. It is easily digestible with good diuretic and laxative properties and also invigorates the heart and brain and is useful in the disorders of the circulatory system. The fruits also possesses anti - cancer properties. Its roots also used in treatment of jaundice besides the leaves reduce blood sugar levels. Due to its high medicinal value, it is becoming popular day by day in the country (Kumar, 2011).

**Fertilizer studies**

Growth is an irreversible increase in size, shape of the plant and it is affected by the complex interaction between environmental factors and physiological processes which are influenced by the application of external inputs like water and nutrients.

Das *et al.*, (1987) studied N at 0, 30, 60 or 90 kg ha$^{-1}$, P$_2$O$_5$at 0, 20, 40 or 60 kg ha$^{-1}$ and basal K$_2$O at 40 kg ha$^{-1}$. The crop was harvested 150 days later. Plant growth and yield increased with rising N: P rates, with the maximum average early yield (45.9 q ha$^{-1}$) and total yield (138.8 q ha$^{-1}$) being obtained at 90:60 kg ha$^{-1}$ in pointed gourd.

Kumar *et al.*, (1990) investigated N at 0, 30, 60 or 90 kg ha$^{-1}$ and P$_2$O$_5$ at 0, 20, 40 or 60 kg ha$^{-1}$. Half of N and entire P plus K$_2$O at 40 kg ha$^{-1}$ were applied at planting and the remaining N was applied 60 days later. The number of fruits plant$^{-1}$ increased from 111.3 at zero N to 167.16 at 60 kg N ha$^{-1}$ and declined to 165.44 at the highest N rate. With P, the number of fruits plant$^{-1}$ increased from 130.82 at zero P to 150.8 at the highest P rate in pointed gourd.

Tripathy *et al.*, (1993) found that NPK each at 30 Kg ha$^{-1}$ gave higher yield and longest fruits while plant height and leaf area were greater with N, P$_2$O$_5$, and K$_2$O each at 60kg ha$^{-1}$ level in spine gourd.

Misra *et al.*, (1994) reported that the application of 150 kg N ha$^{-1}$, 35 kg P ha$^{-1}$ and 67 kg K ha$^{-1}$ gave the highest yield and fruit quality in the Parwal.

Tripathy *et al.*, (1994) reported that 30:30:30 NPK kg ha$^{-1}$ was best for higher fruit yield in pointed gourd. Fruit yield was highly and positively correlated with plant height, leaf area, fruit plant$^{-1}$ and fruit weight.

Goswami and Sharma (1997) reported increased fruit yield in spine gourd with increased levels of P$_2$O$_5$ upto 60 Kg ha$^{-1}$ and K$_2$O upto 75 kg ha$^{-1}$ and no significant interaction was observed between P and K. Further, revealed that neither P nor K had a significant effect on the length of the main vine and K had no effect on ascorbic acid content but this was highest when P was applied at 40 kg P$_2$O$_5$ ha$^{-1}$.

Choudhari and More (2002) revealed that highest vine length, fruit diameter, fruit weight, number of fruits per vine, yield per
vine and yield ha\(^{-1}\), and highest nutrient content in the crop, as well as the lowest nutrient residues in the soil after harvest were recorded when 200:125:125 kg NPK ha\(^{-1}\) was applied in cucumber.

Das et al., (2004) investigated the influence of nitrogen and phosphorus fertilization on growth and yield of pointed gourd and observed that plant growth and yield increased with rising N:P rates and with the maximum average early yield (45.9 q ha\(^{-1}\)) and total yield (138.8 q ha\(^{-1}\)) at 90:60 kg ha\(^{-1}\).

Umamaheswarappa et al., (2005) found that nitrogen levels had a significant effect on number of days required for initiation of first male and female flowers, number of male and female flowers per vine, number of days required for fruit set. The phosphorus levels also showed positive effect on number of male and female flowers vine\(^{-1}\), fruit set per cent and sex ratio in cucumber cv. Poinsette.

El-Gengaihi et al., (2007) found that highest number of fruits was produced with use of the combined medium nitrogen dose and high potassium doses.

The obtained data revealed that higher fruit number with higher fresh and dry weight could be obtained by adding nitrogen at 200 kg acre\(^{-1}\) with potassium at a rate of 100 kg acre\(^{-1}\) bitter gourd.

Shivashankaramurthy et al., (2007) recorded that the combination of NPK has showed significant effect on vegetative characters like number of pistillate flowers, leaf chlorophyll content, yield attributes such as number of fruits, fruit weight and yield in gherkin and concluded that NPK @ 175:125:125 kg ha\(^{-1}\) is the optimal level for good yield and quality of fruits in gherkin. Vishwakarma et al., (2007) with the 80 kg N ha\(^{-1}\) as well as 60 kg P\(_2\)O\(_5\) ha\(^{-1}\) recorded least number of days taken for germination, first female flower anthesis and first harvest; and highest mean values for number of nodes to first female flower, number of fruits plant\(^{-1}\), fruit length, fruit diameter, average fresh weight, yield plant\(^{-1}\), vine length, estimation of chlorophyll and total soluble solids. Treatment combination (80 kg N ha\(^{-1}\) + 60 kg P\(_2\)O\(_5\) ha\(^{-1}\)) emerged as superior over all other treatment combinations in relation to growth, yield attributing components, yield and quality for cultivation of spine gourd.

Hilli et al., (2009) reported that higher dose of fertilizer (100:100:100 kg ha\(^{-1}\)) resulted significantly more vine length, higher fruit and seed yield compared to other levels of fertilizers in ridge gourd.

Jilani et al., (2009) indicated that NPK fertilizer (100-50-50) application in cucumber showed the best performance in almost all the parameters studied, as it took least days for flowering (39.33), fruit setting (11.55), maturity (7.88), maximum fruit plant\(^{-1}\) (35.5), maximum fruit length (18.36 cm), maximum fruit weight (136.03 g) and yield ha\(^{-1}\) (60.02) tons.

Rahul et al., (2010) recorded that the interaction combinations of N P K (200 kg N ha\(^{-1}\) + 50 kg P\(_2\)O\(_5\) ha\(^{-1}\) + 100 kg K\(_2\)O ha\(^{-1}\)) recorded the maximum weight of fruit (230.45 g) and maximum number of fruits plant\(^{-1}\) (13.81) in cucumber cv. Japanese long green.

Sanap et al., (2010) reported that the number of branches, diameter of fruit, yield vine\(^{-1}\) and yield ha\(^{-1}\) were highest when 250 kg N, 50kg P\(_2\)O\(_5\) and 100kg K\(_2\)O ha\(^{-1}\) was applied in bitter gourd.

Sharma and Sharma (2010) found the highest plant height (58.88 cm) was observed at 100% recommended dose of NPK (125-75-60
kg ha\(^{-1}\)) compared to lower doses in cauliflower. Rani et al., (2012) concluded that in pointed gourd the 100% fertigation through drip significantly maximum fruit length (10.55 cm), fruit width (3.96 cm), average fruit weight (38.50 g), weight of fruits vine\(^{-1}\) (6.31 kg) and yield (15.78 tons ha\(^{-1}\)).

Kumar et al., (2012) revealed that in bottle gourd the application of organic manures alone or in combination with half of recommended dose of NPK enhanced the growth and yield attributes in bottle gourd over full dose of recommended NPK (100:50:50 kg ha\(^{-1}\)) and were significantly at par with 10t FYM+ half RDF.

Higher yields can only be obtained with the use of organic manures in combination with chemical fertilizers.

Sureshkumar and Johnson naorem (2015) found that Phosphorus 90 kg ha\(^{-1}\) + Potassium 80 kg ha\(^{-1}\) registered the maximum values in growth parameters viz., vine length, number of branches plant\(^{-1}\), number of leaves plant\(^{-1}\) in bitter gourd.

Maluki et al., (2015) concluded that 50 Kg P\(_2\)O\(_5\) ha\(^{-1}\) and 120 Kg N ha\(^{-1}\) had a positive significant effect on number of days to flowering, number of fruits plant\(^{-1}\), fruit weights, firmness, rind thickness, total soluble solids and no significant difference in sex expression ratio in water melon.

**Plant density studies**

Plant density spacing significantly influences the productivity per unit area by decreasing or increasing the availability of total assimilates to fruits.

Moerman (1984) reported that fruit numbers m\(^2\) were greatest at a spacing of 46 cm, but subsequently the closest spacing gave the best results. Differential effects of spacings on fruit storage quality were slight in cucumber.

Yadav et al., (1989) reported that spaced at 1.5 × 1.5 m or 3.0 × 1.5 m, were trained on the flat or on the bower system. Data are tabulated on the number of shoots plant\(^{-1}\), vine length, days to flower initiation, days to first picking, fruit length, diameter and weight, number of fruits plant\(^{-1}\), and fruit yield. The highest yields (136.3 q ha\(^{-1}\)) were obtained at the closer spacing in pointed gourd.

Pandit et al., (1997) found that the total and early fruit yields were highest (101.71 and 169.82 q/ha, respectively) when plants were spaced 0.60 m apart in rows in pointed gourd.

Dash et al., (2000) noticed that the spacing of 150 cm proved to be the most effective in pointed gourd and 15 female plants around one male was found to be best.

Jan et al., (2000) observed that plant spacing of 50 cm in bottle gourd had significant influence on days to germination, fruit weight (gm), fruit volume (ml), number of fruits vine\(^{-1}\), vine length (cm) and yield ha\(^{-1}\). Increasing plant spacing increased all the above mentioned parameters, except yield ha\(^{-1}\).

Dash and Tripathy (2001) denoted that four densities: 5, 10, 15 and 20 for every male plant at three spacings: 90, 120 and 150 cm around a single male plant at the centre in a circular manner. The increase in distance of female plant from the male plant increased the vine length, number of branches and leaves plant\(^{-1}\), number of female flowers and yield. However, planting 15 female plants 150 cm away from the male plant at the centre records the maximum yield in pointed gourd.

Choudhari and More (2002) concluded that
the highest number of fruits per vine, yield vine\(^{-1}\), yield ha\(^{-1}\), vine length, content of nutrients in the plant after harvesting and lowest residues of nutrients in the soil were recorded in 1.80 m x 0.45 m spacing in cucumber.

Gebologlu and Salgam (2002) found that highest fruit yield was obtained from the 20 cm within row spacing and 75 cm between rows spacing in cucumber.

Ravikumar et al., (2005) found that spacing of 1.50 m x 0.5 m recorded higher fruit yield (154.9 q ha\(^{-1}\)), seed setting (84.1%) and seed yield (76.6 kg ha\(^{-1}\)) though lower in fruit length (18.9 cm) and diameter (19.7 cm) as compared to wider spacing 1.50 x 0.75 m. in cucumber.

Dev (2011) reported that among spacing i.e., 100 cm x 100 cm, 150 cm x 100 cm and 200 cm x 100 cm, the wide spacing recorded significant difference with maximum yield of 200.1 q ha\(^{-1}\) with 37.4 fruits of an average weight 116.2 g plant\(^{-1}\) in bitter gourd.

Kleiton et al., (2013) reported that in water melon the total yield of fruit ha\(^{-1}\) was higher in 1000 plant/ha (66.7 t) compared to 500 plant/ha (33.57 t).

Nweke et al., (2013) showed that in cucumber number of branches, number of leaves and vine length decreased as the plant spacing increased from 50 cm x 30 cm to 50 cm x 40 cm. The closest plant spacing (50 cm x 30 cm) recorded the highest value in all the parameters assessed in this trial except for number of flowers, Days to 50% anthesis, length of fruit and weight of fruit in cucumber.

Sylvestre et al., (2014) found that spacing of 1m x 2 m gave the highest number of fruits and yield (28.59 t ha\(^{-1}\)) in water melon.

Aniekwe and Anike (2015) revealed that plant spacing 50 cm x 40 cm gave rise to a profuse branched plants with longer vines (144.7 cm), greater number of leaves (35.2) and leaf area (181.05 cm\(^2\)), while fruit length of 20.4 cm and the highest fruit diameter (9.53 cm) resulted from the widest plant spacing of 50 cm x 50 cm. The closest plant spacing (50 cm x 30 cm) consistently produced the lowest values in all the vegetative and yield parameters considered except in fruit weight (1.0 kg) in cucumber.

Oga and Umekwe (2016) reported that spacing at 50cm x 60cm significantly increased the number of leaves and 50% anthesis. Spacing at 50cm x 60cm was the adequate measurement for minimizing days to 50% flowering (37.19 days) and maximizing total number of fruits (2.94), weight of fruits (3.03 kg) and total yield (7.57 kg ha\(^{-1}\)). Plant spacing at 50 cm x 40 cm consistently gave the least values in all the yield parameters measured except on the number of fruits in water melon.

**Interaction effects between different fertilizers and plant densities on growth, yield and yield attributes of cucurbitaceous crops**

Vishnu Shukla and Prabhakar (1987) reported that N: P\(_2\)O\(_5\): K\(_2\)O at either 180:100:100 kg ha\(^{-1}\) as a full dose or one-third of this amount as a reduced dose and spacing the plants at 300x45 cm with one plant hill\(^{-1}\) gave the highest average yield of 384.54 q ha\(^{-1}\). The average yield was 385.37 q ha\(^{-1}\) with the full dose of NPK and 300.74 q ha\(^{-1}\) with the reduced dose in bottle gourd.

Jan et al., (2000) obtained that NPK fertilizer doses has significant effect on days to germination, fruit weight (gm), fruit volume (ml), number of fruits vine\(^{-1}\), vine length (cm) and yield ha\(^{-1}\) (tones). Increasing NPK
fertilizer doses also increased the above mentioned parameters. Maximum yield (20.403 t ha⁻¹) was obtained from (164-114-164NPK kg ha⁻¹). Plant spacing had significant influence on days to germination, fruit weight (gm), fruit volume (ml), number of fruits vine⁻¹, vine length (cm) and yield ha⁻¹. Increasing plant spacing increased all the above mentioned parameters, except yield ha⁻¹. Maximum yield (19.709 t ha⁻¹) was obtained from (50 cm) in bottle gourd.

Choudhari and More (2002) studied spacing and fertilizer requirement of cucumber hybrids. The highest number of fruits vine⁻¹, yield vine⁻¹, yield ha⁻¹, vine length, content of nutrients in the plant after harvesting and lowest residues of nutrients in the soil were recorded in 1.80 m × 0.45 m spacing. The highest vine length, fruit diameter, fruit weight, number of fruits vine⁻¹, yield vine⁻¹ and yield ha⁻¹, and highest nutrient content in the crop, as well as the lowest nutrient residues in the soil after harvest were recorded when 200:125:125 kg NPK ha⁻¹ was applied.

Sabo et al., (2013) reported that the interaction between the treatments indicated that 150 kg ha⁻¹ of NPK and a spacing of 1 × 1.5 m gave the highest number of fruits and yield ha⁻¹. Therefore, based on the result of these findings, it is hereby recommended that the use of 150 kg NPK ha⁻¹ at a spacing of 1 × 1.5 m should be adopted by the farmers for profitable watermelon production.

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