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# EFFECT OF BIOFUEL GENERATED DE-OILED CAKES ON GROWTH AND YIELD OF TOMATO

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**KEYWORDS**

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## ABSTRACT

A field experiment was carried out at Bio-fuel Park, Madenur, Hassan in Rabi season of 2014-15 to assess the performance of tomato (*Solanum lycopercicum;* variety- Arka vikas) using different biofuel generated de-oiled cakes. Experiment consisted of eight treatments with combination of different oil cakes, Vermicompost, FYM and chemical fertilizers with three replications laid in randomized complete block design. Treatment received Calophyllum cake at 20% N equivalent + 80% N through fertilizers ($T_8$) showed significantly higher fruit yield per plant (4.18 kg), yield per hectare (77.4 t/ha) and number of fruits per plant (80.6), with 15.79% increase in yield over control. But the results on yield were on par with the treatment $T_5$, which received Neem cake at 20% N equivalent (75.09 t/ha) and T4 which received Pongamia cake at 20% N equivalent (70.06 t/ha).Soil application of organic and inorganic nutrients results in improvement in yield and soil nutrient status after harvest, hence different de-oiled cakes can be used as tailored organic fertilizers in integrated nutrient management practice with replacement of chemical fertilizers.

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## INTRODUCTION

Tomato (*Solanum lycopersicum* L.) belongs to the botanical family solanaceae; it is the world's largest grown vegetable crop after potato and onion. Tomato is produced on large scale in China, USA, India, Turkey, Russia, Italy, Iran and Spain (Anon., 2011). Tomato represents an essential part of human diet, it is a good nutritional resource rich in vitamin C and antioxidants mainly lycopene, carotene, organic acids and phenols (Giovanelli and Paradiso, 2002). Nutrient management practices are very important in tomato production due to high productive ability. Supplementation of secondary and micro-nutrient through amendment and fertilizers depending on the soil condition can substantially increase the yield in tomato (Nambiar, 1994). This can be managed through integrated nutrient management, which involve a combined use of fertilizers and organics to sustain crop production and maintenance of soil health (Nanjappa *et al.*, 2001), this might be possible due to balanced supply and availability of nutrients, through chemical fertilizers and macro and micro nutrients from farm yard manure, neem cake and Vermicompost (Pal *et al.,* 2015).

The oil cakes after expelling oil can be recycled as valuable major and micro-nutrients sources. The seed cake was the major byproduct of the biodiesel production process and attempt has to make to know the utilization of these cakes (Doddabasawa and Ravikumar, 2014). These non-edible cakes are more viable option to meet this demand significantly as edible oil cakes cannot be utilized for agriculture purposes. Micronutrient content enhancement in soil was reported by using oil cakes. Neem cake significantly increases the exchangeable calcium, iron, manganese, copper and zinc content in soil (Elnasikh *et al.*, 2011). Pongamia seed cake also contain micro nutrients like Iron 1000 ppm, Zinc 59 ppm, Manganese 74 ppm, Boron 19 ppm, Sulphur 1894 ppm and can be utilized as a good source of manure (Osman *et al.,* 2009),

Importance of neem cake in agriculture is known since time immemorial, however the studies on the manurial value of pongamia, mahua, simarouba, calophyllum and other oil seed cakes on the productivity of annual crop plants are limited. Considering the above facts, the present study was therefore under taken to evaluate effect of different biofuel oil seed cakes on growth and yield of tomato.

## MATERIALS AND METHODS

A field experiment was carried out during Rabi season of 2014-15 to study the impact of different biofuel oil cakes on growth and yield of tomato (*Solanum lycopersicum* L.) var. Arka vikas at the Biofuel Park, Madenur, Hassan, University of Agricultural Sciences, Bangalore. The location is situated at an altitude of 423.7 m above mean sea level and latitude of 13.00$^0$ North and Longitude of 76.09$^0$ East. A drought tolerant tomato variety, 'Arka vikas' developed by IIHR Bengaluru, was used as material for present study. Biofuel oilseed cakes like Pongamia, Neem, Mahua, Simarouba and Calophyllum were obtained as a byproduct while expelling oil from the seeds at Biofuel Park, were utilized for the study. These cakes were

analyzed for its nutrient (NPK) content and presented in Table-1.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with eight treatments and three replications. The eight treatments includes, $T_1$: FYM alone 100%, $T_2$: 100% NPK through fertilizers (control), $T_3$: Vermicompost at 20% N Equivalent + 80% N through fertilizers, $T_4$: Pongamia cake at 20% N Equivalent + 80% N through fertilizers, $T_5$: Neem cake at 20% N Equivalent + 80% N through fertilizers, $T_6$: Mahua cake at 20% N Equivalent + 80% N through fertilizers, $T_7$: Simarouba cake at 20% N Equivalent + 80% N through fertilizers and $T_8$: Calophyllum cake at 20% N Equivalent + 80% N through fertilizers. Tomato seedlings of 45 days old were transplanted at spacing of 90 X 60 cm and for each treatment different oil cakes (20% N Equivalent), full dose of P and K were applied. The cakes along with nitrogen also contain P and K. Hence, the subsequent amount of P and K were reduced from fertilizers to make the recommended fertilizer dose. For oil cake treatment rest of the 80% nitrogen was applied in 2 split doses as basal dose and during earthing up using urea. Proper package of practices were followed at regular intervals. For control treatment ($T_2$) 100% recommended dose of NPK (115: 100: 60 kg/ha) was applied through inorganically using Urea, DAP and MOP respectively.

Different growth and yield parameters were recorded during the crop growth period like height of the plant (cm), number of branches, total number of fruits per plant, fruit yield per plant (kg), average fruit weight (g) and fruit yield per hectare (t/ha).The weight of fruits harvested from each picking was recorded and total yield per plant was worked out by adding the yield of all harvests. Harvesting durations were grouped into 20 days intervals from the first harvest, to know the distribution of harvest. For the calculation of fruit yield per hectare, yield of each plot was taken and converted to hectare basis. The recorded data was analyzed statistically following the analysis of variance table as suggested by Panse and Sukhatme (1985) at 5% level of significance.

## RESULTS AND DISCUSSION

### Effect on growth and yield

The analysis of variance indicated that, treatments comprising different combinations of organic nutrients such as Calophyllum, Pongamia, Neem cakes along with FYM and inorganic fertilizers appeared to have significant effect on fruit yield and productivity of tomato compared to 100% through inorganic fertilizer alone (Table 2). Significantly higher fruit yield of tomato was recorded with application of Calophyllum cake at 20% N equivalent + 80% N through fertilizers ($T_8$) i.e. 4.18 kg/ plant, which was on par with treatment comprising of Neem ($T_5$) and Pongamia cakes ($T_4$) at 20% N equivalent (4.0 and 3.78 kg/ plant respectively). Least fruit yield of tomato per plant was recorded in treatment with FYM alone 100% ($T_1$: i.e. 2.64 kg/ plant). Highest number of fruits per plant was recorded in Calophyllum cake treatment at 20% N equivalent- $T_8$(80.6) and was on par with 20% N through Neem, Pongamia, Mahua cake and control plants (76.11, 73.6, 72.53 and 69.93 respectively), while the least number of fruits were recorded in plants applied FYM alone ($T_1$: negative control i.e. 54.73).The results for number of branches, height of the plant and average weight of single fruit was found to be non significant between the treatments. Application of Calophyllum oil seed cakes as 20% N equivalent resulted in 15.79 percent of higher fruit yield and 15.26 percent of higher fruit set per plant than the control treatment with 100% RDF through fertilizers. Integrate nutrient management significantly influenced the yield in

**Table 1: Nutrient content of different de-oiled cakes**

| Sl.no | Oil Cakes | pH | EC(ds/m) | OC(%) | Total N(%) | Total P(%) | Total K(%) |
|---|---|---|---|---|---|---|---|
| 1 | Pongamia | 5.8 | 1.0 | 51.5 | 3.9 | 0.60 | 0.88 |
| 2 | Neem | 5.7 | 1.0 | 20.6 | 3.9 | 0.36 | 1.0 |
| 3 | Mahua | 4.7 | 1.6 | 51.9 | 1.5 | 0.29 | 0.36 |
| 4 | Simarouba | 5.6 | 0.9 | 53.9 | 7.1 | 0.38 | 0.5 |
| 5 | Calophyllum | 4.5 | 1.1 | 42.4 | 2.1 | 0.29 | 0.11 |

**Table 2: Effect of de-oiled cakes on growth and yield of tomato**

| Treatment | Number of branches | Height of the plant(cm) | Yield per plant (kg) | Yield (ton/ ha) | Number of fruits per plant | % Change overcontrol | | Avg. weight of single fruit (g) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Yield | Number of fruits | |
| $T_1$:FYM alone 100% | 6.0 | 52.3 | 2.64 | 48.99 | 54.73 | -26.87 | -21.74 | 48.33 |
| $T_2$:RDF- 100% NPK through fertilizers (Control) | 6.6 | 55.6 | 3.61 | 66.80 | 69.93* | - | - | 51.58 |
| $T_3$:Vermicompost @ 20% N Equivalent | 5.9 | 51.2 | 2.90 | 53.76 | 64.32 | -19.67 | -8.02 | 45.14 |
| $T_4$:Pongamia cake @ 20% N Equivalent | 5.8 | 54.4 | 3.78* | 70.06* | 73.6* | 4.71 | 5.25 | 51.40 |
| $T_5$:Neem cake@ 20% N Equivalent | 6.3 | 65.0 | 4.05* | 75.09* | 76.11* | 12.19 | 8.84 | 53.28 |
| $T_6$:Mahua cake @ 20% N Equivalent | 6.3 | 53.1 | 3.59 | 66.49 | 72.53* | -0.55 | 3.72 | 49.51 |
| $T_7$:Simarouba cake @ 20% N Equivalent | 5.4 | 52.4 | 3.12 | 57.82 | 58.3 | -13.57 | -16.63 | 53.55 |
| $T_8$:Calophyllum cake @ 20% N Equivalent | 6.8 | 56.6 | 4.18* | 77.41* | 80.6* | 15.79 | 15.26 | 51.86 |
| S. Em ± | - | - | 0.092 | 32.93 | 4.083 | - | - | - |
| CD @ 5% ($p$=0.05) | NS | NS | 0.544 | 10.058 | 3.536 | - | - | NS |

Note: * F-test value is significant at CD @ 5% ($p$=0.05); NS = Non significant.

**Table 3: Fruit yield per plant during different duration of crop growth period**

| Treatment | | Yield from 0-80 days (kg) | Yield from 80-100 days (kg) | Yield from100-120 days (kg) | Yield from 120-140 days (kg) | Yield from 140-160 days (kg) |
|---|---|---|---|---|---|---|
| $T_1$ | FYM alone (Negative control) | 0.09 | 1.08 | 0.66 | 0.54 | 0.15 |
| $T_2$ | RMP (Positive control) | 0.55 | 1.46 | 0.69 | 0.71* | 0.19 |
| $T_3$ | Vermicompost | 0.46 | 0.89 | 0.86* | 0.47 | 0.22 |
| $T_4$ | Pongamia cake | 0.47 | 1.41 | 0.82 | 0.83* | 0.25 |
| $T_5$ | Neem cake | 0.94* | 1.23 | 0.95* | 0.67* | 0.25 |
| $T_6$ | Mahua cake | 0.4 | 1.40 | 0.83* | 0.61 | 0.35* |
| $T_7$ | Simarouba cake | 0.28 | 0.98 | 0.85* | 0.73* | 0.27 |
| $T_8$ | Calophyllum cake | 0.72 | 1.60* | 0.97* | 0.65* | 0.23 |
| S. Em ± | | 0.006 | 0.006 | 0.001 | 0.017 | 0.003 |
| CD @ 5% ($p=0.05$) | | 0.078 | 0.130 | 0.147 | 0.188 | 0.062 |

Note: F-test value is significant at CD @ 5% ($p=0.05$)

**Table 4: Comparison of nutrient status of experiment site before and after the experiment**

| Soil status | OC (%) | pH | EC ($dSm^{-1}$) | Available- N(kg $ha^{-1}$) | Available- P(kg $ha^{-1}$) | Available- K(kg $ha^{-1}$) |
|---|---|---|---|---|---|---|
| Before experiment | 0.32 | 7.82 | 0.09 | 262.64 | 27.64 | 280.47 |
| After experiment | 0.37 | 7.88 | 0.13 | 279.44 | 31.29 | 301.46 |

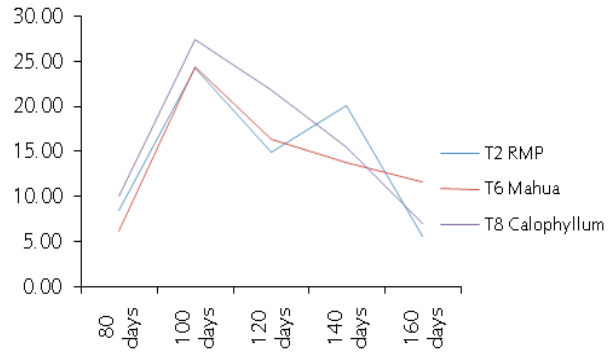


**Figure 1: Number of fruits during crop growth period in comparing Mahua, Calophyllum cakes with control treatment**

tomato (Harikrishna *et al.*, 2002; Patil *et al.*, 2004; Singh *et al.*, 2013). Similar yield increase was obtained in Tomato by application of Jatropha oil cake in a pot experiment (Chaturvedi and Kumar, 2012). Similar trend of yield increase was obtained by addition of neem cake in mung bean (Abdelhamid *et al.*, 2004). Correspondent results were obtained by Shivakumar *et al.* (2011) that treatment with neem cake at 100% N equivalent obtained significant results in yield of finger millet.

The harvesting started from 67$^{th}$ day of planting, and lasts for 160 days. Treatment plants applied with Neem cakes were early in bearing and showed significantly higher yield in initial 80 days among all. In later stages from 140 to 160 days of planting, significantly higher yield of fruits were observed in Mahua cake applied plants, this may be due to slower release of nutrients (Table 3).

Even though the good amount of nutrient present in Mahua cake, crop is unable to utilize those nutrients because of the short duration of the crop. In control plants (RDF- 100% NPK through fertilizers) sudden decrease in number of fruits after 140 days was observed compare to Mahua cake applied plants, which shown gradual decrease (Fig.1). Mahua and Simarouba cake applied plants were lush green and lasted for long time. Life of the plant was extended due to continuous supply of nutrients slowly; it means that cake application will be more beneficial for long duration crops. Study conducted by Linares *et al.* (2003) supports that, Mahua cake takes two months to decompose. Most of the oilcakes possess certain bioactive compounds specific to the particular plant species. These compounds act as an allelopathic agent like phenols, organic acids and other complex constituents which restricts its use as a fertilizer agent (Martin *et al.*, 2002). Even though the presence of good amount of nutrient in them, yield reduction in Mahua and Simarouba cake is may be due to presence of allelopathic agents and slow release of nutrients. Oil cakes inhibit nitrification process in soil and improved the N recovery from applied N in arable soils.

### Effect on soil fertility

Soil analysis in experimental site after the harvest showed the increment of organic carbon content (%), pH, EC, available nitrogen (kg $ha^{-1}$), phosphorous and potash in the soil (Tabe-4). Soil responded positively to the oil cakes application and the remaining nutrients in soil can be utilized for next season crop. Similar results were also reported by Shivakumar *et al.* (2011) where there was improvement in the soil fertility after the experimentation with de-oiled cakes compare to inorganic farming. Addition of oil cakes serves as a source of organic matter, major and micro nutrients, hence it enhances the organic carbon as well as nutrient in soil significantly (Tiyagi and Alam, 1995; Elnasikh *et al.*, 2011).

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