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# Impact of inorganic fertilizer substitutions by vermicomposted coconut leaves on productivity and economics of coconut

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**Abstract**

Investigations were carried out to study the impact of inorganic fertilizer substitutions by vermicompost on productivity of coconut during 2001 to 2009 at CPCRI, RS, Vittal in a 22 year old coconut garden under laterite soil. The treatments *viz.* recommended inorganic fertilizer (500g N, 320g $P_2O_5$ and 1200g $K_2O$ palm/year), 25 % of N in the form of Vermicompost (VC) (9.6 kg/palm)+75 % of NPK, 50 % N in the form of Vermicompost VC (19.2 kg/palm)+50 % of NPK, 75 % N in the form of Vermicompost (VC) (28.8 kg/palm)+25 % NPK and 100 % N in the form of VC alone (38.5 kg/palm) were imposed in randomized block design. Five year pooled nut yield data indicated that, application of vermicompost in combination with inorganic fertilizer either at 25 % Vermicompost (VC) + 75 % NPK (65 nuts) or 50 % VC + 50 % NPK (63.2 nuts) resulted in significantly higher nut yield. The copra content and oil content did not differ significantly among the treatments. However, the copra content was ranged between 182.2 g to 184.4 g/nut and oil content ranged between 64.0 to 65.8 %. Economics of different treatments indicated that, the net return obtained under 25 % Vermicompost (VC) + 75 % NPK and 50 % VC + 50 % NPK was higher (Rs. 16,673/- and Rs. 16,144/-per ha, respectively) compared to other treatments.

*Keywords:* Coconut, copra, economics, nut yield, vermicompost

## Introduction

Coconut (*Cocos nucifera* L.) is an important crop of the humid tropical region and India is the largest producer and is mainly cultivated in coastal belt of west and east coast. Kerala, Tamil Nadu, Andhra Pradesh and Karnataka are major coconut growing states accounting for more than 90 % of the area and production. Coconut is a perennial crop committed to the land for more than 60 years. The annual nutrient export by various parts of the palm *viz*. nuts, fronds, trunk, bunch and spathe reported by different workers vary from 20 to 174 kg N, 2.5 to 20 kg P and 35 to 249 kg K $ha^{-1}$ (Pillai and Davis, 1963; Ramadasan and Lal, 1966; Ollangnier and Ochs, 1978), but there appears to be a general agreement on the ratio of N and K removed by the palms (1: 1.44 - 1.75). Soil is not an inexhaustible source of nutrients and hence, the nutrient depletion over a period of time will adversely affect the nut yield, if the soil is not replenished with the nutrients. The crop with a density of 175 palms/ha requires 353 kg/ha of N, P and K as per Central Plantation Crops Research Institute recommendation. This is based on general recommendation from CPCRI for fertilizing the matured bearing palms at 500g N, 320g $P_2O_5$ and 1200g $K_2O$ $palm^{-1}$ $year^{-1}$, to be applied in two split doses *viz*. one-third in May-June and two-third in September-October (Nelliat, 1973). But, the consumption of fertilizer in coconut is approximately 36 kg/ha which is very low (Nair *et al*., 1996). However, the supply through fertilizers can meet only 15% of the total nutrient requirement. This calls for attention towards other sources of nutrients to meet the crop needs.

Unlike inorganic fertilizers, the nutrient supply from organic manure is slow and steady apart from very low nutrient loss and the availability of micronutrients coupled with the added advantage of improving soil

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physico-chemical and biological properties. Plantation crops produce huge amount of biomass for recycling in the form of suitable organic manure and accounts for more than 30-50 % of the produce (Nampoothiri, 2001). Plantation crops have sufficient potential to benefit from natural farming and sustain their yield with low external input as they produce considerable quantities of biomass for recycling. Vermicomposting is the method of composting the organic matter by earthworms under favourable soil moisture and temperature conditions. Earthworms can mediate decomposition of lignin as well as poly phenol and thus accelerate the humification process. CPCRI at Kasaragod, Kerala has identified a local strain of earthworm (*Eudrilus* sp.), similar to African Night Crawler, which is quite efficient in composting coconut leaves into granular vermicompost (Prabhu *et al*. 1998). The vermicompost obtained from coconut leaves has been found to play an important role in low external input resources, as one of the components of organic farming for sustaining soil health, fertility and crop productivity. The research work was initiated to study the impact of vermicompost substituting inorganic fertilizer on yield of coconut.

## Materials and Methods

### Experimental Site

The experiment was conducted at Central Plantation Crops Research Institute, Regional Station, Vittal, Dakshina Kannada district (Karnataka), which is located 58 m above mean sea level and receives an average annual rainfall of approximately 4000 mm. The mean maximum and minimum temperatures ranges from 36°C and 21°C, respectively. The experimental site is a lateritic soil classified as *Oxic haplustults* with a pH of 5.6 and available soil nutrient status of 143 ppm N, 10.1 ppm P and 53 ppm K at a surface depth of 25 cm. The mechanical composition of soil is 60.8 % sand, 4.6 % silt and 34.6 % clay at surface depth of 25 cm.

### Experimental details

The experiment was laid out in a 22 year old coconut garden (cv. West Coast Tall) which was planted at a distance of 7.5m x 7.5m in a square system during 2000-01. Each treatment consisted of a plot size of six palms (337.5 sq. meters), with four replications in Randomized block design. The treatments included were:

T1: Recommended N,$P_2O_5$,$K_2O$ alone (500:320: 1200 g/palm/year),

T2: 25% N in the form of Vermicompost (VC) + 75 % NPK,

T3: 50 % N in the form of VC + 50 % NPK,

T4: 75 % N in the form of VC + 25 % NPK and

T5: 100 % N in the form of VC alone

Quantity of NPK and vermicompost applied under different treatments is given in Table 1.

**Table 1. Quantity of vermicompost and inorganic fertliser applied in different treatments**

| Treatment | VC (kg/palm) | N (g/palm) | $P_2O_5$ (g/palm) | $K_2O$ (g/palm) |
|---|---|---|---|---|
| T1: Recommended NPK alone | - | 500 | 320 | 1200 |
| T2: 25 % N in the form of Vermicompost (VC) + 75 % NPK | 9.6 | 375 | 240 | 900 |
| T3: 50 % N in the form of VC + 50 % NPK, | 19.2 | 250 | 160 | 600 |
| T4: 75 % N in the form of VC + 25 % NPK | 28.8 | 125 | 80 | 300 |
| T5: 100 % N in the form of VC alone | 38.5 | - | - | - |

As per the treatments, vermicompost was applied during Sept.-October months and inorganic fertilizers in the form of urea, mussorie rock phosphate and muriate of potash were applied in two equal splits during April-May and Sept.-October months. Vermicompost was obtained by decomposing coconut leaves as per the procedure explained by Prabhu *et al.* (1998) from the leaves of the experimental plot and it was having nutritional composition of N: 1.3 %, $P_2O_5$: 0.2 % and $K_2O$: 0.14 % (mean of two years) which was applied on N equivalent basis.

Coconut palms were irrigated with drip system from November onwards to May months as per the recommendations of CPCRI (2001). During December to January months, 27 l of water and 32 l of water during February to May per palm per day was applied. Coconut basins were mulched with coconut leaves during summer months in order to reduce the evaporation of moisture from the soil. Data on coconut yield during each harvest was recorded during each year. Copra and oil content estimation was carried out from the samples collected during 3 harvests ie., during October 2008, December, 2008 and April 2009 from each treatments and mean was worked out.

The input cost mentioned here includes labour charges (imputed and actual), fertilizer charges (except in case of 100 percent vermicompost alone), plant protection measures, irrigation charges and other

miscellaneous overhead charges. The returns were computed in rupee terms by combining the weighed average yield of various years under consideration with weighed average market prices prevailed during respective years.

## Results and Discussion

### Coconut nut yield

The nut yield recorded among the treatments over the years and pooled data is presented in Table 2. In general, there was increase in the yield of coconut and the yield obtained in different treatments was higher over the years than the pre-treatment yields, which was mainly due to the effect of treatments and irrigation provided to coconut palms. During 2008-09, application of 25 % N through VC+75% NPK (T2) treatment recorded significantly higher yield (75.8 nuts/palm) and was on par with 50 % N through VC+50 % NPK (T3) treatment (72.1 nuts/palm) and differed significantly compared to other treatments. The yield obtained under T1, T4 and T5 was on par and ranged from 52.4 to 57.1 nuts/palm/year.

Pooled data on nut yield for 2004-05 to 2008-09 (5 years), indicated the significant differences among the treatments (Table 2). Application of 25 % N through VC+75 % NPK (T2) (65 nuts/palm/year) and 50 % N through VC+50 % NPK (T3) (63.2 nuts/palm/year) recorded significantly higher nut yield and were on par with each other and differed significantly with other treatments. Increase in yield under these treatments might be due to better availability of required nutrients which resulted in improvement in yield. Talashilkar *et al*. (2008) also reported increase in yield of coconut due to application of inorganic fertilizer (50 %) and 50 % through vermicompost. Positive effect of integration of organic and inorganic fertilizer combination on coconut has been reported by many workers (Upadhyay *et al*. 2009, Subramanian *et al.*, 2005, Hanumanthappa *et al*. 2004, Srinivasa Reddy and Upadhyay, 2002 and Venkitaswamy and Khan, 2002). Experimental results in root (wilt) affected garden indicated that through an integrated nutritional management involving application of vermicompost, balanced fertiliser, soil health as well as health of palms could be improved over the years or maintained without further deterioration (Krishnakumar and Maheswarappa, 2010). Nut yield recorded under T1, T4 and T5 treatments were on par with each other and ranged from 50.4 nuts/palm to 51.5 nuts/palm/year. Application of inorganic fertilizer or vermicompost alone could not result in increase in yield of coconut.

**Table 2. Nut yield as influenced by different treatments**

| Treatment | Pre-Experimental Yield (Nuts/palm) | Yield during transition period (Nuts/palm) | Nut yield/palm | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1999-2001 | 2002-2004 | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 | Mean of 2004 to 2009 |
| T1: Recommended NPK alone | 41.2 | 43.2 | 46.2 | 49.4 | 58.4 | 48.2 | 52.4 | 50.9 |
| T2: 25 % N in the form of Vermicompost (VC) + 75 % NPK | 40.2 | 40.4 | 52.8 | 60.6 | 66.3 | 69.4 | 75.8 | 65.0 |
| T3: 50 % N in the form of VC + 50 % NPK, | 42.3 | 41.2 | 53.2 | 57.7 | 68.8 | 64.2 | 72.1 | 63.2 |
| T4: 75 % N in the form of VC + 25 % NPK | 42.6 | 45.6 | 47.2 | 49.9 | 55.6 | 47.5 | 57.1 | 51.5 |
| T5: 100 % N in the form of VC alone | 40.5 | 43.5 | 51.2 | 49.2 | 50.8 | 46.0 | 55.0 | 50.4 |
| CD (P=0.05) | NS | NS | 4.82 | 5.35 | 5.07 | 6.74 | 12.46 | 4.69 |

### Copra and oil content

The copra and oil content did not differ significantly among the treatments. The copra content was ranged between 182.2 g to 184.4 g/nut and oil content ranged between 64.0 to 65.8 % (Fig. 1). In the present study, application of inorganic fertilizer alone or in combination did not have any effect on copra and oil content, which might be due to the fact that, under each treatment the palms have received the nutrients in the form of organic or inorganic sources and irrigation was provided commonly. Srinivasa Reddy and Upadhyaya (2002) also reported non-significant difference among the integrated management and chemical fertilizer alone treatments with respect to copra content in coconut under littoral sandy soil.

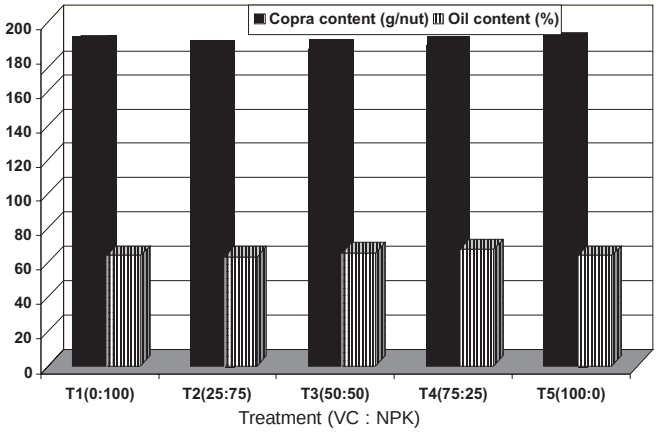


**Fig. 1. Copra and oil content of coconut as influenced by different treatments**

## Economics

The data on economic analysis of the different treatments is presented in Table 3 and the total cost of production was highest in T1 and was lowest in T5

**Table 3. Economic analysis of the different treatments (Average of 2004 to 2009)**

| Treatment | Total cost (Rs./ha) | Gross return (Rs./ha) |
|---|---|---|
| T1: Recommended NPK alone | 35860 | 38675 |
| T2: 25 % N in the form of Vermicompost (VC) + 75 % NPK | 34902 | 50575 |
| T3: 50 % N in the form of VC + 50 % NPK, | 33943 | 49088 |
| T4: 75 % N in the form of VC + 25 % NPK | 32983 | 39419 |
| T5: 100 % N in the form of VC alone | 32027 | 37188 |

treatment. It is found that T2 and T3 treatments could give higher net return (Rs. 16,673/- and Rs. 16,144/-per ha, respectively) (Fig. 2) compared to other treatments. As the vermicompost was produced within the coconut

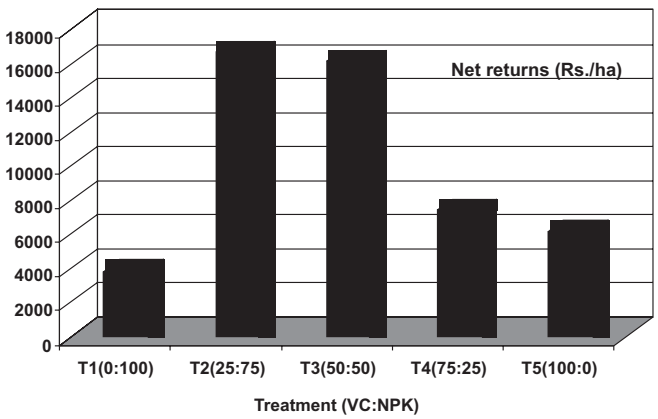


**Fig. 2. Net returns (Rs./ha) as influenced by different treatments**

garden and recycled to the palms, the total cost involved was less and resulted in higher net returns. Similar results of higher net returns were obtained with integrating organic and inorganic fertilsier as reported by Hanumanthappa *et al.* (2004) and Venkitaswamy and Khan (2002). The net return obtained under NPK alone was only Rs 3815/- per ha which indicated very low inocome for a coconut farmer.

## Conclusion

From the above study, it can be concluded that, application of vermicompost in combination with inorganic fertilizer either in 25 % N through Vermicompost (VC) (9.6 kg)+75 % NPK or 50 % N through VC (19.2 kg)+50 % NPK combination found to be beneficial to achieve higher yield and higher net return in coconut.

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