Formulation and field evaluation of nutrient stick in oriental pickling melon 
(*Cucumis melo* L.)

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Received: 15-11-2018 Accepted: 16-05-2019 DOI: 10.18805/IJARe.A-5167

**ABSTRACT**

The study was conducted with the objectives to prepare and formulate a multi nutrient stick and to evaluate and compare its effect on oriental pickling melon with fertigation. The investigation was carried out in two parts: formulation of nutrient stick and field experiment using oriental pickling melon. The trials were conducted at College of Agriculture, Padannakkad and Regional Agricultural Research Station, Pilicode during 2016-18. The nutrient stick was formulated as per the nutrient requirement of oriental pickling melon. The nutrient release studies conducted using nutrient stick proved it to be suitable for soil application. A field experiment was carried out in randomized block design with nine treatments and three replications. The treatment combination with foliar silicon spray was found to be highly effective to the crop in terms of quality and yield parameters. The residual available soil nutrients especially nitrogen, phosphorus and potassium were higher in treatments with fertigation as compared to fertilizer application in the form of nutrient stick, which indicated better efficiency of nutrient sticks. These results clearly indicated the suitability of fertilizer application in the form of nutrient stick along with drip irrigation.

**Key words:** Fertigation, Nutrient stick, Oriental pickling melon, Silicon nutrition.

**INTRODUCTION**

Fertilizer stick, also referred to as fertilizer spike or fertilizer stake, is a slow-release complete fertilizer composition formulated in the form of a stick and is composed of ten essential nutrients (N, P, K, Ca, Mg, S, Fe, Zn, Cu, Mn, and B). The nutrients are embedded in a suitable matrix selected after lab trials that ensures a constant supply of nutrients. As we irrigate, the stick gradually dissolves and releases nutrients into the soil from where the plants absorb via the roots. It is used for potted plants as well as plants grown in the field. Fertilizer stick application reduces excessive delivery of nutrient to plants thereby preventing nutrient imbalance. This is achieved since fertilizer stick is prepared in pre-mixed formulae that suit crop requirement and can be used primarily in vegetable crops, ornamental crops, and fruit trees (Ishoo, 2015). We evaluated the dissolution pattern of the stick under laboratory condition and found it to be completely dissolving in water within two days and in soil within 25 days.

Cucurbitaceous crops are cultivated throughout Kerala. Among them, oriental pickling melon (*Cucumis melo var conomon*) is commonly cultivated and most preferred culinary vegetable. It is one of the crops grown in the summer rice fallows of Kerala. Different varieties of oriental pickling melon are in cultivated in which Soubaghya has gained wide acceptance among the vegetable growers of Kerala due its less vigorous and high yielding quality, to medium sized with uniform oblong shape with green in colour with light green lines and on ripening the fruits turns attractive golden colour and short maturation period (65-75 days), which makes it suitable for the short spell of summer rice fallows and market preferences.

The main constrain for oriental pickling melon production during summer rice fallows is scarcity of water for irrigation. In order to ensure sufficient water and nutrient to irrigated oriental pickling melon cultivated in summer, efficient management practices such as fertigation, nutrient stick and foliar spray of nutrients are promising options for efficient management that improves the water as well as fertilizer use efficiencies. Nutrient stick facilitates the application of a wide range of plant nutrients in the correct proportion and in a crop specific manner throughout plant growth. The balanced adequate amounts of nutrients application help the plant to use other essential nutrients more effectively. Recently, slow-release fertilization has been widely practised for balanced fertilizer application, and it increase fertilizer use efficiency. The present investigation was undertaken in this background i.e., to prepare the nutrient stick and evaluate its performance in oriental pickling melon and to compare its effect with fertigation. As the foliar-application of nutrients is an effective method of nutrient application and considering the importance of silicon in yield improvement, conferring plant resistance to both biotic and abiotic stresses, the foliar application of silicon had also been

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included in the investigation to evaluate the effect of foliar silicon on growth, yield and nutrient uptake in oriental pickling melon (*Cucumis melo* var. *conomon*).

**MATERIALS AND METHODS**

The whole study was conducted in two parts one with the preparation of nutrient stick and second to evaluate the nutrient stick and foliar methods of nutrient application in oriental pickling melon as a field experiment.

Nutrient stick is a complete fertilizer composite that is formulated in stick form and contains ten essential nutrients at needed concentration. Raw materials used for the preparation of nutrient stick are factomphos, potassium sulphate, gypsum, magnesium sulphate, iron sulphate, zinc sulphate, borax, copper sulphate and manganese sulphate. Different combinations of powdered fertilizer materials suitable binding agents were heated for 20 minutes. The fertilizer stick formulation condition was standardized and further evaluated for solubility in water and in soil. These nutrient sticks were evaluated in the field with oriental pickling melon as the test crop. The composition of the nutrient stick (for a plant) is given in Table 1.

The field experiment was conducted at Regional Agricultural Research Station, Pilicode, (Kasaragod, Kerala) during the period of March to May 2017. Geographically, the experimental site lies in tropic region, at 12° 12’ N latitude and 75° 10’ E longitude and at an altitude of 15 m above mean sea level with a warm humid tropical climate.

The experiment was carried out in a randomized block design with nine treatments and three replications to ensure the principle of randomization and replication in the experimental design. The randomized block design was set up in such a way that the plot had been divided into 27 plots, each of 4 m length and 3 m width, in each plot 4 pits of size 50 x 50 x 30 cm were opened at a spacing of 2 m x 1.5. Thus each replication contains 9 uniform plots to carry out 9 different treatment applications. The crop production was done by following all the cultural practices starting from the land preparation to the harvest. The different treatment combinations were chosen based on the scientific recommendations of Kerala Agricultural University package of practices of crop production for different crops cultivated in Kerala. The treatment combinations used were with conventional irrigation practices with Kerala Agricultural University (KAU) package of practice (POP) recommendation (T1), drip irrigation + soil test based nutrient application as per modified KAU POP (T2), drip irrigation + nutrient stick (T3). 75% of NPK as per KAU POP through fertigation + 25% nutrient stick (T4), 50% of NPK as per KAU POP through fertigation + 50% nutrient stick (T5), T6 + potassium silicate spray @ 0.25% (T7), T8 + potassium silicate spray @ 0.25% (T9), T9 + potassium silicate spray @ 0.25% (T10).

Observations on different yield attributes were taken to study the effect of treatments on growth and development of the crop. Four plants were randomly selected and tagged from each pit to record the periodical observations. The characters analyzed using the average values of tagged four plants. All the growth parameters such as germination percentage (placing seeds in moistened filter paper for three days and recorded the number of seeds germinated on the fourth day), days to first male flowering (number of days from date of sowing to date of emergence of male flowers from four tagged plants of each pit was recorded and calculated the average), days to female flowering (number of days from date of sowing to date of the emergence of female flowers from four tagged plants of each pit was recorded and calculated the average), the number of fruits per plant (the number of fruits harvested from all the plants in each plot was noted and the average number of fruits per plant is intended), days to harvest (number of days taken by the plant to produce physiologically matured fruits), the weight of fruits (g) (calculated from total fruit yield and total number of fruit per plot), Fruit length (four fruits having mean weight were randomly selected for fruit length determination. The length of fruits was recorded in cm and calculated the average), the yield of fruit per hectare (total weight of the fruit harvested from each plot was recorded and the yield was calculated in kg per plot and yield in tonnes per hectare were calculated) and the incidence of pest and disease were recorded during the course of the investigation.

Analysis of variance was done separately for all the parameters at different stages as per the statistical design randomized block design and significant was tested as per the “F” test (Snedecor and Cochran, 1964).

**RESULTS AND DISCUSSION**

The stick was standardized into a cylindrical shaped rough surface structure with 5 cm length and 15 cm diameter. The quantity and quality of the nutrients present in the stick will remain as such even after mixing the nutrient stick with other fertilizers. The release pattern of the nutrients from the stick as evaluated by lab trial. In the trial, 10 g of the fertilizer stick was mixed with 50, 100, 150, 250 and 500 ml of water at room temperature as well as at 100°C. The fertilizer water

**Table 1:** Composition of Kerala Agricultural University package

| Nutrient content (for a plant) | Amount (g) |
|-------------------------------|------------|
| Factomphos                   | 50.0       |
| Urea                          | 20.0       |
| Potassium sulphate            | 20.0       |
| Gypsum                        | 20.0       |
| Magnesium sulphate            | 10.0       |
| Iron sulphate                 | 5.0        |
| Zinc sulphate                 | 5.0        |
| Borax                         | 2.0        |
| Copper sulphate               | 2.0        |
| Manganese sulphate            | 1.0        |
ratio of the stick in 250 ml water demonstrated a constant release pattern. Oertli and Lunt (1962) reported that nutrient release from a controlled-release fertilizer over a range of temperatures doubled every 10°C rise in temperature. This shows the influence of temperature on the dissolving pattern of the nutrient stick in the water. In general, nitrogen release was the fastest followed by potassium, whereas phosphorus release was significantly slower in water. The main factor slowing the release was assumed to be the lower solubility of ions with phosphorus being the least soluble.

In the soil release pattern studies, a stick was buried in 200 g of soil taken in a 500 ml beaker and it a field capacity in every five days the sample was slowly taken by emptying the soil to a tray and observing for the presence of stick. It was observed that the stick completely gets disintegrated in the soil in a period of 25 days. Jacob (2005) and Broschat (2005) reported that ammonium (NH₄) and nitrate (NO₃) released 85-91% and 71-85%, respectively, of available nutrients during the period. However, the release of phosphate (P₂O₅) was found to be only 19-37% of original composition during the release period. Macronutrient release ranking was NO₃ > NH₄ > K > sulphur > magnesium > P. Micronutrients release (iron, manganese, zinc and molybdenum) decreased very little from initial contents.

The effect of fertigation nutrient stick and foliar spray of potassium silicate on male flower emergence of the crop was not significant. Days taken to male flower emergence varied almost 21 to 23 days for all the treatments. Whereas, days have taken to first female flower emergence of crop oriental pickling melon var. Soubhagya as influenced by fertigation, nutrient stick and foliar spray is given in Table 2. The female flower emergence of var. Soubhagya was also not significantly influenced by treatments, as indicated in data presented in Table 2. Days taken to female flower emergence were almost 27 to 29 days for all the treatment combination. A similar finding was reported by Ningaraju (2013) and Ashly (2015) in oriental pickling melon with fertigation of nutrients under high-density planting. They had reported that fertilizer application had no significant influence on days taken to first flowering.

The levels of fertigation, nutrient stick and foliar spray of silicon have not influenced the time taken for the formation of first fruit showing no significant effects. Days taken to first fruit formation varied between 31 to 33 days. The effect of treatment application exhibits significant influence on average fruit length, fruit weight, and number of fruits per plant, mean yield and days taken for the fruit harvest. It shows that fertilizer application could make a substantial effect on yield attributes of crop oriental pickling melon.

The numbers of days taken from sowing to harvest were recorded for the treatments. The data were subjected to analysis of variance for RBD. The result indicated the influence of treatments (Table 3) and showed a significant difference with respect to crop duration for harvest. The shortest duration recorded was 59.6 days for T₄ (75% of NPK as per KAU POP through fertigation + 25% nutrient stick. The usual harvest duration of the crop variety Soubhagya was 65 to 75 days. The best treatment T₆ could reduce the duration by 5 to 15 days from the normal duration. These shows the nutrients were absorbed efficiently during the vegetative growth of the plant. The analysis of soil sample at 45 days after sowing indicated that the treatment T₆ recorded the highest content of potassium in the soil. This indicated the element potassium, triggers fruit set in plants had been efficiently made available to the crop by the treatment T₆, which resulted in the early fruit set of the crop. In the summer rice fallows, initial ploughing operation for the first crop of rice has to be done immediately after the receipt of summer showers, and that is why the short duration variety Soubhagya variety is preferred by farmers.

The data on average fruit length (cm) are given in Table 3. The result indicated a significant influence of treatments on fruit length. Among the treatments, maximum fruit length (20.1 cm) was recorded in T₆ (T₄ + Potassium

Table 2: Effect of fertigation, nutrient stick and foliar spray of silicon on male flower emergence, female flower emergence and days to first fruit set.

| Treatment | Days to male flower emergence | Days to female flower emergence | Days to first fruit set |
|-----------|-----------------------------|-------------------------------|------------------------|
| T₁        | 21.1                        | 28.4                          | 32.0                   |
| T₂        | 22.4                        | 28.6                          | 32.6                   |
| T₃        | 22.0                        | 28.3                          | 31.4                   |
| T₄        | 22.0                        | 29.2                          | 33.0                   |
| T₅        | 21.5                        | 27.0                          | 32.6                   |
| T₆        | 23.0                        | 29.3                          | 32.5                   |
| T₇        | 21.5                        | 27.6                          | 31.4                   |
| T₈        | 21.4                        | 28.8                          | 32.2                   |
| T₉        | 21.6                        | 27.3                          | 31.3                   |
| C.D.      | NS                          | NS                            | NS                     |
| SE(m)     | 0.451                       | 0.672                         | 0.521                  |

Table 3: Effect of fertigation, nutrient stick and foliar spray of silicon days to harvest and average fruit length.

| Treatment | Average fruit length (cm) | Days to harvest |
|-----------|---------------------------|-----------------|
| T₁        | 17.26                     | 64.3            |
| T₂        | 17.86                     | 60.3            |
| T₃        | 17.93                     | 60.3            |
| T₄        | 19.30                     | 59.6            |
| T₅        | 19.16                     | 62.3            |
| T₆        | 18.53                     | 64.0            |
| T₇        | 19.28                     | 60.3            |
| T₈        | 20.10                     | 62.0            |
| T₉        | 18.63                     | 61.3            |
| C.D.      | 0.685                     | 2.42            |
| SE(m)     | 0.227                     | 0.801           |
silicate spray 0.25 per cent). Elongation of fruit cells resulted in the increased fruit length. Gibberellins are the hormones responsible for the elongation of the cell. The application of potassium silicate spray 0.25 per cent enhanced the synthesis of gibberellins and alpha-amylase as it plays a crucial role in amino acid and proteins metabolism. This finally resulted in increased fruit length. The similar result was obtained by Aramini et al., (1995).

The data on the number of fruits per plant are presented in Table 4. The number of fruits per plant was significantly influenced by the nutrient stick, foliar spray and fertigation. T₇ (T₇ + Potassium silicate spray - 0.25 per cent) recorded the maximum number of fruits per plants (3.12). Phosphorous is the element responsible for the production of flower buds in plants. The treatment application of treatment T₇ supplied the required amount of nitrogen and phosphorous throughout the crop period as the treatment had the application of nutrient stick along with the foliar spray. In addition, the application of potassium silicate as foliar spray enhanced the absorption of phosphorous by the plants from the soil. The combined effect of phosphorous and potassium in the crop resulted in the production of more number of flower buds and synthesis of phytohormones such as auxin and ethylene respectively which lead to the production of more number of fruits per plant. Abduljabbar and Ghurbat (2010) reported that mineral nutrients influence sex expression in soils that are deficient in K, where the inclusion of K in the compound fertilizer increased the female flowers and subsequently enhanced fruit yield in squash. A similar result was reported by Shaymaa et al., (2009) in tomato under fertigation and Ningaraju (2013) in oriental pickling melon.

The data on the average weight of the fruit is given in Table 4. The levels of fertigation, nutrient sticks and foliar sprays of potassium silicate significantly influenced the average weight of the fruit of crop oriental pickling melon var. Southagya. The maximum average weight of the fruit (98.1 g) was observed with the treatment T₇ (T₇ + Potassium silicate spray @ 0.25 per cent). The increase in fruit weight with the treatment application of T₇ is due to the involvement of hormonal metabolism, increase in cell division and cell expansion of the cell.

Fruit yield is the major economic factor considered in cucumber cultivation. The data on mean fruit yield (kg plot⁻¹) of the crop is given in Table 4.

The application of nutrient stick, level of fertigation and foliar spray of silicon influenced the fruit yield. The maximum fruit yield (44.98 kg/plot) was observed with the treatment T₇ (T₇ + Potassium silicate spray @ 0.25 per cent). Number of fruits per plant and total fruit, the yield was increased significantly with treatment application. The highest number of fruit per plant and total fruit yield per plot were recorded in treatment T₇ (with drip irrigation + nutrient stick (100 per cent) + potassium silicate spray @ 0.25 per cent). This treatment has registered its favourable and positive results with respect to yield parameters of the oriental pickling melon. This might be attributed to the reason that nutrient supplied in this treatment are sufficient

Table 4: Effect of fertigation, nutrient stick and foliar spray of silicon average weight of the fruit, total fruit yield and number of fruits per plants.

| Treatment | Average fruit weight (g) | Total fruit yield (kg/plot) | Number of fruits per plant |
|-----------|--------------------------|-----------------------------|---------------------------|
| T₁        | 770                      | 27.53                       | 2.25                      |
| T₂        | 822                      | 31.11                       | 2.36                      |
| T₃        | 848                      | 41.00                       | 3.02                      |
| T₄        | 941                      | 39.49                       | 2.62                      |
| T₅        | 889                      | 37.20                       | 2.61                      |
| T₆        | 826                      | 32.56                       | 2.44                      |
| T₇        | 900                      | 44.98                       | 3.12                      |
| T₈        | 981                      | 42.85                       | 2.73                      |
| T₉        | 926                      | 38.82                       | 2.62                      |
| C.D.      | 48.13                    | 4.587                       | 0.232                     |
| SE(m)     | 15.917                   | 1.517                       | 0.077                     |

Table 5: Effect of fertigation, nutrient stick and foliar spray of silicon on available N, P and K in soil.

| Treatment | Available nitrogen (kg ha⁻¹) | Available phosphorous (kg ha⁻¹) | Available potassium (kg ha⁻¹) |
|-----------|------------------------------|---------------------------------|-------------------------------|
|           | 45 DAS Harvest | 45 DAS Harvest | 45 DAS Harvest | 45 DAS Harvest | 45 DAS Harvest | 45 DAS Harvest | 45 DAS Harvest |
| T₁        | 252 | 212 | 94 | 79.6 | 327 | 256 |
| T₂        | 246 | 228 | 95 | 86.6 | 235 | 174 |
| T₃        | 245 | 234 | 91 | 81.3 | 190 | 181 |
| T₄        | 313 | 288 | 112 | 97.2 | 322 | 156 |
| T₅        | 304 | 267 | 109 | 88.2 | 298 | 134 |
| T₆        | 248 | 216 | 97 | 87.7 | 251 | 179 |
| T₇        | 244 | 269 | 98 | 83.14 | 215 | 158 |
| T₈        | 318 | 281 | 108 | 96.9 | 352 | 217 |
| T₉        | 312 | 279 | 111 | 83.4 | 269 | 178 |
| C.D.      | 53.730 | 12.411 | NS | 6.23 | 39.290 | 49.977 |
| SE(m)     | 17.769 | 4.105 | 6.600 | 2.061 | 12.994 | 16.528 |
and balanced. Proper balanced fertilizer application enables higher uptake of nutrients by the plants and had resulted in increased yield. Increase in fruit yield per plot could be related to a significantly higher number of fruits per plant in nutrient stick applied plot and increase of fruit weight in fertigation over the conventional method. Ningaraju reported a linear increase in yield and yield attribute due to the increase in levels of fertilizer application.

Among the treatment levels, the average weight of fruit and fruit length increased in the treatment requiring 75 per cent of NPK as per KAU POP through fertigation + 25 per cent nutrient stick + potassium silicate spray @ 0.25 per cent, the values obtained were 981g and 20.1cm respectively. Days to fruit, harvest differed significantly as influenced by treatments. Days to fruit harvest were early in treatment T4, which was 75 per cent of NPK as per KAU POP through fertigation + 25 per cent nutrient stick. Early maturity was recorded in the fertigated plot. Days to first fruit harvest in nutrient stick and the fertigated field was 59 to 62 days respectively and in the conventional method of irrigation plus fertilizer application (KAU POP recommendation) was 64 days. The result indicates that the application of balanced fertilizer application reduces the days taken for the maturity of fruits from flowering. The positive relations between fertilizer application and irrigation on enhancing fruit yield in a melon have been reported by Harnandez and Aso (1991).

CONCLUSION

Nutrient stick is a complete fertilizer composite in solid formulation. It contains ten essential nutrients. Results of the field experiment clearly indicate that the application of fertilizers in the form of nutrient stick along with silicon foliar spray has positive effects on growth and yield of oriental pickling melon. The treatments which included the application of silicon as foliar spray recorded maximum shelf life of fruits, extending to six months after harvest.

The results obtained from this experiment clearly indicate that application of fertilizers through nutrient stick along with foliar silicon was found to be highly effective. In fertigation treatments residual available soil nutrients were higher as compared to fertilizer through nutrient stick, indicating better efficiency of nutrient sticks.

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