Evaluation of mature coconut water on soil nutrient availability and stimulation plant growth and yield of Greengram

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Abstract

The pot culture study was conducted in completely randomized design (CRD) with nine treatments replicated three times. The surface soil (0-15 cm) collected from the field no 37, Eastern block, TNAU farm was utilised for the study. The recommended dose of fertilizers adopted was 25:50:25 N: P2O5:K2O kg per ha and the test crop was greengram (Var. Co8). The mature coconut water (MCW) was added in the soil at the time of 0, 15, 30 and 45th days after sowing. The highest soil available nitrogen (170.8 kg ha⁻¹), phosphorus (33.2 kg ha⁻¹ and potassium (1098 kg ha⁻¹ ) was noticed in treatment T9 receiving MCW 2000 l ha⁻¹. The application of mature coconut water resulted in increased number of pods per pot, grain yield and stover yield of Greengram. The number of pods per pot was observed to be highest (16.33) in T9 receiving MCW 2000 l ha⁻¹ and remained on par with T8 (16.33), T7 (16.33), T6 (16.00), and T5 (16.00) and T4 (15.67) receiving MCW 1750, 1500, 1250, 1000 and 750 L ha⁻¹ respectively.

Keywords: Matured coconut water (MCW), greengram, soil nutrient availability, yield

1. Introduction

Sustainable production in food grains, pulses, and oilseeds could be achieved through supplying adequate quantity of essential nutrients which are major constraints in crop production. The deficiency of nutritive elements in plants may be provoked by two causes viz., the availability of the element in the soil and the inability of the crops to absorb it. Once the nutritional deficiency is identified, these nutrients should be applied for increased availability to the crops. The nutrient source may be organic or inorganic fertilizers sources. The primary nutrient elements such as N, P and K are more important for the crop growth (White and Brown, 2010) [29]. They may be organic or inorganic sources or waste products of bio systems which are in their ready plant availability and water solubility or it may increase the availability soil nutrients for crop growth. Micronutrients are also very important for their efficient plant growth and to complete its life cycle (Tripathi et al., 2015) [28].

Because of the recent increase in fertilizer prices and environmental concerns, the need for efficient use of fertilizer has increased. Organic fertilizers or organic waste fertilizer sources have been utilized in conjunction with fertilizers to increase fertilizer use efficiency. Use of wastes as organic sources of nutrients will reduce the cost of cultivation, which means growers can use less priced product of high quantity to achieve the same results as compared to inorganic fertilizers (Baghdadi et al., 2018) [10]. Here comes the possibility of utilization of waste mature coconut water which can be collected during the breaking of mature coconuts for copra making. The mature coconut water contains organic nutrients, which can meet the nutrient requirement of soil microbes. These materials are available more in recent days due to more consumption and cultivation of coconut (CDB, 2019) [11]. The mature coconut water was found to be suitable medium for multiplying number of beneficial microorganisms. The mature coconut water which is rich source of sugars, electrolytes and growth regulators such as auxins, gibberelins and cytokinins (Mamaril et al., 1988) [12] was not evaluated for use as liquid organic manure. The panchakavya widely recommended as foliar spray for crop growth promotion contains tender coconut water as a component. The mature coconut water contains most of constituents present in tender coconut water though in different proportion (Yong et al., 2009) [30] needs to be explored for boosting the crop growth. The positive influence of coconut water derived growth hormones on growth, development and yield of sweet pepper was observed, when applied in soil and sprayed (Mamaril and Lopez, 1997) [16]. The foliar
spray of mature coconut water was found to increase the growth parameters in fenugreek (Amrutt Gaddamwar and Rajput, 2013) [2] and rice (Jayachandran et al., 2001) [13]. The other uses of mature coconut water attempted were blending with lemon juice (Chauhan et al., 2012) [6]. Substitution for milk @ 25% in Yoghurt (Pandiyen et al., 2011) [21], microbial medium for multiplication of Bacillus Thuringiensis (Chilcott and Pillai, 1985) [7], Trichoderma harzianum and Pseudomonas fluorescens (Mathew et al., 2010) [18], Trichoderma viride (Kumar et al., 2000) [15], Metarhizium anisopliae (TNAU., 2016) [27], PGPR-Pseudomonas sp. and Bacillus pumilus (Anith, 2009) [3], manufacturing of Vinegar (CDB, 2016) [9], Biopolymer production (Thirumavalavan et al., 2009 and Seesuriyachan et al., 2011) [26, 23], preparation of Fermented spirit (Jayatissa et al., 1972) [14] cut flower vase life enhancement (Agambodi et al., preparation of Fermented spirit (Jayatissa et al., 1972) [14], enhancing nodulation in legumes (Schaffer and Alexander, 1967) [22] and preparation of Al₂O₃ nanoparticles (Soares et al., 2013) [24].

The experiments are pertaining to the liquid organic manure and the effect of applying as nutrient source through soil application. Hence, keeping these points in view, the present study on pot culture was carried out with the objective of studying the influence of mature coconut water on soil nutrient availability, nutrient uptake of greengram, yield and yield parameters of greengram crop under pot culture.

2. Materials and Methods

The detailed information about pot culture study, methods of soil and plant sample collected, and analysis of collected samples are presented in this investigation.

2.1 Pot culture experiment

A pot culture experiment was conducted in glass house to examine the effect of mature coconut water on growth and yield of greengram. The pot culture study was conducted in completely randomized design with nine treatments replicated three times. The recommended dose of fertilizers (25:50:25 N: P₂O₅:K₂O kg per ha) were mixed with soil and sowing was done with greengram (Var. Co8).

Application of fertilizers and Biofertilizers

2.2 Treatments

Application of mature coconut water (MCW) was done as per the treatments in four equal splits at the time of 0, 15, 30 and 45th day after sowing. The treatment details are as follows,

| Treatments | Levels     |
|------------|------------|
| T1         | MCW Control |
| T2         | MCW 250 L ha⁻¹ |
| T3         | MCW 250 L ha⁻¹ |
| T4         | MCW 750 L ha⁻¹ |
| T5         | MCW 1000 L ha⁻¹ |
| T6         | MCW 1250 L ha⁻¹ |
| T7         | MCW 1500 L ha⁻¹ |
| T8         | MCW 1750 L ha⁻¹ |
| T9         | MCW 2000 L ha⁻¹ |

Results and Discussion

2.1 Soil and plant samples

Plant samples were collected at harvest (70th day after sowing) of greengram. The soil samples were taken after harvest. These samples were analysed to obtain the utilization of nutrients through various methods and the analysed methods were given below.

2.1.2 Statistical analysis

The data obtained from the investigation were subjected to statistical scrutiny to determine the influence of various treatments and the same is depicted below Table 1.

Table 1: Methods employed for analysis of soil and plant samples

| Nutrient     | Method                                    | Reference                  |
|--------------|-------------------------------------------|----------------------------|
| Soil samples |                                           |                           |
| Soil reaction (pH) | Potentiometry (1:2.5 Soil: Water) | Chang and Jackson,1957 [5] |
| Electrical conductivity (EC) | Conductometry (1:2.5 Soil: Water) | Chang and Jackson,1957 [5] |
| Available nitrogen | Alkaline KMnO₄ | Subbiah and Asija (1956) |
| Available phosphorus | Olsen’s method | Olsen et al., (1954) |
| Available Potassium | Neutral normal Ammonium acetate | Stanford and English (1949) |

Table 2: Soil samples and nutrient availability

| Treatments | Nutrient availability | Levels     |
|------------|-----------------------|------------|
| T1         | Nitrogen              | 67.1 kg ha⁻¹ |
| T2         | Phosphorus            | 159.6 kg ha⁻¹ |
| T3         | Potassium             | 169.9 kg ha⁻¹ |
| T4         | Nitrogen              | 67.1 kg ha⁻¹ |
| T5         | Phosphorus            | 159.6 kg ha⁻¹ |
| T6         | Potassium             | 169.9 kg ha⁻¹ |
| T7         | Nitrogen              | 67.1 kg ha⁻¹ |
| T8         | Phosphorus            | 159.6 kg ha⁻¹ |
| T9         | Potassium             | 169.9 kg ha⁻¹ |

3. Result and Discussion

The soil used for conducting pot culture study was alkaline in reaction (pH-8.6), medium in salinity (EC-0.46 dSm⁻¹), sandy clay loam in texture, low in soil available nitrogen (160 kg ha⁻¹), high in available phosphorus (26.8 kg ha⁻¹) and high in available potassium (1050 kg ha⁻¹).
The soil available K was significantly influenced by the soil application of mature coconut water. The highest soil available K (1098 kg ha\(^{-1}\)) was recorded in T9 receiving MCW 2000 L ha\(^{-1}\); however it remained on par with T8 (1089 kg ha\(^{-1}\)), T7 (1087 kg ha\(^{-1}\)), T6 (1078 kg ha\(^{-1}\)) and T5 (1069 kg ha\(^{-1}\)) which received MCW @ 1750, 1500, 1250 and 1000 L ha\(^{-1}\) respectively. The lowest soil available potassium was recorded in the T1 (1012 kg ha\(^{-1}\)) which remained on par with T2 (1040 kg ha\(^{-1}\)), T3 (1049 kg ha\(^{-1}\)) and T4 (1052 kg ha\(^{-1}\)) receiving MCW @ 250, 500 and 750 L ha\(^{-1}\) respectively. The MCW supporting soil microbial growth might have increased P solublising microbes and there by soil available P.

The number of pods per pot was observed to be highest (16.33) in T9 receiving MCW 2000 L ha\(^{-1}\) however it remained on par with T8 (15.67) and T7 (15.00) receiving MCW 1750 and 1500 L ha\(^{-1}\) respectively. The general trend in K uptake was similar to that of P uptake. The highest K uptake (154.8 mg/pot) was observed in T9 receiving MCW 2000 L ha\(^{-1}\), which remained on par with T8 (152.4 mg/pot), T7 (151.4 mg/pot) receiving MCW 1750 and 1500 L ha\(^{-1}\) respectively.

### Table 2: Effect of matured coconut water on soil nutrient availability at post-harvest stage of Greengram under pot culture.

| Treatment         | Available Nitrogen | Available phosphorus | Available potassium |
|-------------------|--------------------|----------------------|--------------------|
| T1- MCW Control   | 159.6              | 26.5                 | 1012               |
| T2- MCW 250 L ha\(^{-1}\) | 162.4              | 26.8                 | 1040               |
| T3- MCW 500 L ha\(^{-1}\) | 163.3              | 28.4                 | 1049               |
| T4- MCW 750 L ha\(^{-1}\) | 165.2              | 29.2                 | 1052               |
| T5- MCW 1000 L ha\(^{-1}\) | 165.2              | 30.1                 | 1069               |
| T6- MCW 1250 L ha\(^{-1}\) | 167.1              | 30.9                 | 1078               |
| T7- MCW 1500 L ha\(^{-1}\) | 168.0              | 31.4                 | 1087               |
| T8- MCW 1750 L ha\(^{-1}\) | 169.9              | 32.3                 | 1089               |
| T9- MCW 2000 L ha\(^{-1}\) | 170.8              | 33.2                 | 1098               |
| SED               | 2.0                | 0.3                  | 20                 |
| CD (P=0.05)       | 4.2                | 0.6                  | 41                 |

### 3.2 Total nutrient uptake

The total N, P and K uptake of greengram was positively influenced by soil application of matured coconut water (Table 3). The highest N uptake (145.8 mg/pot) was observed in T9 receiving MCW 2000 L/ha and it remained on par with T8 (143.8 mg/pot), T7 (144.5 mg/pot), T6 (141.7 mg/pot), and T5 (139.2 mg/pot) receiving MCW @ 1750, 1500 1250 and 1000 L ha\(^{-1}\) respectively. Similarly, highest P uptake (18.28 mg/pot) was observed in T9 receiving MCW 2000 L ha\(^{-1}\) however it remained on par with T8 (17.99 mg/pot) receiving MCW 1750 L ha\(^{-1}\). The general trend in K uptake was similar to that of P uptake. The highest K uptake (154.8 mg/pot) was observed in T9 receiving MCW 2000 L ha\(^{-1}\), which remained on par with T8 (152.4 mg/pot), T7 (151.4 mg/pot) receiving MCW 1750 and 1500 L ha\(^{-1}\) respectively.

### Table 3: Effect of matured coconut water on total nutrient uptake (mg/pot) at harvest stage of greengram under pot culture (Mean of three replications)

| Treatment         | Nitrogen | Phosphorus | Potassium |
|-------------------|----------|------------|-----------|
| T1- MCW Control   | 121.7    | 13.04      | 125.9     |
| T2- MCW 250 L ha\(^{-1}\) | 126.4    | 14.02      | 131.9     |
| T3- MCW 500 L ha\(^{-1}\) | 132.6    | 15.50      | 137.9     |
| T4- MCW 750 L ha\(^{-1}\) | 137.8    | 15.70      | 143.5     |
| T5- MCW 1000 L ha\(^{-1}\) | 139.2    | 15.85      | 145.2     |
| T6- MCW 1250 L ha\(^{-1}\) | 141.7    | 16.48      | 148.8     |
| T7- MCW 1500 L ha\(^{-1}\) | 144.5    | 16.88      | 151.6     |
| T8- MCW 1750 L ha\(^{-1}\) | 143.8    | 17.99      | 152.4     |
| T9- MCW 2000 L ha\(^{-1}\) | 145.8    | 18.28      | 154.8     |
| SED               | 3.2      | 0.40       | 2.8       |
| CD (P=0.05)       | 6.7      | 0.90       | 5.8       |

### 3.3 Yield and yield attributes

The number of pods per pot, pod weight per pot, gram weight per pot and stover weight per pot was found to be positively influenced by soil application of mature coconut water (Table 4). The number of pods per pot was observed to be highest (16.33) in T9 receiving MCW 2000L ha\(^{-1}\) and remained on par with T8 (16.33), T7 (16.33), T6 (16.00), and T5 (16.00) and T4 (15.67) receiving MCW 1750, 1500, 1250, 1000 and 750 L ha\(^{-1}\) respectively. The similar pattern was observed in pod weight (g) per pot, grain weight (g/pot) and stover weight (g/pot). The lowest values were observed in T1 (No MCW) and T2 (MCW 250 L ha\(^{-1}\)). This correlates well with the increased yield of cowpea due to soil application of jivamirtham @ 500 L ha\(^{-1}\) at 20 DAS along with 75% RDF and panchakavya @ 6 % at flowering (Desai et al., 2014) [10]. Panchgavya application study by Naik et al., 2013 [17] confirmed the results that, panchgavya (coconut water as one of the ingredients) applied both in foliar or media application on Cymbidium hybrid ‘Sleeping Nymph’ resulted in better growth and spike production. Panchgavya application which contains matured coconut water of 4% on some plants improved the plant growth in terms of plant height and chlorophyll content also macro and micronutrients (zinc, copper, and manganese), microbial activity had increased as compared to FYM, and vermicompost applied soils. Hence, Application of Panchgavya with matured coconut water could beneficially utilized as an alternative organic supplement in agriculture which boost the crop production significantly (Jain et al., 2014) [12].

### Table 4: Effect of matured coconut water on yield and yield attributes of greengram under pot culture (Mean of three replications)

| Treatment         | No of pods per pot | Pod weight (g) per pot | Grain weight (g) per pot | Stover weight (g) per pot |
|-------------------|---------------------|------------------------|--------------------------|---------------------------|
| T1- MCW Control   | 13.67               | 3.00                   | 1.74                     | 3.59                      |
| T2- MCW 250 L ha\(^{-1}\) | 14.00               | 3.20                   | 1.79                     | 3.71                      |
| T3- MCW 500 L ha\(^{-1}\) | 15.00               | 3.40                   | 1.86                     | 3.85                      |
| T4- MCW 750 L ha\(^{-1}\) | 15.67               | 3.43                   | 1.92                     | 3.97                      |
| T5- MCW 1000 L ha\(^{-1}\) | 16.00               | 3.51                   | 1.93                     | 3.99                      |
| T6- MCW 1250 L ha\(^{-1}\) | 16.00               | 3.55                   | 1.95                     | 4.03                      |
| T7- MCW 1500 L ha\(^{-1}\) | 16.33               | 3.58                   | 1.97                     | 4.08                      |
| T8- MCW 1750 L ha\(^{-1}\) | 16.33               | 3.60                   | 1.96                     | 4.06                      |
| T9- MCW 2000 L ha\(^{-1}\) | 16.33               | 3.63                   | 1.97                     | 4.08                      |
| SED               | 0.59                | 0.10                   | 0.04                     | 0.07                      |
| CD (P=0.05)       | 1.23                | 0.21                   | 0.08                     | 0.16                      |

* Data are on moisture free basis
4. Summary and Conclusion

The application of mature coconut water has enhanced the soil nutrient availability and uptake of nutrients (N, P and K), which resulted in increased number of pods per pot, grain yield and stover yield of greengram. The mature coconut water supporting the multiplication of microbes might have resulted in the buildup of soil organic nitrogen, solubilisation of soil phosphorus and potassium resulting in the increased nutrient uptake and yield. The pot culture study shows the potential of using mature coconut water up to a level of 750 L ha⁻¹ for increasing the yield of greengram, which needs to be confirmed in the field trial involving fertigation of mature coconut water.

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