

## Efficacy of Organic Based Nutrients on Mulberry in Three Types of Soils During Different Seasons in Relation to Rearing Performance of Double Hybrid Silkworm (*Bombyx Mori L.*)



### Science

**KEYWORDS :** Organic based nutrients, mulberry, double hybrid silkworm, *Bombyx mori*, soil types, seasons

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### ABSTRACT

Studies were conducted to know the efficacy of organic based nutrients on mulberry in three types of soils (sandy clay loam, clay and red loamy) under varied seasons (monsoon, winter and summer) to record the rearing performance of double hybrid silkworm ( $CSR_{66} \times CSR_{26}$ )  $\times$  ( $CSR_{22} \times CSR_{27}$ ) in farmers' rearing houses of Challakere, Hiriyur and Molakalmur taluks of Chitradurga district of Karnataka state during 2013-14 and 2014-15. The pooled data of two years on rearing, cocoon and post-cocoon parameters were statistically analyzed at  $p \leq 0.05$  and  $p \leq 0.01$ . The results of the investigation revealed that, rearing (matured larval weight, total larval duration effective rate of rearing and cocoon yield), cocoon (cocoon weight, shell weight and shell ratio) and post-cocoon (filament length and denier) parameters were significantly superior in the batches of silkworms that were fed on the leaves of mulberry plots supplied with vermicompost (Equivalent to 50 % of Rec. FYM) + FYM (50% of Rec. FYM) + N-biofertilizer + P-biofertilizer + 200N + 110P + 140 K kg/ha/yr followed by sheep manure (Equivalent to 50% of Rec. FYM) + FYM (50 % of Rec. FYM) + N-biofertilizer + P-biofertilizer + 200N + 110P + 140 K kg/ha/yr in red loamy soil during winter season. However, these parameters were significantly inferior in control batches Rec. FYM (20MT/ha/yr) + 350N + 140P + 140K kg/ha/yr in clay soil during summer season.

### INTRODUCTION

Mulberry (*Morus alba L.*) is a sole food plant of the silkworm, *Bombyx mori L.*, plays a vital role in the growth and development of silkworm and in turn silk production. Leaf quality and quantity not only influence the growth and development of silkworm, but has a great bearing on the production of quality and quantity of cocoon and raw silk. Silkworm being monophagous insect derives almost all the nutrients essential for its growth from the mulberry leaf. Furthermore, nearly 70% of the silk produced by the silkworm is directly derived from proteins of mulberry leaves. According to Miyashita (1986), mulberry leaf contributes to an extent of 38.20% for successful cocoon crop production.

The yield and quality of mulberry leaf depends on soil type, plant variety and availability of plant nutrients and agro-ecological conditions, which reflects on the quality of silk production. Mulberry leaf productivity is highly dependent on plant nutrients like nitrogen, phosphorus and potassium and are known to respond well to the addition of organic manures. Application of organic manures to mulberry results in significant influence on cocoon yield, shell ratio, silk productivity and filament length (Sannappa *et al.*, 2005). Organic sources release the nutrients slowly and can limit the loss of plant nutrients by leaching and volatilization under adverse soil conditions (alkaline or acidic). In recent years, the chemical fertilizers are becoming costlier day by day due to escalating costs and scarce availability of resources. The highly intensive mulberry cropping system causes depletion of nutrients in soil and excess usage of inorganic fertilizers and pesticides causes deleterious effect on soil health and leaf quality. As per Shashidhar *et al.* (2009), silkworm nutrition is of primary importance as the cocoon production is directly influenced by the quality of mulberry leaves. Silkworm growth and cocoon characters, both quantitatively and qualitatively are not significantly affected when the application of chemical fertilizers to mulberry plant is reduced by 25% and the same is supplemented with bio-inoculants (*Azotobacter sp.*, *Aspergillus awamori* and *Trichoderma harzianum* @ 20, 25 and 20 kg/ha/yr, respectively) (Sori and Bhaskar, 2012). Keeping these points in view, an attempt has been made to study the rearing and cocoon parameters of the silkworm reared on mulberry raised through varied sources of organic based nutrients in three locations consisting three types of soils in three seasons of the year.

### MATERIALS AND METHODS

Investigations were conducted in farmer's fields for three sea-

sons (monsoon, winter and summer) in three types of soils of Challakere, Hiriyur and Molakalmur taluks, in Chitradurga district of Karnataka for two years (2013-14 and 2014-15) in established irrigated mulberry ( $V_1$ ) using organic based nutrients (FYM, compost, vermicompost, sheep manure and biofertilizers) with a spacing of (150 + 90 cm)  $\times$  60 cm to study the rearing performance of double hybrid silkworm ( $CSR_6 \times CSR_{26}$ )  $\times$  ( $CSR_2 \times CSR_{27}$ ). The soils of experimental sites were sandy clay loam (Challakere), clay (Hiriyur) and red loamy (Molakalmur) and the plots were situated in the Central dry zone (Zone-IV) of Karnataka and lies between 13° 34' to 15° 02' North latitude and 75° 37' to 77° 01' East longitude and having maximum and minimum temperature of 37°C and 15°C, respectively. The experiments were laid out in Randomized Block Design consists of eight treatments with three replications. Organic based nutrients were applied to mulberry garden based on the recommended dose of FYM @ 20 MT/ha/yr. The N biofertilizer (*Azospirillum brasilense*) (@ 23 kg/ha/yr) and P biofertilizer (*Aspergillus awamori*) (@ 5 kg/ha/yr) and chemical fertilizers (NPK) were applied in kg/ha/yr. The leaves grown under different treatments were fed separately to silkworms from brushing to ripening. Three hundred worms were maintained in each treatment and the treatments were replicated thrice. Mulberry cultivation and silkworm rearing were carried out as per the standard package of practices (Dandin and Giridhar, 2010).

### Treatments

T <sub>0</sub>	Recommended FYM (20MT/ha/yr)+350N+140P+140K kg/ha/yr (Control)
T <sub>1</sub>	Rec. FYM+N-biofertilizer+P-biofertilizer+200 N+110 P+140 K kg/ha/yr
T <sub>2</sub>	Compost (Equivalent to 50 % of Rec. FYM+FYM (50% of Rec. FYM) + 350N+140P+140K
T <sub>3</sub>	Vermicompost (Equiv. to 50 % of Rec. FYM) + (50 % of Rec. FYM) + 350 N+140 P+140 K
T <sub>4</sub>	Sheep Manure (Equiv. to 50 % of Rec. FYM) + FYM (50 % of Rec. FYM) +350N +140P+140K
T <sub>5</sub>	Compost (Equiv. to 50 % of Rec. FYM)+FYM(50% of Rec. FYM)+N-biofertilizer+P-biofertilizer +200N+110P+140K
T <sub>6</sub>	Vermicompost (Equiv. to 50 % of Rec. FYM) +FYM (50 % of Rec. FYM) +N- biofertilizer+P-biofertilizer+200N+110P+140K
T <sub>7</sub>	Sheep manure (Equiv. to 50% of Rec. FYM) +FYM (50 % of Rec. FYM)+N- biofertilizer + P-biofertilizer+200N+110P+140K.

During the period of investigation, following observations were recorded.

**Matured larval weight (g):** Ten larvae were randomly selected from each treatment, replication-wise during fifth day of fifth instar and weighed; average single larval weight was computed.

**Total larval duration (days):** Total larval duration was recorded in different treatments, replication-wise.

**Effective rate of rearing (ERR) (%):** ERR was calculated using the following formula.

ERR (%) =	No. of cocoons harvested	x 100
	No. of larvae brushed	

**Cocoon yield (kg/100 DFLs):** Cocoon yield was calculated using the following formula.

CY (kg/100 DFLs) =	CYR x 50,000	x 100
	NLR	

Where,

CY = Cocoon yield

CYR = Cocoon yield / replication (g)

NLR = Number of larvae / replication

**Cocoon weight (g):** Cocoon weight was recorded by weighing 10 cocoons individually using sensitive electronic balance and single cocoon weight was calculated.

**Shell weight (g):** Shell weight was recorded by removing floss layer and cutting open the cocoon to remove pupa and the last larval skin *i.e.*, exuvium.

**Shell ratio (%):** Shell ratio was calculated using the following formula.

Shell ratio (%) =	Shell weight (g)	x 100
	Cocoon weight (g)	

**Filament length (m):** Five cocoons from each treatment were taken and reeled individually on a single cocoon reeler (epprouvette). Total number of revolutions was recorded and converted in to meter using the following formula:  $L = R \times 1.125$

Where, L= Total length of the filament in meter/cocoon.

R= Number of revolutions recorded by epprouvette.

1.125 = Circumference of epprouvette.

**Denier:** The raw silk filament reeled with the epprouvette was dried in oven at 70-80°C and denier was determined using the following formula:

Denier =	Weight of the silk filament (g)	x 9000
	Length of the filament (m)	

Data recorded in the current investigation was analyzed statistically for the test of significance using Fisher's method of "Analysis of Variance" and the level of significance for 'F-test' was tested both at  $p \leq 0.05$  and  $p \leq 0.01$  as per the procedure outlined by Cochran and Cox (2000).

**RESULTS AND DISCUSSION**

**Rearing parameters**

**Matured larval weight (g)**

Matured larval weight differed significantly when larvae fed on mulberry leaf raised by applying varied sources of organic based

nutrients. In the present study, matured larval weight was significantly ( $p \leq 0.01$ ) higher in  $T_6$  *i.e.*, vermicompost (Equivalent to 50 % of recommended FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K when applied to red loamy soil in winter season followed by  $T_7$  *i.e.*, sheep manure (Equivalent to 50% of Rec. FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K. In the interactions of treatments x locations, matured larval weight was significant ( $p \leq 0.01$ ), while treatments x seasons, locations x seasons and treatments x locations x seasons did not show significant results. Considerably, matured larval weight was lower in control (Rec. FYM (20 MT/ha/yr)+350N+140P+140K kg/ha/yr) (Table 1). These results are in close conformity with the work of Naika *et al.* (2011), who reported that matured larval weight was significantly higher with enriched vermicompost (100% N) + recommended P and K due to positive relationship with foliar constituents. Similarly, Singh *et al.* (2012) recorded significantly higher matured larval weight with the application of chemical fertilizers (NPK), vermicompost and *Azotobacter* biofertilizer. Similarly, Sori and Bhaskar (2012) also registered significantly higher matured larval weight in the combined application of bio-inoculants along with FYM and chemical fertilizers. As per Sujathamma *et al.* (2014), matured larval weight was significantly more with the application of 50% recommended dose of fertilizer (RDF) + Aishwarya granules + Biophos granules + Biopotash granules at 2 or 3 days after pruning of mulberry due to improved soil health, thereby facilitating efficient uptake of nutrients by the plant.

**Total larval duration (days)**

Silkworm larvae fed on the mulberry leaf raised by applying different sources of organic nutrients showed significant influence on total larval duration. The total larval duration was significantly ( $p \leq 0.01$ ) shorter in  $T_6$  *i.e.*, vermicompost (Equivalent to 50 % of recommended FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K followed by  $T_7$  *i.e.*, sheep manure (Equivalent to 50% of Rec. FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K when applied to red loamy soil during summer season. The interactions of treatments x locations, treatments x seasons and locations x seasons showed significant results for total larval duration and it was non-significant with treatments x locations x seasons. Notably, total larval duration was longer in control (Rec. FYM (20 MT/ha/yr)+350N+140P+140K kg/ha/yr) with clay soil during winter season (Table 2). The current findings are similar to the work of Amarnatha *et al.* (2011) who reported that the larval duration differed significantly when silkworms reared on mulberry leaf produced through organic based integrated nitrogen management. Similarly, Naika *et al.* (2011) observed that total larval duration was least with enriched vermicompost (100% N) combined with recommended P and K. According to Sori and Bhaskar (2012), combined application of bio-inoculants along with FYM and inorganic fertilizers when applied to mulberry produced significantly shorter total larval duration.

**Effective Rate of Rearing (%)**

Effective rate of rearing (ERR) differed significantly when larvae fed on mulberry leaf raised by applying varied sources of organic nutrients to mulberry. In the current study, ERR was significantly ( $p \leq 0.01$ ) superior in  $T_6$  *i.e.*, vermicompost (Equivalent to 50 % of recommended FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K followed by  $T_7$  *i.e.*, sheep manure (Equivalent to 50% of Rec. FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K when applied to red loamy soil in winter season. ERR in the interactions of treatments x locations and treatments x seasons differ highly significant ( $p \leq 0.01$ ), whereas locations x seasons, it was significant ( $p \leq 0.05$ ). However, treatments x locations x seasons did not produce significant results with regard to ERR.

Considerably, ERR was inferior in control (Rec. FYM (20 MT/ha/yr)+350N+140P+140K kg/ha/yr) in clay soil during summer season (Table 3). These observations are similar to the work of Das *et al.* (2002), who observed that silkworms reared using mulberry leaf obtained by the application of vermicompost significantly improved the ERR due to enhanced leaf quality when vermicompost was used as a organic source. Similarly, Philomena *et al.* (2003) recorded higher ERR when silkworms fed on mulberry leaves obtained by applying lower dose of inorganic fertilizers with higher dose of organic manures. Further, Baqual and Das (2006) also reported that the silkworms (CSR hybrid) when fed on mulberry leaf raised by supplying 75% recommended dose of N and P along with rock phosphate co-ordinate with microbial inoculants recorded significantly higher ERR. As per Amarnatha *et al.* (2011), ERR was significantly maximum in the batches of silkworm larvae (PM x CSR<sub>2</sub>) fed on mulberry leaves obtained with the application of biofertilizers (20 kg/ha) along with recommended nitrogen (20%) each through compost, vermicompost, green manure and castor oil cake and 20% N and recommended dose of P and K fertilizers. The ERR was superior with enriched vermicompost (100% N) along with recommended P and K due to positive relationship with foliar constituents of mulberry, resulting in better rearing performance (Naika *et al.*, 2011). Sori and Bhaskar (2012) also reported that the combined application of bio-inoculants along with FYM and inorganic fertilizers to mulberry produced significantly higher ERR.

#### Cocoon yield (kg/100 DFLs)

The cocoons spun by the silkworms fed on mulberry leaf obtained by supplying the crop with different sources of organic manures had notable influence on cocoon yield. The cocoon yield of silkworm differed significantly ( $p \leq 0.01$ ) when larvae fed on mulberry leaf raised by applying varied sources of organic nutrients. In the present study, the cocoon yield was significantly higher in T<sub>6</sub> i.e., vermicompost (Equivalent to 50 % of recommended FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K (80.95kg/100 dfls) followed by T<sub>7</sub> i.e., sheep manure (Equivalent to 50% of Rec. FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K (79.54 kg/100 dfls) when applied to red loamy soil during winter season. Cocoon yield was also significant ( $p \leq 0.01$  and  $p \leq 0.05$ ) in the interactions of treatments x locations and treatments x seasons, while locations x seasons and treatments x locations x seasons did not show significant influence on to cocoon yield. Notably, cocoon yield was lower in control (Rec. FYM (20 MT/ha/yr)+350N+140P+140K kg/ha/yr) in clay soil during summer season (Table 4). The current findings are similar to the work of Rao *et al.* (2007), who reported that the cocoon yield of PM x NB<sub>4</sub>D<sub>2</sub> was slightly higher with the application of VAM and *Azotobacter* biofertilizer (50% reduce in N and P fertilizer) mainly due to the efficiency of microbial inoculants which compensated the less use of chemical fertilizers by fixing atmospheric N, supply of P and synthesis of other nutrients as a result improvement in leaf quality, thus improves the growth of silkworm and cocoon yield. Similarly, Amarnatha *et al.* (2011) opined that ERR showed significant influence in larvae of PM x CSR<sub>2</sub> were fed on mulberry leaves obtained with the application of biofertilizers (20 kg/ha) along with recommended nitrogen (20%) each through compost, vermicompost, green manure and castor oil cake and 20% N and recommended dose of P and K fertilizers. Similarly, Naika *et al.* (2011) also recorded higher cocoon yield with enriched vermicompost (100% N) + recommended P and K to mulberry and consequent to rearing of silkworms using mulberry leaf. As per Singh *et al.* (2012), cocoon yield was significantly higher with the application of chemical fertilizers (NPK) along with vermicompost and *Azotobacter* biofertilizer. Further, Sori and Bhaskar (2012) reported that the combined application of bio-inoculants along with FYM and inorganic fertilizers mulberry produced significantly higher cocoon yield. On the other

hand, Babu *et al.* (2013) reported that the silkworm rearing (bio-assay) conducted using mulberry leaves raised by supplying different sources of organic based nutrients in three different seasons did not show significant difference with respect to cocoon yield.

#### Cocoon parameters

##### Cocoon weight (g)

The cocoons spun by the silkworms fed on mulberry obtained by supplying the crop with different sources of organic manures significantly influenced the cocoon weight. Significantly ( $p \leq 0.01$ ) more cocoon weight was recorded in T<sub>6</sub> i.e., vermicompost (Equivalent to 50 % of recommended FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K followed by T<sub>7</sub> i.e., sheep manure (Equivalent to 50% of Rec. FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K in red loamy soil during winter season. Among three types of soils and seasons, significantly ( $p \leq 0.01$ ) higher cocoon weight was found in red loamy soil (Molakalmur) during winter season. In the interactions of treatments x locations and locations x seasons cocoon weight registered highly significant ( $p \leq 0.01$ ) and significant ( $p \leq 0.05$ ) results, respectively and it was non-significant in the interactions of treatments x seasons and treatments x locations x seasons. However, cocoon weight was less in control (Rec. FYM (20 MT/ha/yr)+350N+140P+140K kg/ha/yr) in clay soil during summer season (Table 5). These observations are in close conformity with the work of Ravikumar (2003), who reported that feeding silkworms (CSR<sub>2</sub> x CSR<sub>4</sub>) fed on mulberry leaf obtained by application of 50% N through FYM and 50% N through urea recorded highest cocoon weight. Similarly, Baqual and Das (2006), who observed higher cocoon weight when silkworms (CSR hybrid) fed on mulberry leaf treated with 75% recommended dose of N and P along with rock phosphate co-inoculated with beneficial micro-organisms. Shashidhar *et al.* (2009) recorded highest cocoon weight in PM x CSR<sub>2</sub> silkworm hybrid with the application of vermicompost (100% N) and recommended P and K. Further, these results are also in close conformity with the work of Vijaya *et al.* (2009), who reported that the application of different levels of NPK and foliar nutrients has increased the shell weight. Naika *et al.* (2011), who recorded significantly highest cocoon weight with the application of vermicompost (100% N) + recommended P and K. As per Singh *et al.* (2012), cocoon weight was significantly higher with the application of chemical fertilizers (NPK) along with vermicompost and *Azotobacter* biofertilizer. Sori and Bhaskar (2012) who reported that the combined application of bio-inoculants along with FYM and inorganic fertilizers to mulberry produced significantly higher cocoon weight. Sujathamma *et al.* (2014) also reported that significantly increased cocoon weight with the application of 50% RDF + Aishwarya granules + Biophos granules + Biopotash granules at 2 or 3 days after pruning of mulberry due to improved soil health, thereby facilitating efficient uptake of nutrients by the plant.

##### Shell weight (g)

Cocoons spun by the silkworms reared on mulberry leaf obtained by supplying the crop with application of organic manures significantly influenced shell weight. It is observed from the Table 6 that the shell weight was significantly ( $p \leq 0.01$ ) more in T<sub>6</sub> i.e., vermicompost (Equivalent to 50 % of recommended FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K followed by T<sub>7</sub> i.e., sheep manure (Equivalent to 50% of Rec. FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K in red loamy soil during winter season. The interactions, treatments x locations registered significant ( $p \leq 0.01$ ) result with respect to shell weight, treatments x seasons, locations x seasons and treatments x locations x seasons interactions did not differ significantly. However, shell weight was lower in control (Rec. FYM (20 MT/ha/yr)+350N+140P+140K kg/

ha/yr) in clay soil during summer season. The current findings are similar to the work of Ravikumar (2003) who reported that feeding silkworms ( $CSR_2 \times CSR_4$ ) with mulberry leaf obtained by application of 50% N through FYM and 50% N through urea found higher shell weight. Similarly, Baqual and Das (2006) who observed that the shell weight was higher in silkworms ( $CSR$  hybrid) fed on mulberry leaf raised by applying 75% recommended dose of N and P along with rock phosphate co-inoculated with beneficial micro-organisms. Shashidhar *et al.* (2009) observed maximum shell weight in PM x  $CSR_2$  silkworm hybrid with the application of vermicompost (100% N) and recommended P and K. Further, Vijaya *et al.* (2009) reported that the application of different levels of NPK and foliar nutrients has increased the shell weight. Naika *et al.* (2011) who recorded significantly highest shell weight with the application of vermicompost (100% N) + recommended P and K. Similarly, Singh *et al.* (2012) registered higher shell weight with the application of chemical fertilizers (NPK) along with vermicompost and *Azotobacter* biofertilizer. Sori and Bhaskar (2012) reported that the combined application of bio-inoculants along with FYM and inorganic fertilizers to mulberry produced significantly higher shell weight. Sujathamma *et al.* (2014) reported that the silkworms fed on mulberry grown by applying 50% RDF + Aishwarya granules + Biophos granules + Biopotash granules at 2 or 3 days after pruning significantly increased shell weight.

#### Shell ratio (%)

Marked impact was exerted on shell ratio among the batches of silkworms fed on mulberry raised through the application of varied sources of organic manures. Shell ratio was significantly ( $p \leq 0.01$ ) more in  $T_6$  i.e., vermicompost (Equivalent to 50 % of recommended FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K followed by  $T_7$  i.e., sheep manure (Equivalent to 50% of Rec. FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K in red loamy soil during winter season. In the interactions, treatments x locations, locations x seasons registered significant ( $p \leq 0.01$ ) results with respect to shell ratio, while treatments x seasons and treatments x locations x seasons did not show significant result. However, shell ratio was lower in control (Rec. FYM (20 MT/ha/yr)+350N+140P+140K kg/ha/yr) in clay soil during summer season (Table 7). The current findings are similar to the work of Ravikumar (2003), who reported that feeding silkworms ( $CSR_2 \times CSR_4$ ) with mulberry leaf obtained by application of 50% N through FYM and 50% N through urea found higher shell weight. Similarly, Baqual and Das (2006) recorded higher shell ratio when silkworms ( $CSR$  hybrid) reared on mulberry leaf raised by supplying 75% recommended dose of N and P along with rock phosphate co-inoculated with beneficial micro-organisms. Shashidhar *et al.* (2009) who observed that the maximum shell ratio was registered in PM x  $CSR_2$  silkworm hybrid with the application of vermicompost (100% N) and recommended P and K. These results are in close conformity with the work of Vijaya *et al.* (2009), who reported that the application of NPK levels and foliar nutrients has increased the shell ratio. Naika *et al.* (2011), who recorded significantly highest shell ratio with the application of vermicompost (100% N) + recommended P and K. Further, Singh *et al.* (2012) recorded more shell ratio with the application of chemical fertilizers (NPK) along with vermicompost and *Azotobacter* biofertilizer. Sori and Bhaskar (2012) reported that the combined application of bio-inoculants along with FYM and inorganic fertilizers to mulberry produced significantly higher shell ratio. Babu *et al.* (2013) opined that the silkworm rearing (bio-assay) conducted in three different seasons showed significant difference with respect to shell ratio in different organic based nutrients when applied to mulberry. Application of 50% RDF + Aishwarya granules + Biophos granules + Biopotash granules at 2 or 3 days after pruning significantly increased shell ratio (Sujathamma *et al.*, 2014).

#### Post-cocoon parameters

##### Filament length (m)

Filament length of cocoons that were spun by the worms fed on the leaves of mulberry raised with the varied levels of organic based nutrients differed significantly ( $p \leq 0.01$ ) with lengthier filament being in  $T_6$  i.e., vermicompost (Equivalent to 50 % of recommended FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K followed by  $T_7$  i.e., sheep manure (Equivalent to 50% of Rec. FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K in red loamy soil during winter season. The interactions of treatments x locations and locations x seasons yielded significant ( $p \leq 0.01$ ) results for filament length and treatments x seasons and treatments x locations x seasons did not show significant results. Notably, the filament was shorter in control (Rec. FYM (20 MT/ha/yr)+350N+140P+140K kg/ha/yr) in clay soil during summer season (Table 8). The current findings are similar to the work of Baqual and Das (2006), who observed that the filament length was more in silkworm ( $CSR$  hybrid) reared on mulberry leaf raised by applying 75% recommended dose of N and P along with rock phosphate co-inoculated with beneficial micro-organisms. Similarly, Rao *et al.* (2007) reported that the filament length of PM x  $NB_4D_2$  was found slightly more with the application of VAM and *Azotobacter* biofertilizer (50% reduce in N and P fertilizer). As per Naika *et al.* (2011), application of vermicompost (100%) + recommended P and K yielded longer cocoon filament. Further, Sori and Bhaskar (2012) who reported that the combined application of bio-inoculants along with FYM and inorganic fertilizers to mulberry registered significantly longer filament. Sujathamma *et al.* (2014) who reported that significantly increased filament length with the application of 50% RDF + Aishwarya granules + Biophos granules + Biopotash granules at 2 or 3 days after pruning due to improved soil health.

##### Denier

Significantly ( $p \leq 0.01$ ) thicker denier was recorded in  $T_6$  i.e., vermicompost (Equivalent to 50 % of recommended FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K when applied to red loamy soil in winter season followed by  $T_7$  i.e., sheep manure (Equivalent to 50% of Rec. FYM)+FYM (50 % of Rec. FYM)+N-biofertilizer+P-biofertilizer+200N+110P+140K. In the interactions of treatments x locations and locations x seasons, denier was highly significant ( $p \leq 0.01$ ), whereas, treatments x seasons showed significant ( $p \leq 0.05$ ). However, treatments x locations x seasons did not show significant influence with respect to denier. Considerably, the denier was thinner in control (Rec. FYM (20 MT/ha/yr)+350N+140P+140K kg/ha/yr) in clay soil during summer season (Table 9). The current findings are similar to the work of Shashidhar *et al.* (2009), who reported that significantly better performance of silkworms with respect to cocoon and post-cocoon parameters by feeding the silkworms on leaves fertilized by different sources of nitrogen with or without biofertilizers, resulting in enhanced leaf quality through better uptake of nutrients. Similarly, Naika *et al.* (2011) opined that, application of vermicompost (100%) + recommended P and K has recorded significantly higher denier. Further, Sori and Bhaskar (2012) reported that the combined application of bio-inoculants along with FYM and inorganic fertilizers to mulberry produced significantly higher denier. As per Sujathamma *et al.* (2014), significantly less denier was recorded with the application of 50% RDF + Aishwarya granules + Biophos granules + Biopotash granules at 2 or 3 days after pruning due to improved soil health, thereby facilitating efficient uptake of nutrients by the plant, in turn better post cocoon parameters.

#### CONCLUSION

The current study inferred that, application of organic manures through vermicompost and FYM followed by sheep manure and

FYM, compost and FYM in equal proportion along with recommended doses of chemical and bio-fertilizers to mulberry produced superior rearing and cocoon parameters in double hybrid silkworm ( $CSR_6 \times CSR_{26}$ ) x ( $CSR_2 \times CSR_{27}$ ). Thus, in the event of shortage of FYM, 50% recommended dose of FYM can be compensated through the use of vermicompost/sheep manure/compost to suffice the manurial requirement of mulberry.

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**Table 1: Matured larval weight (g) of silkworm reared on mulberry raised by applying organic based nutrients in three types of soils during different seasons**

T	L			S		T x L			T x S			L x S			T x L x S												
						L1	L2	L3	S1	S2	S3	S1	S2	S3	L1			L2			L3						
															S1	S2	S3	S1	S2	S3	S1	S2	S3				
T0	3.539	L1	4.210	S1	4.180	T0	3.543	3.432	3.642	T0	3.553	3.586	3.478	L1	4.247	4.265	4.119	T0	3.569	3.601	3.458	3.452	3.392	3.639	3.705	3.583	
T1	3.946	L2	3.883	S2	4.209	T1	4.054	3.678	4.108	T1	4.017	4.034	3.789	L2	3.925	3.927	3.796	T1	4.157	4.187	3.814	3.704	3.704	3.626	4.187	4.210	3.926
T2	4.149	L3	4.355	S3	4.060	T2	4.235	3.950	4.261	T2	4.181	4.199	4.067	L3	4.366	4.435	4.265	T2	4.262	4.274	4.168	4.013	4.016	3.818	4.263	4.306	4.214
T3	4.247					T3	4.287	4.022	4.432	T3	4.284	4.294	4.162					T3	4.314	4.315	4.231	4.086	4.087	3.892	4.452	4.482	4.362
T4	4.202					T4	4.261	3.804	4.545	T4	4.213	4.245	4.149					T4	4.285	4.295	4.202	3.815	3.815	3.773	4.538	4.626	4.473
T5	4.299					T5	4.386	3.991	4.518	T5	4.330	4.366	4.203					T5	4.419	4.436	4.307	4.060	4.060	3.854	4.510	4.601	4.447
T6	4.437					T6	4.502	4.133	4.676	T6	4.454	4.499	4.358					T6	4.527	4.560	4.420	4.156	4.156	4.085	4.680	4.780	4.568
T7	4.378					T7	4.416	4.059	4.659	T7	4.409	4.447	4.276					T7	4.442	4.451	4.354	4.123	4.123	3.930	4.663	4.768	4.545
F-value	30.95**		59.12**		62.45**			12.36**			1.245 <sup>NS</sup>				1.326 <sup>NS</sup>												0.085 <sup>NS</sup>

T: Treatments (T0 to T7) L = Locations L1 = Challakere (Sandy clay loam soil) L2 = Hiriyr (Clay soil) L3 = Molakalmur (Red loamy soil)  
 S : Seasons S1 = Monsoon S2 = Winter S3 = Summer \*\*: Highly significant (p ≤ 0.01) NS: Non-significant

**Table 2: Total larval duration (days) of silkworm reared on mulberry raised by applying organic based nutrients in three types of soils during different seasons**

T	L			S		T x L			T x S			L x S			T x L x S												
						L1	L2	L3	S1	S2	S3	S1	S2	S3	L1			L2			L3						
															S1	S2	S3	S1	S2	S3	S1	S2	S3				
T0	24.19	L1	23.69	S1	23.78	T0	24.25	24.10	24.23	T0	24.16	24.81	23.60	L1	23.72	24.77	22.86	T0	24.11	25.06	23.58	24.18	24.19	23.91	24.20	25.19	23.31
T1	23.89	L2	23.66	S2	24.47	T1	23.95	23.71	24.01	T1	23.86	24.59	23.23	L2	23.79	23.82	23.37	T1	23.79	24.90	23.18	23.82	23.87	23.43	23.96	24.99	23.09
T2	23.77	L3	23.80	S3	22.99	T2	23.80	23.66	23.83	T2	23.80	24.50	23.00	L3	23.84	24.83	22.73	T2	23.75	24.84	22.85	23.79	23.84	23.25	23.85	24.86	22.78
T3	23.69					T3	23.72	23.60	23.76	T3	23.75	24.45	22.85					T3	23.64	24.75	22.71	23.75	23.79	23.26	23.82	24.80	22.65
T4	23.70					T4	23.71	23.69	23.70	T4	23.79	24.41	22.89					T4	23.70	24.67	22.76	23.81	23.86	23.38	23.86	24.71	22.52
T5	23.68					T5	23.67	23.63	23.73	T5	23.74	24.42	22.87					T5	23.61	24.72	22.68	23.78	23.81	23.31	23.83	24.78	22.61
T6	23.50					T6	23.56	23.39	23.54	T6	23.56	24.23	22.71					T6	23.55	24.56	22.60	23.52	23.52	23.13	23.60	24.61	22.40
T7	23.57					T7	23.62	23.51	23.58	T7	23.63	24.33	22.76					T7	23.59	24.63	22.65	23.67	23.68	23.18	23.63	24.67	22.44
F-value	18.93**		19.30**		765.6**			2.858**			6.776**				658.4**												0.021 <sup>NS</sup>

T: Treatments (T0 to T7) L = Locations L1 = Challakere (Sandy clay loam soil) L2 = Hiriyr (Clay soil) L3 = Molakalmur (Red loamy soil)  
 S : Seasons S1 = Monsoon S2 = Winter S3 = Summer \*\*: Highly significant (p ≤ 0.01) NS: Non-significant

**Table 3: Effective rate of rearing (%) of silkworm reared on mulberry raised by applying organic based nutrients in three types of soils during different seasons**

T	L			S		T x L			T x S			L x S			T x L x S												
						L1	L2	L3	S1	S2	S3	S1	S2	S3	L1			L2			L3						
															S1	S2	S3	S1	S2	S3	S1	S2	S3				
T0	87.44	L1	90.89	S1	92.20	T0	87.32	85.70	89.30	T0	88.91	89.48	83.93	L1	92.18	92.43	88.07	T0	88.91	89.56	83.50	86.89	87.56	82.67	90.94	91.33	85.61
T1	89.18	L2	89.77	S2	92.86	T1	88.96	87.43	91.15	T1	90.36	91.06	86.11	L2	90.74	91.52	87.06	T1	90.30	90.85	85.72	88.56	89.28	84.45	92.22	93.06	88.17
T2	90.61	L3	92.82	S3	88.43	T2	90.00	89.65	92.18	T2	92.01	92.46	87.37	L3	93.68	94.64	90.15	T2	91.54	91.64	86.83	90.85	91.50	86.53	93.61	94.22	88.72
T3	91.80					T3	91.37	91.22	92.81	T3	92.94	93.54	88.93					T3	92.34	92.83	88.72	92.23	92.00	88.33	93.94	94.78	89.63
T4	90.97					T4	90.40	88.54	93.96	T4	91.86	92.75	88.30					T4	91.92	92.09	87.24	89.10	90.39	86.11	94.56	95.65	91.56
T5	92.15					T5	92.39	90.67	93.41	T5	93.15	93.83	89.48					T5	93.43	93.72	90.00	91.90	92.44	87.67	94.11	95.34	90.78
T6	93.98					T6	93.91	92.74	95.28	T6	94.53	95.21	92.19					T6	94.98	94.75	92.03	93.33	94.28	90.61	95.26	96.61	93.94
T7	93.17					T7	92.78	92.25	94.50	T7	93.84	94.55	91.13					T7	93.82	93.94	90.55	92.91	93.72	90.11	94.78	96.00	92.72
F-value	21.35**		46.52**		177.2* *			11.57**			7.297**				2.967*												0.072 <sup>NS</sup>

T: Treatments (T0 to T7) L = Locations L1 = Challakere (Sandy clay loam soil) L2 = Hiriyr (Clay soil) L3 = Molakalmur (Red loamy soil)  
 S : Seasons S1 = Monsoon S2 = Winter S3 = Summer \*: Significant (p ≤ 0.05) \*\*: Highly significant (p ≤ 0.01) NS: Non-significant

**Table 4: Cocoon yield (kg/100 DFLs) of silkworm reared on mulberry raised by applying organic based nutrients in three types of soils during different seasons**

T	L			S		T x L			T x S			L x S			T x L x S												
						L1	L2	L3	S1	S2	S3	S1	S2	S3	L1			L2			L3						
															S1	S2	S3	S1	S2	S3	S1	S2	S3				
T0	68.08	L1	75.95	S1	76.35	T0	67.98	62.95	73.32	T0	69.15	70.22	64.88	L1	77.00	77.71	73.14	T0	69.03	70.49	64.43	63.56	64.59	60.70	74.86	75.57	69.52
T1	71.56	L2	70.69	S2	77.24	T1	73.02	66.20	75.48	T1	72.48	73.56	68.65	L2	71.29	72.66	68.10	T1	73.89	74.95	70.20	66.95	68.05	63.59	76.61	77.64	72.16
T2	73.92	L3	79.78	S3	72.83	T2	74.21	70.09	77.47	T2	75.09	75.98	70.69	L3	80.78	81.34	77.23	T2	75.49	76.23	70.91	71.04	72.42	66.80	78.74	79.29	74.37
T3	76.84					T3	77.02	74.08	79.43	T3	77.78	78.80	73.93					T3	77.80	78.94	74.32	75.17	76.06	71.01	80.37	81.44	76.46
T4	75.39					T4	75.52	68.31	82.32	T4	76.26	77.07	72.80					T4	76.84	77.31	72.39	68.85	70.19	65.88	83.15	83.58	80.14
T5	77.50					T5	78.43	72.52	81.54	T5	78.41	79.01	75.18					T5	79.45	79.90	75.98	73.01	74.50	70.03	82.76	82.65	79.23
T6	80.95					T6	81.65	76.10	85.10	T6	81.46	82.32	79.09					T6	82.77	82.82	79.40	76.22	78.23	73.84	85.39	85.90	84.02
T7	79.54					T7	79.76	75.26	83.60	T7	80.22	80.94	77.46					T7	80.76	81.04	77.48	75.57	77.28	72.95	84.33	84.50	81.97
F-value	28.53**		95.24**		219.7* *			23.43**			2.657*				2.184 <sup>NS</sup>												0.007 <sup>NS</sup>

T: Treatments (T0 to T7) L = Locations L1 = Challakere (Sandy clay loam soil) L2 = Hiriyr (Clay soil) L3 = Molakalmur (Red loamy soil)  
 S : Seasons S1 = Monsoon S2 = Winter S3 = Summer \*: Significant (p ≤ 0.05) \*\*: Highly significant (p ≤ 0.01) NS: Non-significant

Table 5: Cocoon weight (g) of silkworm reared on mulberry raised by applying organic based nutrients in three types of soils during different seasons

T	L			S			T x L			T x S			L x S			T x L x S											
							L1	L2	L3	S1	S2	S3	S1	S2	S3	L1	L2	L3	L1			L2			L3		
																			S1	S2	S3	S1	S2	S3	S1	S2	S3
T0	1.947	L1	2.088	S1	2.068	T0	1.948	1.839	2.053	T0	1.949	1.961	1.930	L1	2.088	2.102	2.076	T0	1.948	1.967	1.930	1.839	1.847	1.831	2.061	2.068	2.031
T1	2.009	L2	1.972	S2	2.073	T1	2.053	1.899	2.074	T1	2.012	2.023	1.994	L2	1.983	1.977	1.956	T1	2.049	2.062	2.049	1.898	1.912	1.887	2.089	2.087	2.047
T2	2.038	L3	2.138	S3	2.057	T2	2.064	1.951	2.099	T2	2.038	2.049	2.025	L3	2.134	2.140	2.139	T2	2.061	2.081	2.047	1.954	1.964	1.936	2.100	2.103	2.093
T3	2.087					T3	2.106	2.025	2.128	T3	2.090	2.095	2.078					T3	2.105	2.127	2.091	2.043	2.028	2.010	2.121	2.131	2.132
T4	2.064					T4	2.088	1.930	2.175	T4	2.064	2.071	2.059					T4	2.089	2.100	2.075	1.936	1.941	1.913	2.166	2.170	2.189
T5	2.096					T5	2.121	2.017	2.157	T5	2.101	2.099	2.096					T5	2.124	2.131	2.109	2.039	2.014	2.000	2.139	2.154	2.179
T6	2.154					T6	2.178	2.061	2.223	T6	2.160	2.154	2.148					T6	2.180	2.188	2.166	2.084	2.058	2.042	2.215	2.216	2.236
T7	2.130					T7	2.148	2.050	2.192	T7	2.131	2.134	2.125					T7	2.147	2.157	2.139	2.067	2.056	2.028	2.178	2.188	2.209
F-value	22.51**		93.09**		19.31*		12.93**				0.580 <sup>NS</sup>				5.003*				0.007 <sup>NS</sup>								

T: Treatments (T0 to T7) L = Locations L1 = Challakere (Sandy clay loam soil) L2 = Hiriyyur (Clay soil) L3 = Molakalmur (Red loamy soil)  
 S: Seasons S1 = Monsoon S2 = Winter S3 = Summer \*: Significant (p ≤ 0.05) \*\*: Highly significant (p ≤ 0.01) NS: Non-significant

Table 6: Shell weight (g) of cocoon of silkworm reared on mulberry raised by applying organic based nutrients in three types of soils during different seasons

T	L			S			T x L			T x S			L x S			T x L x S											
							L1	L2	L3	S1	S2	S3	S1	S2	S3	L1	L2	L3	L1			L2			L3		
																			S1	S2	S3	S1	S2	S3	S1	S2	S3
T0	0.366	L1	0.410	S1	0.418	T0	0.364	0.342	0.392	T0	0.367	0.375	0.356	L1	0.422	0.428	0.405	T0	0.368	0.377	0.348	0.341	0.349	0.336	0.393	0.400	0.384
T1	0.389	L2	0.383	S2	0.426	T1	0.391	0.356	0.418	T1	0.392	0.399	0.375	L2	0.385	0.391	0.372	T1	0.394	0.401	0.379	0.356	0.364	0.348	0.424	0.432	0.398
T2	0.402	L3	0.445	S3	0.404	T2	0.403	0.372	0.430	T2	0.405	0.412	0.390	L3	0.446	0.457	0.433	T2	0.408	0.413	0.387	0.373	0.380	0.362	0.434	0.444	0.421
T3	0.424					T3	0.422	0.406	0.443	T3	0.424	0.437	0.413					T3	0.425	0.434	0.414	0.405	0.419	0.393	0.442	0.457	0.431
T4	0.415					T4	0.414	0.369	0.461	T4	0.417	0.424	0.404					T4	0.416	0.421	0.403	0.370	0.377	0.359	0.465	0.474	0.448
T5	0.423					T5	0.436	0.382	0.452	T5	0.430	0.431	0.410					T5	0.441	0.447	0.421	0.396	0.383	0.366	0.450	0.463	0.443
T6	0.460					T6	0.463	0.426	0.490	T6	0.461	0.469	0.449					T6	0.467	0.474	0.449	0.428	0.432	0.415	0.490	0.496	0.482
T7	0.445					T7	0.452	0.409	0.473	T7	0.444	0.457	0.432					T7	0.456	0.460	0.438	0.406	0.424	0.398	0.471	0.488	0.459
F-value	32.75**		94.73**		212.0*		13.26**				0.744 <sup>NS</sup>				1.265 <sup>NS</sup>				0.095 <sup>NS</sup>								

T: Treatments (T0 to T7) L = Locations L1 = Challakere (Sandy clay loam soil) L2 = Hiriyyur (Clay soil) L3 = Molakalmur (Red loamy soil)  
 S: Seasons S1 = Monsoon S2 = Winter S3 = Summer \*\*: Highly significant (p ≤ 0.01) NS: Non-significant

Table 7: Shell ratio (%) of cocoon of silkworm reared on mulberry raised by applying organic based nutrients in three types of soils during different seasons

T	L			S			T x L			T x S			L x S			T x L x S											
							L1	L2	L3	S1	S2	S3	S1	S2	S3	L1	L2	L3	L1			L2			L3		
																			S1	S2	S3	S1	S2	S3	S1	S2	S3
T0	18.87	L1	20.11	S1	20.28	T0	18.90	18.81	18.10	T0	18.91	19.10	18.50	L1	20.29	20.46	19.54	T0	18.90	19.17	18.07	18.77	19.68	18.40	19.05	19.35	18.91
T1	19.45	L2	19.80	S2	20.70	T1	19.43	19.06	21.17	T1	19.37	19.83	18.93	L2	19.66	20.29	18.32	T1	19.32	19.50	18.37	19.57	19.34	18.72	20.23	20.72	19.45
T2	19.94	L3	20.87	S3	19.79	T2	19.90	19.95	23.64	T2	20.08	20.29	19.42	L3	20.93	21.42	20.21	T2	19.86	19.82	18.98	19.69	19.81	19.22	20.87	21.11	20.18
T3	20.37					T3	20.13	20.08	25.91	T3	20.32	20.66	18.94					T3	20.21	20.40	19.83	19.81	18.65	18.60	20.93	21.31	20.28
T4	20.15					T4	19.84	19.17	23.60	T4	20.23	20.90	19.85					T4	19.96	20.09	19.41	19.18	19.44	18.79	21.58	21.97	20.65
T5	20.59					T5	20.49	19.94	21.13	T5	20.58	21.16	20.04					T5	20.90	21.12	20.05	19.71	20.48	19.64	21.10	21.88	20.41
T6	21.63					T6	21.78	21.66	22.05	T6	21.57	21.60	21.22					T6	21.94	22.14	21.26	20.61	21.89	20.85	22.11	22.46	21.57
T7	21.11					T7	21.01	20.75	21.57	T7	21.08	21.65	20.86					T7	21.22	21.30	20.47	20.18	21.32	20.54	21.63	22.31	20.78
F-value	22.32**		23.35**		174.1*		11.02**				1.004 <sup>NS</sup>				8.83**				0.011 <sup>**</sup>								

T: Treatments (T0 to T7) L = Locations L1 = Challakere (Sandy clay loam soil) L2 = Hiriyyur (Clay soil) L3 = Molakalmur (Red loamy soil)  
 S: Seasons S1 = Monsoon S2 = Winter S3 = Summer \*\*: Highly significant (p ≤ 0.01) NS: Non-significant

Table 8: Filament length (m) of cocoon of silkworm reared on mulberry raised by applying organic based nutrients in three types of soils during different seasons

T	L			S			T x L			T x S			L x S			T x L x S											
							L1	L2	L3	S1	S2	S3	S1	S2	S3	L1	L2	L3	L1			L2			L3		
																			S1	S2	S3	S1	S2	S3	S1	S2	S3
T0	1053	L1	1181	S1	1114	T0	1134	893.1	1131	T0	1069	1083	1005	L1	1189	1207	1146	T0	1146	1163	1093	898.7	905.0	875.5	1162	1182	1047
T1	1070	L2	945.7	S2	1130	T1	1154	912.7	1143	T1	1085	1100	1025	L2	952.8	957.8	926.5	T1	1162	1178	1122	921.3	927.3	889.3	1171	1194	1065
T2	1086	L3	1174	S3	1057	T2	1166	941.0	1158	T2	1102	1117	1046	L3	1200	1225	1098	T2	1174	1190	1134	948.0	952.0	923.0	1185	1208	1081
T3	1108					T3	1188	964.1	1173	T3	1122	1138	1065					T3	1195	1214	1153	969.7	975.2	947.4	1200	1224	1096
T4	1100					T4	1182	926.2	1192	T4	1115	1130	1057					T4	1192	1208	1147	934.5	938.3	905.1	1218	1243	1118
T5	1112					T5	1201	951.7	1184	T5	1126	1142	1069					T5	1209	1229	1164	958.3	962.0	935.2	1210	1235	1106
T6	1141					T6	1214	998.6	1211	T6	1151	1171	1102					T6	1218	1240	1183	1007	1013	975.9	1229	1258	1146
T7	1128					T7	1206	977.8	1200	T7	1140	1158	1085					T7	1212	1234	1172	984.7	989.0	959.6	1223	1252	1124
F-value	25.05**		1405**		2669**		25.12**				1.083 <sup>NS</sup>				445.4**				0.017 <sup>NS</sup>								

T: Treatments (T0 to T7) L = Locations L1 = Challakere (Sandy clay loam soil) L2 = Hiriyyur (Clay soil) L3 = Molakalmur (Red loamy soil)  
 S: Seasons S1 = Monsoon S2 = Winter S3 = Summer \*\*: Highly significant (p ≤ 0.01) NS: Non-significant

**Table 9: Dearer of cocoon filament of silkworm reared on mulberry raised by applying organic based nutrients in three types of soils during different seasons**

T	L		S		T x L			T x S			L x S			T x L x S														
	L1	L2	S1	S2	L1	L2	L3	S1	S2	S3	L1	L2	L3	L1			L2			L3								
														S1	S2	S3	S1	S2	S3	S1	S2	S3						
T0	2.292	L1	2.502	S1	2.544	T0	2.177	2.359	2.340	T0	2.279	2.317	2.280	L1	2.526	2.570	2.411	T0	2.200	2.182	1.151	2.348	2.461	2.268	2.289	2.309	2.421	
T1	2.445	L2	2.499	S2	2.612	T1	2.306	2.451	2.579	T1	2.427	2.480	2.427	L2	2.465	2.600	2.360	T1	2.316	2.363	2.239	2.442	2.543	2.367	2.521	2.533	2.600	
T2	2.508	L3	2.696	S3	2.533	T2	2.378	2.474	2.671	T2	2.499	2.555	2.469	L3	2.642	2.659	2.709	T2	2.418	2.439	2.276	2.457	2.594	2.373	2.623	2.634	2.756	
T3	2.614					T3	2.601	2.528	2.712	T3	2.665	2.679	2.558					T3	2.639	2.763	2.483	2.508	2.652	2.424	2.660	2.683	2.783	
T4	2.587					T4	2.433	2.457	2.811	T4	2.546	2.608	2.546					T4	2.467	2.477	1.860	2.424	2.575	2.372	2.746	2.772	2.913	
T5	2.635					T5	2.631	2.509	2.766	T5	2.622	2.700	2.584					T5	2.630	2.724	2.509	2.493	2.641	2.391	2.713	2.733	2.850	
T6	2.750					T6	2.828	2.584	2.663	T6	2.723	2.823	2.787					T6	2.833	2.929	2.722	2.524	2.713	2.514	2.811	2.825	2.962	
T7	2.683					T7	2.662	2.562	2.827	T7	2.653	2.735	2.663					T7	2.677	2.742	2.568	2.522	2.687	2.475	2.759	2.776	2.945	
T-value	0.121**		13.68*		48.21*		53.77**			2.067*					176.1**													

T: Treatments (T0 to T7) L = Locations L1 = Challakere (Sandy clay loam soil) L2 = Hiriyur (Clay soil) L3 = Molakalmuru (Red loamy soil)  
 S : Seasons S1 = Monsoon S2 = Winter S3 = Summer \* : Significant (p ≤ 0.05) \*\* : Highly significant (p ≤ 0.01) NS: Non-significant

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