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Effect of Surface, Subsurface Manuring and Fertilization on Growth and Yield of Mulberry

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ABSTRACT

A field experiment was carried out to study the effect of surface, subsurface manuring and fertilization on growth and yield of mulberry crop at Kurburu village, Chintamanitaluk, Chikkaballapur district during *kharif* 2023. The experiment was laid out in split plot design with fourteen treatment combinations and three replications. Main plots include two different types of manuring *viz*., Surface manuring (M_1) and Subsurface manuring (M_2) at 60-75 cm depth with FYM (Farm yard manure) and enriched manure (R_1-Absolute control), R_2-50% RDF + FYM, R_3- 75% RDF + FYM, R_4-100% RDF + FYM, R_5-50% RDF + enriched compost, R_6-75% RDF + enriched compost, R_7- 100% RDF + enriched compost. Growth and yield parameters were recorded at 30, 45 and 60 Days after pruning (DAP). The results of the experiment revealed that the subsurface manuring with enriched manure recorded highest shoot length (100.47, 115.95 and 159.10cm), number of shoots plant^{-1} (12.37, 13.41 and 14.39), number of leaves plant^{-1} (146.46, 263.29 and 355.59) and leaf yield (880.21 g plant^{-1} and 22.53 t ha^{-1}) at harvest. Effect of subsurface manuring recorded better on growth and yield of mulberry due to slow mineralization and release of nutrients for longer period.

Keywords : Surface & subsurface manuring, Fertilization, Mulberry, Growth, Yield

MULBERRY is a perennial plant cultivated and managed as a seasonal crop for its foliage to feed silkworms, requires substantial inputs of organic manure and inorganic fertilizers. To achieve optimal leaf yield in irrigated mulberry gardens in tropical regions of South India, it is recommended to apply NPK at 350:140:140 kg/ha/year along with 20 metric tons of farmyard manure (FYM) per hectare per year (Dandin *et al.,* 2003). The quality of mulberry leaves is a critical determinant of silkworm nutrition and silk yield significantly influenced by soil fertility and climatic conditions. A comprehensive understanding of these factors is essential for optimizing mulberry cultivation practices to enhance silk production. Intensive crop schedules and frequent harvesting of mulberry leaf shoot biomass (5 crops per year, yielding approximately 80-100 metric tons per hectare annually) result in a continuous depletion of soil fertility in mulberry gardens. Consequently, regular supplementation of essential nutrients, coupled with soil conditioning through manuring, is crucial for maintaining balanced soil nutrient status and improving the production of high-quality mulberry leaves. The balanced fertilization has positive impact on mulberry leaf quality and cocoon production. Furthermore, the yield potential and quality of mulberry leaves are significantly influenced by factors such as genotype, cultivation practices, soil moisture and the nutrient status of mulberry garden soils (Chen *et al.,* 2009).

Subsoil manuring increased deep root growth of crop and in turn increased the crop growth through more water and nutrient uptake which was closely related to the improved subsoil physical properties that resulted from subsoil manuring (Gill *et al.,* 2009). The integrated nutrient management (INM) increases, plant height and number of branches per plant. This was due to increased nutrient availability under INM treatments that led to higher conversion of carbohydrates into protein, which then elaborated into protoplasm and cell wall material, resulting in an increase in cell size. It expressed itself morphologically in terms of plant height, branch number and eventually, dry matter accumulation. Cellulose is a very long-lasting composition that takes a long time to decompose (Sindhi *et al*., 2016). Among all other inputs, organic manure has highest impact on mulberry leaf quality and yield. Currently, focus of research is to maximize the production per unit of manure. Hence, further improvement in quality and yield of crop may need to adopt new method of application of manure like subsurface manuring. Subsurface manuring which supplies nutrients and moisture directly to the crop root zone. Crops can be 'spoon-fed' with nutrients and moisture. The spoon feeding characteristic of the subsurface manure application has a great potential to minimize the nutrient losses. Organic manure (FYM) application in subsurface helps slowly decompose and release of nutrients into soil and soil moisture conservation along with improvement in soil structure. Higher leaf production and productivity is achieved by improved method of organic manure application along with moisture conservation practices. In this context, current study was undertaken to find out best method of organic manure application for enhancement of quality and yield of mulberry.

Material and Methods

The experiment was conducted during *kharif* 2023 in well-established three year old V-1 mulberry garden at Kurburu village, Chintamanitaluk, Chikkaballapur district, Karnataka. The field is located at a latitude of 13°312 N and longitude of 78°.071 East and at an altitude of 930 m above mean sea level in the eastern dry zone of Karnataka (Zone-5). The experiment with fourteen treatment combinations *viz.,* methods of manure placement (M_1 - Surface manuring and M_2 - Subsurface (60-75 cm depth) manuring), seven sub plot treatments (R_1-Absolute control, R_2- 50% RDF with FYM, R_3- 75% RDF with FYM, R_4- 100% RDF with FYM, R_5- 50% RDF with enriched compost, R_6- 75% RDF with enriched compost, R_7- 100% RDF with enriched compost) were laid out in split plot design with three replications.

The growth parameters at 30, 45 and 60 DAP of crop were recorded in each treatment on randomly selected five plants from each net plot and mean value was worked out. The experimental data collected on growth components of plant were subjected to Fisher's method of Analysis of Variance (ANOVA) at $p \leq 0.05$ as outlined by Panse and Sukhatme (1967).

Results and Discussion

The results and discussion on the effect of surface, subsurface manuring and fertilization on growth and yield of mulberry crop are presented in the following sub headings:

Shoot Length

The data on shoot length varied significantly due to different treatments at 30, 45 and 60 DAP (Table 1). Non-significant difference in shoot length was observed among different methods of application of manure. Subsurface manuring at 60-75 cm depth has recorded highest shoot length (100.47, 115.95 and 159.10cm) over surface manure application (101.19, 112.90 and 137.83cm). After 30 DAP surface manure applied plots showed higher shoot length and the significant difference observed after 45 and 60 DAP due to the availability of nutrients by solubilisation, mineralisation in surface manured plots and in

TABLE 1

Shoot length of mulberry as influenced by surface, subsurface manuring and fertilization at 30, 45 and 60 DAP

Treatments Methods of application (M)	Shoot length (cm)		
	30 DAP	45 DAP	60 DAP
M_1 : Surface manuring	89.73	101.79	124.44
M_2 : Subsurface manuring	88.62	105.29	145.16
F - test	NS	NS	*
S.Em. ±	-	-	1.53
CD ($p \leq 0.05$)	-	-	9.32
Fertilizer recommendation (R)			
R_1 : Absolute control	70.14	90.37	111.44
R_2 : 50% RDF + FYM	82.76	99.73	126.24
R_3 : 75%RDF + FYM	87.47	101.35	135.35
R_4 : 100%RDF + FYM	89.84	102.78	137.85
R_5 : 50% RDF + enriched compost	95.67	107.06	138.89
R_6 : 75%RDF + enriched compost	97.51	109.07	145.35
R_7 : 100%RDF + enriched compost	100.83	114.43	148.47
F - test	*	*	*
S.Em. ±	0.94	0.84	2.25
CD ($p \leq 0.05$)	2.75	2.44	6.57
Interaction (M×R)			
T_1 - M_1 R_1	68.37	89.61	106.08
T_2 - M_1 R_2	85.17	97.35	119.60
T_3 - M_1 R_3	90.21	99.86	123.29
T_4 - M_1 R_4	90.19	99.55	126.24
T_5 - M_1 R_5	95.33	105.86	126.28
T_6 - M_1 R_6	97.65	107.40	131.72
T_7 - M_1 R_7	101.19	112.90	137.83
T_8 - M_2 R_1	71.92	91.13	116.79
T_9 - M_2 R_2	80.35	102.11	132.89
T_{10} - M_2 R_3	84.73	102.84	147.40
T_{11} - M_2 R_4	89.48	106.01	149.45
T_{12} - M_2 R_5	96.01	108.26	151.49
T_{13} - M_2 R_6	97.37	110.74	158.98
T_{14} - M_2 R_7	100.47	115.95	159.10
F - test	*	NS	NS
S.Em. ±	1.33	-	-
CD ($p \leq 0.05$)	3.88	-	-

Note : FYM- Farm yard manure, Recommended dose of NPK – 350:140:140 kg ha^{-1} yr^{-1}, DAP- Days after pruning, *- Significant, NS- Non significant subsurface manured plots due to poor aeration, solubilisation of the shoot length in initial days is lower because of microbial population, aeration lead to increase in nutrient availability. The difference in height could be as a result of enhanced soil nutrients such as nitrogen similarly reported by Elamin and Madhavi, 2015 that the residual effect of single organic nutrients and when integrated with chemical fertilizers (RDF) at 50 per cent and 100 per cent RDF given for sorghum has significantly increased plant height of chickpea.

Subsurface manuring with enriched manure + 50% RDF showed highest shoot length of 96.01, 108.26 and 151.46 cm at 30, 45 and 60 DAP compared to subsurface manuring with FYM+ 100% RDF shoot length was 89.48, 106.01 and 149.45cm. The greater shoot length could be due to the enhanced production of plant growth-promoting substances by beneficial microbial inoculants found in organic manures. This helps to robust root system and improved shoot growth due to increased nutrient absorption. Application of 50% RDF + 2T Vermicompost ha^{-1} + Bio NP highest plant height was 26.59, 49.47 and 56.08 cm at 30, 60 DAS and at harvest. Lowest plant height was observed in 50% RDF + Bio NP at harvest (Sodavadiya *et al*., 2023).

Surface manuring with FYM+ 100% RDF shoot length was 90.19, 99.55 and 126.24 cm at 30,45 and 60 DAP it is lowest than surface manuring with enriched manure + 50% RDF. This might be due to the enriched manure that increases the activity of soil micro flora and increased nutrient availability. The results of increase in plant height due to FYM, vermicompost, neemcake has been reported by Patil and Shinde (1995) in maize. Bhushan and khare (2018) also found that vermicompost improved the plant height of maize (Rajasingh and Lourdraj 2014) and Panchal *et al.* (2018). Interaction on place of manure application and combination of nutrients applied found significant after 30 DAP, non-significant after 45, 60 DAP. However, M_2T_7 recorded highest shoot length of 100.47, 115.95 and 159.10cm respectively, which was followed by M_2T_6 which recorded 97.37, 110.74 and 158.98cm. The least shoot length of 68.37, 89.61 and 106.08 cm was recorded by M_1T_1.

Number of Branches Plant^{-1}

The significant difference in number of shoots plant^{-1} was observed among placement of manure and type of manure applied at 45 and 60 DAP (Table 2). Subsurface manured plots recorded a greater number of shoots plant^{-1} {(12.37, 13.41 and 14.39 respectively) over surface manuring (12.51, 12.93 and 13.61 respectively)}. The significant difference in number of shoots might be due to effective utilisation of nutrients by crops which was supplied directly to root zone. This might be attributed to uniform assimilation of nutrients by mulberry crop and steady supply of nitrogen throughout its growth phase. When mineral fertilizer and enriched compost were used together, growth parameters were improved (Barman *et al.,* 2006).

Subsurface manuring with enriched manure + 50% RDF showed highest number of branches per plant (10.90, 11.58 and 12.23) at 30, 45 and 60 DAP compared to subsurface manuring with FYM + 50% RDF (9.30, 9.65 and 9.98, respectively). This might be due to the enriched manure in subsurface increased the nutrient availability and it enhanced greater translocation of photosynthates from source to sink site that resulted into higher yield contributing characters like number of branches/plant. Similar results were reported by Bhushan and Khare (2018), baby corn crop proved to be better performer in both the years of the experiment under the treatment of vermicompost. Number of cobs per plant was 3.53 and 3.80 in 2014 and 2015, respectively. Lowest Number of cobs per plant was recorded in the treatment of neem cake which proved weakest performer among all the three treatments applied.

Subsurface manuring with FYM + 100% RDF showed highest number of branches per plant (11.69, 12.18 and 12.55) at 30, 45 and 60 DAP, compared to surface manuring with FYM + 100% RDF (10.66, 11.04 and 11.57), respectively. This might be due to the effective nutrient cycling near rhizosphere and it enhances growth parameters. Similar results were reported by

TABLE 2

Number of branches plant^{-1} of mulberry influenced bysurface, subsurface manuring and fertilization at 30, 45 and 60 DAP

Treatments Methods of application (M)	Number of branches plant^{-1}		
	30 DAP	45 DAP	60 DAP
M_1 : Surface manuring	9.96	10.34	10.97
M_2 : Subsurface manuring	10.67	11.33	11.99
F - test	NS	NS	*
S.Em. ±	-	-	0.05
CD (p ≤ 0.05)	-	-	0.33
Fertilizer recommendation (R)			
R_1 : Absolute control	8.01	8.59	9.43
R_2 : 50% RDF + FYM	9.25	9.48	9.78
R_3 : 75%RDF + FYM	10.46	10.84	11.23
R_4 : 100%RDF + FYM	11.17	11.61	12.06
R_5 : 50% RDF + enriched compost	10.23	10.72	11.39
R_6 : 75%RDF + enriched compost	10.64	11.42	12.47
R_7 : 100%RDF + enriched compost	12.44	13.17	14.00
F - test	*	*	*
S.Em. ±	0.23	0.24	0.21
CD (p ≤ 0.05)	0.68	0.71	0.61
Interaction (M×R)			
T_1 - M_1 R_1	7.42	8.19	9.03
T_2 - M_1 R_2	9.19	9.32	9.58
T_3 - M_1 R_3	10.06	10.40	10.81
T_4 - M_1 R_4	10.66	11.04	11.57
T_5 - M_1 R_5	9.56	9.86	10.55
T_6 - M_1 R_6	10.33	10.62	11.63
T_7 - M_1 R_7	12.51	12.93	13.61
T_8 - M_2 R_1	8.60	8.98	9.83
T_9 - M_2 R_2	9.30	9.65	9.98
T_{10} - M_2 R_3	10.87	11.28	11.65
T_{11} - M_2 R_4	11.69	12.18	12.55
T_{12} - M_2 R_5	10.90	11.58	12.23
T_{13} - M_2 R_6	10.94	12.22	13.31
T_{14} - M_2 R_7	12.37	13.41	14.39
F-test	NS	NS	NS
S.Em. ±	-	-	-
CD (p ≤ 0.05)	-	-	-

Note : FYM- Farm yard manure, Recommended dose of NPK – 350:140:140 kg ha^{-1} yr^{-1}, DAP- Days after pruning, *- Significant, NS- Non significant

Ramya *et al*. (2023) with respect to number of shoots plant^{-1} among types of irrigation and organic mulches at 30, 45 and 60 DAP. Subsurface drip irrigation at 0.75 CPE has recorded a greater number of shoots plant^{-1} (15.32, 19.69 and 27.43) over surface drip irrigation at 0.75 CPE (14.18, 17.95 and 21.51).

Interaction on the placement of manure application and combination of manure applied found non-significant with respect to number of shoots of mulberry crop. However, $M_2 T_7$ recorded highest number of shoots (12.37, 13.41 and 14.39), which was followed by $M_1 T_7$, recorded 12.51, 12.93 and 13.61, and was on par with $M_2 T_6$, which recorded 10.94, 12.22 and 13.31, respectively. The least number of shoots of 7.42, 8.19 and 9.03, respectively was recorded by $M_1 T_1$.

Number of Leaves Branch^{-1}

The results on number of leaves branch^{-1} were significantly influenced by the placement of manure application and combination of manure applied at 30, 45 and 60 DAP (Fig. 1, 2 and 3). The data on number of leaves branch^{-1} varied significantly due to different treatments of mulberry crop. Number of leaves branch^{-1} (14.07, 14.52 and 14.97 respectively) varied significantly by subsurface manured plots over surface manured plots (13.60, 13.81 and 14.04), respectively. The significant difference in number of leaves might be due to manure in close association with rhizosphere zones of mulberry and making use of nutrients efficiently. Similar results for application of organic manures was obtained by Subbarao & Ravisankar (2001), Kannan *et al*. (2013), Kumar *et al*. (2014), Shalini *et al.* (2023) and Bhusan & khare (2018) where vermicompost application was proved to be best for growth and yield parameters.

Subsurface manuring with enriched manure + 50% RDF showed highest number of leaves per branch (12.53, 13.11 and 13.51) at 30, 45 and 60 DAP compared to subsurface manuring with FYM + 50% RDF (10.43, 11.15 and 11.64), respectively. Subsurface manured plots showed higher number of leaves per branch (11.86, 12.39 and 12.76) at 30, 45 and 60 DAP compared to surface manured plots (11.57, 11.94 and 12.26), respectively. Increased growth attributes like number of leaves per branch confirms the significant effect of subsoil manuring with enriched manure and mineral fertilizer on growth attributes of mulberry crop. This might be due to the improvement in physical properties of soil through subsoil manuring and it improves root growth and enhances water and nutrient uptake by mulberry plant at earlier stages it ultimately increases the yield (Sodavadiya *et al*., 2023), application of 50% RDF + 2 t VC ha^{-1} + Bio NP recorded the highest number of pods plant^{-1} (81.29, 74.88 and 78.09). Interaction on

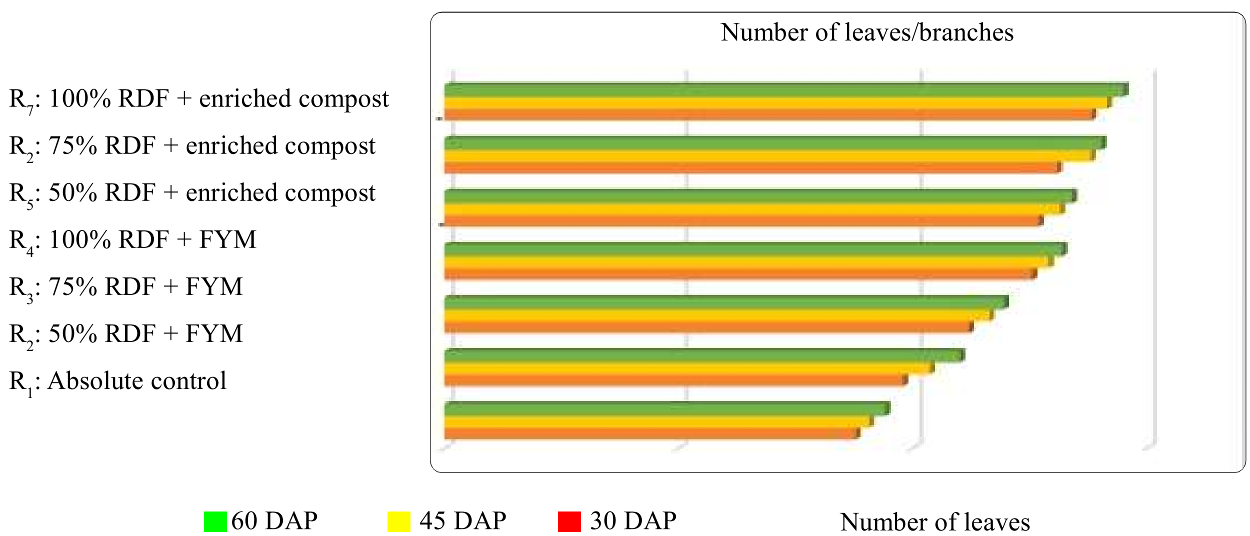


Fig. 1 : Effect of different levels of fertilizationand manures on number of leaves/branch of mulberry

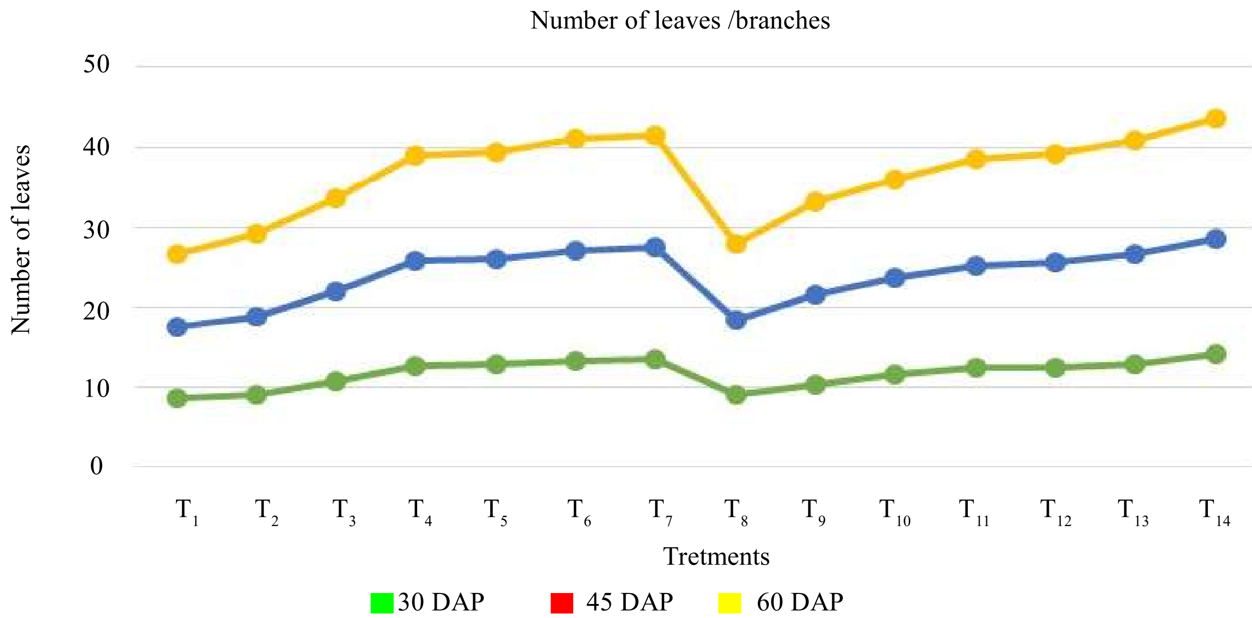
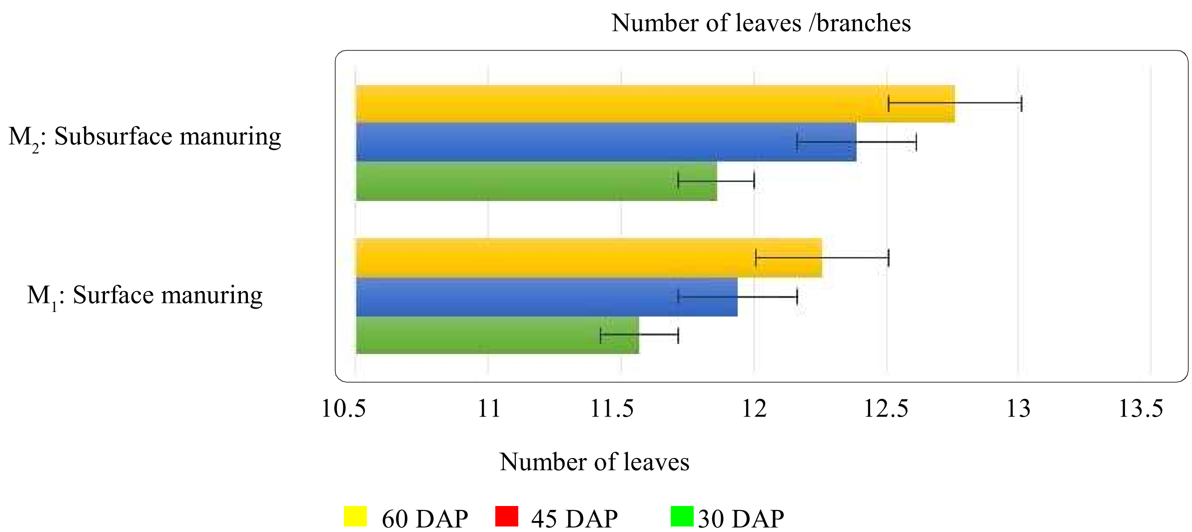


Fig. 2 : Number of leaves branch^{-1} of mulberry influenced by surface, subsurface manuring and fertilization at 30, 45 and 60 DAP (days after pruning)



*FYM - Farm yard manure; RDF - Recommended dose of fertilizers; DAP - Days after pruning

Fig. 3 : Effect of surface and subsurface manuring on number of leaves/branch of mulberry

place of manure application and combination of manure applied found non-significant with respect to number leaves of mulberry crop. However, $M_2 T_7$ recorded highest number of leaves of 14.07, 14.52 and 14.97 respectively by $M_2 T_6$, which recorded 12.94, 13.81 and 14.10, respectively. The least number of leaves of 8.58, 8.88 and 9.25, respectively was recorded by $M_1 T_1$.

Number of Leaves Plant^{-1}

The results on number of leaves plant^{-1} were significantly influenced by the placement of manure application and combination of manure applied at 30, 45 and 60 DAP (Table 3). The data on number of leaves plant^{-1} varied significantly due to different treatments of mulberry crop. Number of leaves plant^{-1} (146.46, 263.29 and 355.59) varied

TABLE 3

Number of leaves plant^{-1} of mulberry influenced by surface, subsurface manuring and fertilization at 30, 45 and 60 DAP

Treatments Methods of application (M)	Number of leaves plant^{-1}		
	30 DAP	45 DAP	60 DAP
M_1 : Surface manuring	132.33	236.35	334.41
M_2 : Subsurface manuring	134.38	245.53	342.77
F - test	NS	*	*
S.Em. ±	-	1.16	0.36
CD (p ≤ 0.05)	-	7.07	2.18
Fertilizer recommendation (R)			
R_1 : Absolute control	120.30	223.22	322.82
R_2 : 50% RDF + FYM	124.62	232.25	326.31
R_3 : 75%RDF + FYM	132.55	235.94	335.92
R_4 : 100%RDF + FYM	132.11	239.43	340.02
R_5 : 50% RDF + enriched compost	138.10	244.58	343.62
R_6 : 75%RDF + enriched compost	139.75	251.51	349.26
R_7 : 100%RDF + enriched compost	146.06	259.66	352.19
F - test	*	*	*
S.Em. ±	1.38	1.58	2.13
CD (p ≤ 0.05)	4.01	4.61	6.21
Interaction (M×R)			
T_1 - M_1 R_1	120.20	218.77	321.67
T_2 - M_1 R_2	123.00	231.07	325.80
T_3 - M_1 R_3	129.44	232.45	330.32
T_4 - M_1 R_4	133.47	234.48	334.74
T_5 - M_1 R_5	137.06	238.99	337.02
T_6 - M_1 R_6	137.50	242.67	342.55
T_7 - M_1 R_7	145.66	256.04	348.78
T_8 - M_2 R_1	120.39	227.67	323.98
T_9 - M_2 R_2	126.24	233.44	326.83
T_{10} - M_2 R_3	135.67	239.43	341.51
T_{11} - M_2 R_4	130.74	244.39	345.30
T_{12} - M_2 R_5	139.14	250.17	350.22
T_{13} - M_2 R_6	142.01	260.35	355.97
T_{14} - M_2 R_7	146.46	263.29	355.59
F - test	NS	NS	NS
S.Em. ±	-	-	-
CD (p ≤ 0.05)	-	-	-

Note : FYM- Farm yard manure, Recommended dose of NPK – 350:140:140 kg ha^{-1} yr^{-1}, DAP- Days after pruning, *- Significant, NS- Non significant significantly by subsurface manured plots over surface manured plots (145.66, 256.04 and 348.78), respectively. The significant difference in number of leaves might be due to manure in close association with rhizosphere zones of mulberry and making use of nutrients efficiently. The highest number of leaves per plant can be attributed to the continuous supply of nutrients as both application of inorganic fertilizers and enriched compost as organic source in turn released nutrients slowly which makes them available to the plants continuously. Similar results were observed by Sukumari (1997), Singh and Chauhan (2009) and Varshney *et al.* (2008). The higher number of filled pods per plant and number of seeds per pod in turn increased pod and seed yield per plant under different subsoil manured treatments.

Susurface manuring with enriched manure + 50% RDF showed highest number of leaves per plant (139.14, 250.17 and 350.22) at 30, 45 and 60 DAP compared to subsurface manuring with FYM + 100% RDF (130.74, 250.17 and 350.22), respectively. The increase in growth and yield traits of crop due to the residual effect of organic manures might be due to higher availability of nitrogen and potassium to plants, besides increased water holding capacity and other physic-chemical and biological properties of soil. As sufficient quantity of organic manures were applied for the earlier crop, micronutrients were also available in sufficient quantity for the next crop also. Similar findings were reported by Sohu *et al*. (2015) also recorded higher number of pods per plant through the residual effect of integrated use of FYM or PM (Poultry manure) with inorganic fertilizers. The highest mean number of pods per plant (66.0) was observed in plots where half dose of NPK (18-36-10 kg) was added along with PM at 20 t ha^{-1}.

Susurface manuring with enriched manure + 50% RDF showed highest number of leaves per plant (139.14, 250.17 and 350.22) at 30, 45 and 60 DAP compared to subsurface manuring with FYM + 50% RDF (126.24, 233.44 and 326.83), respectively. This might be due to the direct application of enriched manure near effective root zone that lead to better utilisation of nutrients by mulberry plant and helped in increasing the yield. Similar results were observed by Ramya *et al*. (2023), where innumber of leaves $plant^{-1}$ were significantly influenced by types of irrigation and organic mulches at 30, 45 and 60 DAP. Number of leaves $plant^{-1}$ (141.72, 252.02 and 350.96) varied significantly by subsurface drip irrigation at 0.75 CPE over surface drip irrigation at 0.75 CPE (134.26, 244.73 and 339.77, respectively). Interaction on the placement of manure application and combination of manure applied found non-significant with respect to number leaves of mulberry crop. However, $M_2 T_7$ recorded highest number of leaves (146.46, 263.29 and 355.59) which was followed by $M_2 T_6$ (142.01, 260.35 and 355.97, respectively). The least number of leaves of 120.20, 218.77 and 321.67, respectively was recorded by $M_1 T_1$.

Leaf Yield (g $plant^{-1}$)

The findings on leaf yield g $plant^{-1}$ were significantly influenced by the placement of manure application and combination of manure applied at harvest (Table 4) and leaf yield g $plant^{-1}$ varied significantly due to different treatments of mulberry crop. Subsurface manured plots increased leaf yield (880.21 g $plant^{-1}$) varied significantly over surface manured plots (874.47 g $plant^{-1}$). Subsurface manuring has proven to be an efficient manuring method with potential advantages of high nutrient use efficiency. The good vegetative growth by the enhanced availability of moisture and nutrient status by subsoil manuring. The yield increases were consistent with those occurring for three consecutive crops grown on subsoil manured land at Ballan, in south-western Victoria, from 2005 to 2007 (Gill *et al*., 2009 and Sale *et al*., 2011). Similarly, Sale *et al*. (2018) also reported that yield increase in wheat and canola crop at different sites were consistent after second and third year of intervention of subsoil manuring from 2009 to 2012. Susurface manuring with enriched manure + 50% RDF showed highest leaf yield of 817.43 (g $plant^{-1}$) at 60 DAP compared to subsurface manuring with FYM + 50% RDF is 765.24 at 60 DAP.

The enriched biomass compost improved soil physico-chemical properties and enhanced soil nutrient availability which increased the pod yield

TABLE 4

Leaf yield (g $plant^{-1}$), Leaf yield (t ha^{-1}) of mulberry influenced by surface, subsurface manuring and fertilization

Treatments Methods of application (M)	Leaf yield (g $plant^{-1}$)	Leaf yield (t ha^{-1})
M_1 : Surface manuring	787.07	20.15
M_2 : Subsurface manuring	801.08	20.51
F - test	NS	NS
S.Em. ±	-	-
CD ($p \leq 0.05$)	-	-
Fertilizer recommendation (R)		
R_1 : Absolute control	710.14	18.18
R_2 : 50% RDF + FYM	747.15	19.13
R_3 : 75%RDF + FYM	782.36	20.03
R_4 : 100%RDF + FYM	800.13	20.49
R_5 : 50% RDF + enriched compost	815.12	20.87
R_6 : 75%RDF + enriched compost	826.30	21.15
R_7 : 100%RDF+ enriched compost	877.34	22.46
F - test	*	*
S.Em. ±	8.20	0.21
CD ($p \leq 0.05$)	23.93	0.61
Interaction (M×R)		
T_1 - M_1 R_1	704.15	18.02
T_2 - M_1 R_2	729.06	18.66
T_3 - M_1 R_3	770.03	19.71
T_4 - M_1 R_4	794.53	20.34
T_5 - M_1 R_5	812.80	20.81
T_6 - M_1 R_6	824.43	21.10
T_7 - M_1 R_7	874.47	22.39
T_8 - M_2 R_1	716.13	18.33
T_9 - M_2 R_2	765.24	19.59
T_{10} - M_2 R_3	794.69	20.34
T_{11} - M_2 R_4	805.72	20.63
T_{12} - M_2 R_5	817.43	20.92
T_{13} - M_2 R_6	828.17	21.20
T_{14} –M_2 R_7	880.21	22.53
F-test	NS	NS
S.Em. ±	-	-
CD ($p \leq 0.05$)	-	-

Note : FYM- Farm yard manure, Recommended dose of NPK – 350:140:140 kg ha^{-1} yr^{-1}, DAP- Days after pruning, *- Significant, NS- Non significant

(Eneji *et al.,* 1997, Eneji *et al.,* 2001 and Iqbal *et al.,* 2015). Also, the phosphorus enriched biomass compost might have assisted in increased root extension which enhanced the nutrient uptake by the crop eventually improved the yield attributing parameters of the crop over RDF (Sailajakumari & Ushakumari; 2002, Dubey & Verma; 1999 and Joshi *et al.,* 2016). The organics, inorganics and microbial inoculants sustain optimum yields, maintain soil physical, chemical and microbiological properties which in turn make soil a better medium for plant growth. An integrated nutrient management system can be a much better approach in sustaining soil health which in turn enhances the yield of crops. Similar results were reported by Yadav *et al.* (2017), Janaki *et al.* (1997), Sharma *et al.* (2005), Jagadale *et al.* (2005), Singh & Chauhan (2002), Smith *et al.* (2001) and Rajkhowa *et al.* (2012). Interaction on the placement of manure application and combination of manure applied found non-significant with respect to leaf yield g $plant^{-1}$ of mulberry crop. However, M_2 T_7 recorded highest leaf yield of 880.21 g $plant^{-1}$, which was followed by M_1 T_7, which recorded 874.47 g $plant^{-1}$. The least leaf yield of 704.15 g $plant^{-1}$ was recorded in M_1 T_1.

Leaf Yield (t ha^{-1})

The findings on leaf yield (t ha^{-1}) were significantly influenced by the placement of manure application and combination of manure applied at 60 DAP (Table 4) and leaf yield varied significantly due to different treatments when imposed for mulberry crop. Subsurface manured plots increased leaf yield (22.53 t ha^{-1}) varied significantly over surface manured plots (22.39 t ha^{-1}). Subsurface manuring has proven to be an efficient manuring method with potential advantages of high nutrient use efficiency. Akanbi *et al.* (2010) reported that high dry matter yield achieved with high nutrient levels favoured the growth of plant parameters, resulting in improved dry matter yield. Subsurface manuring with enriched manure + 50% RDF showed highest leaf yield (20.92 t ha^{-1}) at 60 DAP compared to subsurface manuring with FYM + 50% RDF (19.59 t ha^{-1}).

Similar results were reported by Sale *et al*. (2018) wherein the increase in wheat ear density due to the residual effects of subsoil manuring can be attributed to improved subsoil water and nutrient availability. This alleviated the competition among tillers for limited assimilates during the stem elongation and ear development stages. Additionally, higher nutrient levels were observed in plants treated with subsoil manuring. Interaction on place of manure application and combination of manure applied found non-significant with respect to leaf yield t ha^{-1} of mulberry crop. However, $M_2 T_7$ recorded highest leaf yield t ha^{-1} of 22.53 t ha^{-1}, which was followed by $M_1 T_7$, (22.39 t ha^{-1}). The least leaf yield of 18.02 t ha^{-1} was recorded by $M_1 T_1$. Though manure is an important tool among all other agricultural inputs, but method of manure application plays an important role in determining the growth and yield of mulberry. Thus subsurface manuring with fertilization showed better results over surface manure with fertilizer application as it is placed below soil surface and near to root zone of mulberry which helps in absorption of nutrients and reduction in evaporation loss directly from soil surface.

The study demonstrated that the placement of appropriate proportion of manure application significantly influenced mulberry growth and leaf yield. Subsurface manuring proved to be an efficient method, enhancing nutrient use efficiency and resulting in higher growth and leaf yield compared to surface manuring. The highest leaf yield (22.53 t ha^{-1}) was recorded in subsurface-manured plots compared to surface-manured treatments. Therefore, this study suggests that the subsurface application of enriched manure + RDF enhances mulberry growth and yield by reducing nutrient losses while maximizing crop productivity.

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